ISA Recommendation

Application Layer Communication Protocols for the Interface in Intelligent Street Lighting Systems

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Technical Committee on Standardization

This recommendation is prepared by ISA Technical Committee on Standardization Working Group 11:

“Application Layer Communication Protocols for the Interface in Intelligent Street Lighting Systems”

Working Group Members:

Hao Xu (China Solid State Lighting Alliance) [WG leader]

Feng Huang (Signify (China) investment Co., Ltd.)

Fan Zhang (Xiamen Hualian Electronics Co., Ltd.)

YingHua Wang (Shanghai Sansi Technology Co., Ltd.)

JiangHua Li (Shenzhen Unilumin Group Co. Ltd.)

XiaoDong Wang (Hangzhou Honyar Electrical Co., Ltd.)

Huarong Zhu (Shanghai Yaming Lighting Co., Ltd.)

Yu Xia (HPWINNER)

Contents

1 Scope

This standard is established to standardize the application layer communication protocols between the field (Wide Area Network)WAN gateway and the (Central Management System)CMS in intelligent street lighting systems in order to promote the development of the intelligent street lighting control system towards the direction of modularization, standardization, interoperability and extensive application scope. This standard includes the format, data encoding and rules of the data transmission between the field WAN gateway and the CMS, as well as the methods of securing the system.

2 Terms and Definitions

2.1 Controller

The controller is installed in the light poles or luminaires, which will detect the ambient environment and control the luminaire, including single lamp controller and sensor.

2.2 Gateway

The gateway is installed in the Power Distribution Cabinet, which can automatically control the power supply of illuminated line, collecting the running data, retransmitting the control data between CMS and controller.

2.3 Gateway ID

The unique identifier of field WAN gateway.

2.4 Luminaire ID

The unique identifier of luminaire.

2.5 Central Management System (CMS)

The equipment to manage and control the spot-control terminal, hereinafter also referred to as server.

2.6 Command

The message of applying for data or to be controlled.

2.7 CommandACK

The command being used to respond the message that has received the commands.

2.8 Event

The message that the luminaire reports the data forwardly.

2.9 Alarm

The message that luminaire will report data actively when meet certain triggering conditions.

2.10 EventACK

The message applied to respond received event or alarm.

2.11 Command Result

The message applied to return the executions of commands.

2.12 Heartbeat packet

The message of maintaining the communication link between gateway or luminaire with gateway function and the server.

2.13 Threshold

The boundary value of a field or system.

2.14 Bootstrap server

The server that can initialize the gateway or luminaire with gateway function.

3 Abbreviations

The abbreviations mentioned in this standard are shown in Table 1.

Table 1 the Abbreviations

Abbreviation	Full Term
ACK	Acknowledgement
AES	Advanced Encryption Standard
CMS	Central Management System
CoAP	Constrained Application Protocol
GPRS	General Packet Radio Service
HTTP	HyperText Transfer Protocol
IP	Internet Protocol
JSON	JaveScript Object Notation
LED	Light-Emitting Diode
LoRa	Long Range
LTE	Long Term Evolution
LPWAN	Low Power Wide Area Network
NB-IoT	Narrow Band Internet of Things
PLC	Power Line Communication
RSA	Rivest-Shamir-Adleman
SIM	Subscriber Identification Module
TCP	Transmission Control Protocol

UDP	User Datagram Protocol
WPAN	Wireless Personal Area Network
XML	Extensible Markup Language

4 System structure

4.1 System composition

The structure of intelligent street lighting system is defined by the control logic of street lighting. The Main structure covers two different logic frameworks: 3 layer and 2 layer. The 3 layer structure consists of CMS, Gateway and lighting controller. While, 2 layer structure only has CMS and lighting controller because that the gateway function has been integrated in the lighting controller. The structure of intelligent street lighting system can be seen in Appendix A.

4.2 System description

CMS is made up of hardware, software and networking, including remoting server, working station, communication devices etc.

Gateway is installed in the power distribution cabinet, which responsible for data collecting, controlling, and managing, followed by order of CMS. It also play a key role on link between CMS and lighting controller.

Lighting controller is the module in the intelligent street lighting system, which is installed in the street pole or driver. It also could integrate with sensors for data collection.

5 Basic requirement

5.1 Function set supported by interface of intelligent street lighting system

5.1.1 Control function

5.1.1.1 Set default lights-on time of the luminaire

Use CMS to set the everyday lights-on time of the luminaire.

5.1.1.2 Set default lights-off time of the luminaire

Use CMS to set the everyday lights-off time of the luminaire.

5.1.1.3 Set default illumination adjustment parameter of the luminaire

Use CMS to set the default illumination adjustment parameter of the luminaire, including illumination value and adjusting time.

5.1.1.4 Set the planned lights-on time of the luminaire

Use CMS to set the lights-on time during a certain period from a beginning date to an ending date.

5.1.1.5 Set the planned lights-off time of the luminaire

Use CMS to set the lights-off time during a certain period from a beginning date to an ending date.

5.1.1.6 Set lights-on time of the luminaire according to longitude and latitude (optional)

CMS will compute automatically and set everyday lights-on time according to the longitude and

latitude of the luminaire.

5.1.1.7 Set lights-off time of the luminaire according to longitude and latitude (optional)
CMS will compute automatically and set everyday lights-off time according to the longitude and latitude of the luminaire.

5.1.1.8 Set the illumination adjustment plan of the luminaire
CMS will set the illumination-adjustment time during a certain period from a beginning date to an ending date.

5.1.1.9 Set the threshold that triggers alarm
CMS will set the thresholds of the luminaire's temperature, humidity, current, and voltage. When the temperature, humidity, current, or voltage exceeds threshold, it will trigger the event of alarming by the luminaire.

5.1.1.10 Real-time turning on lights
CMS will turn on lights in real time.

5.1.1.11 Real-time turning off lights
CMS will turn off lights in real time.

5.1.1.12 Adjust illumination in real time
CMS is set to adjust illumination of the luminaire in real time.

5.1.1.13 Query the status of the luminaire in real time
CMS will query the status of the luminaire in real time, including the luminaire's temperature, current, voltage, etc.

5.1.1.14 Set the automatic/manual operation mode of the luminaire
CMS will set the luminaire on automatic or manual operation mode.

5.1.1.15 Request the luminaire to upload logs
CMS will request the luminaire to upload logs.

5.1.1.16 Restore to factory default
CMS will restore the luminaire to factory setting..

5.1.1.17 Set clock time inside the luminaire (or Gateway)
CMS will set the clock time in the luminaire (or the Gateway).

5.1.1.18 Set luminaire grouping
CMS will group the luminaire.

5.1.1.19 Delete luminaire grouping
CMS will delete the group setting of luminaire.

5.1.1.20 Set luminaire scene
CMS will set luminaire scenes.

5.1.1.21 Delete luminaire scene
CMS will delete luminaire scenes.

5.1.1.22 Loop control of the gateway

CMS will control the gateway's execution of power-on and power-off operation of the loop.

5.1.1.23 Gateway restoration/restart function

CMS will control the gateway's execution of restoration or restart.

5.1.1.24 Illumination setting when communication fails

CMS will set the illumination adjustment value to be performed when communication faults happen to luminaire.

5.1.1.25 Illumination setting while the luminaire is powered on

CMS will set the illumination adjustment value to be performed while the luminaire is powered on.

5.1.2 Data acquisition

It's a process that data acquisition runs periodically by the pre-set acquisition interval and acquisition index, and then the acquired data will be submitted to the Server.

5.1.2.1 Temperature acquisition (optional)

Obtain the temperature value that is acquired by the temperature sensor in luminaire.

5.1.2.2 Illumination acquisition (optional)

Obtain the illumination value that is acquired by the light sensor in luminaire.

5.1.2.3 Ambient illumination acquisition (optional)

Obtain the ambient illumination value that is acquired by the light sensor.

5.1.2.4 Input voltage acquisition (optional)

Obtain the input voltage value of the driver that is acquired by the voltage sensor in luminaire.

5.1.2.5 Input current acquisition (optional)

Obtain the input current value of the driver that is acquired by the current sensor in luminaire.

5.1.2.6 Output voltage acquisition (optional)

Obtain the output voltage value of the driver that is acquired by the voltage sensor in luminaire.

5.1.2.7 Output current acquisition (optional)

Obtain the output current value of the driver that is acquired by the current sensor in luminaire.

5.1.2.8 Acquisition of parameters related to electric power (optional)

Obtain relevant parameters of some single light or electric power of the loop controlled by the gateway.

5.1.2.10 Data acquisition by existing sensor (optional)

Obtain relevant values of ambient condition changes which are acquired by the existing sensor.

5.1.2.11 SIM card data information acquisition in WAN gateway (optional)

Obtain relevant values of available data information in SIM card from WAN gateway or luminaire.

5.1.3 Fault alarm

5.1.3.1 Alarm when the luminaire's temperature exceeds threshold (optional)

Once it's detected that the luminaire's temperature exceeds threshold, the luminaire will send alarm message to CMS.

5.1.3.2 Clear the alarm for the luminaire's temperature exceeding threshold (optional)
Once it's detected that the luminaire's temperature returns within threshold, the message of clearing the alarm for the luminaire's temperature exceeding threshold will be sent to CMS.

5.1.3.3 Alarm when the luminaire's illumination was below threshold (optional)
Once it's detected that the luminaire's illumination was below threshold, the luminaire will send alarm message to CMS.

5.1.3.4 Clear the alarm for the luminaire's illumination exceeding threshold (optional)
Once it's detected that the luminaire's illumination returns within threshold, the message of clearing the alarm for the luminaire's illumination exceeding threshold will be sent to CMS.

5.1.3.5 Alarm when the luminaire driver's input voltage exceeds threshold (optional)
Once it's detected that the luminaire driver's input voltage exceeds threshold, the luminaire will send alarm message to CMS.

5.1.3.6 Clear the alarm for the luminaire driver's input voltage exceeding threshold (optional)
Once it's detected that the luminaire driver's input voltage returns within threshold, the message of clearing the alarm for the luminaire's driver input voltage exceeding threshold will be sent to CMS.

5.1.3.7 Alarm when the luminaire driver's input current exceeds threshold (optional)
Once it's detected that the luminaire driver's input current exceeds threshold, the alarm message of the luminaire driver's input current exceeding threshold will be sent to CMS.

5.1.3.8 Clear the alarm for the luminaire driver's input current exceeding threshold (optional)
Once it's detected that the luminaire driver's input current returns within threshold, the message of clearing the alarm for the luminaire driver's input current exceeding threshold will be sent to CMS.

5.1.3.9 Alarm when the luminaire driver's output voltage exceeds threshold (optional)
Once it's detected that the luminaire driver's output voltage exceeds threshold, the luminaire will send alarm message to CMS.

5.1.3.10 Clear the alarm for the luminaire driver's output voltage exceeding threshold (optional)
Once it's detected that the luminaire driver's output voltage returns within threshold, the message of clearing the alarm for the luminaire driver's output voltage exceeding threshold will be sent to CMS.

5.1.3.11 Alarm when the luminaire driver's output current exceeds threshold (optional)
Once it's detected that the luminaire driver's output current exceeds threshold, the luminaire will send alarm message to CMS.

5.1.3.12 Clear the alarm for the luminaire driver's output current exceeding threshold (optional)
Once it's detected that the luminaire driver's output current returns within threshold, the message of clearing the alarm for the luminaire driver's output current exceeding threshold will be sent to

CMS.

5.1.3.15 Alarm when fault happens to communication between the field WAN gateway and luminaire (optional)
Once the field WAN gateway detects the fault that's happening to the communication with its controlled luminaire, it will send the alarm of communication fault to CMS.

5.1.3.16 Alarm when fault happens to communication between the CMS and controller (optional)
Once CMS detects that there is a communication failure between CMS and controller, it's required to send the alarm message to CMS.

5.1.3.17 Alarm when the luminaire fails to work by the control settings (optional)
Once the field WAN gateway detects that the luminaire fails to work by the control settings, it will send the alarm message to CMS.

5.1.3.18 Alarm for anti-theft (optional)
Once the field WAN gateway detects that the gateway or luminaire is moved or disassembled abnormally, it's required to send the alarm message to CMS.

5.1.3.19 Alarm for power grid (optional)
Once the field WAN gateway detects that the power gird and three-phase output imbalance happened abnormally, it's required to send the alarm message to CMS.

5.1.4 Operation and maintenance

5.1.4.1 Read luminaire's serial number
CMS will read the luminaire's serial number at the time of ex-factory.

5.1.4.2 Read luminaire's date of production
CMS will read the luminaire's date of production.

5.1.4.3 Read luminaire's installation information
CMS will read the time, place, and personnel of installing luminaire and asset ownership of the luminaire.

5.1.4.4 Set information of luminaire installation
CMS will set the time, place, and personnel of installing luminaire and asset ownership of the luminaire.

5.1.4.5 Read maintenance information
CMS will read the last luminaire maintenance time, personnel and maintenance operation description.

5.1.4.6 Set maintenance information
CMS will set the last luminaire maintenance time, personnel and maintenance operation description.

5.1.4.7 Read the version information of the software/hardware inside the luminaire (or gateway)
CMS will read the version information of the software and hardware in luminaire (or gateway)

5.1.4.8 Count the turn-on rate of luminaires (optional)

Based on running status, CMS will count the turn-on rate of luminaires

5.1.4.9 The electricity power statistic (optional)

CMS will count the power consumption of electricity based on the controller data.

5.1.4.10 Luminaire on-site inspection (optional)

CMS can offer tools of on-site inspection for luminaires which located in highly potential risk place.

5.1.5 Configuration management

5.1.5.1 Set Gateway ID

CMS will set the ID of the gateway.

5.1.5.2 Set the ID of the luminaire controlled by gateway

CMS will set the ID of the luminaire managed by gateway.

5.1.5.3 Set the IP address (or domain name) of CMS

Engineer will set the IP address (or domain name) into Gateway or luminaire with gateway function

5.1.5.4 Set the port number of CMS

Engineer will set the port number to Gateway or luminaire with gateway function.

5.1.5.5 Set log type

CMS will set the type of the logs saved at run-time by Gateway or luminaire with gateway function, including the logs of debugging information and error messages.

5.1.6 Data security

5.1.6.1 Encryption setting

CMS will set whether the data transmitted by Gateway or luminaire with gateway function needs to be encrypted.

5.1.6.2 Update the key

CMS will update the encryption key applied in data transmission by Gateway or luminaire with gateway function.

5.1.6.3 Network Access Control

CMS will authorize the luminaire to access network through computing and exchanging keys with Gateway or luminaire with gateway function.

5.2 Communication process between the field WAN gateway and CMS

5.2.1 Command and Command ACK process

The commands include the requests of configuration, data query, operation maintenance and other control requests, all of which are sent actively by CMS to gateway or luminaire with gateway function.

a) CMS first sends a command to gateway or luminaire with gateway function. And after gateway or luminaire with gateway function receives the Command, it should return Command ACK within T1.

b) If CMS cannot receive the Command ACK within T1, it should retry sending and at most N1 times; if CMS still cannot receive it after trying N1 times, then this command sending shall be considered a failure.

c) After gateway or luminaire with gateway function sends the Command ACK, it should return command result within T2. If not, command execution shall be considered a failure.

Wherein, T1, T2 and N1 are configurable parameters and saved by CMS. They are defined as follows:

--- T1: CommandACK Timeout, recommendation value is 30 seconds;
--- T2: CommandResult Timeout, recommendation value is 300 seconds;
--- N1: CommandRetry Times, recommendation value is 3 times.
Command and command ACK flowchart is shown in Figure 1.

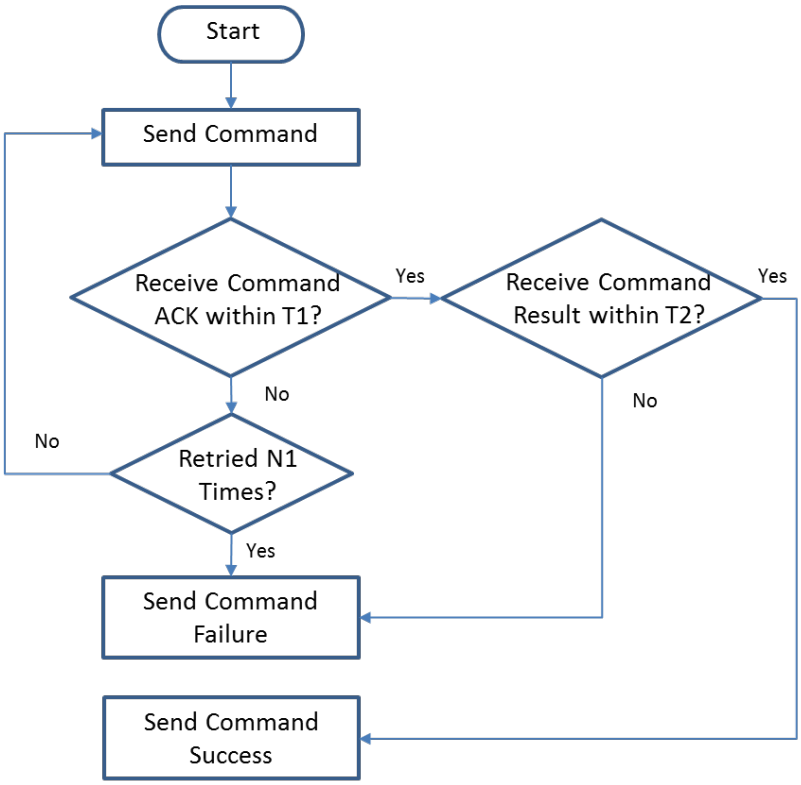

Figure 1 Command and Command ACK Flowchart

5.2.1.1 Configuration process

Configuration process is applied to set the parameters of gateway or luminaire with gateway function and initiated by CMS. Configuration process flowchart is shown in Figure 1.

a) In this process, CMS first sends configuration command to gateway or luminaire with gateway function. After gateway or luminaire with gateway function receives the command, it will return command ACK to CMS. And after executing the command, it should return command result to CMS.

b) If CMS cannot receive command ACK within T1, it should retry the configuration command and at most N1 times; if CMS still cannot receive it after trying N1 times, then this command sending shall be considered a failure.

c) After gateway or luminaire with gateway function sends configuration command ACK, it should return command result within T2 by means of event. If not, the execution of configuration command shall be considered a failure.

The temporal relation between the command, command ACK and command result in the configuration process is shown in Figure 2.

--- solid arrow: control flow, similarly hereinafter;

--- dotted arrow: information flow, similarly hereinafter

--- *: Gateway or Luminaire with Gateway Function

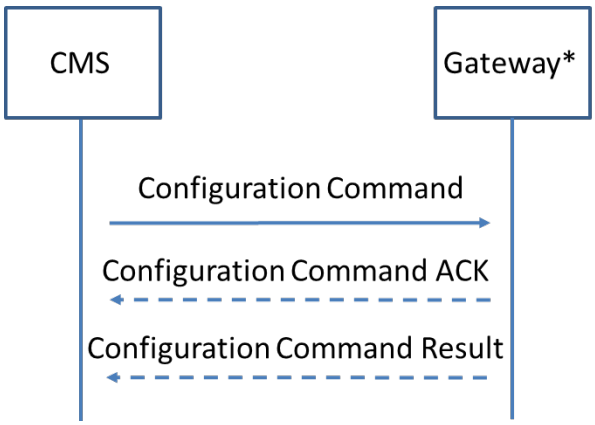

Figure 2 Sequence Diagram of Configuration Process

5.2.1.2 Data query process

Data query process is applied to query the data of the luminaire and initiated by the CMS. Data query process flowchart is shown in Figure 1.

a) In this process, CMS first sends data query command to gateway or luminaire with gateway function. After receiving the data query command, gateway or luminaire with gateway function will return command ACK to CMS. And after executing the command, it should return command result to CMS.

b) If CMS cannot receive data query command ACK within T1, it should retry this command and at most N1 times; if CMS still cannot receive it after trying N1 times, then this command sending shall be considered a failure.

c) After gateway or luminaire with gateway function sends data query command ACK, it should return command result within T2 by means of event. If not, the execution of data query command shall be considered a failure.

The temporal relation between the command, command ACK and command result in the data query process is shown in Figure 3.

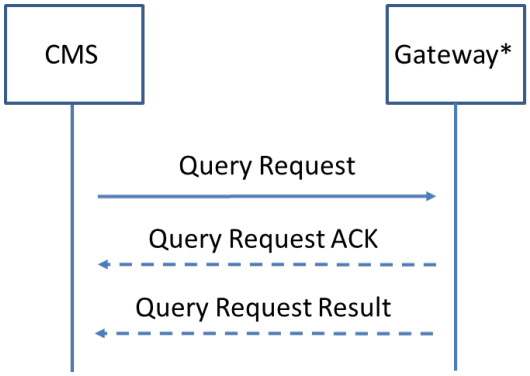

Figure 3 Sequence Diagram of Data Query Process

5.2.1.3 Operation maintenance process

Operation maintenance process is applied to update the operation maintenance state of gateway or luminaire with gateway function after operation maintenance is completed and it is initiated by CMS. Operation and maintenance command process flowchart is shown in Figure 1.

a) In this process, CMS first sends operation maintenance command to Gateway or luminaire with gateway function. After receiving the operation maintenance command, gateway or luminaire with gateway function will return operation maintenance ACK to CMS. And after executing the command, it should return operation maintenance result to CMS.

b) If CMS cannot receive operation maintenance ACK within T1, it should retry this command and at most N1 times; if CMS still cannot receive the command ACK after this command is retried N1 times, then this command sending shall be considered a failure.

c) After gateway or luminaire with gateway function sends operation maintenance response, it should return operation maintenance result within T2 by means of event. If not, the execution of the operation maintenance command shall be considered a failure.

The temporal relation between the command, command ACK and command result in the operation maintenance process is shown in Figure 4.

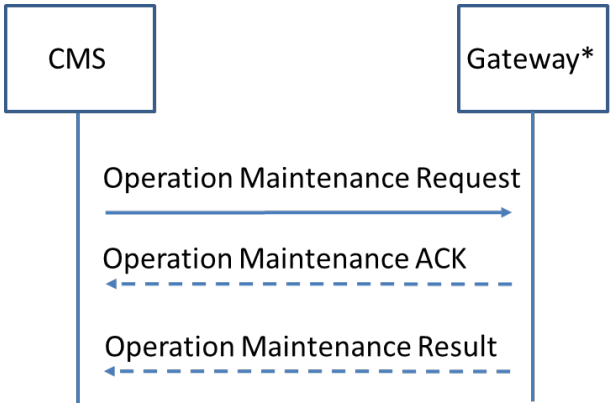

Figure 4 Sequence Diagram of Operation Maintenance Process

5.2.1.4 General control process

General control process is the main process of command transmission between CMS and gateway or luminaire of gateway function and it is initiated by CMS. The general control process flowchart is shown in Figure 1.

a) In this process, CMS first sends control command to gateway or luminaire with gateway function. After receiving the control command, gateway or luminaire with gateway function will return control command ACK to CMS. And after executing the command, it should return the control command result to CMS.

b) If CMS cannot receive control command ACK within T1, it should retry this command and at most N1 times; if CMS still cannot receive the command ACK after this command is retried N1 times, then this command sending shall be considered a failure.

c) After gateway or luminaire with gateway function sends control command ACK, it should return the control command result within T2 by means of event. If not, the execution of the control command shall be considered a failure.

The temporal relation between the command, command ACK and command result in the general control process is shown in Figure 5.

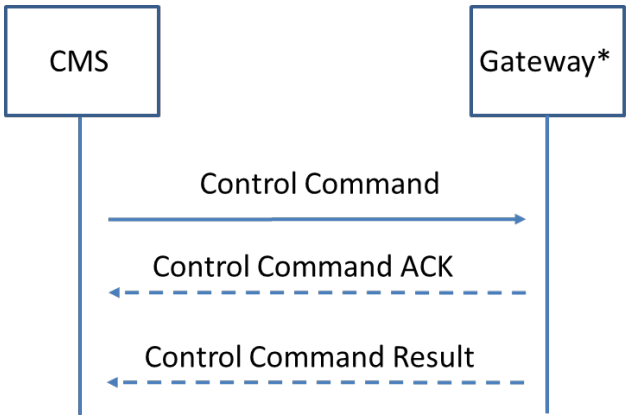

Figure 5 Sequence Diagram of General Control Process

5.2.2 Event reporting process

Event reporting process is applied when gateway or luminaire with gateway function sends control command result, data query result, data acquisition reporting, alarm reporting and alarm-clearance reporting to CMS, and is initiated actively by gateway or luminaire with gateway function.

CMS first receives event reporting from Gateway or luminaire with gateway function, it should return event ACK within T3. Without receiving event ACK, gateway or luminaire with gateway function should retry event reporting and at most N2 times; if it still cannot receive the event ACK after the event reporting has been retried N2 times, event reporting shall be considered a failure and its sending will be abandoned.

Wherein, T3 and N2 are the parameters the CMS has configured to the luminaire through configuration command, and they are defined as follows:

---T3: Event ACK Timeout, recommendation value is 30 seconds;

---N2: Event Retry Times, recommendation value is 1.

Event reporting process flowchart is shown in Figure 6.

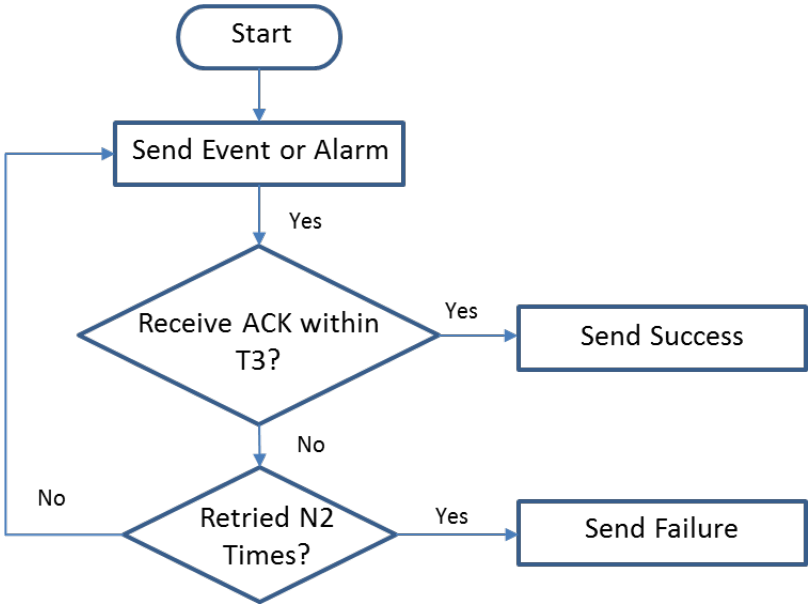

Figure 6 Event Reporting Process Flowchart

5.2.2.1 Fault alarm process

Fault alarm process is applied when gateway or luminaire with gateway function reports its own faults or the faults acquired from its controlled luminaire, and it is initiated actively by gateway or luminaire of gateway function. When gateway or luminaire with gateway function, according to the pre-set threshold range, decides that the data acquired from the luminaire or the monitored sector exceeds threshold, this process will be initiated. Fault alarm process flowchart is shown in Figure 6.

a) In this process, gateway or luminaire with gateway function first reports the fault alarm to CMS when detecting faults. After CMS receives fault alarm, it should return alarm ACK to gateway or luminaire with gateway function, and take responding measures according to fault type.

b) Without receiving the alarm ACK within T3, gateway or luminaire with gateway function should retry the fault alarm reporting at most N2 times; if it still cannot receive the alarm ACK after retrying N2 times, fault alarm reporting shall be considered a failure and its sending will be abandoned.

c) When detecting that the fault has been cleared, gateway or luminaire with gateway function should report the alarm clearance to CMS. After the server receives the reporting, it should return alarm clearance ACK and take responding measures according to fault type.

d) Without receiving the alarm clearance ACK within T3, gateway or luminaire with gateway function should retry the fault alarm clearance reporting at most N2 times; if it still cannot receive the alarm clearance ACK after retrying N2 times, fault alarm reporting shall be considered a failure and its sending will be abandoned.

The sequential relation between the alarm reporting, alarm ACK, alarm clearance reporting and alarm clearance reporting ACK in the fault alarm process is shown in Figure 7.

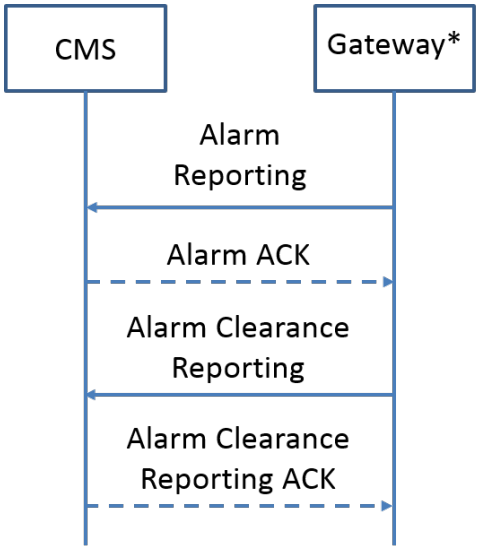

Figure 7 Sequence Diagram of Fault Alarm Process

5.2.2.2 Data acquisition reporting process

Data acquisition reporting process is applied when gateway or luminaire with gateway function reports acquired data to CMS, and it is initiated actively by gateway or luminaire of gateway function.

This process will be initiated when gateway or luminaire with gateway function is required to report the acquired data to CMS according to the pre-set strategy (for example, regular reporting). Data acquisition reporting process flowchart is shown in Figure 6.

a) In this process, gateway or luminaire with gateway function reports actively the acquired data to CMS.
b) When CMS receives the data acquisition reporting, it should return data reporting ACK to gateway or luminaire of gateway function.
c) Without receiving data reporting ACK within T3, gateway or luminaire with gateway function should retry the data acquisition reporting and at most N2 times.
d) If it still cannot receive the data reporting ACK after retrying N2 times, then the sending of data acquisition reporting shall be considered a failure and its sending will be abandoned.

The temporal relation between the data acquisition reporting and data acquisition reporting ACK in data acquisition reporting process is shown in Figure 8.

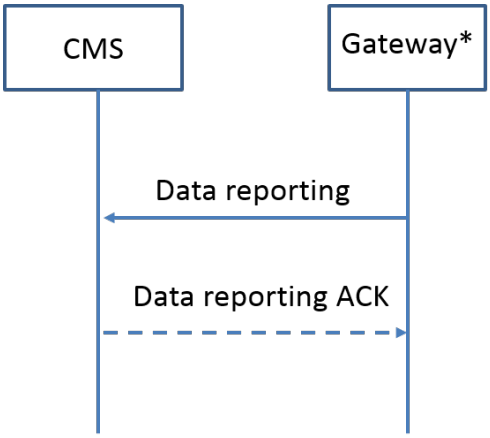

Figure 8 Sequence Diagram of Data Acquisition Reporting Process

5.2.3 Heartbeat packet handling process

Heartbeat packet handling processing is applied to maintain the communication link between the CMS and gateway or luminaire of gateway function while adopting the Transmission Control Protocol (TCP). Heartbeat packet handling process flowchart is shown in Figure 9.

a) When either of gateway or luminaire with gateway function, or CMS detects that there is no data transmitted on data communication link between them for over T4, it should send heartbeat packet to the other one.

b) When the other one receives the heartbeat packet, it should return heartbeat packet ACK.

c) Without receiving heartbeat packet ACK within T5, it should retry sending and at most N3 times; if it still cannot receive the heartbeat packet ACK after retrying N3 times, then the communication link between them should be released.

Both CMS and gateway or luminaire of gateway function must respond to heartbeat packet.

Wherein, T4, T5 and N3 are configurable parameters, which CMS saves and configures to gateway or luminaire with gateway function through configuration command. And they are defined as follows:

---T4, Link Idle Time, recommendation value is 120 seconds;

---T5, Heartbeat ACK Timeout, recommendation value is 30 seconds;

---N3, Heartbeat Retry Times, recommendation value is 2 times.

Heartbeat packet processing flowchart is shown in Figure 9.

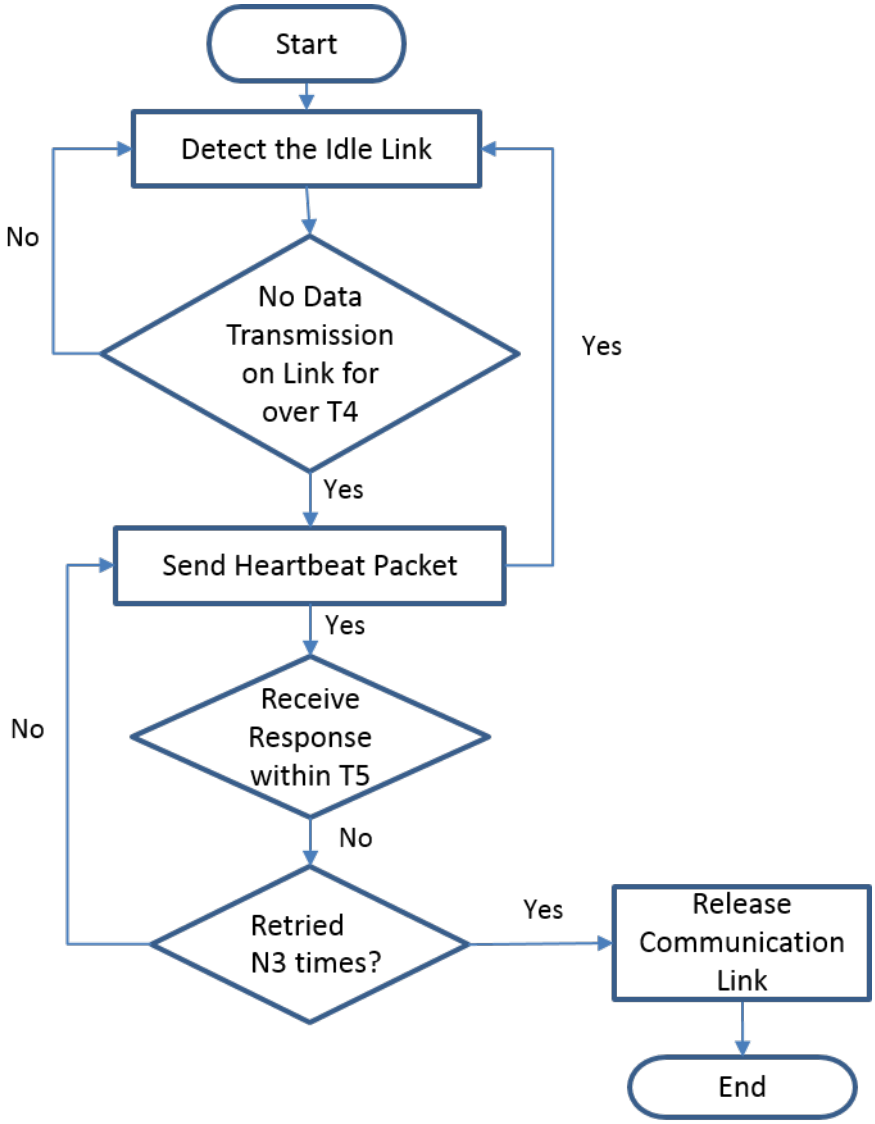

Figure 9 Heartbeat Packet Handling Process Flowchart

5.2.4 Initialization process

5.2.4.1 General

Initialization Process consists of two parts:

a) The configuration process for bootstrap server and gateway

Each gateway serial number will be matched with a unique CMS's IP address, and then the serial number will be synchronized in CMS.

b) The initialization process for gateway

Some significant data should write into gateway, such as gateway serial number, bootstrap server IP (domain), port number.

5.2.4.2 The configuration process for bootstrap server and gateway

Initially, CMS and gateway will be set with a mapping object by bootstrap server. The CMS's IP address, port number, and serial number of gateway or luminaire with gateway function connected with it should be written into this mapping object. One CMS can match with multiple gateway or luminaire with gateway function.

After the mapping process, bootstrap server will synchronize gateway serial number into CMS.

5.2.4.3 The initialization process for gateway

The initialization process is as follows:

a) For the initialized setting, engineer should assign a gateway ID to gateway or luminaire of gateway function through a point-to-point manner(such as short message or Bluetooth, etc.), and send bootstrap server's IP address, port number and the IDs of all its controlled luminaire to gateway or luminaire with gateway function.

b) After gateway or luminaire with gateway function receives the above parameters, it should update gateway ID to bootstrap server. When receiving the ID, bootstrap server will search the mapping information between CMS and gateway ID and send the CMS's IP address and port number to the gateway. The gateway or luminaire with gateway function will update the configuration and send back the initialized result when receiving the above parameters. When the connection between CMS and gateway or luminaire with gateway function built, the access authentication process should be taken by sending the Access Code.

c) If bootstrap server cannot receive the initialized result within T6, the initialization command shall be considered a failure.

---T6: Initialize Timeout, recommendation value is 10 seconds.

The temporal relation of initialization process is shown in Figure 10.

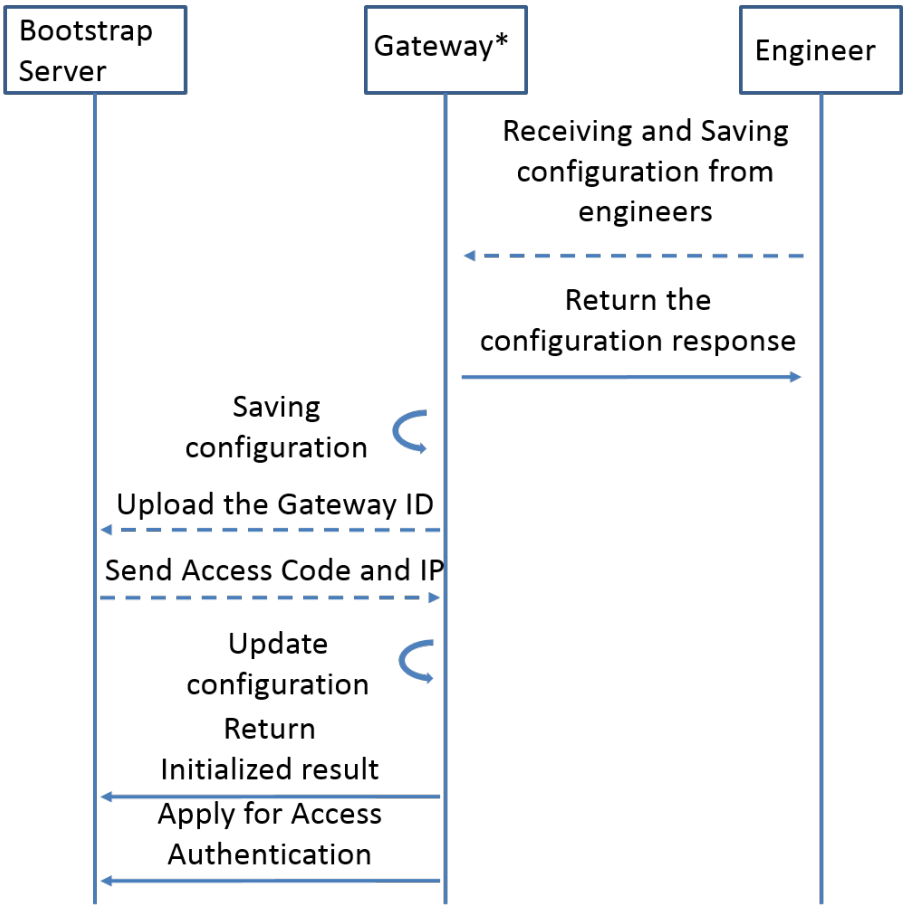

Figure 10 Sequence Diagram of Initialization Process

5.2.5 Data security process

5.2.5.1 General

Data security process includes network access control process and AES Key distribution process. It's applied to secure the management network system and ensure that information will not be disclosed to or utilized by unauthorized individuals, entities, or processes.

5.2.5.2 Network access control process

The network access process for gateway or luminaire of gateway function is applied to protect CMS from the access of illegal gateway or luminaire of gateway function, which means only the gateway or luminaire with gateway function that is authorized can be connected. To ensure the security of network, this standard specifies that CMS should have a fixed IP address (or domain name) and port number; gateway or luminaire with gateway function should have a fixed serial number since it's produced in factory.

Steps for network access by gateway or luminaire of gateway are as follows:

a) When installing the gateway or luminaire with gateway function, CMS should have fixed IP address (or domain name) and port number through initialization process.

b) After initialization is completed successfully, gateway or luminaire with gateway function sends request for accessing network and its serial number to CMS.

c) After CMS receives the request, it will validate if the serial number of gateway or luminaire with gateway function can match with input data from bootstrap server.

--- if they can match perfectly and the serial number turns out to be valid, CMS will first send the confirmation to the gateway, then gateway or luminaire with gateway function will generate RSA key, reserve the private key, and then send the public key to CMS.

--- if they fail to match each other or the serial number turns out to be invalid, gateway or luminaire with gateway function will be considered illegal and rejected to be connected, and CMS will deny responding to all the data sent from gateway or luminaire with gateway function and break connection with it.

d) After CMS receives the RSA public key, it should return the message of success in network access control to gateway or luminaire with gateway function.

e) If CMS cannot receive the response of success message of network access control within T2, the request for network access control shall be considered a failure.

Wherein, T2 is a configurable parameter and saved by CMS. It is defined as follows:

--- T2: Command Result Timeout, recommendation value is 300 seconds.

The network access control process for gateway or luminaire with gateway function is shown in Figure 11.

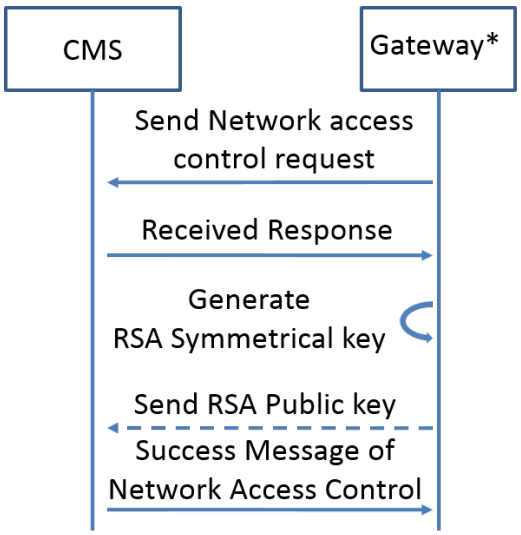

Figure 11 Sequence Diagram of Network Access Control Process for Gateway or Luminaire of Gateway Function

5.2.5.3 AES key distribution process

The AES key distribution process is applied to generate and configure new AES key for gateway or luminaire of gateway function after it accesses network successfully and it is initiated by CMS. In this process, CMS first generates a new AES key and use RSA public key of gateway or luminaire with gateway function to encrypt AES key, and then send a message about the change of AES key and the new AES key generated by RSA public key to gateway or luminaire with gateway function. After gateway or luminaire with gateway function receives the cipher text of the new key, it can decrypt the cipher text by RSA private key and get the new AES key, and after that it should return the result of key updating to the server. For security, gateway or luminaire with gateway function sends Access Code to CMS, then CMS decrypt it and send the validate message for network access. If the validate process is successful, CMS will send a confirmation to gateway or luminaire with gateway function, and then gateway will return a confirmation response.

If CMS can't receive the result of key updating within T2, then key updating shall be considered a failure.

Wherein, T2 is a configurable parameter and saved by CMS. It is defined as follows:

---T2: Command Result Timeout, recommendation value is 300 seconds.

Sequence diagram of key generation, sending, encryption and decryption in AES key distribution process is shown in Figure 12.

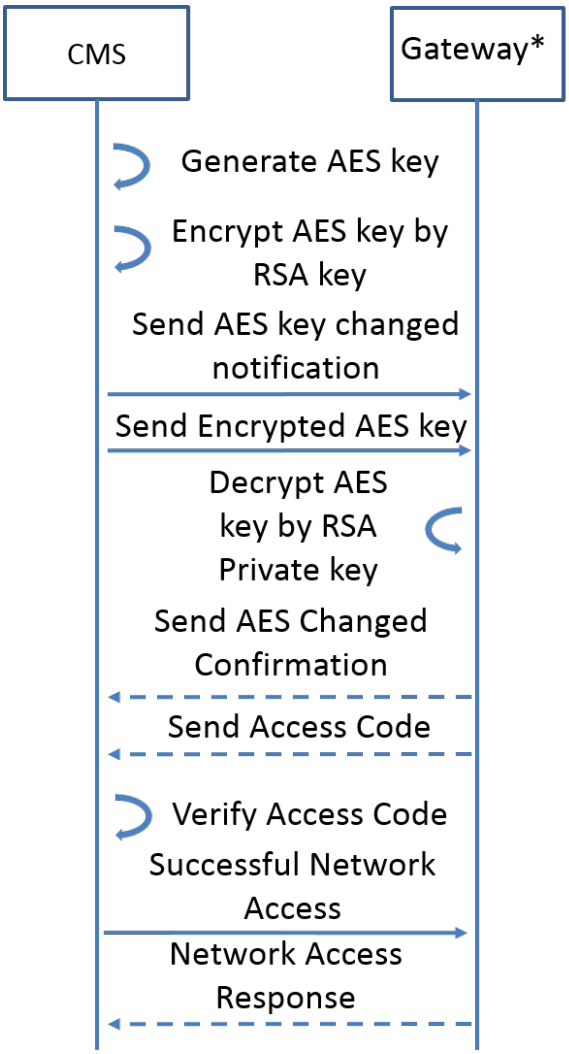

Figure 12 Sequence Diagram of AES Key Distribution Process

5.3 Communication protocol requirement between field WAN gateway and CMS

5.3.1 Communication channel requirement

The WAN (upper level) communication channel can depend on GPRS, 3G, LTE, 433M wireless network, and wireless or wired data network.

The field (lower level) communication channel of can use PLC technology, or WPAN based on IEEE 802.15.4 standard.

The direct WAN communication channel can depend on GPRS, 3G, LTE, NB-IoT, LoRa etc.

5.3.2 General requirement for communication protocol

The communication protocol should meet these requirements as follows:

a) The protocol should open for public.

b) The protocol should support security encryption.

c) The protocol should support online update function.

d) The protocol should support the function described in chapter 1.

e) The protocol should follow the process described in chapter 2.

5.3.3 Communication protocol message format requirement

The message format should be defined in the communication. If TCP / UDP are applied as data bearer, the message will be composed of message header and message body. If not, the message also consists of frame header and frame end.

The message format of gateway and CMS interface application protocol is in the appendix B.

The error code and using example is in the appendix C.

The message format defined by XML/JSON, based on HTTP, is in the appendix D.

Appendix A
(Informative Annex)
System structure of the intelligent street lighting systems

The intelligent street lighting systems consist of three-layer structure and two-layer structure as figure A.1. The left channel is the three-layer structure, which covers the field (lower level) communication between luminaire and gateway and the WAN (upper level) communication between gateway and CMS. The right one is the two-layer structure, which covers the direct WAN communication between luminaire and CMS.

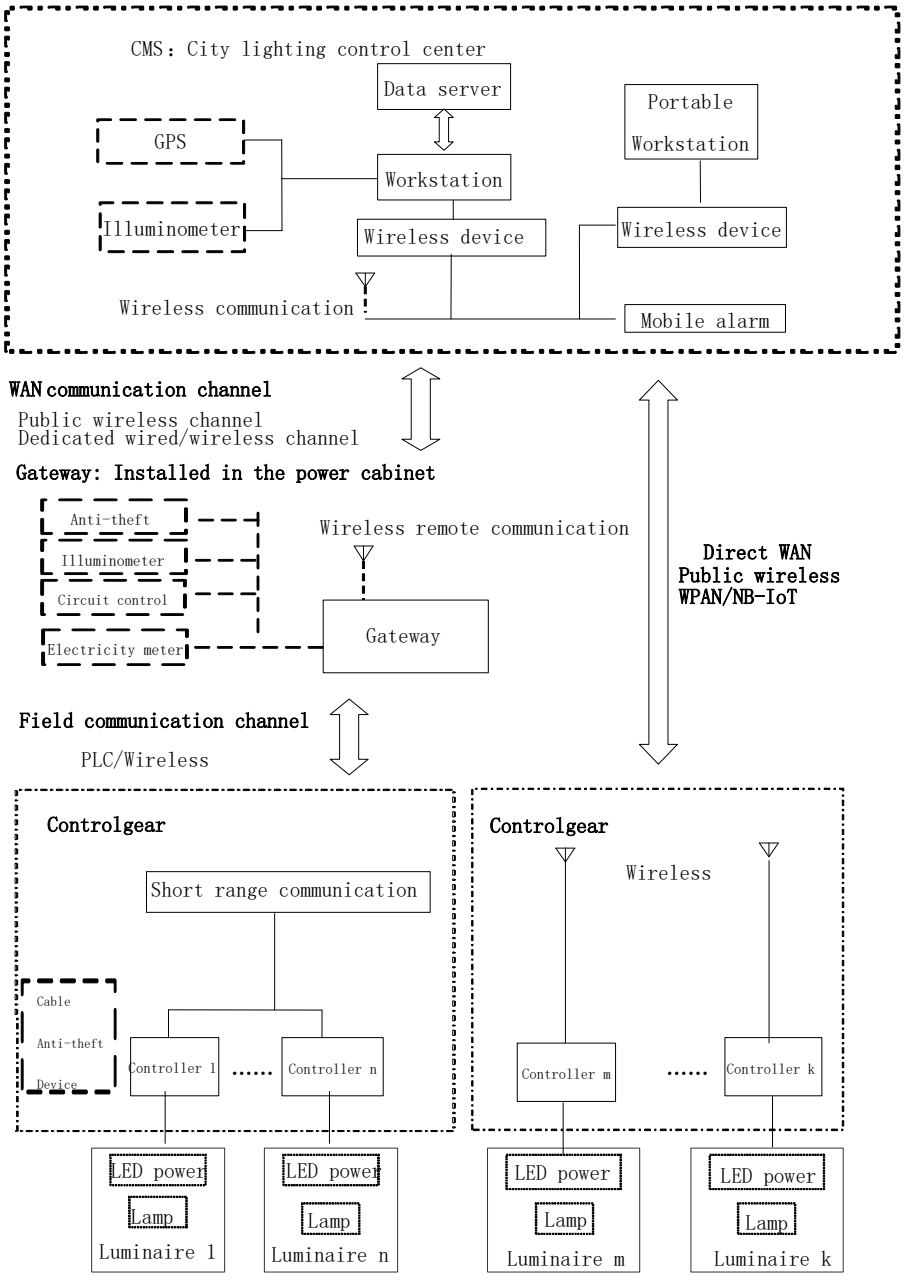

Figure A.1 System structure of the intelligent street lighting systems

Appendix B
(Normative annex)
Message format of the interface protocol between gateway and CMS

B.1 Basic data type

Definition of basic data type is shown in Table B.1.

Table B.1 Definition of Basic Data Type

Data type	Number of bytes	Range
Byte	1	0 ~ 255
Unsigned short	2	0 ~ (2^{16}-1)
Unsigned	4	0 ~ (2^{32}-1)
Long	8	0 ~ (2^{64}-1)
Variable character string	Varchar	End with 0x00

B.2 Message format

B.2.1 The definition of Message format

a) If TCP / UDP are applied as data bearer, the message will be composed of message header and message body. All messages must contain a message header, but the message is optional, as is shown in Figure B.1.

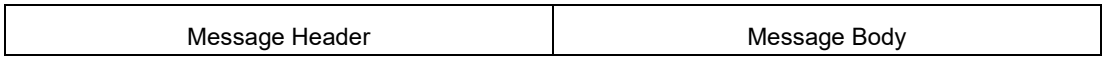

Figure B.1 Message Format with TCP / UDP as Data Bearer

b) If other data bearers are applied, the message must start with the starting character and end with the ETX, as is shown in Figure B.2.

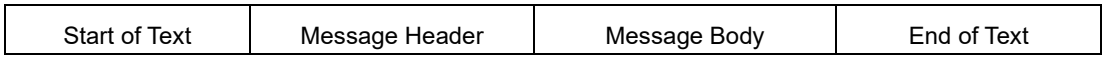

Figure B.2 Message Format with Other Communication Modes

---STX(Start of Text): it marks the start of one frame of message and its value is 0x02;

---ETX(End of Text): it marks the end of one frame of message and its value is 0x03;

---ESC(Escape Character): it escapes the start of text, end of text and escape character in frame-data, and its value is 0X1B;

---Escape rule:

Any bytes between the start of text and end of text that equal to STX，ETX or ESC must be escaped:

STX is escaped to ESC and 0xE7

ETX is escaped to ESC and 0xE8

ESC is escaped to ESC and 0x00

c) Format of Heartbeat packet or Heartbeat packet ACK

---Heartbeat packet data: its length is 1 byte, and its content is 0xFF;

---Heartbeat packet ACK: its length is 1 byte, and its content is 0xFE.

B.2.2 Definition of message header

The definition of message header is shown in Figure B.3.

B0	B1 ~ B4	B5 ~ B6	B7 ~ B11	B12 ~ B15
Message Type	Message Serial Number	Message Length	Reservation	Checksum

Figure B.3 Definition of Message Header

The message header consumes 16 Bytes in total.

Wherein:

a) The definition of one-Byte long Message Type (B0) is as follows:

---0x01: it represents a command request (including configuration command, control command, upgrade command, operation maintenance command, and the command of file upgrade request):

---0x02: it represents a command ACK that the CMS and gateway or luminaire of gateway function should return after receiving the request for command;

--0x03: it represents an event (including command result) and alarm;

--0x04: it represents the response to an event and alarm;

--0x05: it represents the command result and returned data, which means after the server or Gateway or luminaire with gateway function executed the command, it should return the result to the other one.

b) Message Serial Number (B1-B4): 4 Bytes, hexadecimal, ranging from 0 to (2^{32}-1);

c) Message Body Length (B5-B6): 2 Bytes, hexadecimal, ranging from 0 to (2^{16}-1);

d) Reserved Field (B7-B11): 5 Bytes, hexadecimal;

e) Message Body and Checksum (B12-B15): 4 Bytes, hexadecimal, applying CRC32 algorithm.

B.2.3 Definition of message body

Message body is composed of message ID, gateway ID, liminaire ID, one set or multiple sets of parameter types/parameter values, and the ETX of parameter value, as is shown in Figure B.4.

B0～B1	B2～B5	B6～B9	B10～B11	B11～Bxx	B(xx+1)	B(xx+2)～B(xx+4)	B(xx+5)～B(xx+n)	B(xx+n+1)	…
Message ID	Gateway ID	Luminaire ID	Parameter type 1	Parameter value 1	ETX of parameter value 1	Parameter type 2	Parameter value 2	ETX of parameter value 2	…

Figure B.4 Definition of Message Body

Wherein:

--- Message ID: 2 Bytes, hexadecimal number, ranging from 0 to (2^{16}-1);

--- Gateway ID: 4 Bytes, hexadecimal number, ranging from 0 to (2^{32}-1);

--- Luminaire ID: 4 Bytes, hexadecimal number, ranging from 0 to (2^{32}-1);

4 Bytes are applied to describe luminaire ID, where the addresses from FFFFFF01 to FFFFFF20 correspond to the loop addresses from 1 to 32 respectively, FFFFFF21～FFFFFF40 correspond to the group address(group number)1 ~ 32, FFFFFF41 ~ FFFFFFFE are reserved, FFFFFFFF represents broadcast address, and 00000000 is reserved; the command that only needs to be issued to gateway shall be reserved by the address of 00000000; and a single light must have unique ID ranging within 0X00000001~0XFFFFFF00.

--- Parameter Type: 2 Bytes, hexadecimal, ranging from 0 to (2^{16}-1); each parameter has a unique parameter type code;

--- Parameter Value: variable string (ASCII code);

--- ETX of parameter value: 0x00, indicating the end of a string.

Example 1:

An example of the Message Body is shown in Figure B.5.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B13	B14	B15～B16	B17～B24	B25
0x1001	0x1001	0x002F	0x01	XX	0x00	0x02	XXXXXXXX	0x00

Figure B.5 Example of Message Body

Wherein:

--- Message ID(B0-B1): 0x1001;

--- Gateway ID(B2-B5): 0x00001001;

--- Luminaire ID(B6-B9): 0x020F;

--- Parameter type 1(B10-B11): 0x01;

--- Parameter value 1(B12-B13): XX(ASCII);

--- ETX of parameter value 1(B14): 0x00;

--- Parameter type 2(B17-B24): 0x02;

--- Parameter value 2 (B17-B24): XXXXXXXX (ASCII);

--- The ETX of parameter value 2(B25): 0x00.

B.3 Command classification

B.3.1 Command format

The command format which is transmitted between gateway or luminaire with gateway function and CMS is composed of message header and message body, as is shown in Figure B.6.

Message Header	Message Body

FigureB.6 Command Format

B.3.2 Command ACK

After gateway or luminaire with gateway function has received the command sent from CMS, it should return command ACK informing that it has received the command.

The command ACK does not contain message body. Only the message type of message header in the received message needs to be changed to 0x02(event and command ACK), and message length and checksum are just given the value of 0. After receiving the command ACK, the CMS

will run matching process according to message serial number. The structure of command ACK is shown in Figure B.7.

B0	B1～B4	B5～B6	B7～B11	B12～B15
0x02	Message Serial Number	0x00	0x00000	0x0000

Figure B.7　Structure of Command ACK

B.3.3　Command result

Gateway or luminaire with gateway function should return Command result to CMS after returning command ACK.

The message structure of command result is shown in Figure 20.

Message Header	Message Body

Figure B.8　Message Structure of Command Result

The message header of command result is defined as follows in Figure B.9.

B0	B1～B4	B5～B6	B7～B11	B12～B15
0x05	Message Serial Number	Message Length	0	Checksum

Figure B.9　Definition of Message Header of Command Result

The message body of command result is defined in Figure B.10.

Message ID	Gateway ID	Luminaire ID	Error Code

Figure B.10　Definition of Message Body of Command Result

Wherein:

--- Message ID: 2 Bytes, hexadecimal, ranging from 0 to (2^{16}-1);

--- Gateway ID: 4 Bytes, hexadecimal, ranging from 0 to (2^{32}-1);

--- Luminaire ID: 4 Bytes, hexadecimal, ranging from 0 to (2^{32}-1);

---Error Code: 4 Bytes, hexadecimal, ranging from 0 to (2^{32}-1);

Table B.2 Command List

Command	Message ID
Configuration	0x1001
Operation maintenance	0x1002
Set default lights-on time	0x1201
Set default lights-off time	0x1202
Set the default illumination adjustment parameter	0x1203
Set the planned lights-on time	0x1204
Set the planned lights-off time	0x1205
Set the illumination adjustment plan	0x1206
Set the threshold that triggers alarm	0x1207

Real-time turning on and off lights/adjusting illumination	0x1208
Query the status of luminaire in real time	0x1209
Set data acquisition interval by luminaire	0x120A
Set luminaire grouping	0x120B
Delete luminaire grouping	0x120C
Set luminaire scene	0x120D
Delete luminaire scene	0x120E
Set automatic/manual operation mode	0x120F
Request luminaire to upload logs	0x1210
Reset luminaire to Factory Default	0x1211
Update RSA Key	0x1212
Update AES Key	0x1213
Time Synchronization	0x1214
Set default illumination for communication faults	0x1215
Set luminaire to adjust illumination while it's powered on	0x1216
Access Authentication Request Command	0x1300

B.3.4 Configuration command

After system installation is completed, it's required to set a unique identifier (Gateway ID) for every gateway or luminaire of gateway function in this system. The CMS sends the ID of gateway or luminaire of gateway function together with luminaire ID, Server IP, and port number to gateway or luminaire of gateway function by configuration command. In the operation of system, server IP, port number and other values that have been set can be changed by configuration command.

According to the description of the message body format in B.2.3, the message body format of configuration command is as follows:

Message ID, gateway ID, luminaire ID, {[parameter type, parameter value, parameter ETX], ..., [parameter type, parameter value, parameter ETX]}. If gateway parameters only are to be configured, then luminaire ID is fixed to 0.

The message ID of configuration command is 0x1001.

Parameters of configuration command are shown in Table B.3.

Table B.3 Parameters of Configuration Command

Parameter Type	Parameter Type Value	Maximum Length(Byte)	Parameter Description
GatewayID	0x01	10	Gateway ID is represented in decimal by string, and it is assigned by server, with a range of 0x00000001 ~ 0xffffffff.
ServerIP	0x02	16	It represents the IP address of the server
ServerPort	0x03	4	It represents the port number of the server

Protocol	0x04	1	Protocol: “1”: UDP; “2”: TCP.
LogLevel	0x05	1	Log Level: “1”: Debug; “2”: Error.
LogCategory	0x06	32	Log Category: “COMM”: log category of communication; “APP”: log category of application layer Luminaire manufactures can define log category by its own.
CommandACKTimeout	0x07	4	It represents the maximum response time, specified in seconds.
CommandRetryTimes	0x08	2	It represents the retry times when command ACK fails to be received or sent out.
CommandResultTimeout	0x09	4	It represents the maximum waiting time for command result, specified in seconds.
EventACKTimeout	0x0A	4	It represents the maximum response time of event, specified in seconds.
EventRetryTimes	0x0B	2	It represents the retry times when event response fails to be received or sent out.
LinkIdleTime	0x0C	4	It represents the idle time when heartbeat pack is sending through the communication link, specified in seconds.
HeartbeatACKTimeout	0x0D	4	It represents the timeout of heartbeat pack ACK.
HeatBeatRetryTimes	0x0E	2	It represents the retry times when heartbeat ACK fails to be received.
Controlled Luminaire ID	0x0F	10	ID of the luminaire controlled by gateway is represented in decimal by string, and it is assigned by server, with a range of 0x00000001 ~ 0xffffffff. One or more luminaire IDs are contained in a command.
Alarm Message Receiver	0x11	11	The mobile number receive the message has 11characters.
GPS	0x12	18	GPS location: North latitude and longitude coordinates. The unit is sexagesimal. (degree/minute/second, the character is direction)
Period of Query	0x13	5	The query period of gateway. The unit is minute.
Luminaire group ID	0x14	4	The group of luminaire, 0xFFFF means all

			luminaires.
Luminaire Serial Number	0x15	16	Luminaire Serial Number

Example 1:

The original gateway ID is 0x0001 and gateway ID is reset to 1234, then the message body is shown in Figure B.11.

B0～B1	B2～B5	B6～B9	B9～B10	B11～B14	B15
Configuration message ID	Gateway ID	Luminaire ID	Type of Parameter 1(Gateway ID)	Value of Parameter 1(value of Gateway ID)	ETX of Parameter 1
0x1001	0x0001	0x0000	0x01	“1234”	0x00

Figure B.11　Message Body of Configuration Command

Example 2:

For instance, gateway ID is 0x0001, server ID is set at 10.10.10.10, and its port number is 1234. The protocol of UDP is applied. The ID of one controlled luminaire is 1000, and its serial number is AABBCCDDEE. Another luminaire ID is 1001 and its serial number is BBCCDDEEFF. Then the message body is shown in Figure B.12.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B27	B28
Configuration message ID	Gateway ID	Luminaire ID	Type of Parameter 1(Server IP)	Value of Parameter 1(value of Server IP)	ETX of Parameter 1
0x1001	0x00000001	0x00000000	0x02	“10.10.10.10”	0x00
B29～B30	B31～B34	B35	B36～B37	B38	B39
Type of Parameter 2(Server Port)	Value of Parameter 2(Server Port)	ETX of Parameter 2	Type of Parameter 3(Protocol)	Value of Parameter 3(UDP)	ETX of Parameter 3
0x03	“1234”	0x00	0x04	“1”	0x00
B40～B41	B42～B45	B46	B47～B48	B49～B58	B59
Parameter Type of Controlled Luminaire	Parameter Value of Controlled Luminaire	ETX of Parameter	Type of the Serial Number Of Controlled Luminaire	Value of the Serial Number Of Controlled Luminaire	ETX of Parameter
0x0F	“1000”	0x00	0x15	“AABBCCDDEE”	0x00
B60～B61	B62～B65	B66	B67～B68	B69～B78	B79
Parameter Type of Controlled Luminaire	Parameter Value of Controlled Luminaire	ETX of Parameter	Type of the Serial No. Of Luminaire	Value of the Serial No. Of Luminaire	ETX of Parameter

0x0F	“1001”	0x00	0x31	“BBCCDDEEFF”	0x00

Figure B.12　Message Body of Configuration Command

Example 3:

Gateway ID is 0x1001, LogLevel is set as Error, and the LogCategory is not set, then the message body is shown in Figure B.13.

B0～B1	B2～B5	B6～B9	B10～B11	B12	B13
Configuration Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(Log Level)	Value of Parameter	ETX of Parameter 1
0x1001	0x00001001	0x00000000	0x05	“2”	0x00

Figure B.13　Message Body of Configuration Command

The configuration command ACK is shown in Figure B.14.

B0	B1～B4	B5～B6	B7～B11	B12～B15
0x02	Message Serial Number	0	0	0

Figure B.14　Configuration Command ACK

The definition of the message header of configuration command ACK is shown in Figure B.15.

B0	B1～B4	B5～B6	B7～B11	B12～B15
0x05	Message Serial	Message Body Length	0	Check of Message Body

Figure B.15　Definition of Message Header of Configuration Command ACK

The definition of the message body of configuration command result is shown in Figure B.16.

B16～B17	B18～B21	B22～B25	B26～B29
Message ID	Gateway ID	Luminaire ID	Error Code

Figure B.16　Definition of Message Body of Configuration Command Result

B.3.5　Operation maintenance

While the system is in service, the CMS can maintain the luminaire by the command of operation maintenance.

In compliance with the description of message body in B.2.3, the message body format of operation maintenance command is as follows:

Message ID, Gateway ID, Luminaire ID, {[parameter type, parameter value], [parameter ETX], ..., [parameter type, parameter value], [parameter ETX]}

The message ID of operation maintenance command is 0x1002.

The definition of operation maintenance message is shown in Table B.4.

Table B.4　Definition of Operation Maintenance Message

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
MaintainanceInfo	0x11	128	Maintenance information of operations

Example 4:

Gateway ID is 0x00001001, Luminaire ID is 0x00000001, and maintenance is performed on this luminaire, then the message body is shown in Figure B.17.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B20	B21
Maintenance Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(MaintainanceInfo)	Value of Parameter 1(MaintainanceInfo)	ETX of Parameter 1
0x1002	0x00001001	0x00000001	0x11	“xxxxxxxxx”	0x00

Figure B.17　Message Body of Maintenance Message

The message structure of operation maintenance command ACK is shown in Figure B.18.

B0	B1～B4	B5～B6	B7～B11	B12～B15
0x02	Message Serial Number	0	0	0

Figure B.18　Operation Maintenance Command ACK

The definition of the message header of maintenance result is shown in Figure B.19.

B0	B1～B4	B5～B6	B7～B11	B12～B15
0x05	Message Serial Number	Message Body Length	0	Check of Message Body

Figure B.19　Definition of Message Header of Maintenance Result

The definition of the message body of maintenance result is shown in Figure B.20.

B16～B17	B18～B21	B22～B25	B26～B29	B30～
Message ID	Gateway ID	Luminaire ID	Error Code	Error Information

Figure B.20　Definition of Message Body of Maintenance Result

B.3.6　Control command

B.3.6.1　Message format

In compliance with the description of message body format in B.2.3, the message body format of control command is as follows:

Message ID, Gateway ID, Luminaire ID, {[parameter type, parameter value, parameter ETX], ..., [parameter type, parameter value, parameter ETX]}

As for the control command, if luminaire ID is 0xFFFFFFFF, it means that this control command shall be sent to all the luminaire which are in the control of the server.

Message ID of control command ranges from 0x1200 to 0x13000.

The definition of the message header of control command result is shown in Figure B.21.

B0	B1～B4	B5～B6	B7～B11	B12～B15
0x05	Message Serial Number	Message Body Length	0	Check of Message Body

Figure B.21　Definition of Message Header of Control Command Result

The definition of the message body of control command result is shown in Figure B.22.

B16～B17	B18～B21	B22～B25	B26～B29	B30～
Message ID	Gateway ID	Luminaire ID	Error Code	Error Information

Figure B.22　Definition of Message Body of Control Command Result

B.3.6.2　Set default lights-on time

Message ID: 0x1201

After the server has set default lights-on time, the luminaire will perform the action of turning on lights automatically and periodically when they are not on. The definition of this command is shown in Table B.5.

Table B.5　Definition of the Command of Setting Default Lights-On Time

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
Time	0x20	4	The default lights-on time is represented in 24-hour system by hhmm.

Example 5:

Set the luminaire of 0x12345678 controlled by the gateway of 0x10000000 to turn on at 18:00 every day and the message body is shown in Figure B.23.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B15	B16
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(time)	Value of Parameter 1(time)	ETX of Parameter 1
0x1201	0x10000000	0x12345678	0x20	“1800”	0

Figure B.23　Message Body of Setting Default Lights-On Time

B.3.6.3.　Set default lights-off time

Message ID: 1202

After the server has set default lights-off time, the luminaire will perform the action of turning off lights automatically and periodically when the lights are on. The definition of this command is shown in Table B.6.

Table B.6 Definition of Setting Default Lights-On Time

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
Time	0x20	4	The default lights-off time is represented in 24-hour system by hhmm.

Example 6:

Set the luminaire of 0x1234 controlled by the gateway of 0x1000 to turn off at 6:00 every day and the message body is shown in Figure B.24.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B15	B16
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(Time)	Value of Parameter 1(Time)	ETX of Parameter 1
0x1202	0x1000	0x1234	0x20	“0600”	0

Figure B.24　Message Body of Setting Default Lights-Off Time

B.3.6.4　Set default illumination adjustment parameter

Message ID: 0x1203

After the server has set the default illumination adjustment parameter, the luminaire will perform the action of adjusting the illumination automatically and periodically. The definition of this command is shown in Table B.7.

Table B.7 Definition of Setting Default Illumination Adjustment Parameter

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
Time	0x20	4	The default illumination adjustment time is represented in 24-hour system by hhmm.
Illumination	0x21	3	Illumination is represented in decimal by 00-100.

Example 7:

Set the luminaire of 0x1234 controlled by the gateway of 0x1000 to adjust the illumination to 70% at 21:00 every day and the message body is shown in Figure B.25.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B15	B16	B17～B18	B19～B20	B21

Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(Time)	Value of Parameter 1(Time value)	ETX of Parameter 1	Type of Parameter 2(Illumination)	Value of Parameter 2(Illumination value)	ETX of Parameter 2
0x1203	0x1000	0x1234	0x20	“2100”	0	0x21	“70”	0

Figure B.25　Message Body of Setting Default Illumination Adjustment Time

B.3.6.5　Set planned lights-on time

Message ID: 0x1204

After the server has set the planned lights-on time, the luminaire will perform the plan during this period. The definition of this command is shown in Table B.8.

Table B.8　Definition of Setting Planned Lights-On Time

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
Time	0x20	4	The planned lights-on time is represented in 24-hour system by hhmm.
BeginDate	0x22	8	Beginning date，yyyyMMdd
EndDate	0x23	8	Ending date，yyyyMMdd

Example 8:

Set the luminaire of 0x1234 controlled by the gateway of 0x1000 to turn on at 17:30 every day from October 1st, 2012 to October 7th, 2012 and the message body is shown in Figure B.26.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B15	B16
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(Time)	Value of Parameter 1(Time value)	ETX of Parameter 1
0x1204	0x1000	0x1234	0x20	“1730”	0x00
B17～B18	B19～B26	B27	B28～B29	B30～B37	B38
Type of Parameter 2(BeginDate)	Value of Parameter 2(BeginDate value)	ETX of Parameter 2	Type of Parameter 3(EndDate)	Value of Parameter 3(EndDate value)	ETX of Parameter 3
0x22	“20121001”	0x00	0x23	“20121007”	0x00

Figure B.26　Message Body of Setting The Planned Lights-On Time

B.3.6.6　Set planned lights-off time

Message ID: 0x1205

After the server has set the planned lights-off time, the luminaire will perform the plan during this period. The definition of this command is shown in Table B.9.

Table B.9 Definition of Setting the Planned Lights-Off Time

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
Time	0x20	4	The planned lights-off time is represented in 24-hour system by hhmm.
BeginDate	0x22	8	Beginning date, yyyyMMdd
EndDate	0x23	8	Ending date, yyyyMMdd

Example 9:

Set the luminaire of 0x1234 controlled by the gateway of 0x1000 to turn off at 7:00 every day from October 1st, 2012 to October 7th, 2012 and the message body is shown in Figure B.27.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B15	B16
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(Time)	Value of Parameter 1(Time value)	ETX of Parameter 1
0x1205	0x1000	0x1234	0x20	“0700”	0x00
B17～B18	B19～B26	B27	B28～B29	B30～B37	B38
Type of Parameter 2(BeginDate)	Value of Parameter 2(BeginDate value)	ETX of Parameter 2	Type of Parameter 3(EndDate)	Value of Parameter 3(EndDate value)	ETX of Parameter 3
0x22	“20121001”	0x00	0x23	“20121007”	0x00

Figure B.27 Message Body of Setting The Planned Lights-Off Time

B.3.6.7 Set the illumination adjustment plan

Message ID: 0x1206

After the server has set the illumination adjustment plan, the luminaire will perform the plan during this period. The definition of this command is shown in Table B.10.

Table B.10　Definition of Setting the Illumination Adjustment Plan

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
Time	0x20	4	The planned adjustment time is represented in 24-hour system by hhmm.
BeginDate	0x22	8	Beginning date, yyyyMMdd
EndDate	0x23	8	Ending date, yyyyMMdd
Illumination	0x21	3	Illumination is presented in decimal with a range of 0 ~ 100, for example “70” represents the illumination of “70%”.

Example 10:

Set the luminaire of 0x1234 controlled by the gateway of 0x1000 to adjust the illumination to 70% at 22:00 every day from October 1st, 2012 to October 7th, 2012 and the message body is shown in Figure B.28.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B15	B16
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(time)	Value of Parameter 1(time)	ETX of Parameter 1
0x001206	0x1000	0x1234	0x20	“2200”	0x00
B17～B18	B19～B26	B27	B28～B29	B30～B37	B38
Type of Parameter 2(Begin Date)	Value of Parameter 2(BeginDate value)	ETX of Parameter 2	Type of Parameter 3(EndDate)	Value of Parameter 3(EndDate value)	ETX of Parameter 3
0x22	“20121001”	0x00	0x23	“20121007”	0x00
B39～B40	B41～B42	B43	/	/	/
Type of Parameter 4(Illumination)	Value of Parameter 4(Illumination value)	ETX of Parameter 4	/	/	/
0x24	70	0x00	/	/	/

Figure B.28　Message Body of Setting the Illumination Adjustment Plan

B.3.6.8　Set threshold that triggers alarm

Message ID: 0x1207

Set the threshold that triggers alarm of the luminaire. The definition of the command parameter is shown in Table B.11.

Table B.11 Definition of the Parameter of Setting the Threshold That Triggers Alarm

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
ResourceType	0x25	2	Temperature: “01”; Humidity: “02”; Current: “03”; Voltage: “04”; All:”00”.
ThresholdValue	0x26	8	It’s the threshold range that will trigger alarm. When it exceeds threshold, the luminaire will send alarm message to the server.

Wherein:

a) Temperature: Centigrade, floating number, range:0~255

b) Humidity: relative value%, floating number, range:0~100

c) Voltage: Unit is V, floating number, range:0~400

d) Current: Unit is A, floating number, range:0~255

Example 11:

Set the luminaire of 0x1234 controlled by the gateway of 0x1000 to alarm when the temperature exceeds 100 Degrees Celsius, and the message body is shown in Figure B.29.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B13	B14
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(ResourceType)	Value of Parameter 1(ResourceValue)	ETX of Parameter 1
0x1207	0x1000	0x1234	0x25	“01”	0x00
B15～B16	B17～B19	B20	/	/	/
Type of Parameter 2(ResourceType)	Value of Parameter 2(ThresholdValue)	ETX of Parameter 2	/	/	/
0x26	“100”	0x00	/	/	/

Figure B.29 Message Body of Setting Threshold That Triggers Alarm

B.3.6.9 Real-time turn on or off luminaires/adjusting illumination

Message ID: 0x1208

Set the threshold that triggers alarm by luminaire. The definition of the command parameter is shown in Table B.12.

Table B.12 Definition of Real-Time Turning on or off luminaires/Adjusting Illumination

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
Illumination	0x21	3	Illumination value is represented in decimal with a range of 0~100, for example “70” represents the illumination of 70%.

Example 12:

Set the luminaire of 0x1234 controlled by the gateway of 0x1000 to adjust illumination value to 70% in real time and the message body is shown in Figure B.30.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B13	B14
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(Illumination)	Value of Parameter 1(IlluminationValue)	ETX of Parameter 1
0x1208	0x1000	0x1234	0x21	“70”	0x00

Figure B.30 Message Body of Real-Time Turning on or off luminations/Adjusting Illumination

B.3.6.10 Query the status of luminaire in real time

Message ID: 0x1209

Query the status of the luminaire in real time. The definition of the command parameter is shown in Table B.13.

Table B.13 Definition of Querying the Status of Luminaire in Real Time

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
ResourceType	0x25	2	Temperature: “01”； Humidity: “02”； Current: “03”； Voltage: “04”; Illumination: “05”; All:”00”.
ResourceValue	0x24	5	The value of resource

Example 13:

Query the real-time temperature of the luminaire and the message body is shown in Figure B.31.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B13	B14
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(Temperature)	Value of Parameter 1(TemperatureValue)	ETX of Parameter 1

0x1209	0x1000	0x1234	0x25	“01”	0x00

Figure B.31 Message Body of Querying the Status of Luminaire in Real Time

B.3.6.11 Set data acquisition interval of luminaire

Message ID: 0x120A

Set data acquisition interval of luminaire. The definition of the command is shown in Table B.14.

Table B.14 Definition of Setting Data Acquisition Interval of Luminaire

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
ResourceType	0x25	2	Temperature: “01”； Humidity: “02”； Current: “03”； Voltage: “04”; Illumination: “05”; All: “00”.
Interval	0x29	5	Interval is specified in minute.

Example 14:

Set the temperature acquisition interval of the luminaire of 0x1234 controlled by the gateway of 0x1000 to 30 minutes and the message body is shown in Figure B.32.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B13	B14	B15～B16	B17～B18	B19
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(ResourceType)	Value of Parameter 1(TimeValue)	ETX of Parameter 1	Type of Parameter 2(Acquisition Interval)	Value of Parameter 2(Interval)	ETX of Parameter 2
0x120A	0x1000	0x1234	0x25	“01”	0x00	0x29	“30”	0x00

Figure B.32 Message Body of Setting Data Acquisition Interval of Luminaire

B.3.6.12 Set luminaire grouping commond

A single light can be distributed to different groups (at most 32 groups);

Message ID: 0x120B

Table B.15 Definition of the Group Number of Luminaire

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
Group Number	0x2A	2	“01”~“32”

Example 15:

Set the luminaire of 0x00000001 controlled by the gateway of 0x00000001 to be part of Group 1 and the message body is shown in Figure B.33.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B13	B14
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(Group Number)	Value of Parameter 1(Group Number)	ETX of Parameter 1
0x120B	0x00000001	0x00000001	0x2A	“01”	0x00

Figure B.33　Set Single Luminaire Grouping

B.3.6.13　Delete luminaire grouping command

Message ID: 0x120C

Example 16:

Delete the luminaire of 0x00000001 controlled by the gateway of 0x00000001 from Group 1 and the message body is shown in Figure B.34.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B13	B14
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(Group Number)	Value of Parameter 1(Group Number)	ETX of Parameter 1
0x120C	0x00000001	0x00000001	0x2A	“01”	0x00

Figure B.34　Delete Single Luminaire Grouping

B.3.6.14　Command setting of single luminaire scene

Message ID: 0x120D

Table B.16　Definition of Luminaire Scene

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
Scene Number	0x2B	2	“01”~“99”
Illumination	0x21	3	“000”~“100”

Example 17:

Select Scene 1 for the luminaire of 0x00000001 controlled by the gateway of 0x00000001: adjust illumination to be at 50% and the message body is shown in Figure B.35.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B13	B14
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(Scene Number)	Value of Parameter 1(Scene Number)	ETX of Parameter 1
0x120D	0x00000001	0x00000001	0x2B	“01”	0x00

B15～B16	B17～B18	B19			
Type of Parameter 2(Illumination)	Value of Parameter 2(Illumination value)	ETX of Parameter 2			
0x21	“50”	0x00			

Figure B.35　Set Luminaire Scenes

B.3.6.15　Deleting Command of luminaire scene

Message ID: 0x120E

Delete Scene 1 from the scenes set for the luminaire of 0x00000001 controlled by the gateway of 0x00000001 and the message body is shown in Figure B.36.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B13	B14
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(Scene Number)	Value of Parameter 1(Scene Number)	ETX of Parameter 1
0x120E	0x00000001	0x00000001	0x2B	“01”	0x00

Figure B.36　Delete Luminaire Scene

B.3.6.16　Set automatic/manual operation mode of luminaire

Message ID: 0x120F

Set the operation mode of luminaire and the definition of the command parameter is shown in Table B.17.

Table B.17　Definition of Setting Automatic/Manual Operation Mode of Luminaire

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
OperationMode	0x27	2	01: automatic 02: manual

Example 18:

Select automatic operation mode for the luminaire of 0x00000001 controlled by the gateway of 0x00000001 and the message body is shown in Figure B.37.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B15	B16
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(OperationMode)	Value of Parameter 1(Mode)	ETX of Parameter 1

0x120F	0x1000	0x1234	0x27	“01”	0x00

Figure B.37　Set Message Body of Automatic Operation Mode

B.3.6.17　Request the luminaire to upload logs

Message ID: 0x1210

The server requests the luminaire to upload logs, but there is no command parameter.

Example 19:

The server requests the luminaire of 0x1234 controlled by the gateway of 0x1000 to upload its logs and the message body is shown in Figure B.38.

B0～B1	B2～B5	B6～B9
Message ID	Gateway ID	Luminaire ID
0x1210	0x1000	0x0000

Figure B.38　Message Body of Uploading Luminaire Logs

B.3.6.18　Restore luminaire to factory default

Message ID: 0x1211

Restart the luminaire and the definition of the command parameter is shown in Table B.18.

Table B.18　Definition of Restoring to Factory Default

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
DelayTime	0x28	5	Delay time is specified in seconds.

Example 20:

Set the luminaire of 0x1234 controlled by the gateway of 0x1000 to restore to factory default in ten minutes, and the message body is shown in Figure B.39.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B14	B15
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(DelayTime)	Value of Parameter 1(DelayTime value)	ETX of Parameter 1
0x1120D	0x1000	0x1234	0x28	“600”	0x00

Figure B.39　Message Body of Restoring to Factory Default

B.3.6.19　Update RSA key

Message ID: 0x1212

Definition of command parameter is shown in Table B.19.

Table B.19 Definition of Updating RSA Key

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
RSA key	0x40	32	Base64 transcoding is applied.

B.3.6.20 Update AES key

Message ID: 0x1213

Definition of the command parameter is shown in Table B.20.

Table B.20 Definition of Updating AES Key

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
AES key	0x41	32	Base64 transcoding is applied and the message body of this event is encrypted by RSA public key.

B.3.6.21 Time synchronization

Message ID: 0x1214

The definition of the command parameter is shown in Table 21.

Table 21 Definition of Time Synchronization

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
System time	0x42	14	yyyyMMddhhmmss

B.3.6.22 Set default illumination for communication faults

Message ID: 0x1215

Definition of the command parameter is shown in Table B.22.

Table B.22 Definition of Setting Default Illumination for Communication Faults

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
Illumination	0x21	3	“000”~“100”

Example 21:

Set the luminaire of 0x00000001 controlled by the gateway of 0x00000001 to adjust illumination by default to 90% when faults happen to luminaire, and the message body is shown in Figure B.40.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B13	B14

Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(Illumination)	Value of Parameter 1(Illumination value)	ETX of Parameter 1
0x1215	0x00000001	0x00000001	0x21	“90”	0x00

Figure B.40　Message Body of Setting Default Illumination for Luminaire Faults

B.3.6.23　Set luminaire to adjust illumination value while it’s powered on

Message ID: 0x1216

The definition of the command parameter is shown in Table B.23.

Table B.23　Definition of Illumination Adjustment When Luminaire Is Powered On

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
Illumination	0x21	3	“000”~“100”

Example 22:

Set the luminaire of 0x00000001 controlled by the gateway of 0x00000001 to adjust illumination by default to be 90% while coming with faults, and the message body is shown in Figure B.41.

B0～B1	B2～B5	B6～B9	B10～B11	B12～B13	B14
Message ID	Gateway ID	Luminaire ID	Type of Parameter 1(Illumination)	Value of Parameter 1(Illumination value)	ETX of Parameter 1
0x1216	0x00000001	0x00000001	0x21	“90”	0x00

Figure B.41　Message Body of Illumination Adjustment When Luminaire Is Powered On

B.3.6.24　Request command of access authentication

When luminaire is connected to server for the first time, Luminaire ID, product serial number, and the Access Code which is sent under the configuration command have to be authenticated. If it is authenticated successfully by server, the server will send a RSA key and a AES key which is encrypted with RSA key to it. After the AES key is received by luminaire, it will be applied to encrypt/decrypt all the messages between the server and the luminaire.

Message ID: 0x1300

Definition of the command parameter is shown in Table B.24.

Table B.24 Definition of Request Command of Access Authentication

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
SerialNumer	0x31	32	Serial Number of Luminaire

After receiving the command of access authentication from luminaire, the server should first return command ACK and then validate Luminaire ID, Access Code and Serial Number. If it has

authenticated successfully by server, the server will return the event of RSA key and the event of AES key respectively to the luminaire.

After the luminaire gets the AES key successfully, it will apply this AES key to encrypt the message body of all the messages which are sent to server, and decrypt the message body of all the messages which are received from the server; the server will also apply this AES key to encrypt the message body of all the messages which are sent to luminaire, and decrypt the message body of all the messages which are received from luminaire.

B.4 Event

B.4.1 The definition of Event

Gateway or luminaire with gateway function reports the acquired data by luminaire, fault alarm information, and fault alarm clearance by means of event to the CMS. As for Gateway or luminaire with gateway function that has reported event to server, the message type of its message header is 0x03.

The message structure of event is shown in Figure B.42.

Message Header	Message Body

Figure B.42 Message Structure of Event

The message header of event is defined in Figure B.43.

B0	B1～B4	B5～B6	B7～B11	B12～B15
0x03	Message Serial Number	Message Length	0	Checksum

Figure B.43 Definition of Message Header of Event

The message body of event is defined in Figure B.44.

Event Code	Gateway ID	Luminaire ID	Parameter Type	Parameter Value	ETX of Parameter	...	Parameter Type	Parameter Value	ETX of Parameter

Figure B.44 Definition of Message Body of Event

Wherein:

--- Event Code: 2 Bytes, hexadecimal, ranging from 0 to (2^{16}-1);

--- Gateway ID: 4 Bytes, hexadecimal, ranging from 0 to (2^{32}-1);

--- Luminaire ID: 4 Bytes, hexadecimal, ranging from 0 to (2^{32}-1);

--- Parameter Type: 2 Bytes, hexadecimal, ranging from 0 to (2^{16}-1);

--- Parameter Value: variable string, ending with 0x00.

B.4.2 Event ACK

There is no message body in Event ACK, so only the message type of message header in the received event needs to be changed, and the message length and checksum are just given the value of 0. The message type of message header in event is 0x04. After gateway or luminaire with gateway function receives Event ACK, it should run matching process according to message serial number. The message structure of Event ACK is shown in Figure B.45.

B0	B1～B4	B5～B6	B7～B11	B12～B15
0x04	Message serial number	0	0	0

Figure B.45　Message Structure of Event ACK

B.4.3　Event list

In compliance with the description of message body format in B.2.3, the message body format of the event and alarm is shown in Figure B.46.

Event Code	Gateway ID	Luminaire ID	Parameter Type	Parameter Value	ETX of Parameter	.. .	Parameter Type	Parameter Value	ETX of Parameter

Figure B.46　Message Body of Event and Alarm

---Message type of the message body of event and alarm is 0x03.

---Message of Event ACK contains only the message header and its message type (B0) is 0x04, the serial number in message header is the same with that of the corresponding event.

B.4.4　Fault alarm event

Gateway or luminaire with gateway function reports alarm for faults and clearance of faults alarm to server by means of event.

B.4.4.1　Restart the luminaire

Event Code: 0x2200

Definition of the event parameter: none.

B.4.4.2　Clearance of threshold alarm by luminaire

Event Code: 0x2202

Definition of the event parameter is shown in Table B.25.

Table B.25 Definition of the Parameter of Clearing Threshold Alarm Luminaire

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
ResourceType	0x25	2	Temperature: “01”；

			Humidity: “02”； Current: “03”； Voltage: “04”； Illumination: “05”.
ResourceValue	0x24	5	

B.4.4.3 Alarm when threshold is exceeded

Event Code: 0x2302

Definition of the event parameter is shown in Table B.26.

Table B.26 Definition of the Parameter of Alarming When Threshold Is Exceeded

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
ResourceType	0x25	2	Temperature: “01”； Humidity: “02”； Current: “03”； Voltage: “04”； Illumination: “05”.
ResourceValue	0x24	5	

B.4.4.4 Communication fault alarm between field WAN gateway or luminaire

Event Code: 0x2303

Definition of the event parameter: none.

B.4.4.5 Clear the communication fault alarm between field WAN gateway or luminaire

Event Code: 0x2203

Event parameter: none.

B.4.4.6 Alarm not as the control setting

Event Code: 0x2304

Definition of the event parameter is shown in Table B.27.

Table B.27 Definition of the Parameter of Alarming Not As the Control Setting

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
Set Operation Status	0x53	2	On: 01 Off: 02
Actual Operation Status	0x54	2	On: 01 Off: 02

B.4.4.7 Clear the alarm not as the control setting

Event Code: 0x2204

Event parameter: none.

B.4.4.8 Alarm of anti-theft

Event Code: 0x2305

Event parameter: none.

B.4.4.9 Data acquisition

Event Code: 0x2101

The definition of the event parameter is shown in Table B.28.

Table B.28 Definition of Data Acquisition Event Parameter

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
ResourceType	0x25	2	Temperature: “01”； Humidity: “02”； Current: “03”； Voltage: “04”； Illumination: “05”； Ambient Illumination: “06”； People there or not: “07”.
ResourceValue	0x24	5	Acquired data value

Appendix C
(Informative Annex)
Error Code and Using Example of interface protocol of gateway and CMS

C.1 Error Code

For Definition of Error Code (Error Code is described in decimal by ASCII string of 4 bytes, wherein the strings from 0000 to 0099 are reserved for system, and they are applied to define the error of application protocol. The strings from 0100 to 9998 are error codes customized by manufacturers and they are applied to define internal error of luminaire), 9999 represents unknown error, as is shown in the following table.

Table C.1 Error Code

Error Code	Description	Error Message
0000	Success	None
0001	Message parse error	Error message contains the position where parse error happens, for example, which byte of the message header is parsed of error.
0002	Check and Checksum	Error message contains the checksum in the message and the checksum computed by the luminaire.
0003	Undefined Message ID	None
0004	The command can't be executed temporarily	None
0005	Error number of parameters	Error message contains the supposed number of parameters be and the actual number of parameters.
0006	Parameter format error	Error message contains the position of the error parameter.
0007	Parameter range error	Error message contains the position of the error parameter and its expected range.
0008	Undefined parameter type code	Error message contains the position of the error parameter.

C.2 Definition of parameter

Table C.2 Definition of Parameter

Parameter Type	Value of Parameter Type	Maximum Length(Byte)	Parameter Value Description
Luminaire ID	0x01	10	LuminaireID is described in decimal by string, and assigned by server, ranging from 0 to (2^{32}-1).
Server IP	0x02	16	It represents the IP address of the server.
Server Port	0x03	4	It represents the port number of the server.
Protocol	0x04	1	Protocol: "1": UDP; "2": TCP.
Log Level	0x05	1	Log Level:

			“1”: Debug; “2”: Error.
Log Category	0x06	32	The log category can be defined specifically by luminarie.
Command ACK Timeout	0x07	4	It represents the maximum response time and specified in seconds.
Command Retry Times	0x08	2	It represents the retry times when command ACK fails to be received or sent out.
Command Result Timeout	0x09	4	It represents the maximum waiting time for command result, specified in seconds.
Event ACK Timeout	0x0A	4	It represents the maximum response time of event, specified in seconds.
Event Retry Times	0x0B	2	It represents the retry times when event response fails to be received or sent out.
Link Idle Time	0x0C	4	It represents the idle time when heartbeat pack is sending through the communication link, specified in seconds.
Heartbeat ACK Timeout	0x0D	4	It represents the timeout of heartbeat pack ACK.
Heartbeat Retry Times	0x0E	2	It represents the retry times when heartbeat ACK fails to be received.
Controlled Luminaire ID	0x0F	10	The luminaire ID controlled by gateway is represented in decimal by string, and it is assigned by server, with a range of 0x00000001 ~ 0xffffff00. One or more luminaire IDs are contained in a command.
Maintenance Info	0x10	128	It represents the information about maintenance.
Alarm Message Receiver	0x11	11	The mobile number receive the message has 11characters.
GPS	0x12	18	GPS location: North latitude and longitude coordinates. The unit is sexagesimal. (degree/minute/second, the character is direction)
Period of query	0x13	5	The query period of gateway. The unit is minute.
Luminaire group ID	0x14	4	The group of luminaire, 0xFFFF means all luminaires.
Luminaire Serial Number	0x15	16	Luminaire Serial Number
Time	0x20	4	The default lights-on time is represented in 24-hour system by hhmm.
Illumination	0x21	3	Illumination is represented in decimal by 00-100.
Begin Date	0x22	8	Begin date, yyyyMMdd
End Date	0x23	8	End date, yyyyMMdd
Resource Value	0x24	5	Resource value
Threshold Value	0x26	8	Threshold range
Resource Type	0x25	2	Temperature: “01”；

			Humidity: “02”； Current: “03”； Voltage: “04”； Illumination: “05”; All: “00”.
Operation Mode	0x27	2	0x01: automatic 0x02: manual
Delay Time	0x28	5	Time of delaying(unit: second)
Interval	0x29	5	Acquisition interval(unit: minute)
Group Number	0x2A	2	Group Number(1~32)
Illumination Adjustment Scene	0x2B	2	Scene value
Serial Number	0x31	32	Serial number of luminaire
RSA Symmetric Key	0x40	32	The key applies the base64 transcoding.
AES Key	0x41	32	The key applies the base64 transcoding.
System Time	0x42	14	yyyyMMddHHmmss
File Size	0x50	5	Size of the updating file
Segment Size	0x51	2	Size of each segment
Segment Count	0x52	2	Total segments
Set working status	0x53	2	Light on/off status
Real working status	0x54	2	Light on/off status

Appendix D
(Informative Annex)
Message Using Example of interface protocol of Web based gateway and CMS

D.1 The reference stack of WEB/XML based application protocol

The structure of application layer based on XML/JSON is above HTTP or CoAP. The application layer data is defined by XML/JSON, which is the main part in application layer. The HTTP/CoAP is above TCP/UDP/IP, which do not have the specific requirement for physical layer. The protocol stack is as shown Figure D.1.

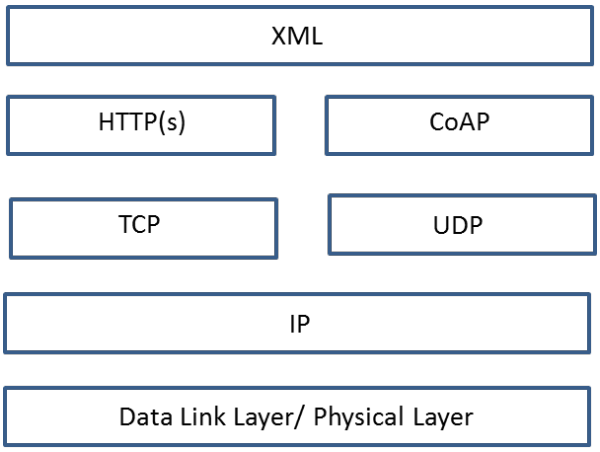

Figure D.1 Structure of WEB/XML based application protocol

D.2 The example of application message

D.2.1 Function message

The application layer data defined by XML/JSON can transmit between CMS and gateway, and other supporting function message is shown as follow:

a) Device detect capability: CMS can automatically detect supporting devices, including the function and property.
b) Device property configuration: CMS can automatically configure the property of devices.
c) Lighting control capability: CMS can control the light on or off and illumination adjustment.
d) Data upload capability: Gateway can upload the message and error log to CMS.

The Sequence Diagram of the application layer data defined by XML/JSON through HTTP is shown in Figure D.2.

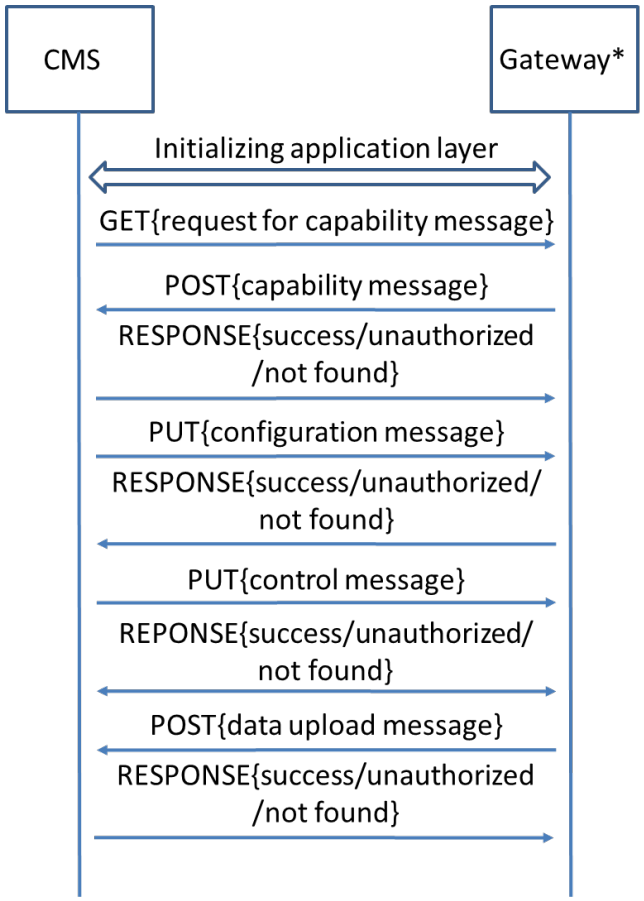

Figure D.2 Sequence Diagram of the application layer data defined by XML/JSON through HTTP

The example of main application message based on XML is shown as follow:

D.2.2 The message of device detect capability

POST /cap/LogicalDevices/
Host: {server host}
Content-Type: application/xml

```
<?xml version="1.0" encoding="utf-8" ?>
<!-- Message sent from gateway to server as part of device capability discovery -->
<Capability>
<LogicalDevice id="LightPointController1" uri="/BridgeA/LightPointController1">
<Asset id="MyAsset1">
                <GeoLocation/>
                <Name/>
            </Asset>
    <LampActuator uri="/BridgeA/LightPointController1/LampActuator">
                <!-- Type of control interface between the lamp actuator and the controlgear, e.g. DALI, 0-10V, etc -->
                <ControlType>DALI</ControlType>
                <!-- Minimum light output in percentage under which the lamp actuator will not perform the command -->
                <MinLightOutput minValue="0" maxValue="100">30</MinLightOutput>
```

```
                <!-- Sets the default light output for the actuator -->
                <DefaultLightOutput>70</DefaultLightOutput>
                <!-- Number of lamps controlled by the actuator-->
                <NumberOfLamps>2</NumberOfLamps>
                <!-- Operational attributes are just announced, no value: -->
                <!-- Sets the active light output target -->
                <TargetLightOutput/>
                <!-- Actual light output value -->
                <LightOutputFeedback/>
                <!-- Current mode of operation of the lamp actuator-->
                <ControlMode
                allowedValues="Automatic|Override|Backup">AUTOMATIC</ControlMode><LampFailure/>
        </LampActuator>
        <ElectricalMetering uri="/BridgeA/LightPointController1/Meter">
                <Voltage/>
                <Current/>
                <PowerFactor/>
                <Power/>
                <Energy/>
        </ElectricalMetering>
</LogicalDevice>
</Capability>
```

D.2.3 The message of device configuration

PUT /LightPointController1
Host: {Bridge host}
Content-Type: application/xml

```
<?xml version="1.0" encoding="utf-8" ?>
<!--   sent from server to Bridge to configure attributes in a logical devices -->
<LampActuator>
                <MinLightOutput>50</MinLightOutput>
                <DefaultLightOutput>100</DefaultLightOutput>
</LampActuator>
```

D.2.4 The message of lighting control

PUT /LightPointControler1
Host {Bridge host}
Content-Type: application/xml

```
<?xml version="1.0" encoding="utf-8" ?>
<LampActuator>
        <TargetLightOutput priority="123">60</TargetLightOutput>
</LampActuator>
```

D.2.5 The message of data uploading

POST drep/LogicalDevices/
Host: {server host}
Content-Type: application/xml

```
<?xml version="1.0" encoding="UTF-8" ?>
<DataReporting>
<LogicalDevice id="LogicalDevice1">
<LampActuator>
<LightOutputFeedback timestamp="2016-06-18 17:00:00">40</LightOutputFeedback>
<LightOutputFeedback timestamp="2016-06-18 18:00:00">50</LightOutputFeedback>
<LightOutputFeedback timestamp="2016-06-18 19:00:00">70</LightOutputFeedback>
<LightOutputFeedback timestamp="2016-06-18 20:00:00">70</LightOutputFeedback>
<LightOutputFeedback timestamp="2016-06-18 21:00:00">70</LightOutputFeedback>
<LightOutputFeedback timestamp="2016-06-18 22:00:00">70</LightOutputFeedback>
<LightOutputFeedback timestamp="2016-06-18 23:00:00">50</LightOutputFeedback>
<LightOutputFeedback timestamp="2016-06-18 23:00:00">50</LightOutputFeedback>
</LampActuator>
<ElectricalMetering>
<Voltage timestamp="2016-06-18 17:00:00">230.9</Voltage>
<Voltage timestamp="2016-06-18 18:00:00">231.2</Voltage>
<Voltage timestamp="2016-06-18 19:00:00">230.3</Voltage>
<Voltage timestamp="2016-06-18 20:00:00">232.1</Voltage>
<Voltage timestamp="2016-06-18 21:00:00">231.8</Voltage>
<Voltage timestamp="2016-06-18 22:00:00">231.1</Voltage>
<Voltage timestamp="2016-06-18 23:00:00">230.9</Voltage>
<Voltage timestamp="2016-06-18 23:00:00">230.7</Voltage>
</ElectricalMetering>
</LogicalDevice>
<LogicalDevice id="LogicalDevice2">
<LampActuator>
<LightOutputFeedback timestamp="2016-06-18 17:00:00">40</LightOutputFeedback>
<LightOutputFeedback timestamp="2016-06-18 18:00:00">60</LightOutputFeedback>
<LightOutputFeedback timestamp="2016-06-18 19:00:00">80</LightOutputFeedback>
<LightOutputFeedback timestamp="2016-06-18 20:00:00">80</LightOutputFeedback>
<LightOutputFeedback timestamp="2016-06-18 21:00:00">80</LightOutputFeedback>
<LightOutputFeedback timestamp="2016-06-18 22:00:00">80</LightOutputFeedback>
<LightOutputFeedback timestamp="2016-06-18 23:00:00">60</LightOutputFeedback>
<LightOutputFeedback timestamp="2016-06-18 23:00:00">60</LightOutputFeedback>
</LampActuator>
<ElectricalMetering>
<Voltage timestamp="2016-06-18 17:00:00">230.7</Voltage>
<Voltage timestamp="2016-06-18 18:00:00">231.3</Voltage>
<Voltage timestamp="2016-06-18 19:00:00">230.2</Voltage>
<Voltage timestamp="2016-06-18 20:00:00">232.4</Voltage>
<Voltage timestamp="2016-06-18 21:00:00">231.5</Voltage>
<Voltage timestamp="2016-06-18 22:00:00">231.8</Voltage>
```

<Voltage timestamp="2016-06-18 23:00:00">230.9</Voltage>
<Voltage timestamp="2016-06-18 23:00:00">230.3</Voltage>
</ElectricalMetering>
</LogicalDevice>
</DataReporting>
