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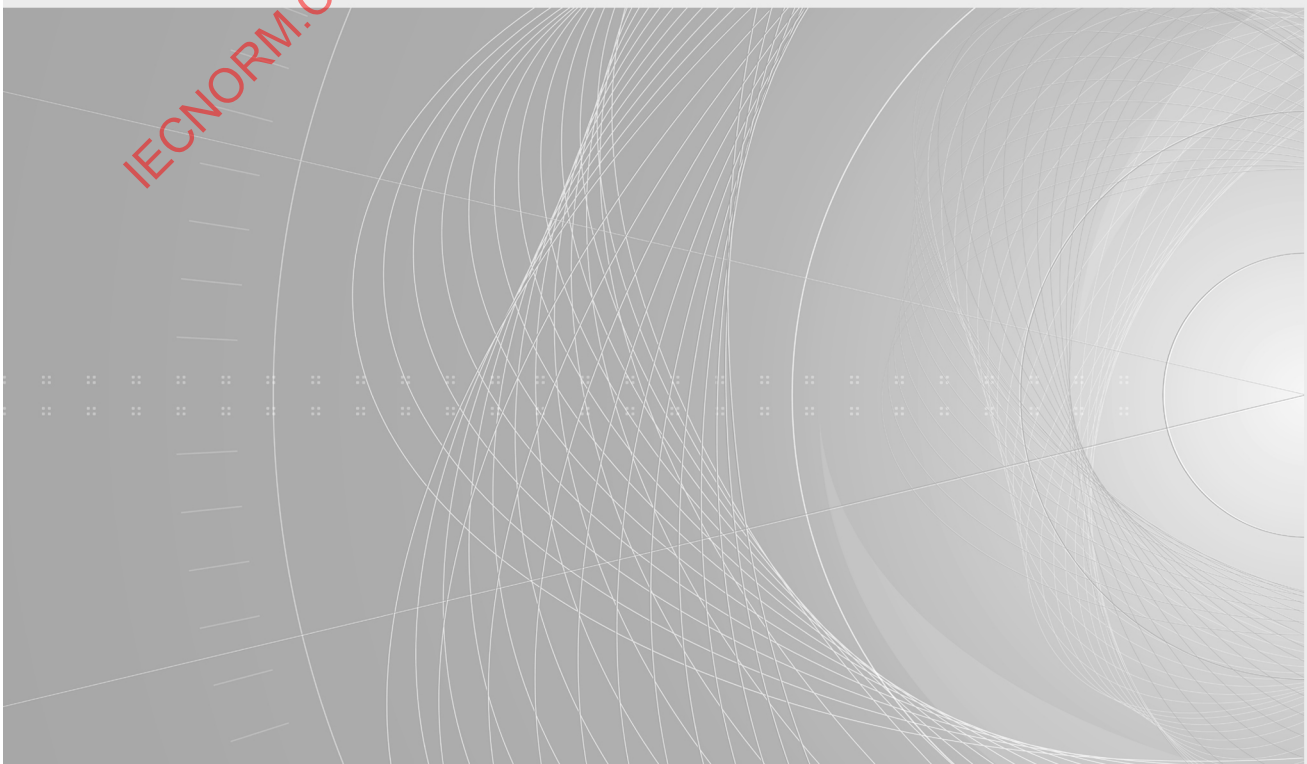
TECHNICAL REPORT

Internet of things (IoT) – Application of sensor network for wireless gas meters



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colour inside

Internet of things (IoT) – Application of sensor network for wireless gas meters

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INTERNET OF THINGS (IoT) – APPLICATION OF SENSOR NETWORK FOR WIRELESS GAS METERS

FOREWORD

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ISO/IEC TR 30148, which is a Technical Report, has been prepared by subcommittee SC 41: Internet of Things and related technologies, of ISO/IEC joint technical committee 1: Information technology.

The text of this Technical Report is based on the following documents:

Draft TR	Report on voting
JTC1-SC41/90/DTR	JTC1-SC41/104/RVDTR

Full information on the voting for the approval of this Technical Report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A bilingual version of this publication may be issued at a later date.

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INTRODUCTION

With the improvement of wireless communication technologies and the demand for intelligent products required by home automation, factory automation and so on, wireless gas meter systems can develop in terms of safety, reliability, and convenience. Wireless gas meters can not only avoid the errors from manual meter reading and issues such as unstable signals during traditional gas meter reading, but also achieve functions such as dynamic rates, energy management, event alarm service, real-time data collection and analysis.

From the perspective of gas meter companies, the promotion of wireless gas meters is conducive to reducing labour costs and improving efficiency. From the point of view of gas meter manufacturers, the implementation of wireless gas meters will also help them to reduce costs. Consumers will readily accept the lower cost and increased convenience of wireless gas meters. So in the near future, with significant cost benefits and technical advantages, wireless gas meters will become more important in the market.

INTERNET OF THINGS (IoT) – APPLICATION OF SENSOR NETWORK FOR WIRELESS GAS METERS

1 Scope

This document describes

– the structure of wireless gas meter networks, and
– the application protocol of wireless gas meter networks.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org./
- ISO Online browsing platform: available at http//www.iso.org./obp

3.1
access point
equipment that is used to connect each wireless gas meter to other networks

3.2
acquisitor
equipment that is used for data acquisition, data transmission, and data relay for wireless gas meters

3.3
application layer
layer that performs calculation, processing and management of data collected by the sensing layer

3.4
application sub-layer
layer that provides services for the application layer

3.5
entity
unit that connects to other units defined in the wireless gas meter networks reference architecture with a distinct set of attributes

3.6
gateway
device that is used to connect wireless gas meter networks to outside IP networks

3.7
handheld device
portable device that is used for provisioning firmware updates and monitoring device status

3.8
message
data unit conveyed between client and server that represents a specific service request or response

3.9
user application object
information processing element for a specific process

3.10
user application process
active process that is used to implement data collection and processing at the upper layer of the application layer

3.11
wireless gas meter
instrument for recording the quantity of gas passing through a particular outlet, which exchanges data with external devices with a microprocessor and a wireless communication chip as its core

3.12
wireless gas meter system
system that is composed of remote meter reading management, payment management, accounting management, gas management and data management

4 Symbols and abbreviated terms

AL	application layer
APDU	application layer protocol data unit
ASL	application sub-layer
ASLDE	application sub-layer data entity
ASLME	application sub-layer management entity
DMAP	device management application process.
GPRS	general packet radio services
ID	identifier
MIB	management information base
PDU	protocol data unit
R/R	request/response
P/S	publisher/subscriber
R/S	report source/sink
SAP	service access point
UAP	user application process
UAO	user application object
VCR	virtual communication relationship
VCR_ID	virtual communication relationship identifier

5 Network structure

The overall structure of the wireless gas meter networks can be divided into three levels: the underlying wireless gas meter networks, the internet/mobile networks, the data centre/application server/cloud management platform. The gateway obtains data information such as balance, valve opening and closing, and device health status, and sends to the data centre. The cloud management platform can control and manage at any time, and users query information through the application server. They are shown in Figure 1.

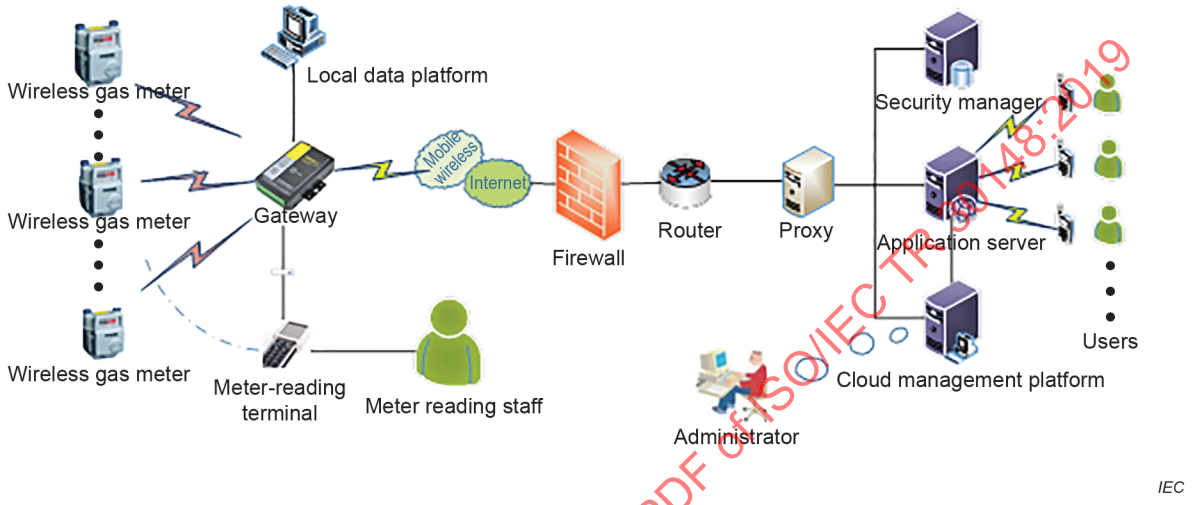

Figure 1 – The structure of the wireless gas networks

The components of the wireless gas meter networks are as follows.

a) Security manager

Application software that supervises various operational security aspects of a multi-device network (e.g. certification function), usually through interaction with wireless gas meter in the supervised device(s). See Annex A.

b) Application server

It is installed in the gas supplier or gas management centre. It is a platform for accessing the Internet and managing user applications. Users can perform business management operations such as gas meter recharging, gas meter status monitoring and gas data storage through the application.

c) Cloud management platform

It is installed in the gas supplier or gas management centre. It is a platform for controlling and managing wireless gas meters. It has functions such as equipment management, network management, network security management and time synchronization.

d) Gateway

It is installed at a place without potential explosion risks and far away from where gas is used. It is important for a gateway to be a safe distance from wireless gas meters. It can cover all gas meters to manage network nodes remotely. It can receive management and control messages from the remote management platform. The main functions are as follows: transmission and storage of wireless gas meter status information; conversion of wireless protocol to wired protocol; management of wireless gas meter; information security management for gas meter identification.

e) Wireless gas meter

Instrument intended to measure, memorize and display the quantity of gas passing the flow sensor. It is installed in locations where there are potential explosion risks and meets the explosion-proof performance functions. If it is exposed to weather it should also be weather-proof against dust and water entry and the effect of UV sunlight exposure and ambient temperature ranges expected at the installed location, if these would impair its function and safety. Wireless connections may include short distance wireless, GPRS, long range wireless and narrowband IoT.

6 Application layer protocol

6.1 Overview

6.1.1 General

AL describes the interaction processes and services between wireless gas meter and wireless gas meter system.

This AL for wireless gas meter networks includes:

– structure and functions;
– three communication models;
– application services and corresponding service primitives;
– message format.

6.1.2 AL function

The AL describes UAP, ASL and DMAP. The DMAP is a special type of UAP, which is dedicated to managing the device and its communications services. DMAP can realize system management functions. AL defines application objects to interact with the wireless gas meter system. It can also define communication services to support interaction between gas meter application processes and ASL.

6.1.3 AL structure

Application layer structure is shown in Figure 2.

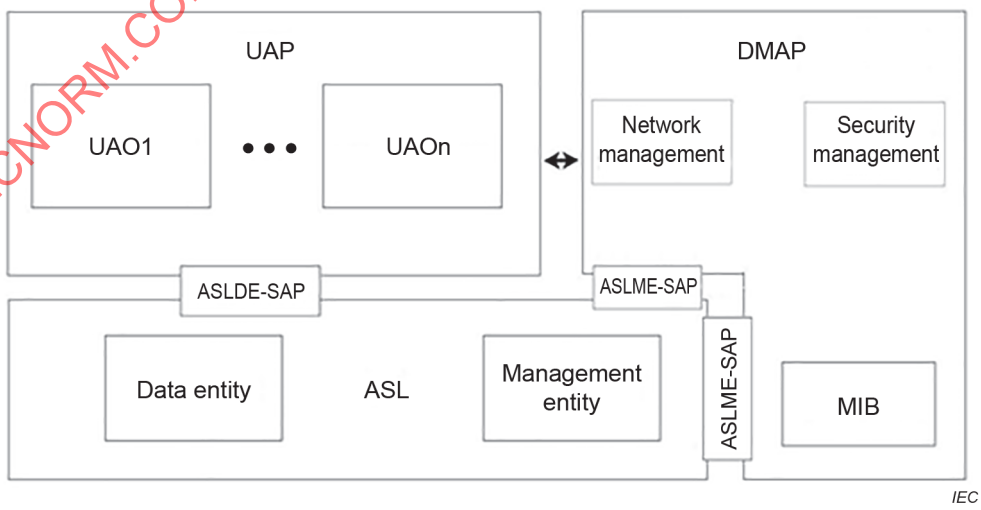

Figure 2 – AL structure

UAP collects data from the wireless gas meter and processes the data; UAP consists of one or more UAOs. DMAP includes the network management module, the security management module and the MIB module. The network management is responsible for managing the attributes of network equipment which is related to communication and networking processes. The security management manages the attributes associated with network security. The information in the MIB exists in the form of attributes to monitor and configure wireless network parameters for gas meters. ASL includes data entities and management entities. Data entities provide data communication services, send data to the network layer and receive data from it. The management entity implements the data interaction with the MIB. UAP and DMAP interact with AL.

ASLDE–SAP and ASLME–SAP are interfaces for communication among parts. ASL provides transparent data transmission services between ASL and UAP.

6.2 User application process

6.2.1 General

According to the ISO/OSI reference model defined, the UAP is performed for specific applications in the network and an integral part of distributed applications in wireless gas meter networks.

6.2.2 Functions of UAP

The functions of the user application process mainly include the following.

– It can collect gas consumption, balance and remaining power in home and industrial sites through a wireless gas meter. After processing this information, it is transmitted to the computer control centre through the data channel.

– It can generate and issue an alarm, and the UAO itself will send an alarm signal when an operating condition is abnormal. This alarm information includes data anomalies, low power and damage caused by external factors, etc.

6.2.3 User application object

A user process consists of one or more user application objects. Each user application object can be defined according to different functions. The user application object is defined as the data acquisition, processing and distribution.

Each user application object is addressed based on the object ID. This parameter uses index addressing when its internal parameters are operated remotely.

6.3 Device management application process

Each device contains a DMAP. The DMAP includes a security device management function. The DMAP cooperates with system manager and the security manager to enable the use of system resources by the wireless gas meter and the wireless gas meter system. For example, the DMAP may ask to join the network, ask for communication bandwidth, request a communication configuration, and report its health. The system manager and the security manager of the wireless gas meter authorize the wireless gas meter to join the network, allocate communication bandwidth, configure the wireless gas meter, and collect health reports. These health reports are stored in the wireless gas meter system manager and are used to make communication configuration decisions.

6.4 Application sub-layer

6.4.1 General

Subclause 6.4 describes the interaction and application scenarios of the three communication models used in the application layer of a wireless gas meter system and the corresponding message format.

6.4.2 Functions of application sub-layer

The application sub-layer for a wireless gas meter system in the network provides data communication services, including sending data to the network layer and receiving data from the network layer, receiving data from the user application process and sending data to the user application process.

– Data transmission service: provide end-to-end transparent data communication services for the user application process and device management application process.

– Data communication services provided by the application sub-layer support three types of communication model:

1) R/R communication model: it is mainly used in the transmission of dynamic, aperiodic data and command; in addition, it needs to maintain the serial number of the information which is used to match the response information from the wireless gas meter.

2) P/S communication model: it supports preconfigured, periodic information transmission. For example, data of gas meter collected by wireless gas meter is sent. The Alert-Report will be a use case scenario of P/S. Once any alarm occurs, the alarm information will be published, and subscribers can obtain that information (if they subscribe to it).

3) R/S communication model: it supports the aperiodic information transmission, such as alarm, event, etc.

6.4.3 Communication models

6.4.3.1 Request/Response model

By using the R/R model, the wireless gas meter system can realize the information acquisition or setting operation of the parameters of the wireless gas meter application objects.

The interactive process of the R/R model is shown in Figure 3.

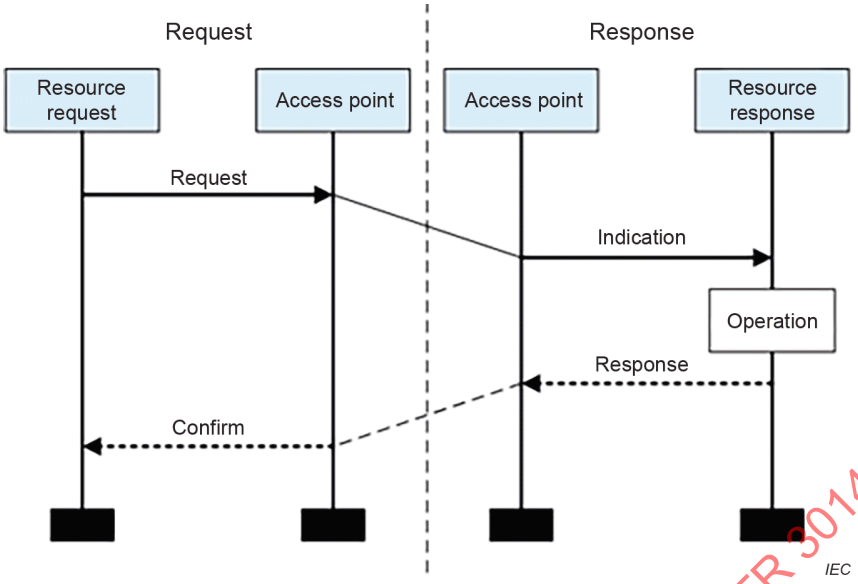

Figure 3 – R/R model interaction process

First, the resource requestor encapsulates the operation data into an APDU according to the message format, and informs the request side access point to transfer the data unit. After receiving the data unit from the client access point, the response side access point will indicate to the resource responder that the data unit has arrived. The resource responder resolves the received APDU according to the message format. If it is a command message, the resource responder will remove the message header and extract the operation code and data load. Then the resource responder performs the corresponding action based on the content. If it is a data message, the resource responder will remove the message header and the data load will be extracted and performed.

In contrast, if some operations need to confirm the received message, the resource responder needs to return the confirmation message and encapsulates the APDU according to the message format, then the resource responder access point initiates a response and tells the access point to send the data unit. After receiving the data unit from the resource responder access point, the resource requestor access point will indicate to the resource requestor that the data unit has arrived. The resource requestor resolves the received APDU according to the message format, extracts the serial number, and verifies the returned operation result.

The R/R model is mainly used for the transmission of dynamic, aperiodic data and command. In addition, the R/R model needs to maintain the serial number of the information which is used to match the response information from the wireless gas meter.

6.4.3.2 Publisher/Subscriber model

P/S model is based on a configured communication relationship. The interactive process of the P/S model is shown in Figure 4.

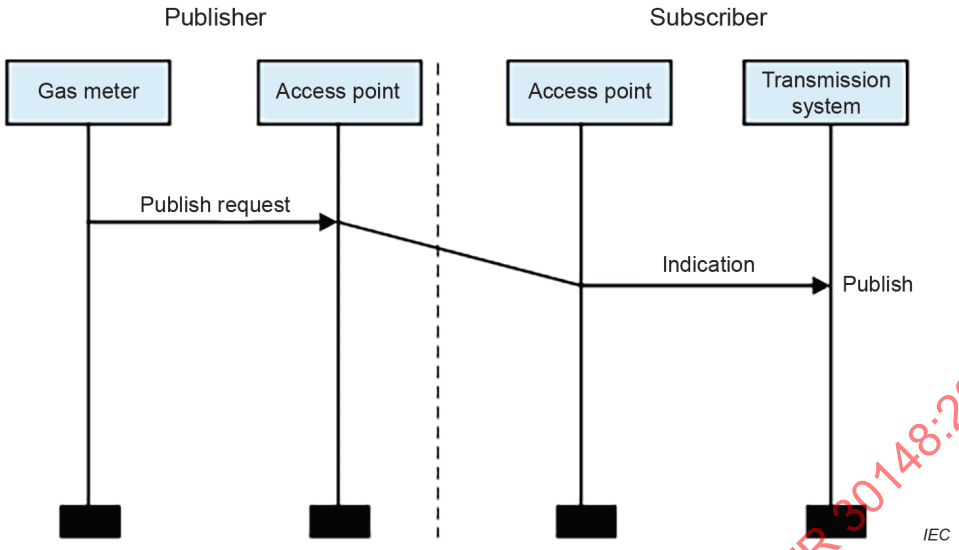

Figure 4 – P/S model interaction process

To achieve a many-to-one publish and subscribe model, the wireless gas meter is a publisher, and the wireless gas meter system is a subscriber. The wireless gas meter system sets the data transmission time parameters and subscribes to the data collected in the period, that is, the communication resources allocated by the network administrator or the cluster head.

The P/S model is mainly used for the transmission of periodic data.

6.4.3.3 Report source/Sink model

The R/S model is used to support the aperiodic alarm or event reports, as well as the confirmation operations for alarms or events.

The sequence of alarm or report in the R/S model is shown in Figure 5.

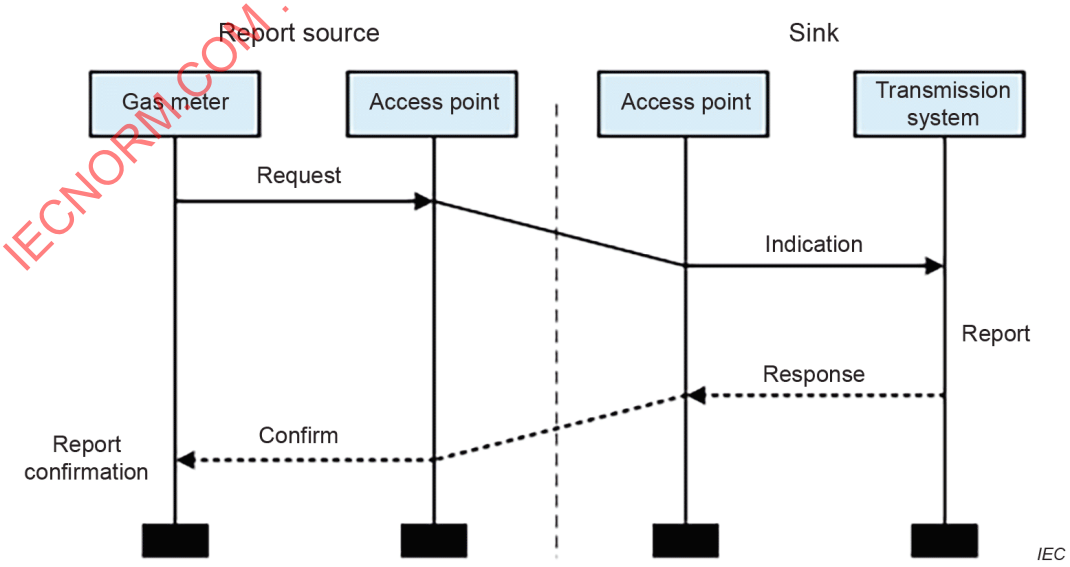

Figure 5 – R/S model interaction process

The source of the message is the device that generates the alarm data. After the data have been prepared, the wireless gas meter will encapsulate the data to be sent into the APDU, and transmit them to wireless gas meter system through the access point. Similarly, the wireless gas meter system will return a confirmed response according to actual conditions and publish the alarm message.

6.4.4 Application sub-layer communication service

This part defines the necessary communication services. These services can enable communication between distributed applications objects and objects in an open, interoperable application environment corresponding with wireless gas meter standards. The communication service is provided by the application sub-layer services between the wireless gas meter and the wireless gas meter system. The application sub-layer communication service is summarized in Table 1.

Table 1 – ASL services

ASL-provided service	Applicable primitives	Description	Function
Request/Response			
Read	Request Indication Response Confirm	Read an attribute value from an object	Used for the transmission of dynamic, aperiodic data and command, such as resetting operation, closing the valve, opening the valve, time synchronization, adjusting the rate, recharging, setting meter reading cycle, querying usage and balance, and so on.
Write	Request Indication Response Confirm	Write a value to an object	
Execute	Request Indication Response Confirm	Execute a method on an object	
Publish/Subscribe			
Publish	Request Indication	Publish single or multiple values from one source object	Used for the transmission of periodic data, such as gas consumption, user balance and remaining power.
Report source/Sink			
Alert-Report	Request Indication	Report an alert	Used to release alarm information, such as wireless gas meter abnormity, lack of balance, low power, equipment failure.
Alert-Acknowledge	Request Indication Response Confirm	Acknowledge an individual alert reception	

6.4.5 Connection service

6.4.5.1 Link service

The link service is used to switch network transmission channels such as Ethernet, GPRS, etc. After the physical connection is completed and the transparent channel is established, a link needs to be established and managed on this channel.

The link services provided by the application layer of the wireless gas meter and wireless gas meter system are shown in Table 2.

Table 2 – Link services provided by the application layer

Service object	Wireless gas meter	Wireless gas meter system
Link	LINK（. Indication, . Response）	LINK（. Request, . Confirm）

The link service (LINK) is initiated by the wireless gas meter system and responded by the wireless gas meter. The LINK mainly implements the following three types of requirements.

– Join: After the physical connection is completed and the transparent channel is established, the application process of the wireless gas meter system sends a join request to the specified wireless gas meter according to the link configuration parameters, then the application process of wireless gas meter confirms the request. Finally, the link is completed.

– Heartbeat: The wireless gas meter uses the "heartbeat" method to make the link channel activity.

– Delete: After the link is established, the wireless gas meter system is not allowed to disconnect automatically. If necessary, it is required to reconfigure the link parameters of the wireless gas meter system and will take effect after restart; or send a delete command to the original wireless gas meter and then perform the new link join according to the new parameters.

The link service includes four primitives: link request primitive, link indication primitive, link response primitive, and link confirm primitive.

1) LINK. Request service primitive

This service is invoked by the application process of the wireless gas meter system and is used to propose three types of link requests to the application process of the wireless gas meter: join, heartbeat, or delete.

The primitive semantics of link request are as follows:

LINK. Request (
Request type,
Heartbeat cycle,
Request time
)

The parameters of the LINK. Request primitive are specified in Table 3.

Table 3 – Parameters of the LINK. Request primitive

Name	Data type	Valid range	Description
Request type	Unsigned8	0 to 255	Join, heartbeat, or delete
Heartbeat cycle	Unsigned16	0 to 65 535	Interval between two heartbeat requests
Request time	Unsigned32	0 to $2^{32} - 1$	Clock time of service when requested

2) LINK. Indication service primitive

This service is invoked by the application layer of the wireless gas meter and is used to indicate the received link request from the wireless gas meter system to the application process of the wireless gas meter. The parameters of this service primitive are the same as LINK. Request.

3) LINK. Response service primitive

This service is invoked by the application process of the wireless gas meter and is used to respond to link requests to the wireless gas meter system.

The primitive semantics of link response are as follows:

LINK. Response (
Request type,
Result,
Request time,
Received time,
Response time
)

The parameters of the LINK. Request primitive are specified in Table 4.

Table 4 – Parameters of the LINK. Response primitive

Name	Data type	Valid range	Description
Request type	Unsigned8	0 to 255	Join, heartbeat, or delete
Result	Unsigned8	0 to 255	Indicate whether the request was successful or failed and the reasons
Request time	Unsigned32	0 to $2^{32} - 1$	The request time of LINK. Request
Received time	Unsigned32	0 to $2^{32} - 1$	The received time of LINK. Indication
Response time	Unsigned32	0 to $2^{32} - 1$	The response time of LINK. Response

4) LINK. Confirm service primitive

This service is invoked by the application layer of the wireless gas meter system and is used to indicate the received link request from the wireless gas meter to the application process of the wireless gas meter system. The parameters of this service primitive are the same as LINK. Response.

6.4.5.2 Connect service

The connect service is initiated by the wireless gas meter, which is used to confirm the application context of the communication between wireless gas meter and wireless gas meter system, including protocol consistency, functional consistency and security authentication.

For the wireless gas meter system, several application connections can be supported without interference. However, for the same wireless gas meter, only one application connection can be supported. When a wireless gas meter requests the application connection again, the previous application connection is invalid automatically if the system accepts the request of the wireless gas meter again.

The connect services provided by the application layer of the wireless gas meter system and wireless gas meter are shown in Table 5.

Table 5 – Connect services provided by the application layer

Service object	Wireless gas meter	Wireless gas meter system
Connect	CONNECT（. Request, . Confirm）	CONNECT（. Indication, . Response）

The connect service includes four primitives: connect request primitive, connect indication primitive, connect response primitive, and connect confirm primitive.

1) CONNECT. Request service primitive

The primitive semantics of connect request are as follows:

CONNECT. Request (
Protocol version number,
The maximum size of the sending frame,
The maximum size of the received frame,
The maximum window size of the received frame,
The maximum processing size of APDU,
Expected application connection timeout,
Authentication mechanism information
)

The parameters of the CONNECT. Request primitive are specified in Table 6.

Table 6 – Parameters of the CONNECT. Request primitive

Name	Data type	Valid range	Description
Protocol version number	Unsigned16	0 to 65 535	The negotiated application layer protocol version number
The maximum size of the sending frame	Unsigned16	0 to 65 535	The maximum size of the frame sent by wireless gas meter
The maximum size of the received frame	Unsigned16	0 to 65 535	The maximum size of the frame received by wireless gas meter
The maximum window size of the received frame	Unsigned16	0 to 65 535	The maximum window size of the frame received by wireless gas meter
The maximum processing size of APDU	Unsigned16	0 to 65 535	The maximum size of APDU processed by wireless gas meter
Expected application connection timeout	Unsigned32	0 to 65 535	Expected application connection timeout
Authentication mechanism information	Unsigned8	0 to 65 535	Including general password, symmetric encryption and digital signature

2) CONNECT. Indication service primitive

This service is invoked by the application layer of the wireless gas meter system and is used to indicate the received connection request from the wireless gas meter to the application process of the wireless gas meter system. The parameters of this service primitive are the same as CONNECT. Request.

3) CONNECT. Response service primitive

The primitive semantics of connect response are as follows:

CONNECT. Response (
Protocol version number,
The maximum size of the sending frame,
The maximum size of the received frame,
The maximum window size of the received frame,
The maximum processing size of APDU,
Timeout,
Authentication response
)

The parameters of the CONNECT. Response primitive are specified in Table 7.

Table 7 – Parameters of the CONNECT. Response primitive

Name	Data type	Valid range	Description
Protocol version number	Unsigned16	0 to 65 535	The negotiated application layer protocol version number
The maximum size of the sending frame	Unsigned16	0 to 65 535	The maximum size of the frame sent by wireless gas meter system
The maximum size of the received frame	Unsigned16	0 to 65 535	The maximum size of the frame received by wireless gas meter system
The maximum window size of the received frame	Unsigned8	0 to 255	The maximum window size of the frame received by wireless gas meter system
The maximum processing size of APDU	Unsigned16	0 to 65 535	The maximum size of APDU processed by wireless gas meter system
Timeout	Unsigned32	0 to $2^{32} - 1$	Negotiated timeout connection
Authentication response	Unsigned8	0 to 255	Authentication response information of application connection request

4) CONNECT. Confirm service primitive

This service is invoked by the application layer of the wireless gas meter and is used to indicate the received connection response from the wireless gas meter system to the application process of the wireless gas meter. The parameters of this service primitive are the same as CONNECT. Response.

6.4.5.3 Release service

The release service is used to disconnect an established application connection. Since the wireless gas meter system is not allowed to request to disconnect the normal application connection, RELEASE. Request service can only be issued by the wireless gas meter, which could not be rejected by the wireless gas meter system in general.

In the process of establishing each application connection, the static timeout of the application connection can be negotiated. When communication time is more than the static timeout, the wireless gas meter system will use RELEASE. Notification to notify the wireless gas meter that the application connection will be disconnected. This service does not require any response from the wireless gas meter.

The release services provided by the application layer of the wireless gas meter system and wireless gas meter are shown in Table 8.

Table 8 – Release services provided by the application layer

Service object	Wireless gas meter	Wireless gas meter system
Release	RELEASE（. Request, . Confirm）	RELEASE（. Indication, . Response）
Timeout		RELEASE（. Notification）

The release service includes five primitives: release request primitive, release indication primitive, release response primitive, release confirm primitive and release notification primitive.

1) RELEASE. Request service primitive

This service is invoked by the application process of the wireless gas meter system and is used to request to disconnect the application connection to the application process of the wireless gas meter.

The primitive semantics of release request are as follows:

RELEASE. Request (
No parameter
)

2) RELEASE. Indication service primitive

This service is invoked by the wireless gas meter system and is used to indicate the received release request from the wireless gas meter to the application process of the wireless gas meter system.

The primitive semantics of release indication are as follows:

RELEASE. Indication (
No parameter
)

3) RELEASE. Response service primitive

This service is invoked by the wireless gas meter system and is used to return the request result to the application process of the wireless gas meter.

The primitive semantics of release response are as follows:

RELEASE. Response (
Result
)

The parameters of the RELEASE. Response primitive are specified in Table 9.

Table 9 – Parameters of the RELEASE. Response primitive

Name	Data type	Valid range	Description
Result	Unsigned8	0 to 255	The result of the request This request could not be rejected by the wireless gas meter system under normal circumstances

4) RELEASE. Confirm service primitive

This service is invoked by the application layer of the wireless gas meter and is used to indicate the received release response to the application process of the wireless gas meter.

The primitive semantics of release confirm are as follows:

RELEASE. Confirm (
Result
)

The parameters of the RELEASE. Confirm primitive are specified in Table 10.

Table 10 – Parameters of the RELEASE. Confirm primitive

Name	Data type	Valid range	Description
Result	Unsigned8	0 to 255	The result of the request This request could not be rejected by the wireless gas meter system under normal circumstances

5) RELEASE. Notification service primitive

This service is invoked by the application process of the wireless gas meter system and is used to notify the application process of the wireless gas meter that the connection has failed due to timeout. This service does not require any response from the wireless gas meter.

The primitive semantics of release notification are as follows:

RELEASE. Notification (
Application connect time,
Application release time
)

The parameters of the RELEASE. Notification primitive are specified in Table 11.

Table 11 – Parameters of the RELEASE. Notification primitive

Name	Data type	Valid range	Description
Application connect time	Unsigned8	0 to 255	Terminal time when application is connected
Application release time	Unsigned8	0 to 255	Terminal time when application is released

6.4.6 Data transmission service

6.4.6.1 General

The data transmission service includes three primitives: data transmission request primitive, data transmission confirm primitive, and data transmission indication primitive. Data transmission service is shown in Table 12.

Table 12 – Data transmission services provided by the application layer

Primitive	Description
ASLDE-DATA. Request	Request to send data
ASLDE-DATA. Confirm	Reply after data transmission is completed.
ASLDE-DATA. Indication	Indicate the arrival of data

6.4.6.2 ASLDE-DATA. Request

The upper layer sends data to the ASL by using the ASDLE-DATA. Request primitive.

The semantics of this primitive are as follows:

ASLDE-DATA. Request (
VCR_ID,
Method Identifier,
Asdu Length,
Asdu
)

The parameters of the ASLDE-DATA. Request primitive are specified in Table 13.

Table 13 – ASLDE-DATA. Request parameters

Name	Data type	Valid range	Description
VCR_ID	Unsigned16	0 to 65 535	Virtual communication relationship
Method Identifier	Unsigned8	0 to 255	Method identifier
Asdu Length	Unsigned8	0 to 255	The length of the data that needs to be transmitted
Asdu	Octet string	Reserved	The data that needs to be transmitted

After receiving the data transmission request from the upper layer, the application sub-layer encapsulates the data according to ASL message format and passes it to the network layer. ASL issues ASLDE-DATA. Confirm to the upper layer with the data transmission status.

6.4.6.3 ASLDE-DATA. Confirm

The ASDLE-DATA. Confirm primitive is invoked to indicate the transmission result. When the data is transferred successfully, the status parameter in this primitive is set to success. Otherwise, the data transmission error information is returned.

The semantics of this primitive are as follows:

ASLDE-DATA. Confirm (
VCR_ID,
Status
)

The parameters of ASLDE-DATA. Confirm primitive are specified in Table 14.

Table 14 – ASLDE-DATA. Confirm parameters

Name	Data type	Valid range	Description
VCR_ID	Unsigned16	0 to 65 535	Virtual Communication Relationship
Status	Usigned8	0 to 255	The status of the corresponding request: 0 = SUCCESS; 1 = INVALID_ADDRESS; 2 = FAIL; Others are reserved

6.4.6.4 ASLDE-DATA. Indication

After receiving message from the network layer, the ASL transfers the user data to the upper layer by using the ASLDE-DATA. Indication primitive. The upper layer then performs the corresponding operation and processes the user data according to different service types.

The semantics of this primitive are as follows:

ASLDE-DATA. Indication (
Method Identifier,
Asdu Length,
Asdu
)

The parameters of ASLDE-DATA. Indication primitive are specified in Table 15.

Table 15 – DATA. Indication parameters

Name	Data type	Valid range	Description
Method Identifier	Unsigned8	0 to 255	Method identifier
Asdu Length	Unsigned8	0 to 255	The length of the data received by ASL
Asdu	Octet string	Reserved	The data received by ASL

6.5 Application sub-layer message format

6.5.1 General

The ASL general message includes the following three parts:

– ASL header: message control, sequence number, payload length.
– ASL Variable header: correspond to different types (commands, data), octet is changed accordingly.
– ASL Payload: this subfield has variable length and is used to fill in the ASL data.

6.5.2 ASL general message format

6.5.2.1 General

The format of the general message is shown in Table 16.

Table 16 – Application sub-layer general message format

ASL header			ASL Variable header	ASL Payload
1 octet	1 octet	1 octet	1 octet	Variable length
Control field	Sequence number	Payload length	Variable header	Payload

6.5.2.2 Message control field

The length of the control field is 8 bits. The message control field includes the message type, security, ACK, transmission model, and reserved subfields. The message control field format is shown in Table 17.

Table 17 – Message control field format

Message type	Security	ACK	Transmission model	Reserved
Bit:0 to 1	Bit:2	Bit:3	Bit:4 to 5	Bit:6 to 7

1) Message type subfield

The length of the message type subfield is 2 bits. Its value is shown in Table 18.

Table 18 – Message type subfield value

Message type value	Message type name
00	Data
01	Command
10	Acknowledgement
11	Reserved

2) Security subfield

The length of the security subfield is 1 bit. The security subfield is used to control whether the ASL uses the security function when transmitting the data. If the security subfield (namely b2) is set to 0, it indicates that the ASL does not use security operation; if b2 is 1, it indicates that the ASL uses the security operation to encrypt the data payload part of the application message, and is encapsulated as the following security format.

The application layer security message is based on the general message plus the security control field and the message integrity check field. The format of the security control is shown in Table 19.

Table 19 – Format of the security control

ASL header				ASL Variable header	ASL Payload	MIC
1 octet	1 octet	1 octet	1 octet	1 octet	Variable length	4 octets
Control field	Sequence number	Payload length	Security	Variable header	Payload	Check

a) Security control subfield

The length of the security control subfield is 1 octet. It is used to indicate the type of security used by the application layer message. Its value is shown in Table 20.

Table 20 – Security control subfield value

Security control value	Security control type
00	NONE
01	ENC
10	MIC-32
11	ENC-MIC-32

b) Message integrity check subfield

The length of the message integrity check subfield is 4 octets, using the MIC-32 check code to check the integrity of the data load field.

3) Acknowledgement subfield

The length of the acknowledgement subfield is 1 bit. It is used to specify whether application message acknowledgement is needed. If the acknowledgement subfield (namely b3) is set to 0, it indicates that the acknowledgement is not needed; if the value of this bit is set to 1, it indicates that the acknowledgement is needed.

4) Transmission model subfield

The length of the transmission model subfield is 2 bits, which is used to indicate the ASL communication model. Its value is shown in Table 21.

Table 21 – Value of transmission model subfields

Value of transmission model	Transmission model
00	R/R
01	P/S
10	R/S
11	Reserved

ASL only uses the transmission model subfield when transmitting a message.