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Abstract: This document is the output text of draft Recommendation ITU-T Y.4420-rev "Framework of Internet of things based monitoring and management for elevators", resulting from the Q2/20 meeting (Geneva, 15-25 September 2025)

At the Q2/20 meeting, a contribution was proposed and discussed. The following table summarizes the proposals and relevant discussion results.

Doc. No.	Source	Title	Proposals	Discussion and results
SG20-C299	Korea (Rep. of)	Y.4420-rev on "Framework of Internet of things based monitoring and management for elevators", proposed text update for consent	It provides clarifications on the highlights and editor's notes.	The contribution was discussed at the meeting and agreed with modifications: - aligned the scope with the content of the document. - revised the figure to changed "Internet" to "Network" and "lift" to "elevator". - approval process changed from AAP to TAP. - revised the bibliography.

Revised Draft Recommendation ITU-T Y.4420-rev

Framework of Internet of things based monitoring and management for elevators

Summary

Recommendation ITU-T Y.4420 describes a framework of Internet of things (IoT) based monitoring and management for elevators, including a protocol and a data model, and requirements for external control of elevators using IoT technologies. Elevators need to interact with applications through communication networks to provide different kinds of services to end users. In many cases, elevators cannot connect to communication networks directly. Therefore, gateways support the interconnection of such elevators with communication networks. Correspondingly, various elevator companies also apply their own data models and protocols. For this reason, interoperability problems have occurred, and therefore this framework will facilitate IoT based monitoring and management for elevators to operate in conjunction with each other.

Keywords

Elevator, Internet of things (IoT), management, monitoring.

Table of Contents

Page

1 Scope 4

2 References 4

3 Definitions 4

3.1 Terms define elsewhere 4

3.2 Terms defined in this Recommendation 5

4 Abbreviations and acronyms 5

5 Conventions 5

6 Overview of IoT based monitoring and management for elevator 5

7 Requirements for external control of elevator based on IoT technologies 7

7.1 Elevator monitoring for external control 7

7.2 Elevator management for external control 7

8 Framework of IoT based monitoring and management for elevator 7

8.1 General framework for IoT based monitoring and management of elevator 7

8.2 Framework of the elevator gateway 9

9 Protocols and data models for IoT based elevator monitoring and management 10

9.1 Protocols for elevator monitoring and management 10

9.2 Message structure for elevator monitoring and management 10

9.3 Data models for elevator monitoring 12

9.4 Data model for elevator remote control and management 15

Appendix I Use cases of IoT based monitoring and management for elevator 17

I.1 Remote control of elevator operation modes 17

I.2 Elevator monitoring in smart building 17

I.3 Autonomous indoor delivery service 18

Bibliography 21

Recommendation ITU-T Y.4420

Framework of Internet of things based monitoring and management for elevators

1 Scope

This Recommendation provides a framework of Internet of things (IoT) based monitoring and management for elevator. The scope of this Recommendation includes:

– overview of IoT based monitoring and management for elevator;

– requirements for external control of elevator based on IoT technologies;

– framework of IoT based monitoring and management for elevator;

– protocols and data models for IoT based elevator monitoring and management.

Use cases of IoT based monitoring and management for elevators are provided in Appendix.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.4101] Recommendation ITU-T Y.4101/Y.2067 (2017), *Common requirements and capabilities of a gateway for Internet of things applications*.

3 Definitions

3.1 Terms define elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 device [b-ITU-T Y.4000]: With regard to the Internet of things, this is a piece of equipment with the mandatory capabilities of communication and the optional capabilities of sensing, actuation, data capture, data storage and data processing.

3.1.2 elevator [b-ISO 8100-20:2018]: A hoisting and lowering mechanism, equipped with a car, that moves within guides and serves two or more landings.

3.1.3 gateway [ITU-T Y.4101]: A unit in the Internet of things which interconnects the devices with the communication networks. It performs the necessary translation between the protocols used in the communication networks and those used by devices.

3.1.4 Internet of things (IoT) [b-ITU-T Y.4000]: A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

NOTE 1 – Through the exploitation of identification, data capture, processing, and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled.

NOTE 2 – From a broader perspective, the IoT can be perceived as a vision with technological and societal implications.

3.1.5 sensor [b-ITU-T L.1301]: A device that transforms a physical value (e.g., temperature, current) into an electrical or logical unit. The sensor can be directly connected with a data stream to the management system or via a conversion device.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

none.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CCTV Closed Circuit Television

CoAP Constrained Application Protocol

ELMP-485 Elevator Monitoring Protocol over RS-485

GW Gateway

HTTP Hypertext Transfer Protocol

IoT Internet of Things

LPWA Low-Power Wide-Area

MQTT Message Queuing Telemetry Transport

NB-IoT Narrowband IoT

RS-232 Recommended Standard 232

RS-485 Recommended Standard 485

5 Conventions

The following conventions are used in this Recommendation:

– The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation is to be claimed.

– The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

– The keywords "can optionally" and "may" indicate an optional requirement which is permissible, without implying any sense of being recommended. These terms are not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

6 Overview of IoT based monitoring and management for elevator

An elevator is a type of vertical transport device that is powered by electric motors that drive traction cables and counterweight systems like a hoist.
An elevator moves people or goods between floors of a building or other structures.
Each component of the elevator, i.e., control board, motor, floor and car, functions as an IoT device, making the elevator effectively a collection of interconnected IoT devices.

Figure 1 describes an overview of the elevator monitoring and management system.

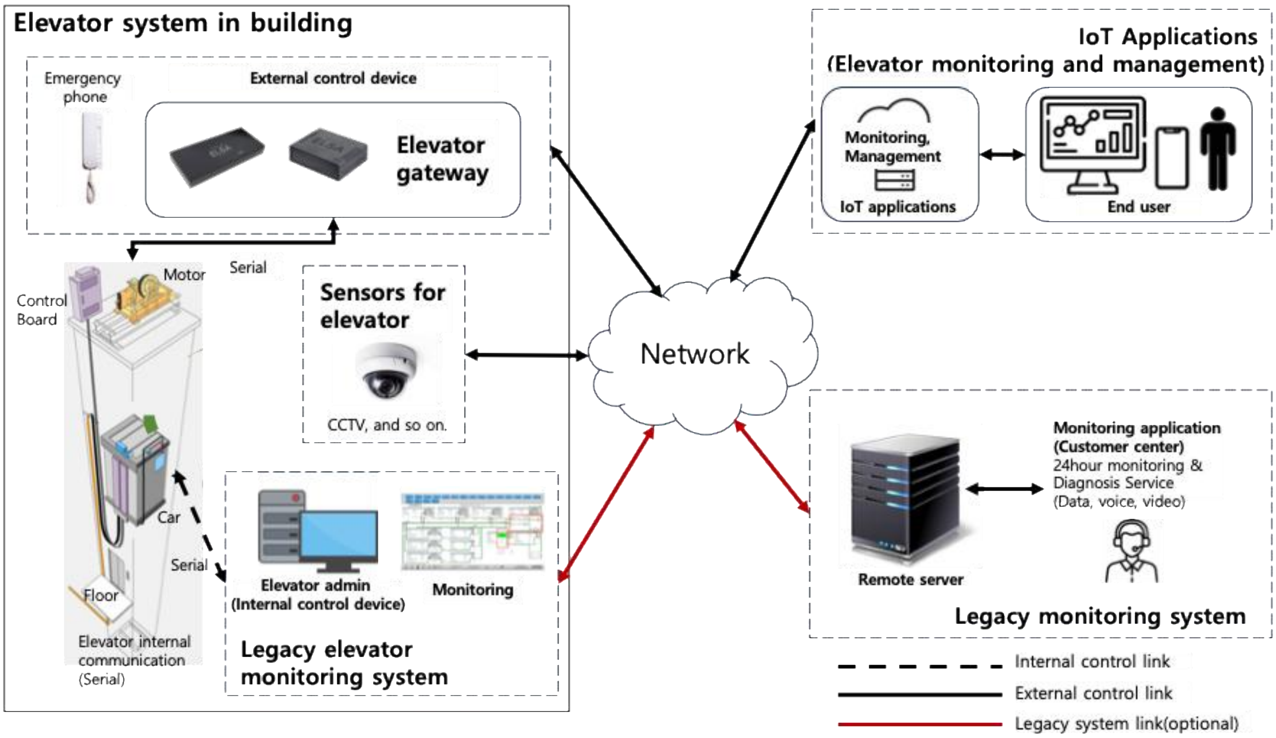

Figure 1 – Overview of elevator monitoring and management system

The control board and the other components of the elevator are connected each other by serial communication. The legacy elevator monitoring system is installed for the purpose of integrating monitoring and management of elevators in a building.
In addition, legacy elevator monitoring system and elevator gateway connect to elevators using serial communication. They are configured to enable network function and stores information on the remote server. Several elevator vendors install remote monitoring systems for elevators. IoT applications and legacy monitoring system are operated for elevator monitoring and management. Devices such as closed circuit television (CCTV) [b-ITU-T X.1114] installed in the elevator are directly linked to the network and used for data transmission to a remote server or monitoring.

The legacy elevator monitoring system has an issue with other devices or other vendors' elevators interworking in the building. This is due to the elevator industry using its own communication protocols and data models for communication between the elevator's control board and other components of the elevator. In addition to this, communication methods are also used to connect with the legacy elevator monitoring system. Therefore, when installing in buildings elevators of different companies, it is difficult to integrate, manage and monitor these elevators.

The elevator operations can be controlled via internal elevator control or via external elevator control.
Internal elevator control refers to direct control through the elevator control board. NOTE - This control can be accessed by the elevator administrator via the debugging and inspection terminals on the elevator control board or the control switch on the elevator control panel.
External elevator control refers to the capability of issuing commands to regulate elevator operations through an external system, such as a smartphone application or a management system. In particular, the utilization of this function enables end users to reserve an elevator through a smartphone application. Also, external elevator control can be integrated within a building management system, thereby restricting access to specific floors to only those end users who have been authenticated.

Elevators can be monitored or controlled externally via the elevator gateway as shown in Figure 1. IoT based monitoring and management for the elevator using elevator gateway has the following advantages: the elevator gateway can interwork with different elevator vendors and other devices in the building; moreover, it can use a variety of existing IoT applications.

Elevators need to interact with applications through communication networks to provide different kinds of services to end users. In many cases, elevators cannot connect to communication networks directly. Therefore, gateways support the interconnection of such elevators with communication networks. Correspondingly, different elevator companies apply their own data models and protocols. For this reason, interoperability problems may occur.

What highlighted above makes it difficult to establish a unified approach for monitoring and managing elevators across different systems. This Recommendation describes a unified framework of IoT based monitoring and management for elevator.

7 Requirements for external control of elevator based on IoT technologies

7.1 Elevator monitoring for external control

– IoT device authentication is recommended for external access to elevator monitoring.
– IoT devices can optionally provide elevator operation statistics for elevator monitoring purposes.
– Elevator gateway is required to provide elevator operating status and current floor information to IoT applications for external control.
– Elevator gateway is required to provide car overload information (see details in Table 5) in order to convey accurate elevator's boarding status.
– Elevator gateway can optionally identify and distinguish devices using a hierarchical identifier structure, consisting of the elevator identifier and the corresponding device identifier.

7.2 Elevator management for external control

– IoT device authentication is required for external access to elevator management.
– IoT devices can optionally provide remote reset of elevators for management purposes.
– Elevator gateway is required to transmit remote call data in order to support elevator calling from IoT applications.
– Elevator gateway can optionally identify and distinguish between external and internal components in order to set appropriate management priorities.

8 Framework of IoT based monitoring and management for elevator

8.1 General framework

Figure 2 illustrates a general framework of IoT based monitoring and management of elevator.

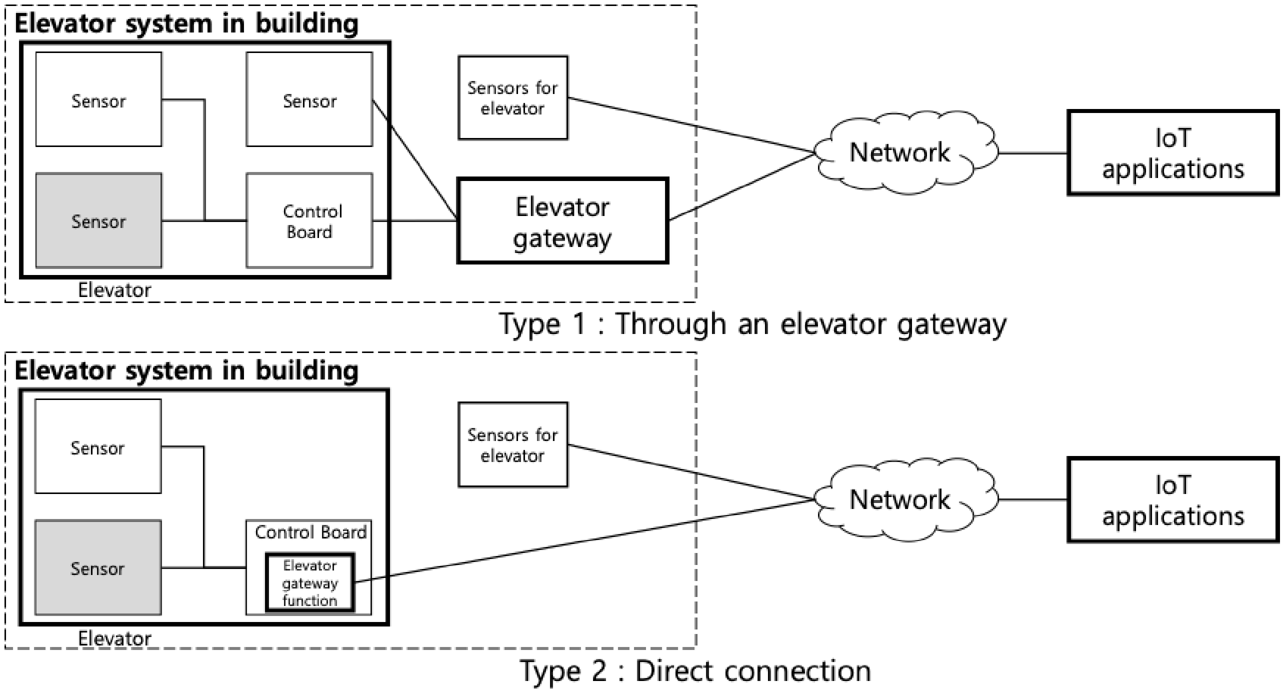

Figure 2 – General framework of IoT based monitoring and management of elevator

The amount of data generated by the sensors in the elevator is generally 100kbps or less. The sensors communicate with the control board using serial communication such as RS-232 [b-TIA-232] and RS-485 [b-TIA-485].

The sensors can be distinguished into full resource sensors (shown as white boxes in figure 2) and resource constrained sensors (shown as grey boxes in figure 2).

Sensors and control board in the elevator interwork with IoT applications. The elevator gateway is the connecting element between control board and IoT applications. However, some full resource sensors and control board may also be directly connected to IoT applications.

The sensors' data are transferred to the IoT applications through the elevator gateway (type 1 case of Figure 2) or directly (type 2 case of Figure 2).

Some elevators are also equipped with extra sensors for purposes such as inspection, monitoring and management. In this case, these extra sensors may not be connected to the control board to prevent that unauthorized connected sensors might cause elevator malfunctions or security issues.

Among the sensors installed in the elevator, CCTV and vibration sensors typically generate 2Mbps or more data. When a large amount of data is transmitted through a gateway, a problem of data transmission error or delay may occur more frequently in the gateway. Accordingly, these kinds of IoT devices may have a direct connection with the IoT applications.

The direct connection between the elevator and the IoT applications takes place according to the elevator administrator's requirements. Some control boards support wireless or wired network communication capabilities to connect directly with the IoT applications. In this case, an elevator gateway function is present in the control board. In case of wireless network communication capabilities, the elevator gateway function can transmit data directly to the IoT applications by using low-power wide-area (LPWA) [b-IEEE 802.15.4w] network or narrowband IoT (NB-IoT) [b-3GPP TR 36.802] communication. NOTE 1 - The LPWA network is capable of long-distance communication and large-scale device access while satisfying the low power required by the IoT environment.

The main function of the elevator gateway is to collect elevator information and to transmit elevator control signals. If the gateway performance is sufficient, it is also possible to execute at the gateway level some functions which are normally performed at the IoT applications level.
The gateway periodically transmits the data to the IoT applications without specific triggering or transmits the data to the IoT applications in case of triggered event (previously registered by the elevator admin).
In the type 1 case of Figure 2, the IoT applications use the elevator gateway to control the sensors or the control board of the elevator. The gateway can also transfer control requests from the IoT applications to the elevator. NOTE 2 - Constrained application protocol (CoAP) [b-IETF RFC 7252], Hypertext transfer protocol (HTTP) [b-IETF RFC 7540] and message queuing telemetry transport (MQTT) [b-ISO/IEC 20922] are typical application protocols used in IoT environments and they are used by the gateway to transmit data.

The IoT applications collect and manage the information from the elevator. The IoT applications include monitoring for elevator safety and operation status, elevator emergency control, and elevator's parts management. It is also possible to configure IoT applications for external calling and remote control of elevators. For example, an IoT application can be configured to have access to the elevator if there is an elevator safety issue.

8.2 Framework of elevator gateway

This clause describes the framework of elevator gateway.

The elevator gateway is equally applicable to both type 1 (connection through an elevator gateway) and type 2 (direct connection) in the general framework.
The elevator gateway follows the reference technical framework of a gateway for IoT applications defined in [ITU-T Y.4101]. As shown in Figure 3, some modules are extended modules for the elevator gateway with respect to the IoT gateway specified in [ITU-T Y.4101]. The extended modules are the device adaptation module and the network adaptation module in the adaptation capabilities group, and the data processing module in the support capabilities group.

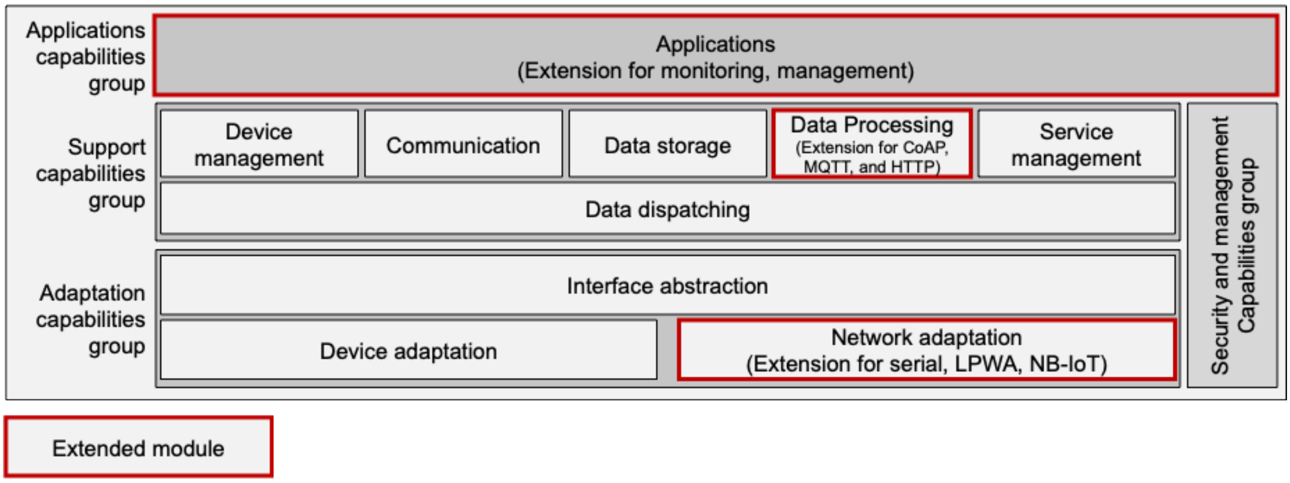

Figure 3 – Framework of elevator gateway (extended from [ITU-T Y.4101])

The elevator gateway requires some extensions for the network adaptation module and the network processing module.

The extension of device adaptation is as follows:

– The elevator gateway needs to extend the device adaptation module to support interworking with the elevator (connection with sensors and elevator control board).

The extension of network adaptation is as follows:

– The elevator's control board and sensors transmit data through non-IP based serial communication. The IoT applications transmit data through non-IP based or IP based communication. For interworking with serial communication devices and IoT applications, the elevator gateway must also extend the network adaptation module to enable serial, LPWA and NB-IoT communications.

The extension of data processing is as follows:

– The data processing module of the elevator gateway encapsulates or decapsulates data based on the application protocol. Accordingly, the data processing module of the elevator gateway must be extended to support specific application protocols used in IoT applications for elevator.

9 Protocols and data models for IoT based elevator monitoring and management

This clause specifies protocols and data models for elevator monitoring and management.

9.1 Protocols for elevator monitoring and management

Figure 4 shows the protocols applied in elevator, elevator gateway and IoT applications. Elevators support control and monitoring through serial protocols like RS-232 and RS-485. The elevator monitoring protocol over RS-485 (ELMP-485) - specified in this Recommendation - supports communication between elevator and the elevator gateway.

The elevator transmits monitoring and management data to the elevator gateway with ELMP-485, and the elevator gateway transmits monitoring and management data to the IoT applications using IoT application protocols (e.g., CoAP, MQTT, and HTTP).

The protocol conversion process occurs in the elevator gateway.

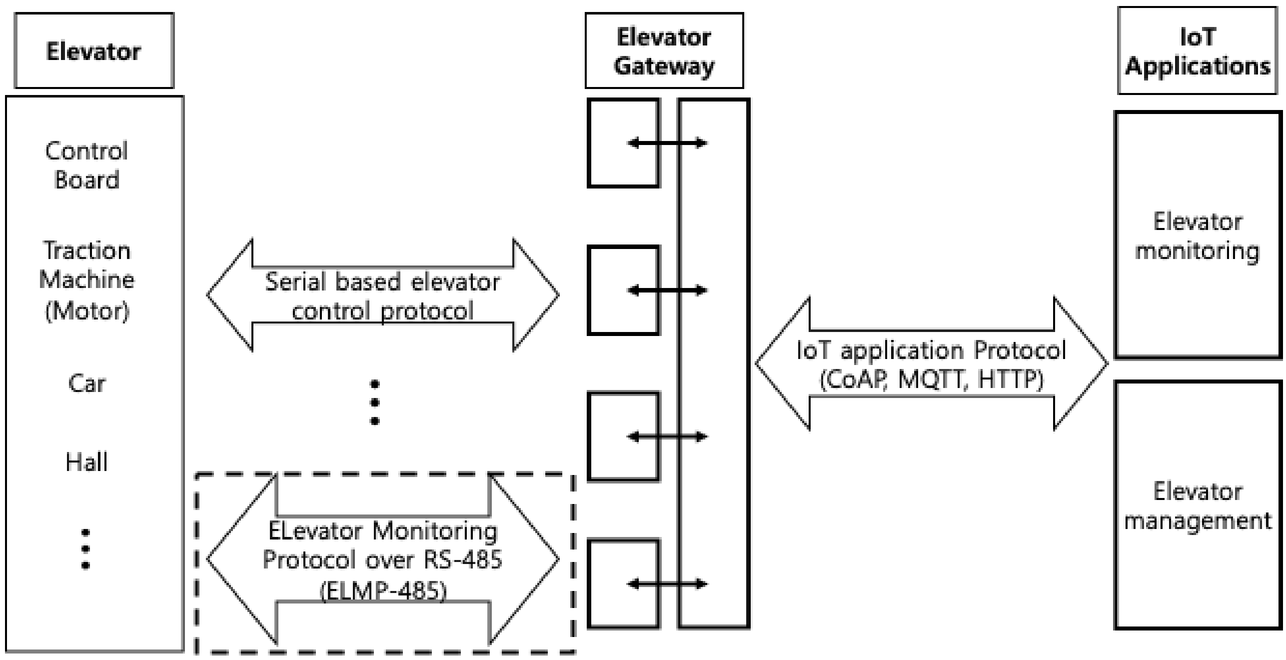

Figure 4 – Protocols for IoT based elevator monitoring and management

9.2 Protocol structure for elevator monitoring and management

The structure of the ELMP-485 protocol is shown in Figure 5.

This message uses a flag value to separate the start and end. The values of the start flag (SF) and the end flag (EF) used are the same and are '0x7E' of 1 byte. This flag value '0x7E' can also be used in areas other than the start and end flags.

Start flag (SF-0x7E)	Destination address (DA)	Message type (Type)	Data field length (Len)	Data field (DATA)	Cyclic redundancy check (CRC)	End flag (EF-0x7E)
1 byte	1 byte	1 byte	2 bytes	n byte	2 bytes	1 byte

Y.4420(21)

Figure 5 – ELMP-485 protocol structure

The destination address classification is shown in Table 1.

Table 1 – ELMP-485 destination address classification

Classification	Address
Broadcast address	0x00
Individual address	0x01 ~ 0xF7
Reserved address	0xF8 ~ 0xFF

The message type is 1 byte and is shown in Table 2. The data field length and the value of the data field are determined according to the message type.

Table 2 – ELMP-485 message type

Value	Message type
0x01	Data request
0x02	Data response
0x03	Update request
0x04	Update response
0x05~0xFF	Discard

An example of the structure of the data request and response is shown in Figure 6.

	SF	DA	Type	Len	Data	CRC-16	EF
Data request	0x7E	0x02	0x01	0x0004	0x03FFF8F0	0x16B9	0x7E

	SF	DA	Type	Len	Data	CRC-16	EF
Data response	0x7E	0x01	0x02	0x0004	0x03F80105	0x3068	0x7E

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Figure 6 – Example of ELMP-485 data request and response structure

If '0x7E' is included in the ELMP-485 message, the escape function is used to prevent it from being recognized as SF or EF. For the escape function, the value of the '0x7D' escape flag is defined. When a value of '0x7E' is used outside the start and end flag areas or an escape flag value of '0x7D' is used, an escape flag value of '0x7D' is added before the corresponding byte. In addition, to prevent escape data from remaining in the transmitted message, the data byte value is XOR to '0x20' and transmitted.

9.3 Data models for elevator monitoring

Figure 7 shows the elevator structure.

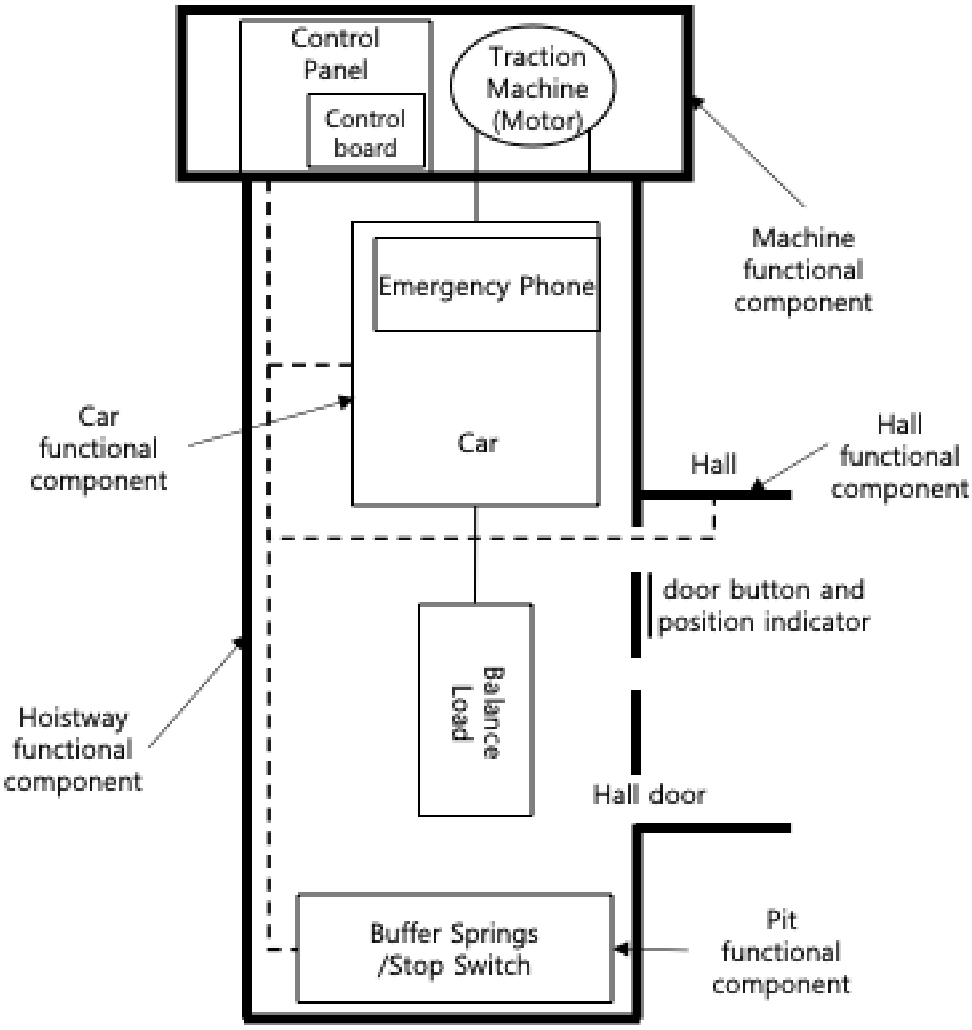

Figure 7 – Functional component structure of the elevator

The elevator is functionally divided into machine, car, hall, pit and hoistway functional components.
The machine functional component assists the control panel and the traction machine (motor).
The car functional component assists the emergency phone and car.
The hall functional component assists components located on each floor.
The pit functional component assists the buffer springs (also named stop switch) located in the inspection space under the elevator for the safe operation of the elevator system.
The hoistway functional component assists the elevator hoistway and includes guide rail, counter weight and wire rope located on the entire hoistway where the car moves.

The basic elevator information is shown in Table 3. This information is determined when the elevator is manufactured and installed in the building. NOTE - In all the tables below of this clause, “M/O” stands for “mandatory/optional” data element. Data access mode can be read (R), write (W), or both.

Table 3 – Basic elevator information

Data element	Data access modes	Data type	M/O	Description
Elevator no.	R	String	M	Elevator unique identifier that can be identified in the network
Elevator local no.	R	String	M	Elevator unique identifier installed in a building
Manufacturer	R	String	M	Elevator manufacturer
Model	R	String	M	Elevator model
Speed	R	Float32	M	Rated speed designed for elevator (unit: m/s)
Load	R	Uint8	O	Rated load designed for elevator (unit: kg)
Floor	R	Uint8	M	Total number of floors that the installed elevator supports (example: the total number of elevator floors operating on the second basement and fourth floors above the ground is indicated as '6')
Base floor	R	Uint8	M	The floor that is the standard for elevator operation (This refers to the lobby floor or the floor that can entered and exited from outside for firefighting purposes)

The data models for elevator monitoring are specified below concerning the machine functional component, the car functional component and the hall functional component.

NOTE - The data models for the hoistway functional component and the pit functional component are out of scope of this Recommendation due to their non relevance for remote monitoring and control.

Table 4 shows the elevator operation status information for the machine functional component.
The machine functional component assists the control panel and the traction machine located at the top of the hoistway or within the hoistway itself. The machine functional component is installed inside the hoistway to hall the functions of the machine room.

Table 4 – Elevator operation status information: Machine functional component

Data element	Data access modes	Data type	M/O	Description
Machine room temperature	R	Float32	O	Current temperature of the machine room where the traction machine, electric motor, and control panel are installed
Control board communication state	R	Boolean	O	Control board status information installed in the machine room (Power and communication status is normal: true)
Control board protocol	R	Uint8	M	Protocol information used by the control board
Control panel model	R	String	M	Control panel mainboard model information
Traction machine operation signal	R	Boolean	M	Traction machine start signal (Operation: true, stop: false)

Table 5 shows the elevator operation status information for the car functional component. The car functional component assists the car and the doors located in the car for transportation purposes, and also includes an emergency call device.

Table 5 – Elevator operation status information: Car functional component

Data element	Data access modes	Data type	M/O	Description
Car operation mode	R	Uint8	M	Elevator basic operation mode (normal, manual check, etc.), Firefighting (optional operation mode), Evacuation (fire, earthquake detection, etc.) (optional operation mode), Dedicated driving (optional operation mode), other optional operation mode.
Car current floor	R	Uint8	M	The floor where the car is located (the lowest floor starts from 0)
Car destination floor	R	Uint8	M	The current floor from where the car moves
Car current direction	R	Uint8	M	Car driving direction (0: stop, 1: upward, 2: downward)
Car current speed	R	Float32	M	Car current running speed (unit: m/s)
Car overspeed	R	Boolean	M	Overspeed, when the rated speed set on the car exceeds 115% (Overspeed-true)
Car overload	R	Boolean	M	Exceeding the rated load of the car (Overload: true)
Car call status	R, W	BitArray	M	Car call status information (If the call is made from each floor, it is displayed as 1)
Car level state	R	Boolean	M	The difference in height between the car and hall is recognized, and if it is within the error of the reference value, it is considered normal.
Car door state	R, W	Uint8	M	Information about whether the car door is open, closed, or in progress. (Open-0, Opening-1, Closed-2, Closing-3)
Operation panel board (OPB) state	R	Boolean	M	Whether the communication state of the OPB installed in the car is normal (Normal: true)

Table 6 shows the elevator operation status information of the hall functional component. The hall functional component assists hall door button and position indicator on each floor.

Table 6 – Elevator operation status information: Hall functional component

Data element	Data access modes	Data type	M/O	Description
Hall door state	R	Boolean	M	Switch status connected to the hall door (Close (True) check switch)
Hall indicator button state	R	BitArray	M	Status information of floor indicators and buttons installed on the hall (normal - indicated as '1')
Hall up call status	R,W	BitArray	M	Hall up call status information
Hall down call status	R,W	BitArray	M	Hall down call status information

Table 7 shows the information of the elevator operation statistics related to operation after elevator construction.

Table 7 – Elevator operation statistics information

Data element	Data access modes	Data type	M/O	Description
Operation count	R	Uint32	M	Total number of trips counted as one elevator start and stop
Operation distance	R	Uint32	O	Total cumulative elevator travel distance (unit: m)
Operation time	R	Uint32	O	Total cumulative elevator operation time (unit: H)
Downtime	R	Uint32	O	Accumulated stop time due to elevator failure (Unit: H)

Table 8 is the information for elevator failure that can be displayed in the elevator control board and in the failure reports.

Table 8 – Elevator error information

Data element	Data access modes	Data type	M/O	Description
Main_ErrorCode	R	Uint16	M	Manufacturer's main error code

9.4 Data model for elevator remote control and management

Table 9 is the basic data model for elevator remote control information that can be sent and received from IoT devices outside the elevator.

Table 9 – Elevator remote control information

Data element	Data access modes	Data type	M/O	Description
Fault Reset	R,W	Uint16	O	Control to externally reset the device in case of fault.
Select floor	R,W	Uint16	M	Control car floor from the outside
Car call (Up)	R,W	Uint16	M	Control car call up status from the outside
Car call (Down)	R,W	Uint16	M	Control car call down status from the outside
Door open	R,W	Uint16	M	Control car door opening from the outside
Door close	R,W	Uint16	M	Control car door closing from the outside

Appendix I

Use cases of IoT based monitoring and management for elevator

(This appendix does not form an integral part of this Recommendation.)

I.1 Remote control of elevator operation modes

The manager of a building should notify the people present in the building and quickly evacuate or rescue them in the event of an earthquake, fire, or other disaster.

In case of a disaster, the elevators are operated in an emergency operation mode, and not in a normal operation mode. The elevators are used to evacuate or rescue people.

It is necessary to install sensors and devices capable of detecting disasters such as fires and earthquakes in buildings, and these sensors and devices must be integrated with the elevators. If such sensors and device are not directly connected to the elevators, the relevant disaster information must be collected and transmitted to an external elevator related disaster management system.

Moreover, in the event of an emergency, the elevators' operation mode should be changed accordingly. To support this, IoT-based management capabilities are required to monitor and manage elevators by utilizing additional sensors, devices, or external information. As shown in Figure I.1, the fire detector or seismograph installed in the building is connected to the elevator through the elevator gateway, and the elevator gateway informing about the earthquake and fire is interconnected with the IoT application.

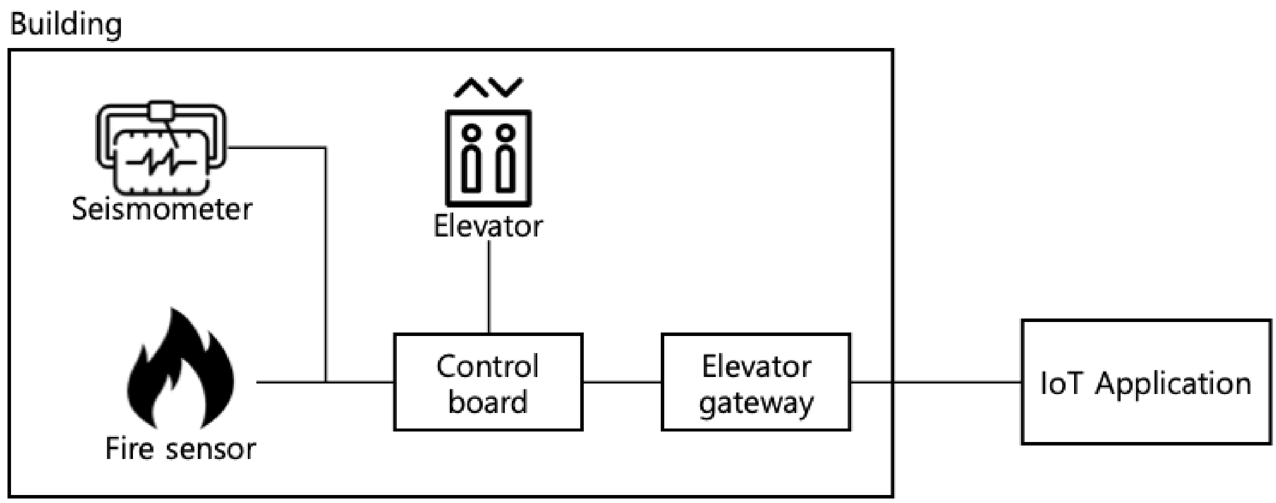

Figure I.1 – Remote control of elevator operation modes

I.2 Elevator monitoring in smart building

As shown in Figure I.2, there are various IoT devices present in smart buildings. The elevator is one of them. In a normal building with multiple elevators installed, the elevators will stop according to the initial setting regardless of the number of people waiting. If one of the elevators closest to the call floor stops, the other elevators will either cancel or stop. Therefore, elevators run inefficiently. However, in smart buildings, the number of people waiting is monitored using CCTV and, based on this information, one or several elevators to the call floor stops. In addition, it is possible to make only a specific floor accessible to a specific user or disable access to a specific floor by interworking with a security system in the smart building.

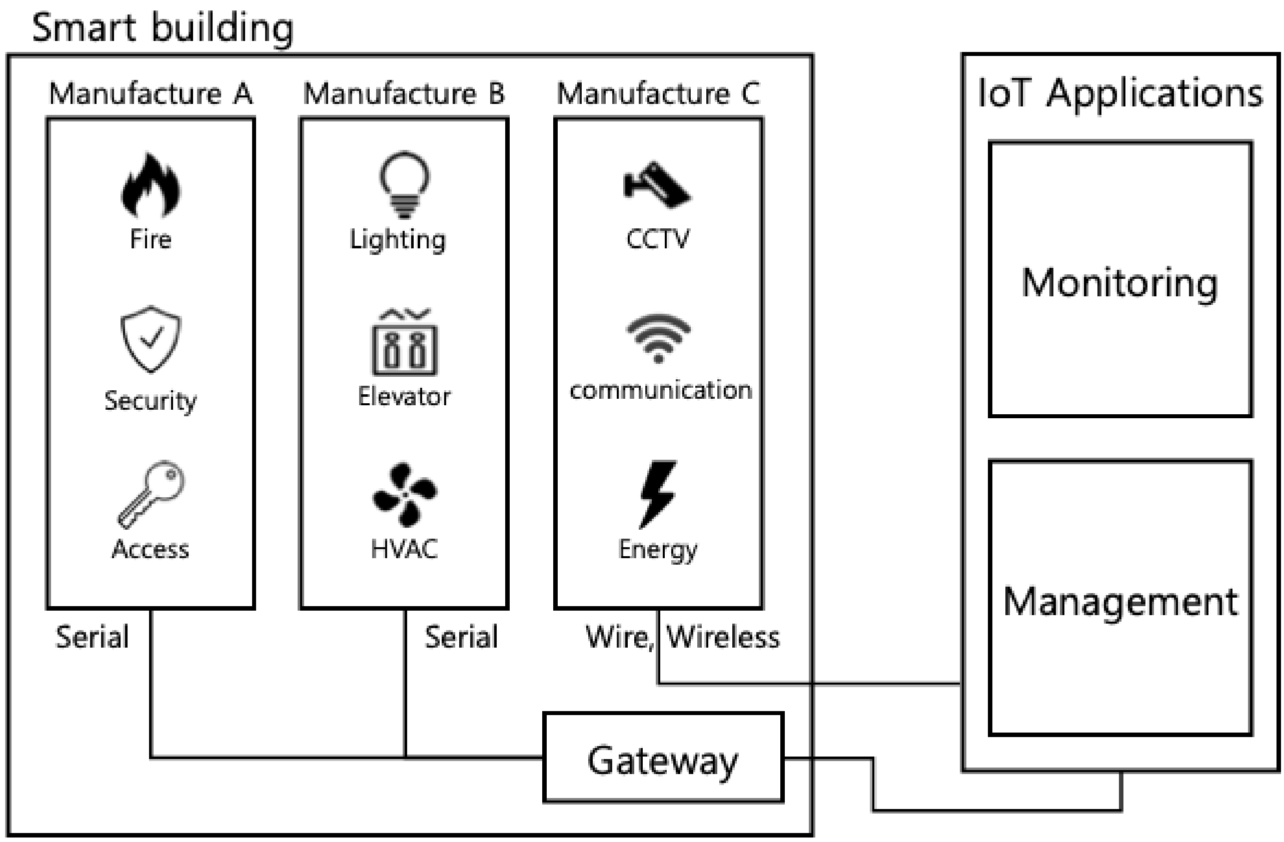

Figure I.2 – Elevator monitoring in smart building

I.3 Autonomous indoor delivery service

Service robot vendors are starting to indoor delivery services. Figure I.3 shows an example of autonomous indoor delivery service. The indoor delivery process is as follows:

– A delivery person drops off the package at pickup location in the building.

– The service robot takes the package

– The service robot enters the building through the speed gate or automatic gate.

– The service robot takes to another floor using an elevator.

– The service robot arrives at its final destination.

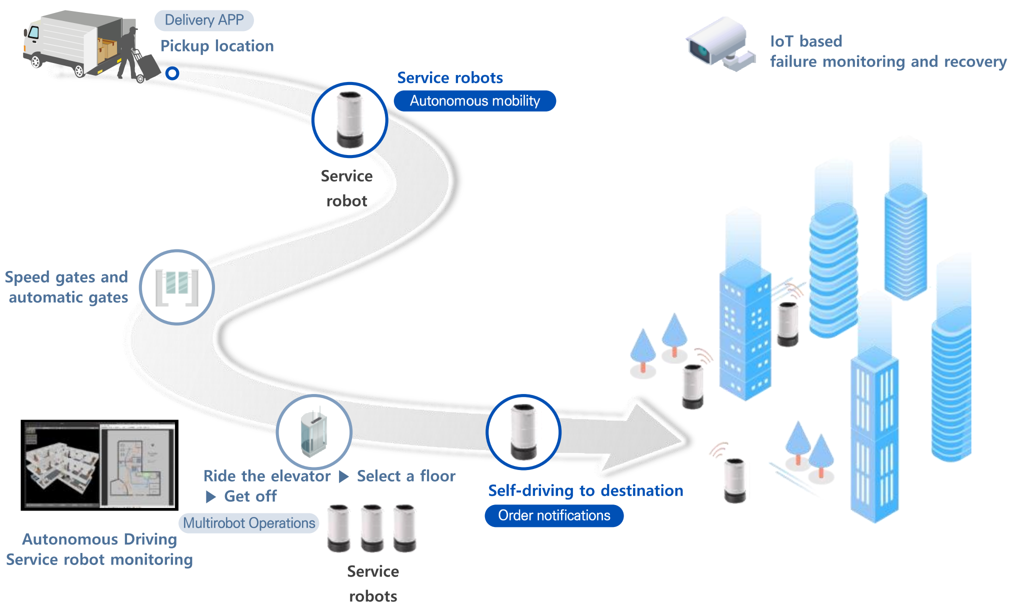

Figure I.3 – Example of autonomous indoor delivery service

Figure I.4 shows the interworking structure for autonomous indoor delivery service's service robot. The service robot's interworking structure consists of three parts:

– Application Services: Various application services, such as autonomous delivery.

– Intelligent Service Robots: A system for managing and monitoring service robots.

– Smart Building Systems: IoT based building system to support autonomous indoor delivery service

In order for the service robot to ride on the elevator, it is necessary to monitor and call the elevator externally.

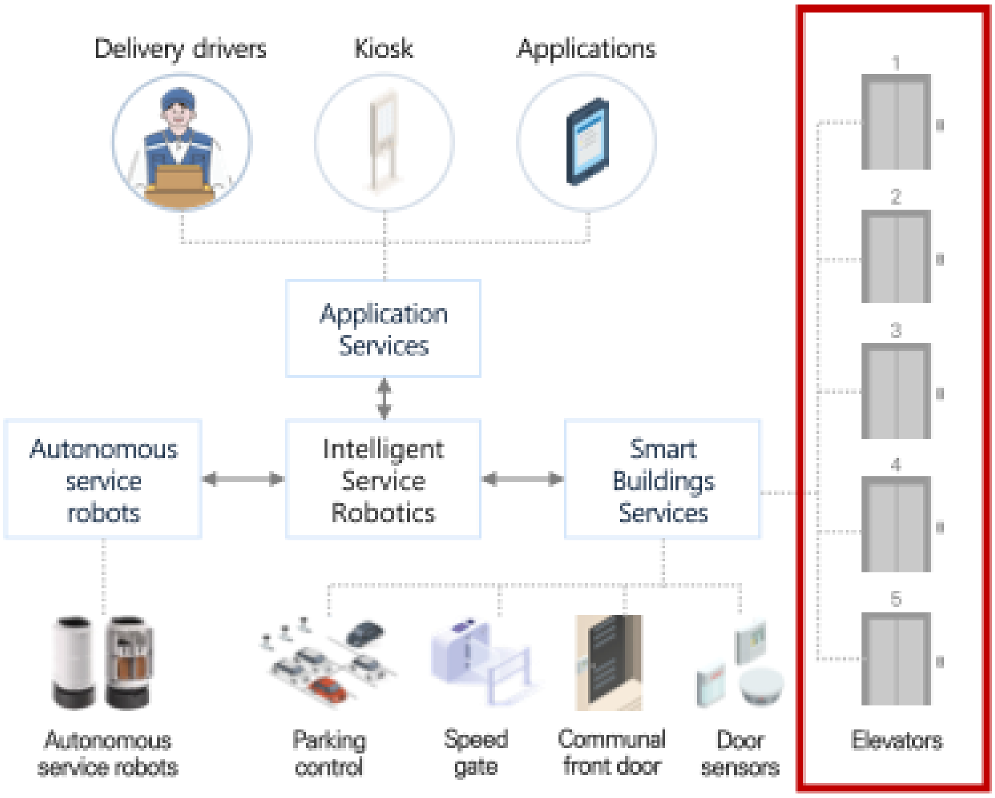

Figure I.4 – Elevator external control system in autonomous indoor delivery service

Bibliography

[b-ISO 8100-20:2018] ISO 8100-20:2018, *Lifts for the transport of persons and goods — Part 20: Global essential safety requirements (GESRs)*.

[b-ITU-T L.1301] Recommendation ITU-T L.1301 (2005), *Minimum Data Set and Communication Interface requirements for Data Centre Energy Management*.

[b-ITU-T X.1114] Recommendation ITU-T X.1114 (2008), *Authorization framework for home networks*.

[b-ITU-T Y.4000] Recommendation ITU-T Y.4000/Y.2060 (2012), *Overview of the Internet of things*.

[b-IEC 61131-3] IEC 61131-3 (2013), *Programmable controllers – Part 3: Programming languages*.

[b-IEEE 802.15.4w] IEEE 802.15.4w (2020), *IEEE Standard for Low-Rate Wireless Networks – Amendment 2: Low Power Wide Area Network (LPWAN) Extension to the Low-Energy Critical Infrastructure Monitoring (LECIM) Physical Layer (PHY)*.

[b-IETF RFC 7252] IETF RFC 7252 (2014), *The Constrained Application Protocol (CoAP)*.

[b-IETF RFC 7540] IETF RFC 7540 (2015), *Hypertext Transfer Protocol Version 2 (HTTP/2)*.

[b-ISO/IEC 20922] ISO/IEC 20922 (2016), *Information technology — Message Queuing Telemetry Transport (MQTT) v3.1.1*.

[b-3GPP TR 36.802] 3GPP TR 36.802 (2016), *Evolved Universal Terrestrial Radio Access (E-UTRA); NB-IOT; Technical Report for BS and UE radio transmission and reception.*

[b-TIA-232] TIA-232 (1997), *Interface Between Data Terminal Equipment and Data Circuit- Terminating Equipment Employing Serial Binary Data Interchange*.

[b-TIA-485] TIA-485 (1998), *Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems*.