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Recommendation

ITU-T L.1630 (01/2023)

SERIES L: Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant

Circular and sustainable cities and communities

Framework of a building infrastructure management system for sustainable cities

ITU-T L-SERIES RECOMMENDATIONS

ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

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Recommendation ITU-T L.1630

Framework of a building infrastructure management system for sustainable cities

Summary

One of the sustainable development goals of a sustainable city is to build resilient and safe city assets. Building is one of the key city assets and is closely related to the circular and sustainable city. Typically, energy and firefighting equipment are key items of equipment within the building infrastructure and may affect the safety of people. Currently, many items of energy and firefighting equipment are separately deployed and managed, so there exist gaps between energy equipment management and firefighting equipment management. Recommendation ITU-T L.1630 defines the framework of a building infrastructure management system which improves the sustainability of a city, particularly of buildings as a city asset. The framework provides a holistic management of building infrastructure. It also presents service use cases composed of functional elements.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Keywords

Building, building infrastructure, management system, sustainable city.

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Framework of a building infrastructure management system for sustainable cities

1 Scope

This Recommendation describes a specification of the building infrastructure management system for a sustainable city, as follows:

– Overview of the building infrastructure management system;
– Framework for the building infrastructure management system;
– Service use cases.

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.

None.

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 firefighting infrastructure: A set of equipment that protects or evacuates people by detecting and notifying fires, enables immediate firefighting activities at the early stage of a fire, and extinguishes fires by automatic or manual operation.

3.2.2 firefighting equipment: An individual item of equipment consisting of a firefighting infrastructure and classified as communication-less legacy firefighting equipment and communication-capable firefighting equipment.

3.2.3 firefighting infrastructure management: A function that supports the operation of fire alarm control equipment and communication using data model and provides intelligent firefighting equipment management service.

3.2.4 energy infrastructure: A set of equipment that receives various types of energy such as electricity, gas and water from the energy providers and distributes the energy to the building infrastructure.

3.2.5 energy equipment: An individual item of equipment consisting of an energy infrastructure and classified as energy receiving equipment and energy distribution equipment.

3.2.6 energy infrastructure management: A function that supports the operation of energy equipment and communication using a data model and provides an intelligent energy equipment management service.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AI Artificial Intelligence

BIMS Building Infrastructure Management System

CoAP Constrained Application Protocol

EESS Electrical Energy Storage System

HVAC Heat, Ventilation and Air Conditioning

MQTT Message Queuing Telemetry Transport

OCF Open Connectivity Foundation

PV Photovoltaic

5 Conventions

None.

6 Overview of building infrastructure management system

6.1 Overview

A building infrastructure management system (BIMS) is a system that monitors and controls infrastructure consisting of various types of equipment. BIMS operates building equipment according to the building administrator's operation mode setting, monitors the real-time status of building infrastructure, and alarms a warning signal in a case of abnormal operation. Building infrastructure typically consists of firefighting, energy and environmental equipment. Figure 1 represents the typical structure and components of building infrastructure, which is broadly divided into three layers. The device layer consists of devices and controllers. The devices consist of monitoring devices such as various meters and sensors and actuation devices such as switches and valves. The device controllers connect the devices, perform information collection from them and control them. The control layer is composed of the communication system responsible for the transmission of information necessary for the operation of the infrastructure and the management system that performs actual control of the infrastructure. The management system in the management layer holistically manages the whole building infrastructure, communicates with the operator or manager, provides operation information and delivers operation commands.

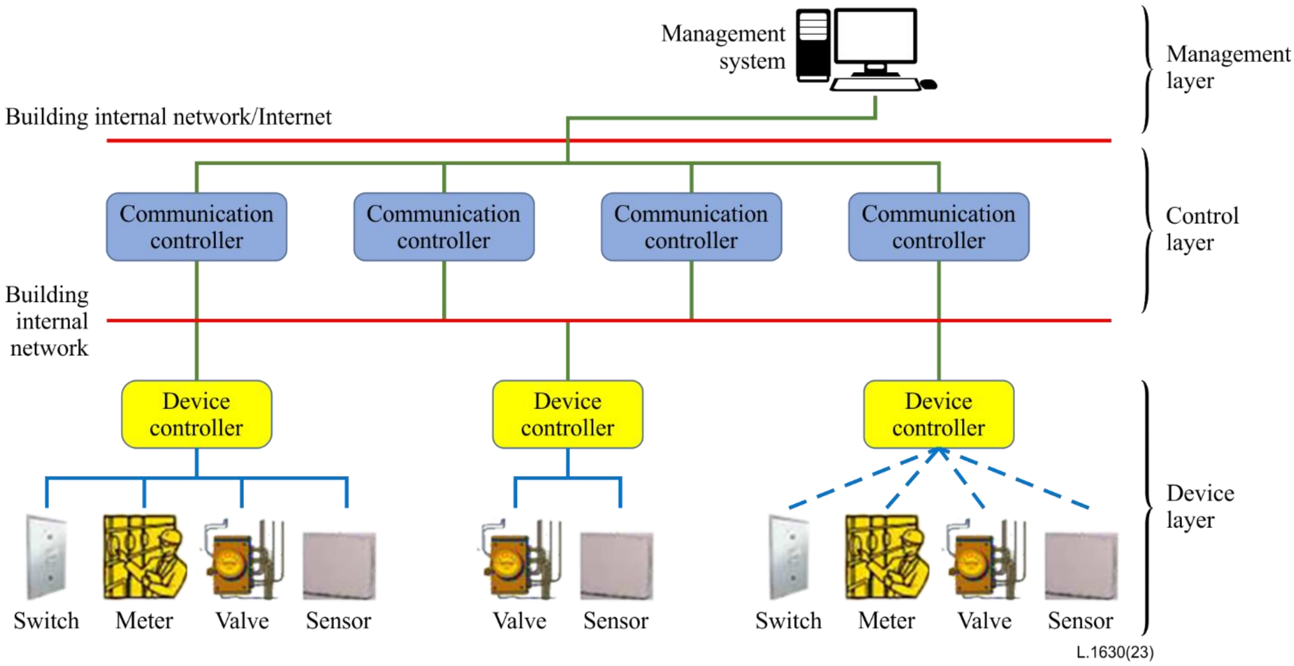

Figure 1 – Typical structure of building infrastructure

Currently, there are several challenges for building infrastructure management.

- Installation and operating cost

In the installation stage of BIMS that supports the efficient operation and management of buildings, building owners tend to install only the most basic functions and modules in order to reduce construction costs. Thus, although building energy consumption information and management tools are continuously developed and provided by the BIMS industry, the opportunity to introduce them is often blocked according to existing practices. To additionally install a BIMS in the subsequent operation stage is generally accompanied by a relatively high cost, so it becomes more difficult to have a reasonable and systematic management opportunity. On the other hand, in the operation stage, it is common to outsource the management of buildings to third party service companies. In other words, although it varies depending on the size and use of the building, there are many cases of outsourcing to a management company that bundles expenses, cleaning and operation and management of facilities. As a result, the possibility of poor management increases.

- Insufficient provision of energy consumption information and management tools

As the importance of reducing greenhouse gases in preparation for climate change has been strengthened, the demands to increase energy efficiency of building have increased significantly. A conventional BIMS typically provides functions for status monitoring and controlling various equipment and systems in a building infrastructure. However, recently BIMSs have also begun to offer a function of providing energy consumption information, and it seems that efforts are being made to provide more advanced management tools. The advanced management tools refer to the simplified control function through comparison of the set value determined by the administrator with the current status value, and an advanced function that helps the administrator in the decision process or replaces the administrator's judgement function in the future. In order to develop and provide such an advanced management tool, it is necessary to collect a large amount of operation management information and develop a management technique through the analysis of this information, but it is known that the current system is insufficient to satisfy the demand level of customers.

- Lack of interoperability between equipment and systems

Insufficient provision of information required by building stakeholders for the systematic management of buildings is mainly due to a lack of effort on the part of the BIMS suppliers. However, a more fundamental reason for not providing sufficient information about the building infrastructure seems to be the lack of interoperability between building equipment and management systems. The conventional systems have been operated in an exclusive and closed form, and as a result, it is impossible to share components (hardware such as measurement and control equipment and various operation management software), and it is not possible to share building operation information without the help of the supplier. In order to respond to the environment-related regulations such as greenhouse gas reduction, building stakeholders are demanding functions that enable a more effective energy management capability beyond simple building management functions.

6.2 Specific challenges for firefighting infrastructure management

A number of fire accidents have occurred in various facilities and caused considerable harm to people. In particular, the outbreak of fires in crowded facilities where large numbers of people are gathered has caused major casualties. In most cases, the cause of accidents that have caused large-scale personal injury is mostly due to fire detection equipment not working properly or intentional turning off of fire alarm equipment. Whether or not the firefighting equipment is in operation determines the scale of harm to people in the event of a fire. However, many firefighting infrastructures are currently not properly managed, and poor management of firefighting infrastructures is recognized as one of the major causes of large-scale accidents. The investigation on the status of firefighting infrastructure management shows high failure rates and the number of malfunctions of the firefighting infrastructure shows an increasing trend. Thus, there is an urgent need for a way to continuously manage the condition of firefighting equipment without errors. There are three major causes of poor management of firefighting infrastructures:

- Physical factor: the limit of the number of people and time required for firefighting equipment inspection.
- Technical factor: decreased reliability and lack of monitoring data.
- Human resources factor: not enough firefighting infrastructure administrators.

Due to these reasons, firefighting infrastructures are not properly managed. In order to mitigate these poor management situations, it is recognized that a system for real time management of the firefighting infrastructure is necessary. In particular, firefighting equipment is installed in a special form due to the restrictions of the relevant laws and regulations, and the connection between systems in other fields is not possible. Therefore, in order to resolve the problems of conventional firefighting infrastructure management, it is required to develop a framework defining the firefighting infrastructure management system.

6.3 Specific challenges for energy infrastructure management

Currently, there are two challenges for building energy infrastructure management.

- Separate installation of systems by providers and incomplete system integration

First, various automation systems such as mechanical equipment, power supply equipment, lighting and transportation equipment are installed in the building. However, they are individually installed and operated according to the specific services.

- Lack of integration with conventional building management systems

As described above, building infrastructure is installed and operated for each service and energy infrastructure is also separately managed. In other words, the building energy infrastructure management system is not integrated with the BIMS and it is currently being built and operated as a separate system. As a result, the initial investment cost increases due to the redundant installation of the systems, as well as the operation of the closed operating system. Therefore, it is difficult to improve energy efficiency through holistic analysis and diagnosis of building energy consumption due to poor information exchange between systems. It is also difficult to operate and manage facilities properly. These are the current status and challenges in energy infrastructure management in buildings.

7 Framework for a building infrastructure management system

7.1 Conceptual framework of a building infrastructure management system (BIMS)

The conceptual framework of a BIMS depicted in Figure 2 consists of the building infrastructure and the building infrastructure management system. As described in clause 6, building infrastructure is typically composed of energy equipment, firefighting equipment and environmental equipment. The building infrastructure is connected to the BIMS through the local network in the building. The BIMS consists of four sub-functions, namely the platform common function, equipment management function, application specific service function, and service interface function. The platform common function performs the data collection from the building infrastructure, storing the gathered data and data analysis using an AI engine. The equipment management function performs the management for the specific equipment, i.e., energy, firefighting and environmental equipment in the building infrastructure. Equipment-specific services are provided by the application specific function. Finally, the service interface function supports the interaction between BIMS and the third party building infrastructure management service provider. BIMS can be communicated with the city-level management platform, for example, a smart sustainable city management platform that monitors and manages the whole infrastructure in a smart city.

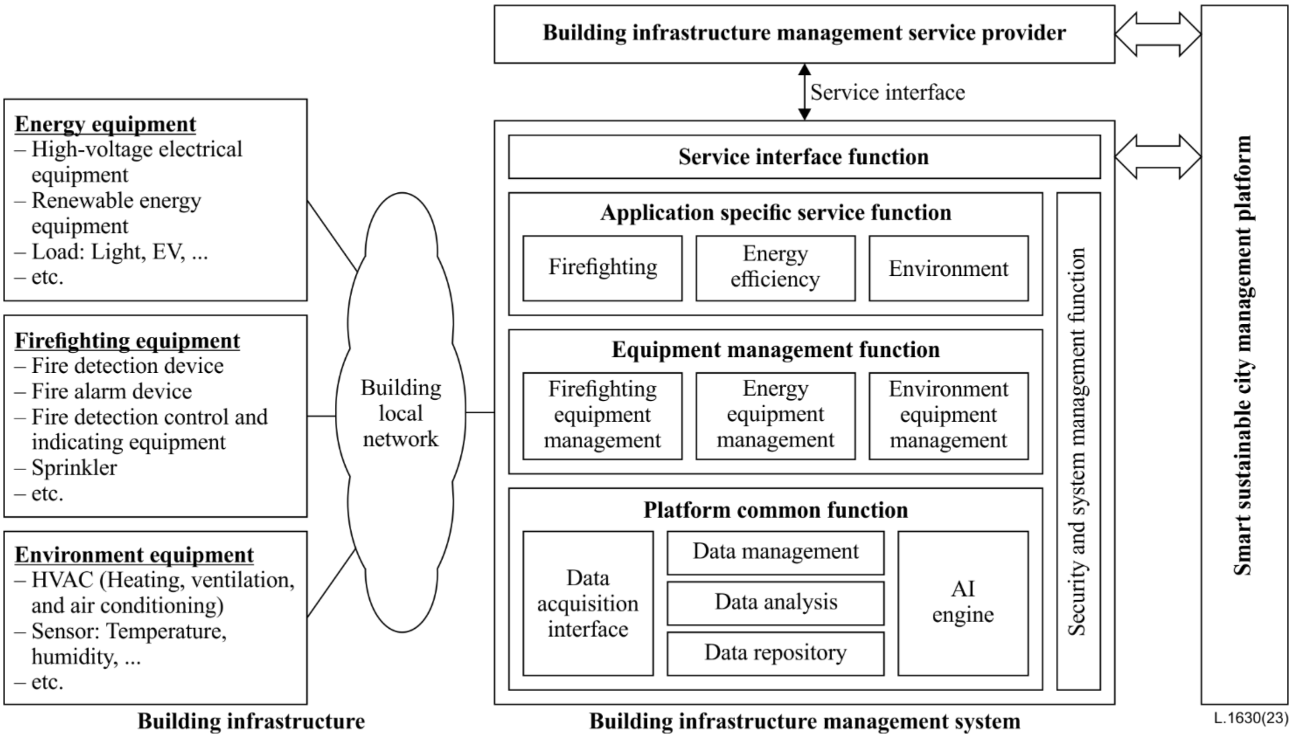

Figure 2 – Conceptual framework of building infrastructure management system (BIMS)

7.2 Functional components of the building infrastructure management system (BIMS)

7.2.1 Building infrastructure

There exist many types of equipment, such as for energy, water, gas, heating, cooling, and firefighting, within a building. This Recommendation considers energy, firefighting and environment equipment, which are major components for building management. Further, this Recommendation deals with communication-capable equipment. As shown in Figure 2, the building infrastructure typically consists of energy equipment, firefighting equipment and building environment equipment. Energy equipment can be further categorized into energy receiving equipment, energy load and distributed energy resources in the building.

The building infrastructure uses various energy sources such as electricity, gas and water supplied by each provider. These energy sources are supplied through an energy distribution equipment and distributed within the building. The safety management of the energy equipment is important, especially that of power distribution equipment that receives high-voltage electricity and converts it to low voltage and distributes the power in the building infrastructure and may cause accidents such as fire or personal injury. Also, disruption to electricity may cause the shutdown of the whole building infrastructure. Energy loads include transportation equipment, electric heat loads and building specific loads. Transportation equipment is the elevators and escalators. The electric heat loads are appliances, office computers, and so on. The environmental equipment includes HVAC (heating, ventilation and air conditioning), water supply and lighting equipment, which are used to manage the comfort of the building environment for the occupants.

7.2.2 Building infrastructure management system

The building infrastructure management system monitors and manages the equipment in the building infrastructure. The platform common function collects status data of building equipment through data acquisition interfaces. Data collection can be performed by various communication protocols such as conventional non-IoT protocols (serial communication protocol, MODBUS, etc.) and IoT protocols (MQTT, COAP, OCF, etc.). The collected data are stored, analysed using an AI engine and managed. When collecting equipment status data, the data are collected in the form of data profiles through data model design. In order to efficiently perform the data management function, the profile units are classified and managed according to the characteristics of the data. Data are classified and stored into equipment configuration data, real-time status measurement data and control data. The data are stored in a database reflecting the characteristics provided by the building infrastructure management services. The AI engine has a function of providing a library suitable for the service algorithm provided by BIMS.

The equipment management function performs the equipment-specific management functions. The firefighting equipment management function performs the real-time management of firefighting equipment using ICT communication. When an abnormal event such as fire accident is detected, it informs the administrator of the equipment of the event to and also it notifies the accident to the local fire station. The energy equipment management function manages the stable operation of energy equipment, especially the safety perspective. The energy equipment management function monitors the status of the energy equipment and manages the safety level and equipment residual lifetime. The environment equipment management function manages the whole environment including temperature, humidity, lighting, and so on.

The application specific service function provides the specific services for building infrastructure. The energy efficiency service function performs various services including energy load estimation and scheduling, the electrical energy storage system (EESS) charging and discharging, energy equipment alarm and control, reporting for the building administrator and the provision of status visualization. The firefighting service function holistically manages the data collected from firefighting infrastructure and provides interfaces for interoperate with the fire department or concerned persons in case of an abnormal event so that appropriate responses can be made. The environmental service provides a comfortable environment for the building occupants through indoor air quality, thermal comfort and illuminance control, and an algorithm suitable for the purpose is applied. The application-specific service function provides BIMS users with visualization capability including visual monitoring, statistics, alarm and warning, reporting and control functions for building infrastructure status, energy usage status, indoor environment, energy cost, and so on.

The security and system management function is performed at all layers of data communication and service, and system management performs operation management and updates related issues for all components of BIMS. The service interface function provides interfaces for various service providers to interact with the BIMS.

7.2.3 Building infrastructure management service provider

The building infrastructure management service provider is a third party service provider that supports the diagnosis and periodic maintenance of the building infrastructure and BIMS. The equipment diagnosis service provides a real-time online or offline inspection based on customer information and the customer's inspection history. Through this, it is possible to check the safety level of each inspection equipment and forecast the expected lifetime of each item of equipment under inspection. The periodic maintenance service involves check and record the data uploading and downloading communication between building infrastructure equipment and BIMS to verify that they are properly functioning.

Appendix I

Service use cases

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

I.1 Service use case for firefighting equipment management

Firefighting equipment installed in buildings sends the equipment status data and event information to BIMS. The event information indicates the occurrence of an accidental fire or a fault in the equipment. The firefighting equipment supports communication functions and can be directly connected to the BIMS through the building's local network. The BIMS notifies the event information to the building owner or administrator. After being informed by the BIMS about the event related to the firefighting equipment, the administrator checks the event information and takes appropriate action if necessary. The event information can be classified based on an identifier for each item of equipment. In the case of equipment event data, the administrator checks the identifier and event information of the equipment to verify whether the firefighting equipment is in abnormal state and then performs appropriate action. In the case of a fire detection event, the administrator performs an early response by checking the fire detection equipment and fire detection area information through the BIMS. In the case of an accidental fire, the information is notified to related parties and safety management organizations such as the fire station.

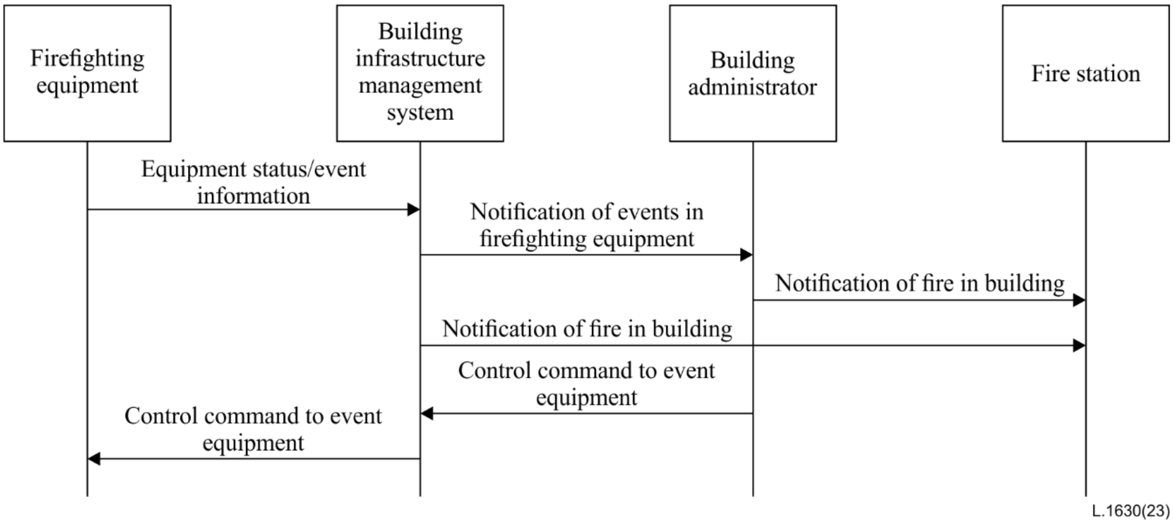

Figure I.1 – Service use case for firefighting equipment management

I.2 Service use case for energy efficiency management

In general, distributed energy resources such as photovoltaic (PV) equipment and EESS are installed and used in a building for energy efficiency. PV is not a resource that can control the amount of power generation because the amount of power generation varies according to changes in the weather. EESS can be controlled through the charging and discharging of electricity, so charging and discharging is scheduled considering the building load usage, PV generation and electricity tariff plan. Figure I.2 shows a use case for using EESS for increasing building energy efficiency. BIMS collects real-time power data from the load and the meter installed in the energy infrastructure, in particular PV generation equipment. In the building energy efficiency service function in BIMS, an EESS charge and discharge scheduling algorithm is periodically performed for efficient energy management. EESS charge and discharge scheduling is optimized through forecasting of electric loads and PV generation forecasting. Energy efficiency service function controls the EESS by charging and discharging scheduling, and provides a visualization service for the EESS charging and discharging status to the user [b-IEC 62933-3-3].

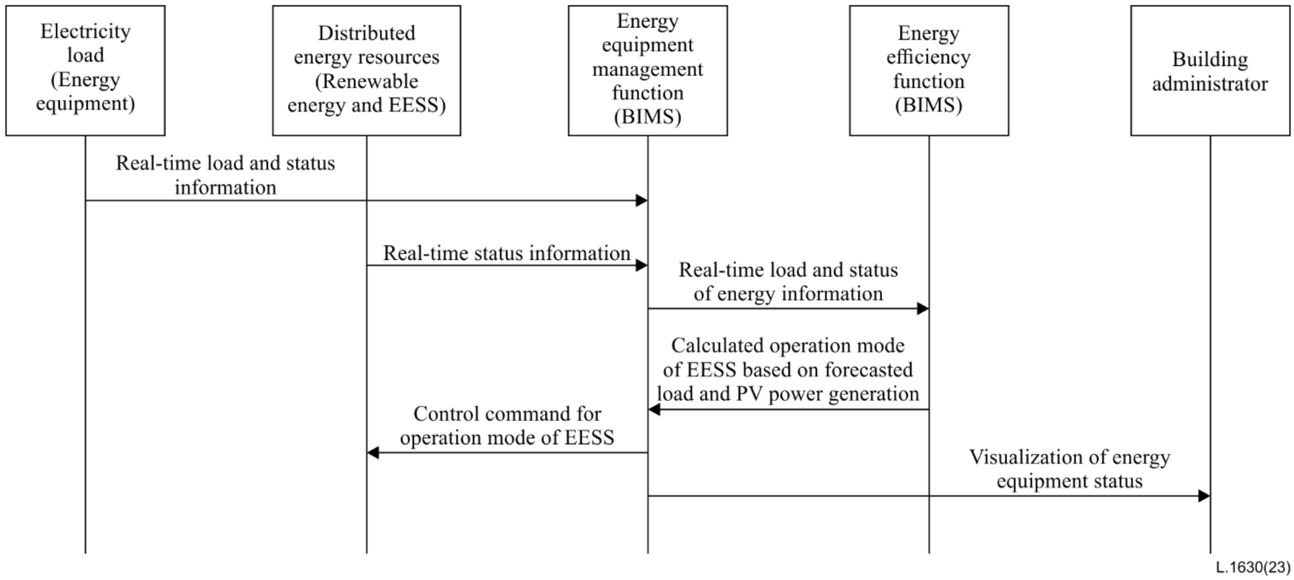

Figure I.2 – Service use case for energy efficiency management

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