Part I ECHONET Lite Overview

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The original language of the ECHONET Lite Specifications is Japanese. This English version is a translation of the Japanese version; in case of any queries about the English version, refer to the Japanese version.

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Chapter 1 Introduction

1.1 Developmental Background

At the beginning of the 21st century, the society is facing a multitude of issues, including global environment issue such as global warming and the need to reduce CO_2 emissions, energy issue and aging society. People have been arguing for the necessity of reducing CO_2 emissions by lowering energy consumption. To help achieve this, the government has set a target of introducing about 28 million kW of solar power generation (20 times the current output) by the year 2020. However, when excess power beyond household consumption flows back into the power distribution system, it raises the voltage of distribution lines and impairs the stable supply of high-quality power. Other issues include those related to the aging society, such as rising healthcare costs and the growing need for nursing care.

Meanwhile, rapid advances in data and communications infrastructure, in the form of high-speed, high-bandwidth communications and multimedia capabilities, are making it easier than ever to connect to the outside world via such media as the Internet.

Society in the 21st century will need to provide safe, secure, pleasant, and environmentally sound services, and this revolution is expected to create a host of business opportunities. An in-home communications infrastructure is therefore needed that will link homes and society to enable such services to be provided, and so various technologies are being studied in Japan and abroad.

The in-home communications infrastructure, or "home network," in particular, will need to provide both fast, high-bandwidth transmission of data and images, as well as a relatively low-speed, low-bandwidth, low-cost network that is compatible with conventional home appliances, equipment and sensor network.

This network of appliances and sensors will enable home appliances, sensors and controllers made by different manufacturers to be connected and communicate with each other organically. The result will be a network system that is safe and secure, comfortable, user-friendly and eco-friendly, in response to challenges including energy conservation, elderly users and home care nursing.

For example, the presence or absence of a resident will be detected and air conditioning and lighting will be controlled efficiently to reduce wasteful energy consumption. Energy from solar power facilities and fuel cells, which are expected to spread in future, will be stored in batteries or electric vehicles and used at night or during hours when household power consumption is high, thus using natural energy efficiently. By operating facilities

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for power generation, storage, and consumption efficiently in a network, environment-friendly and efficient energy management systems can be constructed.

In addition, the declining birth rate and consequent graying of society will increase the need to ensure the safety and security of households with elderly people and to reduce the burden of home nursing care and health management. Home networks will reassure people and help them to monitor their health by easily retrieving useful information for daily life, and could even be linked to hospitals and nursing care networks.

Furthermore, control systems fine-tuned for daily life will make household appliances and equipment more convenient and efficient. When the house is unoccupied, for example, the system would switch to monitoring mode, automatically locking the doors and windows, turning off air conditioners, and turning out the lights. On cold winter nights, the system would turn on the outdoor lights, close the curtains, and warm up cold rooms in preparation for the occupants' return.

1.2 ECHONET Lite Development Objectives

ECHONET (Energy Conservation and Homecare Network), the appliance network described above, comprises the following: 1) a communications protocol for a reliable, low-cost home network that requires no new wiring and can be installed in existing homes; 2) multivendor-compatible home network equipment; 3) system models for use by individual vendors to facilitate the development of application systems; 4) communications middleware and development support tools to mitigate the burden on equipment developers; and 5) application service-compatible middleware to facilitate the development of applications required for energy conservation. Products and service systems complying with the ECHONET Specifications are now being developed.

Since the types of network-connected devices are increasing and home network services are diversifying, there is a growing need to make it easier to build home networks. It was therefore decided to develop the ECHONET Lite Specification by: 1) deleting ECHONET addresses, now redundant due to the spread of media and IP devices having MAC and other fixed addresses; 2) deleting functions not implemented well, such as communication definition objects, profile objects, and service objects, and 3) simplifying the message composition.

ECHONET Lite is based on ECHONET, but is designed to be easier for home network system builders and service system developers. Devices complying with the ECHONET Lite Specification and those complying with the ECHONET Specification cannot be interconnected, but may coexist in the same system.

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1.3 Aims of ECHONET Lite

The ECHONET Lite Specification, like the ECHONET Specification, was drawn up to meet the needs of various groups, ranging from end users to product developers and system installers. The main aims of the specifications are listed below.

(1)   Easy development of multivendor home systems

Home networks will achieve their true value only when they allow the trouble-free interconnection and operation of devices from various manufacturers. System models and specifications assure not only a common communications protocol between devices but also interconnectivity at the system level. Users can then choose and install the device that best meets their needs from a range of ECHONET Lite-compliant products from various vendors.

(2)   Response to long lifetime and home system proliferation

Home network systems are characterized by the long lifetime (renewal cycle) of the appliances and devices comprising the network, yet frequent changes in system configuration driven by changes in family makeup, moves to new homes, and the addition of new devices or services. The ECHONET Lite middleware adapter communication interface, which places only a small burden on devices, is designed such that any device having this interface can be connected easily to a network at any time.

(3)   Easy system installation, and installation, replacement, and relocation of devices

Plug-and-play functionality allows anyone to set up the system and install, replace, and move system devices.

(4)   Connectivity and coexistence with other (AVC) systems

The ECHONET Lite scheme enables low-cost connection to systems based on local standards in expectation of global adoption and connection to in-home image and data processing systems.

1.4 Envisioned Applications

As noted above, the first aim of ECHONET Lite is to develop and promote the adoption of a home network system using the electric appliances and equipment found in ordinary homes.

Fig. 1.1 shows the applications envisioned for ECHONET Lite. As shown, ECHONET Lite is designed for use with application systems containing the same devices and functions found in ordinary homes, including single-family dwellings, duplexes, apartment buildings, dormitories, and condominiums for senior citizens.

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ECHONET Lite also encompasses equipment systems for small office buildings and stores that are similar in terms of scale and system environment (cost, system lifetime, functions, wiring restrictions, etc.) and that have yet to make substantial use of building or other facility management systems. Low-cost, easy-to-use subnetwork systems can be built regardless of building size: entire-building systems for small buildings, or floor-by-floor systems in larger structures.

Systems designed primarily to monitor and control equipment are characterized by severe constraints on memory and other resources but infrequent, low-volume data exchange between individual devices. ECHONET Lite can provide the foundation for a low-speed, low-capacity, low-cost network that meets these requirements.
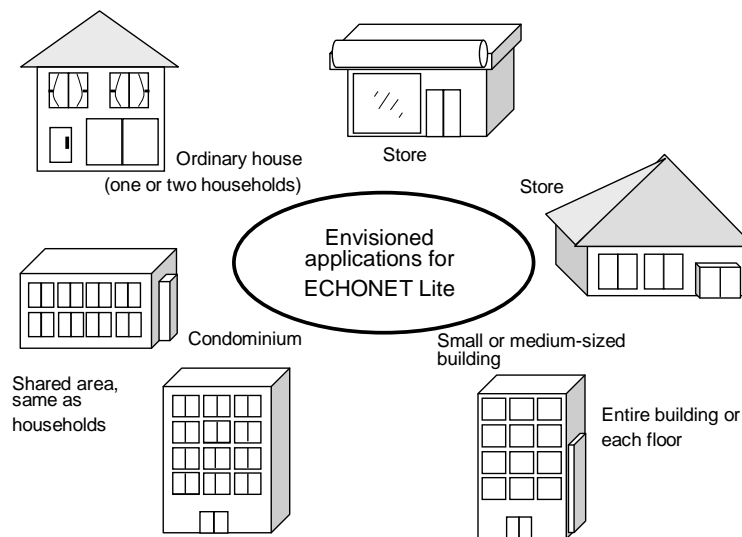
Fig. 1.1   Applications Envisioned for ECHONET Lite

1.5 ECHONET Lite Characteristics

In accordance with the objectives described above, ECHONET Lite was developed to provide the following characteristics:

(1) Object-oriented modeling of system configuration

The specifications were made clear and consistent by using object-oriented modeling of individual device and system functions. This guarantees interconnectivity from communications between individual devices to the system level and assures an integrated multivendor system.

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(2) Simple and open network architecture

For home network services which are becoming increasingly diversified, system components were simplified and a simple message composition was specified for transmission between them. Since the network architecture is open, vendors are free to develop and commercialize communication drivers, middleware, and peripherals complying with the ECHONET Lite Protocol.

(3) Plug-and-play functionality

Under ECHONET Lite, systems will configure themselves automatically when a device is connected to the network, eliminating the need for system setup and installation by users, whether ordinary consumers or trained technicians. This is the true meaning of plug-and-play functionality. An ECHONET Lite system will enable automatic recognition of device-identifying data, automatic recognition of device functions, and support for automatic setup of operating data, such as device installation location and inter-device control relationships.

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Chapter 2 Definition of System Configuration

2.1 ECHONET Lite System Architecture

This section specifies the ECHONET Lite system configuration and system architecture. Fig. 2.1 shows the system architecture.

An ECHONET Lite system incorporates groups of devices with the same management of properties, security, and so on. Therefore, the largest area that ECHONET Lite can manage is referred to as a *domain*. A domain will be specified as the range of controlled resources (home equipment, appliances and consumer electronics, sensors, controllers, remote controls, etc.) present within the network range determined by ECHONET Lite. A *system* is defined as that which performs communication and linked operations between devices and the controllers that monitor/control/operate them and between devices themselves. A system lies within one domain and does not extend over a number of domains. A domain includes one or more systems. Thus, the same device or controller can exist in more than one system. When connecting a system to another system lying outside the domain, an ECHONET Lite gateway is used as an interface.
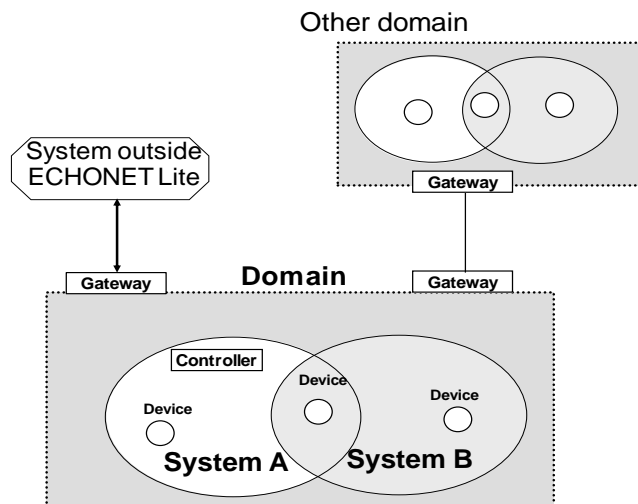

Fig. 2.1 ECHONET Lite System Architecture

Concrete examples are provided below to help explain the domain scope and the configuration of application systems. In reality, of course, each system designer will design systems in accordance with system size and the aforementioned criteria and will not be limited by these specifications.

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Single-family dwellings: Entire structure

Dual-family dwellings: Entire structure, or by family

Apartment buildings: By individual units and shared areas. Depending on its purpose, an application system may be applied to an entire building

Stores: Entire structure

Buildings: Entire structure, floor-by-floor, by type of facility to be managed, etc. depending on building size and type of management

As shown in Fig. 2.2, ECHONET Lite Nodes (a node is defined as any device or controller connected to the network) in a system are able to exchange data freely and without distinction between controllers and devices and between devices themselves. Also, the system is defined without regard to lower-layer protocols, such as the network transmission media to be described later. The figure shows two application systems, A and B, within a domain; the devices within this domain may belong to one or both of these systems. In the example shown in the figure, each system defines the controllers implementing the applications that manage (control, monitor, etc.) the devices connected to the system. Each device can communicate not only with the controllers in its system but also with other devices.

ECHONET Lite specifies the network architecture and system management based on these principles. It does not impose constraints on product system architecture.
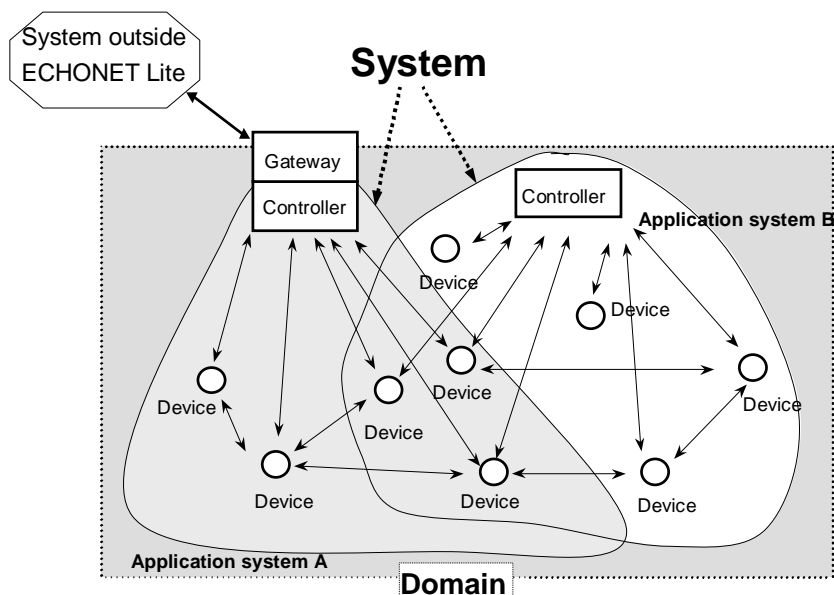

Fig. 2.2 Domain Scope and Application System Configuration (Example)

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2.2 ECHONET Lite Network Configuration

To enable the construction of optimal systems utilizing the unique characteristics of various transmission media, ECHONET Lite allows the use of numerous transmission media and protocols. The ECHONET Lite network configuration model for the main transmission media is shown in Fig. 2.3. As described in the figure, a domain consists of several subnets. A subnet is a network organized from devices of Layer 4 or lower of the OSI reference model that can communicate. Devices belonging to different subnets in a domain are connected through application software of a device connected to both subnets. ECHONET Lite does not specify connection through this kind of application software. Connection outside the domain is made through an ECHONET Lite gateway (GW).

In a subnet, an address for communication by transmission media in Layer 2 (hereafter, referred to as "MAC address" in this specification) or an IP address is used as an ECHONET Lite device identifier for unique identification within a subnet.
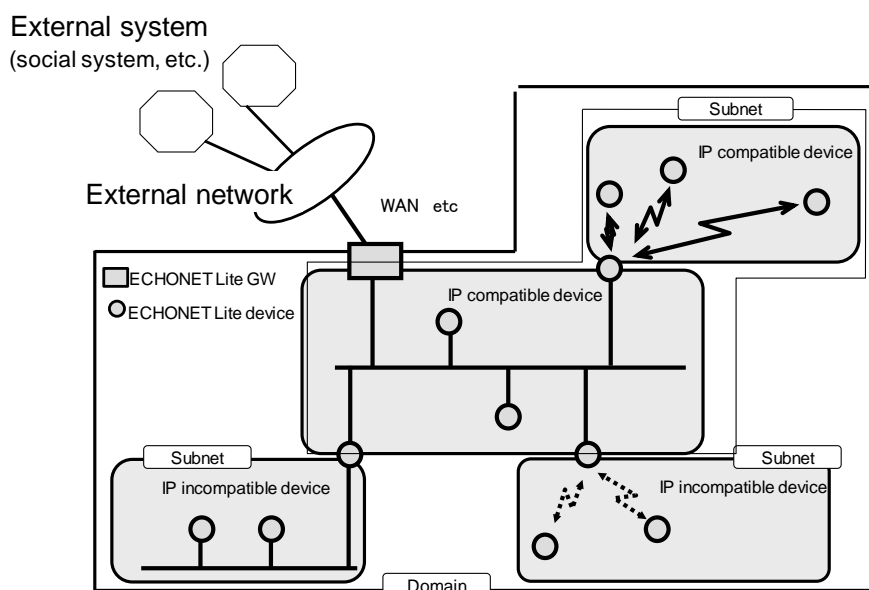

Fig. 2.3 ECHONET Lite Network Model

2.3 ECHONET Lite Component Devices

This section describes the ECHONET Lite component devices defined in the network configuration and system architecture shown above.

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(1) ECHONET Lite Node

A communications node based on the ECHONET Lite Specification. Within ECHONET Lite, this refers to ECHONET Lite communications functions uniquely identified by an ECHONET Lite address. This term makes no distinction between the application functions of the node and is used when describing the node's functions as a single communications terminal in ECHONET Lite. Of ECHONET Lite nodes, one with a send-receive function is defined as a general node and one only with a self-property value notification function as a transmission-only node.

(2) ECHONET Lite Device

An ECHONET Lite Node with ECHONET Lite compatible communications interface and system-compliant functions may include home equipment, home appliances and consumer electronics, and building or store facilities (e.g., lighting, air conditioning, refrigeration, electrical power facilities, ordinary white goods, sensors, and actuators). Also, an ECHONET Lite Node may act as a controller, such as central control devices that monitor, control, or operate these nodes, or control units (e.g., remote control units). For ECHONET Lite, equipment with a self-property value notification function is defined as transmission-only device to support battery driving and other means of minimum power consumption, as well as transmit-receive equipment always on.

(3) ECHONET Lite Middleware Adapter

This adapter is used to connect a device with no ECHONET Lite communication middleware to ECHONET Lite until ECHONET Lite becomes prevalent. The interface between device and ECHONET Lite middleware adapter complies with the separate ECHONET Lite middleware adapter communication interface specifications.

(4) ECHONET Lite Gateway

Connects ECHONET Lite domains to external systems, including other ECHONET Lite domains. A number of ECHONET Lite gateways may exist within the same domain, depending on differences in the external systems to which a connection is being made.

2.4 Connections to External Networks and Systems

In homes, buildings, and stores, a variety of networks exist, including outside networks for connecting to social systems, etc., and those designed to transmit image and other data. ECHONET Lite, which is positioned as a field network, views these networks as being

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outside the domain and connects to them at the application level via ECHONET Lite gateways. When directly sending and receiving messages to and from external systems, protocol conversion is performed at the application level. ECHONET Lite does not specify a unique domain identifier. It is the external system that seeks to identify specific ECHONET Lite domains, and therefore external systems are responsible for adopting effective identification methods.

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Chapter 3 ECHONET Lite Communication Layer Configuration

3.1 Overview of ECHONET Lite Communication Layer Configuration

The ECHONET Lite device communication layer can be broadly divided into three layers: Application Software, Communication Middleware, and Lower-Layer Communication Software. Of the processing blocks and their interfaces shown in the ECHONET Lite communication layer configuration of Fig. 3.1, ECHONET Lite specifies the communication middleware which is shown hatched in the figure.

・Application Software

Application Software can be broadly divided into software that provides remote control of devices connected to the system and software that realizes the hardware functions of individual devices such as air conditioners and refrigerators.

・ECHONET Lite Communication Middleware

ECHONET Lite Communication Middleware is provided between the Application Software and the Lower-Layer Communication Software and processes communication in accordance with the ECHONET Lite communication protocol. In other words, it realizes the principal features of ECHONET Lite.

・Lower Communication Layer

Lower Communication Layer refers to software and transmission media that handle the communication protocol processing unique to each transmission medium, such as power line, wireless, and infrared. It is primarily responsible for processing communications corresponding to Layers 1 to 4 in the OSI reference model.
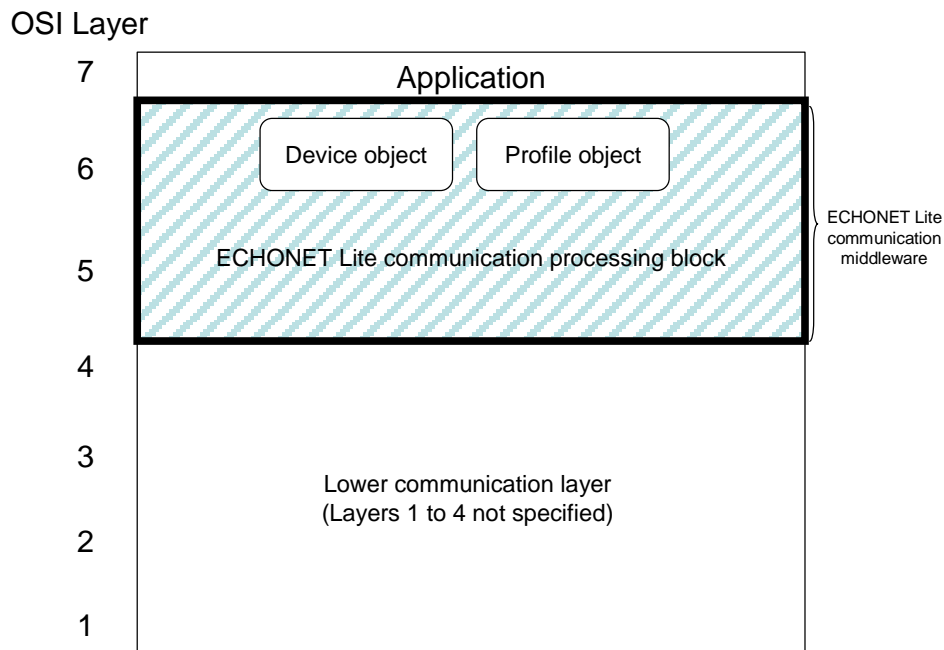
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OSI Layer

Fig. 3.1 ECHONET Lite Communication Layer Configuration

3.2 ECHONET Lite Communication Middleware Components and Processing Objects

ECHONET Lite Communication Middleware, which is specified as ECHONET Lite, consists of the ECHONET Lite Communication Processing Block and ECHONET Objects.

3.2.1 ECHONET Lite Communication Processing Block

The ECHONET Lite Communication Processing Block is responsible for processing the communication protocols needed to facilitate processing when application software is remotely controlling or monitoring a device in an equipment system; for storing the data needed to process communication protocols; and for managing data such as device statuses. In other words, this block performs communication processing for accessing objects, such as the Device Objects of other devices. The ECHONET Lite specifies this communication protocol. Of the data stored by this block, the data and access procedures that are disclosed to other devices are expressed as objects and specified as ECHONET Lite object definitions.

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3.2.2 ECHONET Objects

ECHONET Objects can be classified into two types: device objects and profile objects.

3.2.2.1   ECHONET device objects

A device object is a logical model of the information held by equipment devices or home electrical appliances such as sensors, air conditioners and refrigerators, or of control items that can be remotely controlled. The interface form for remote control is standardized. Since this device object is specified for each type of device, even products of different manufacturers can be remote-controlled in exactly the same way if they are of the same device type. More specifically, the information and control target of each device is specified as a property, and the operating method (setting and browsing) is specified as a service.

Device objects were defined by using the House Keeping (HK) commands specified in JEM-1439. JEM-1439 is mainly intended for household devices. This ECHONET Lite Specification, however, is being standardized also for devices in small and medium-sized buildings and stores.

3.2.2.2   Profile objects

A profile object is profile information held by an ECHONET Lite Node, such as ECHONET Lite Node operation status, manufacturer information, and Device Object list, and having a unified interface format for processing by application software and other ECHONET Lite Nodes. Since profile objects are thus defined, profiles can be controlled in exactly the same way even by ECHONET Lite Nodes of different manufacturers. More specifically, the information and control of each node are specified as the properties of a profile object, including their operation method (setting and browsing).

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Chapter 4 Connection of Devices to ECHONET Lite Networks

4.1 Implementation of ECHONET Lite Specification in Devices

The decision on which part of the ECHONET Lite Specification to use in a product will depend on its positioning in the communication layer and is therefore left to the user. However, by using the same procedure for communication between devices, it is possible for devices to exchange data. Interconnectivity between devices is also needed to prevent an adverse impact on the processing of other devices.

ECHONET Lite allows connection to the ECHONET Lite network via ECHONET Lite middleware adapters. To achieve device interconnectivity, the division of functions between ECHONET Lite middleware adapters and the devices themselves must be clearly stated.

This section explains the various types of ECHONET Lite devices and ECHONET Lite middleware adapters as well as the methods available for connecting devices to an ECHONET Lite network.

4.2 ECHONET Lite Device Types

ECHONET Lite defines and specifies two types of ECHONET Lite devices based on the content of the supported ECHONET Lite Communication Middleware. ECHONET Lite device developers will need to select one of the two types and design their devices in accordance with specifications for the ECHONET Lite communication layer configuration block (see Table 4.1).

(1) Full ECHONET Lite device

(2) ECHONET Lite-ready device

(1) Full ECHONET Lite device (Full_Device)
A Full ECHONET Lite device can connect to an ECHONET Lite system on a stand-alone basis.

(2) ECHONET Lite-ready device (Ready_Device)
An ECHONET Lite-ready device incorporates application software on top of the

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ECHONET Lite Communication Middleware (ECHONET Lite Communication Processing Block) and uses the ECHONET Lite middleware adapter that processes communication with ECHONET Lite Communication Middleware (ECHONET Lite Communication Processing Block) and communication in the lower layer in order to connect to an ECHONET Lite system. As this Specification deals with ECHONET Lite, these are described as ECHONET Lite-ready equipment, but they are the same as ECHONET-ready equipment.

Table 4.1 shows the relationship between the ECHONET Lite communication layer configuration block and the two types of devices described above.

Table 4.1 ECHONET Lite Communications Layer Configuration Block and ECHONET Lite Device Types

	Full_Device	Ready_Device
Application Software	○	○
Device Object	○	－
ECHONET Lite Communication Processing Block	○	－
Lower Communication Layer	○	－
Middleware Adapter Communication Software	－	○

Note: ○: required, － : not specified

4.3 ECHONET Lite Middleware Adapters for Connection to ECHONET Lite

This Specification standardizes an ECHONET Lite middleware adapter that can be connected to an ECHONET Lite-ready device.

When an ECHONET Lite-ready device is connected to an ECHONET Lite middleware adapter, the ECHONET Lite communication middleware and others are added to allow its connection to an ECHONET Lite system. Table 4.2 shows the relationship between each of the ECHONET Lite middleware adapter types and its ECHONET Lite communication layer configuration block.

Table 4.2　Relationship between Each of the ECHONET Lite Middleware Adapter Types and Corresponding ECHONET Lite Communication Layer Configuration Block

	ECHONET Lite Middleware Adapter
Application Software	－
Device Object	○
ECHONET Lite Communication Processing Block	○

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Lower Communication Layer	○
Middleware Adapter Communication Software	○

Note: ○: required, ― : not specified

4.4 Formats of Device Connection to ECHONET Lite Network

The format for connecting a device to an ECHONET network varies with the type of device. There are three formats (see Fig. 4.1):

Format 1: Direct connection of a Full ECHONET Lite device to the network

Format 2: Connection of an ECHONET Lite-ready device to the network using an ECHONET Lite middleware adapter

Format 3: Connection of an existing device to the network using a unique adapter

Format 1: Direct connection of a Full ECHONET Lite device to the network

Full ECHONET Lite device

Device Obj.

Communication processing

ECHONET Lite network

Format 2: Connection of a ECHONET Lite-Ready device

ECHONET Lite middleware adapter

Device Obj.

Communication processing

ECHONET Lite-ready device

ECHONET Lite network

ECHONET Lite middleware adapter communication interface

Format 3: Connection of an existing device

Unique adapter to existing device

Device Obj.

Communication processing

Existing device

ECHONET Lite network

Proprietary network

Fig. 4.1   Device Adapter and Device Combinations

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The ECHONET Lite Specification covers the Full ECHONET Lite devices in Format 1 and the ECHONET Lite adapter in Format 2. "Existing devices" in Format 3 may be considered equivalent to Full ECHONET Lite devices if connected to an adapter fitted with the ECHONET Lite communication function.

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Chapter 5 Structure of ECHONET Specifications and Intended Readership

5.1 Structure of Specifications

The ECHONET Lite specifications are structured into the following volumes.

Part 1   ECHONET Lite Overview

ECHONET Lite objectives, characteristics, overall architecture, definition of basic terminology, and ECHONET Lite device types

Part 2   ECHONET Lite Communication Middleware Specifications

Specifications for message format, protocol processing, Device Object definition, startup sequence, etc., in the ECHONET Lite Communication Middleware

Part 3   ECHONET Lite Communications Equipment Specifications

Hardware specifications of devices as communication hardware and those of the middleware adapter communication interface

Part 4   ECHONET Lite Gateway Specifications

Software specifications of the ECHONET Lite gateway as ECHONET Lite service middleware

APPENDIX,   Detailed Requirements for ECHONET Device Object

Detailed specifications of ECHONET device objects

In particular, apart from this ECHONET Lite Specification, "Interface Specification for Application Layer Communication" and "ECHONET Lite System Design Guidelines" are also drawn up. In "Interface Specification for Application Layer Communication", a specific use of ECHONET Lite is defined at the application level. In "ECHONET Lite System Design Guidelines", guidelines for the design of ECHONET Lite systems are summarized.

5.2 Intended Readers

This ECHONET Lite Specification is intended for ECHONET Lite device developers, ECHONET Lite middleware adapter developers, application software developers, and

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system developers or managers. Readers should focus on the following parts of the Specification.

(1) ECHONET Lite device developers

ECHONET Lite device developers should read the entire Specification in principle, but focus on the components of the ECHONET Lite communication layer configuration that the developer is in charge of.

(2) ECHONET Lite middleware adapter developers

ECHONET Lite middleware adapter developers should mainly read Part 2 "ECHONET Lite Communication Middleware Specifications" and Part 3 "ECHONET Lite Communications Equipment Specifications."

(3) Application software developers

Application software developers should understand the behaviors and control items of controlled devices in the protocol by reading Part 2 "ECHONET Lite Communication Middleware Specifications" and the "APPENDIX, Detailed Requirements for ECHONET Device Object."

In particular, developers of system application software for controllers should refer to "ECHONET Lite System Design Guidelines."

(4) System developers or managers

After understanding "ECHONET Lite System Design Guidelines," system developers or managers should understand the behaviors and control items of controlled devices in the protocol by reading Part 2 "ECHONET Lite Communication Middleware Specifications."

5.3 Version Number of the Specification

After Version 1.00, version numbers are assigned to the ECHONET Lite Specification in accordance with the following rules. The figure below exemplifies Version 2.10. The version of "APPENDIX, Detailed Requirements for ECHONET Device Objects" shall be managed separately from that of ECHONET Lite Specification.

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Specification version number

Ver.2.10

Revision number on the errata or amendment level
－Increment from 0 each time of the confirmation level changes。
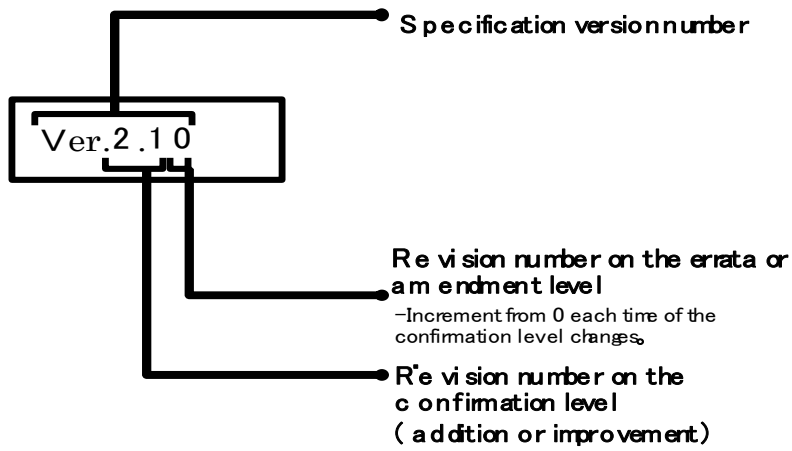
Revision number on the confirmation level
(addition or improvement)

Fig. 5.1 Version Number of the Specification