

# Initiatives on Regulation of Transmission Media Between Smart Meters and HEMS

**Takefumi Yamazaki**  
 Senior Research Engineer,  
 Supervisor  
 NTT Service Evolution Laboratories



## 1. Introduction

Concern for managing the supply and demand for electrical power increased in the wake of the Great East Japan Earthquake in 2011, and with the increased awareness and demand in society to install and spread use of smart meters—electricity meters incorporating a communications function—in society, related initiatives are becoming more active. The government-initiated Japan Smart Community Alliance (JSCA), established in 2010 to unite the government and citizens in advancing smart communities, created the Smart House/Building Standardization and Business Development Forum. To promote the spread of smart meters and related services, The Forum has defined the ECHONET Lite<sup>[1]</sup> standard interface between Home Energy Management Systems (HEMS) and eight types of key devices, including smart meters (the others are air conditioners, lighting, solar power panels, storage batteries, EV/PHV, fuel cells, and hot water heaters).

This paper introduces initiatives for regulating the transmission media and interconnectivity issues when using ECHONET

Lite as the communication interface between smart meters and HEMS.

## 2. Issues with regulation of transmission media for ECHONET Lite

ECHONET Lite is a communications standard set by the ECONET Consortium<sup>[2]</sup>, a standardization organization comprising manufacturers of HEMS-related electronics, communications providers, and power companies. It describes in detail, the states and control commands for more than 90 types of HEMS-related devices. ECHONET Lite defines communications protocols and device objects corresponding to layers 5 to 7 of the OSI model (the upper layers), but does not define layers 4 and below. Since various media could be used for transport, maintaining interconnectivity at the transmission level has been an issue. The lower levels for ECHONET Lite are shown in Figure 1. To implement interconnectivity between ECHONET Lite devices from different device manufacturers, it is very important that they adopt and implement a well-known

■ Figure 1: Lower layers of ECHONET Lite

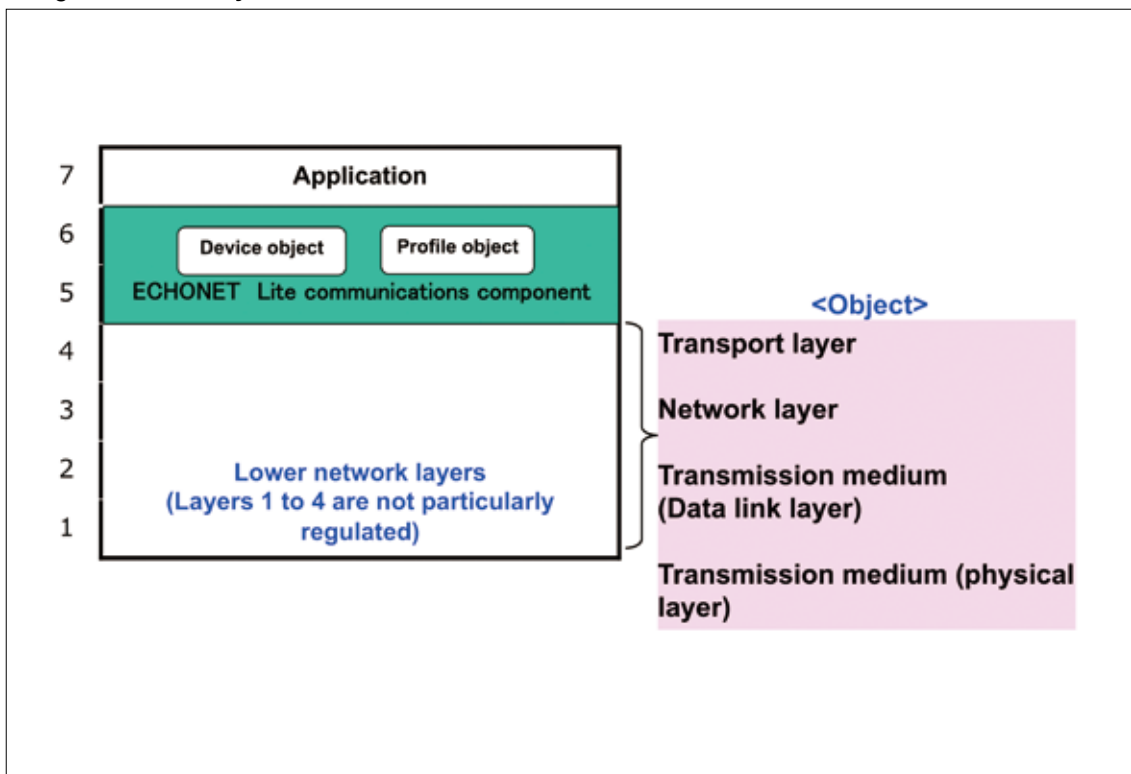
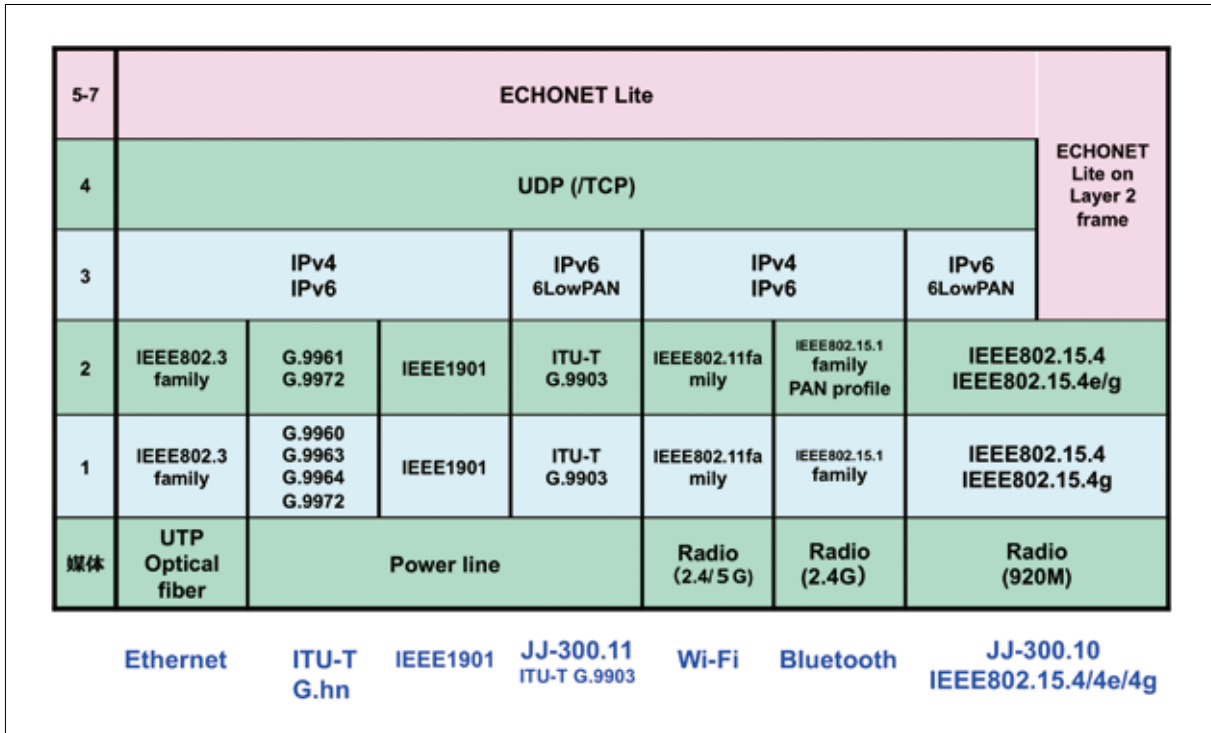


Figure 2: Overview of protocol stacks for ECHONET Lite lower communication layers



standard communication format and not their own original format.

### 3. Regulation of ECHONET Lite lower communication layers at the TTC

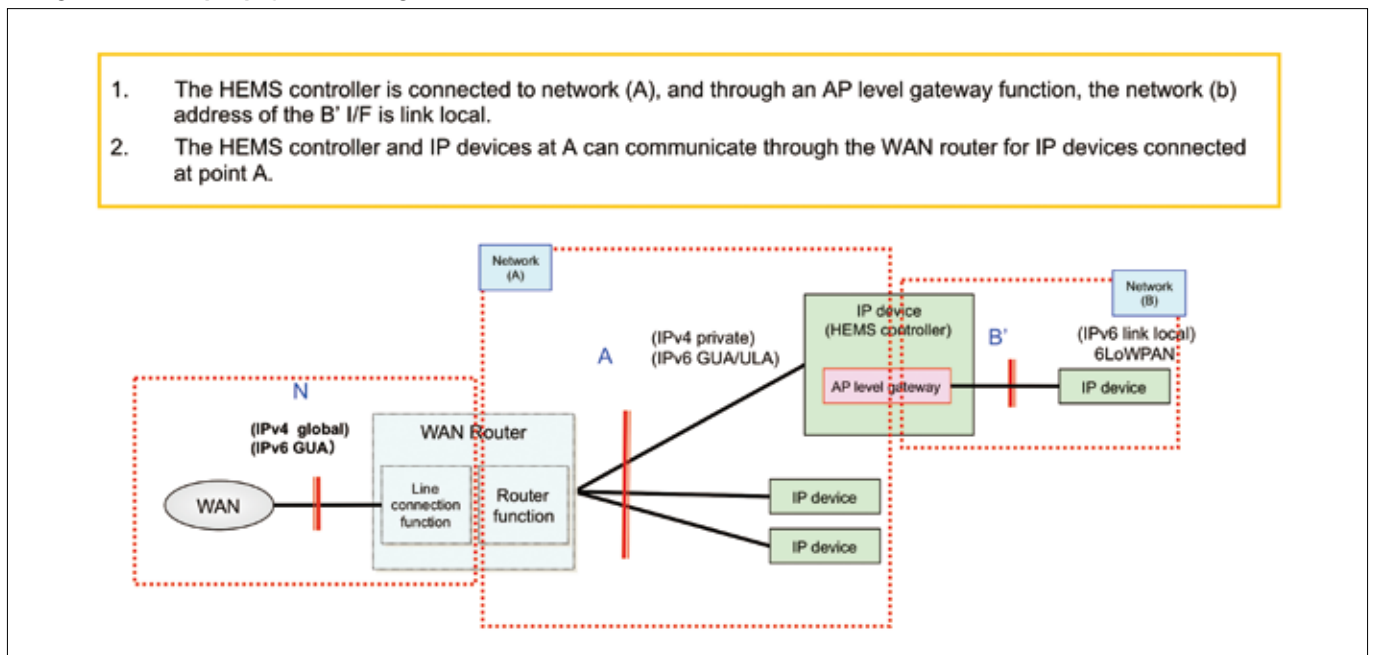
Considering the above issues, the TTC Next-generation Home Network System Expert's Committee has created technical and standardization documents<sup>[3][4]</sup> defining various standards for the ECHONET Lite lower communication layers. An overview of documents related to the standard is given below.

### 3.1 TR-1043 Home Network Communication Interface Implementation Guidelines

This technical document<sup>[5]</sup> specifies well-known communications formats and protocol stacks for the lower communication layers of ECHONET Lite. An overview of these protocol stacks is shown in Figure 2.

The document also gives a network model with configurations of how smart meters and other HEMS related devices are connected to a home network and describes a physical configuration example based on the model. The physical configuration example is shown in Figure 3.

Figure 3: Example physical configuration



### 3.2 JJ-300.10 Home Network Communication Interface for ECHONET Lite (IEEE 802.15.4/4g/4e 920 MHz band)

This standard document<sup>[6]</sup> describes communication format specifications for the physical, data-link, network, and transport layers when using 920 MHz band radio as the lower layer communications environment for ECHONET Lite. The communication specification protocol stacks specified in JJ-300.10 and related standardization organizations are shown in Figure 4.

JJ-300.10 describes three modes: A, B, and C. For modes A and C, it describes the Wi-SUN specification defined by the Wi-SUN Alliance as the Route B connection format, along with parameters, and security specifications. For mode B it describes the ZigBee IP specification defined by the ZigBee Alliance.

### 3.3 JJ-300.11 Home Network Communication Interface for ECHONET Lite (ITU-T G.9903 Narrow band OFDM PLC)

This standardization document<sup>[7]</sup> describes communication formats for the physical, data-link, network, and transport layers when using power lines for the lower-layer communication with ECHONET Lite. The protocol stack for communication

specifications in JJ-300.11 is shown in Figure 5.

### 3.4 TR-1052 HEMS-Smart Meter (Route B) Communication Interface Detailed Implementation Guidelines

This technical document<sup>[8]</sup> defines the required authentication methods and connection sequences in detail for each of the HEMS-Smart meter (Route B) transport media. Specifically, a common authentication ID and password format are specified for the Route B connection so that the same authentication can be used regardless of the selected transport medium. The Route B authentication ID and password usage and detailed connection sequence are also described for JJ-300.10v2 mode A (Wi-SUN IP) and JJ-300.11.v2 (G3-PLC), and JJ-300.10v2 mode B (ZigBee IP).

## 4. HEMS-Smart Meter Route B Communication Format Operational Guidelines and state of adoption at various power companies

JSCA is creating the “HEMS-Smart meter Route B Communication Format and Operating Guidelines”<sup>[9]</sup>, describing

■ Figure 4: Overview of JJ-300-10

Protocol Stack	Protocol/Standard		
Session – Application	ECHONET Lite		
Transport layer protocol	a1. UDP	a2. TCP	b. ECHONET Lite on Layer 2 frame
Network layer protocol	IPv6 / 6LoWPAN		
Data link layer protocol	IEEE802.15.4, IEEE802.15.4e/g		
Physical layer protocol	IEEE802.15.4, IEEE 802.15.4g		
Medium	Radio (920 MHz band)		

a1: TTC JJ-300.10 (Mode A, Mode B)  
a2: Published specification documents do not yet exist.  
B: TTC JJ-300.10 (Mode C)

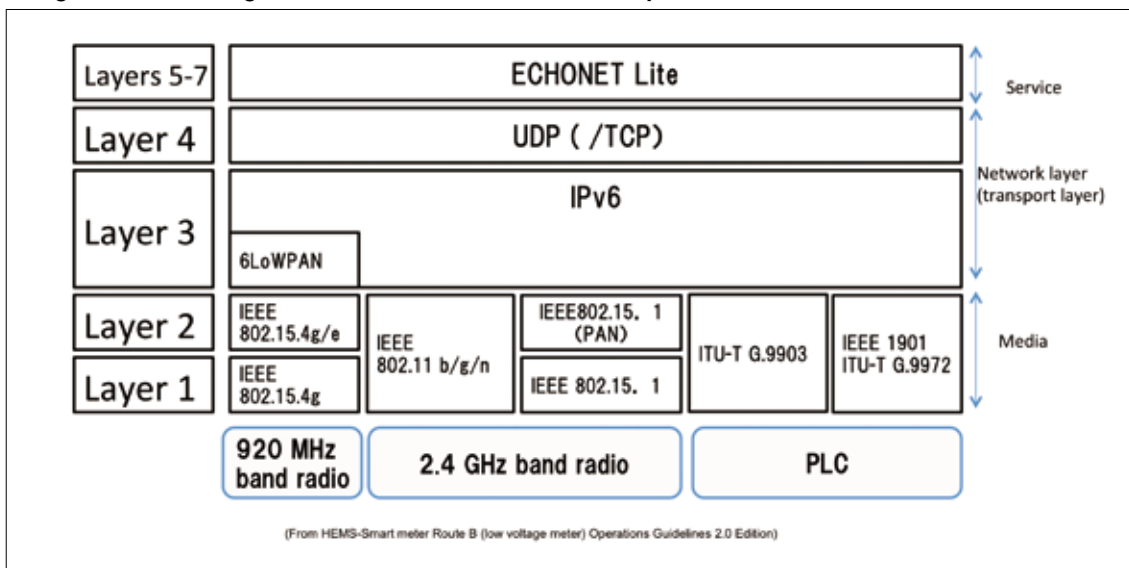
Mode	Selection in Table 1	Relevant organization	
Mode A	a	ECHONET Consortium	Wi-SUN
Mode B	a		ZigBee
Mode C	b		Wi-SUN

■ Figure 5: Overview of JJ-300-11

Protocol Stack	Protocol/Standard		
Session – Application	ECHONET Lite		
Transport layer protocol	a1. UDP	a2. TCP	b. ECHONET Lite frame on Layer 2
Network layer protocol	IPv6 / 6LoWPAN		
Data link layer protocol	ITU-T 9903		
Physical layer protocol	ITU-T 9903		
Medium	Power line		

a1: TTC JJ-300.11 (over IP)  
a2, b: Published specification documents do not yet exist.

Figure 6: Basic diagram of well-known standard media protocol stack for HEMS



agreed-upon common items for opening and operating Route B communications between smart meters and HEMS, so that these connections can operate properly. The guidelines describe the transmission media, communication formats and network structure with reference to the TTC technical documents introduced in Section 3. The protocol stack described in these guidelines is shown in Figure 6.

The Route B communication formats adopted by each power company are also shown in Figure 7, with JJ-300.10 Mode A (Wi-SUN IP) as the main format, and JJ-300.11 (G3-PLC) as the complementary format, according to the operational guidelines above.

### 5. Conclusion

We have introduced TTC standardization activities for transport media, as necessary to guarantee interconnectivity of devices using ECHONET Lite, which is the standard protocol used between smart meters and HEMS. Standardization of the communications interface between smart meters and HEMS is a key component of using smart meters effectively, and implementation of the standard specifications that include these transport media will be very significant for the proliferation and utilization of smart meters.

In the future, as ECHONET Lite is incorporated into various devices, it will be necessary to support new communications standards, and the standardization and technical documents will need to be revised to ensure interconnectivity. As such, the role that the TTC and others will need to play will continue to be significant.

Drafts of the TTC standardization and technical documents discussed here were discussed at the New Generation Network Promotion Forum, IP Network Working Group, Residential ICT Strategic Working Group (lead by Prof. Yasuo Tan [JAIST/NICT]), and went through deliberation in the Next Generation Home Network Systems Experts Committee before being settled. We would like to express our sincere gratitude to all those involved.

#### References

- [1] ECHONET Lite, <http://www.echonet.gr.jp/english/index.htm>
- [2] ECHONET Consortium, <http://www.echonet.gr.jp/>
- [3] ITU Journal, "Trends in standardization of communication protocols on home networks in the HEMS field," Vol. 43, No. 11, 2013-11
- [4] TTC REPORT, Next generation home network systems experts committee (TR-1051,TR-1052,TR-1053), Vol.29/No.2 2014-7
- [5] TTC Technical Report: TR-1043 Home network communication interface implementation guidelines
- [6] TTC Standard, JJ-300.10 Home network communication interface for ECHONET Lite (IEEE802.15.4g/4e 920 MHz band)
- [7] TTC Standard, JJ-300.11 Home network communication interface for ECHONET Lite (ITU-T G.9903 narrow band OFDM PLC)
- [8] TTC Technical Report: TR-1052 HEMS-Smart meter (Route B) communication interface detailed implementation guidelines
- [9] JSCA Smart house/building standards/business promotion forum, Reference #3: HEMS-Smart meter Route B operating guidelines, 1st Ed. (2013-05), 2nd Ed. (2014-12)

Figure 7: Route B communications at various power companies

**RFP status for communication and related systems (Route B) at each power company**

Communication formats for routes selected by each power company (as of Sept. 2014)

	Main format	Complementary format
Hokkaido Electric Power Company	920 MHz band radio (Wi-SUN format (IP))	PLC (G3-PLC format)
Tohoku Electric Power Company	920 MHz band radio (Wi-SUN format (IP))	PLC (G3-PLC format)
Tokyo Electric Power Company	920 MHz band radio (Wi-SUN format (IP))	PLC (G3-PLC format)
Chubu Electric Power Company	920 MHz band radio (Wi-SUN format (IP))	PLC (G3-PLC format)
Hokuriku Electric Power Company	920 MHz band radio (Wi-SUN format (IP))	PLC (G3-PLC format)
The Kansai Electric Power Company	920 MHz band radio (Wi-SUN format (IP))	PLC (G3-PLC format)
The Chugoku Electric Power Company	920 MHz band radio (Wi-SUN format (IP))	PLC (G3-PLC format)
Shikoku Electric Power Company	920 MHz band radio (Wi-SUN format (IP))	PLC (G3-PLC format)
Kyushu Electric Power Company	920 MHz band radio (Wi-SUN format (IP))	PLC (G3-PLC format)
The Okinawa Electric Power Company	920 MHz band radio (Wi-SUN format (IP))	PLC (G3-PLC format)

\* Each company in principle considers installing the "Main format", but selects the "Complementary format" when environmental or other conditions make this difficult.