Cyber Security Guideline for Japanese VPP System: the convergence of IoT and an energy system

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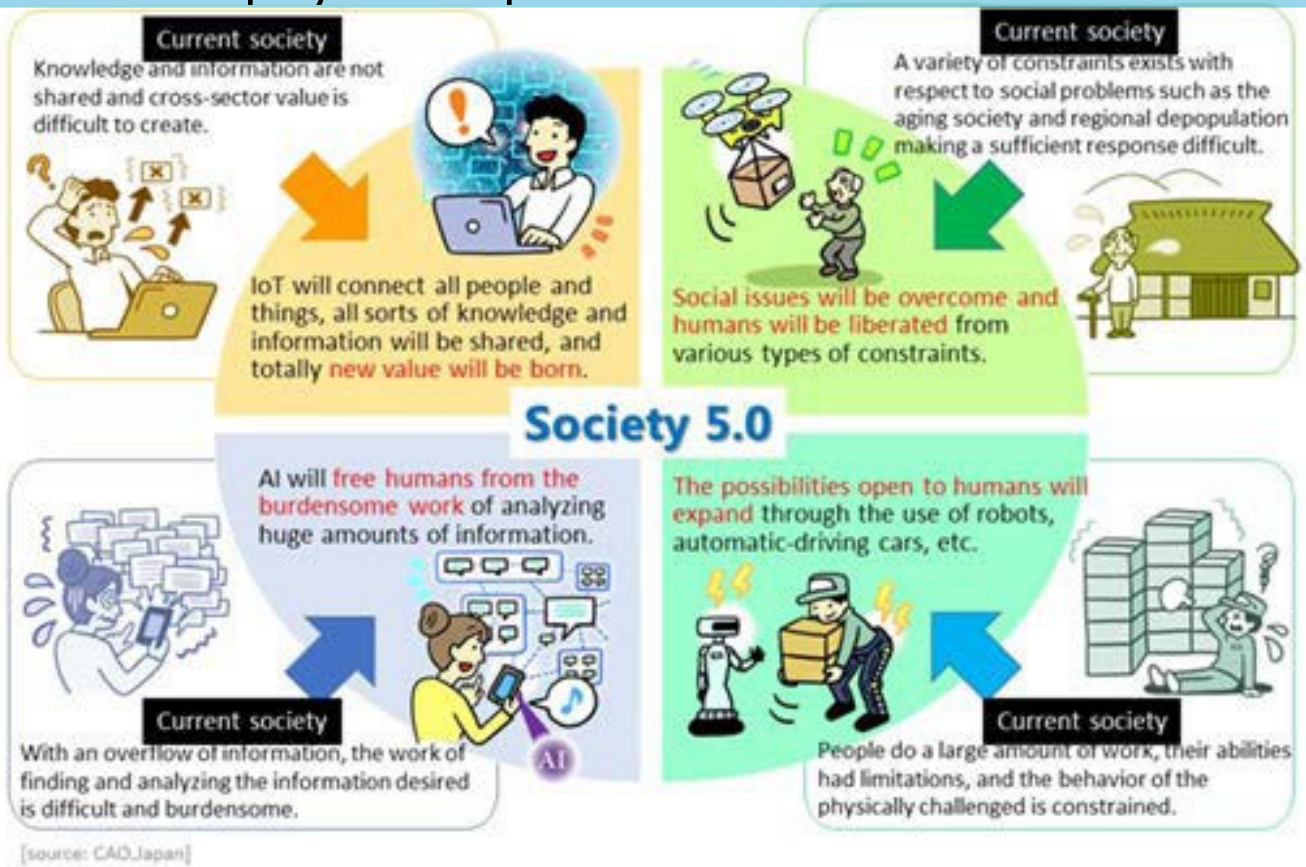
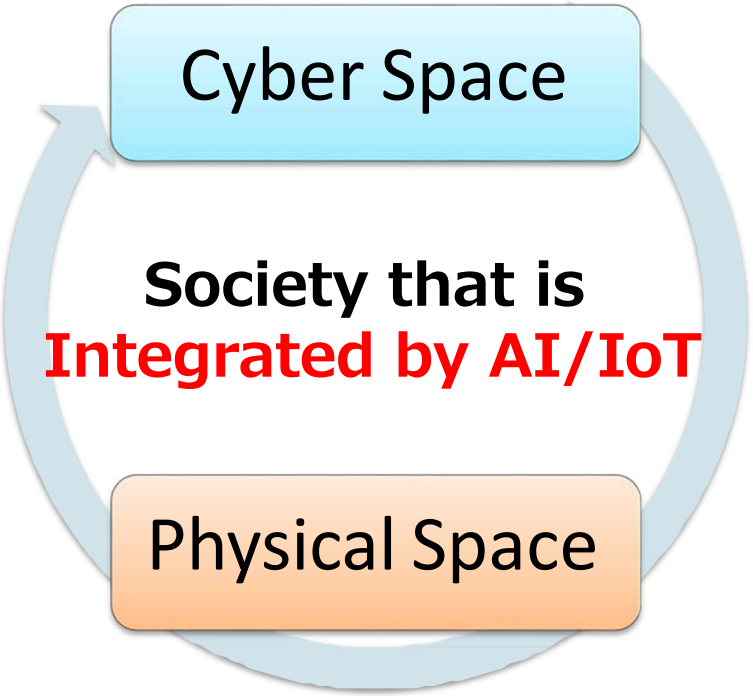
Society 5.0

- Society 5.0 as the national strategy since 2017 is a human-centered society that balances economic advancement with the resolution of social problems by a system that highly integrates cyberspace and physical space.



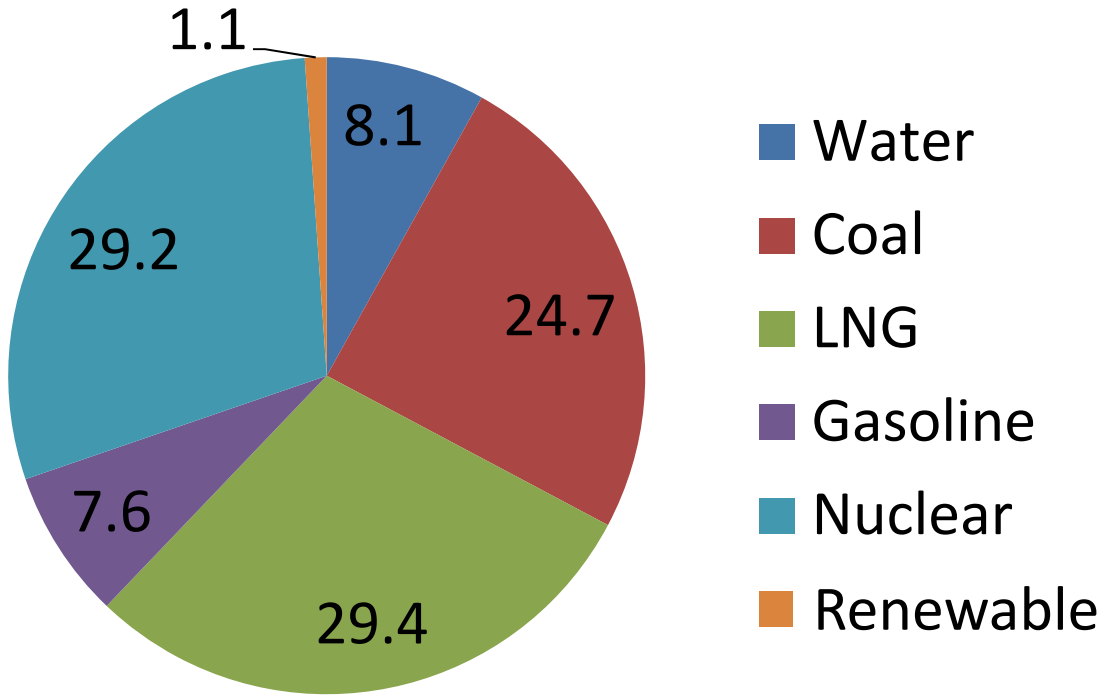
Society 5.0: Convergence of Physical and Cyber Space in engaging the society towards the more human centered and the sustainable



- ✓ Human Centered
- ✓ Balances Economic Advancement & Resolution of Social Problems

To recover the disaster in Japan's power supply since 2011

- Japan lost large portions of its electric supply due to the big earthquake in Mar 2011: 30% of the nation wide power supply.
- At that time, 30% power supply was generated by the nuclear.
- Japan pushed the restart of aging power stations, the renewable energy injection, and energy management at a demand side



New trend : EV and PV are coming to a home

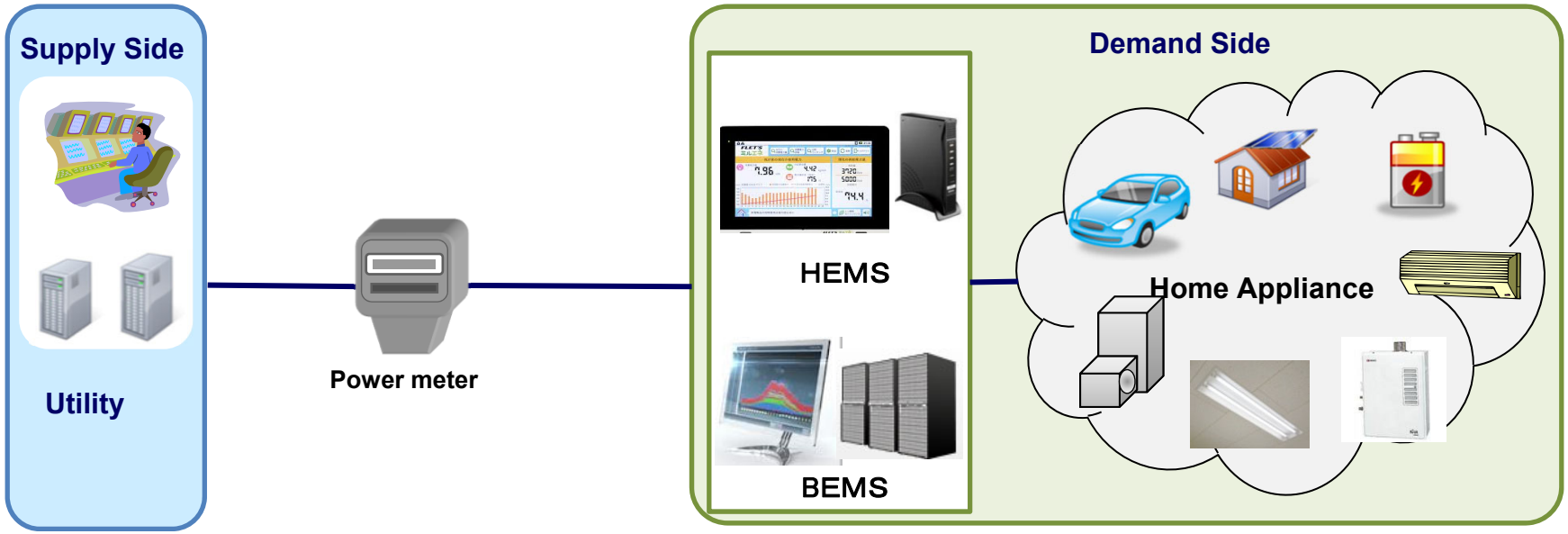
- EV eats 40Kwh for running 400 KM
- 248.7 Kwh# is a monthly electronic use in a household in Tokyo.
- Renewable energy such as solar and wind power keep on increasing :New policy that Japanese government released in 2014 aimed at reaching 20 % of total energy supply in 2030

10% in 2010
to 15% in 2016

Source:http://www.tepco.co.jp/corporateinfo/illustrated/power-demand/residential-customer-j.html

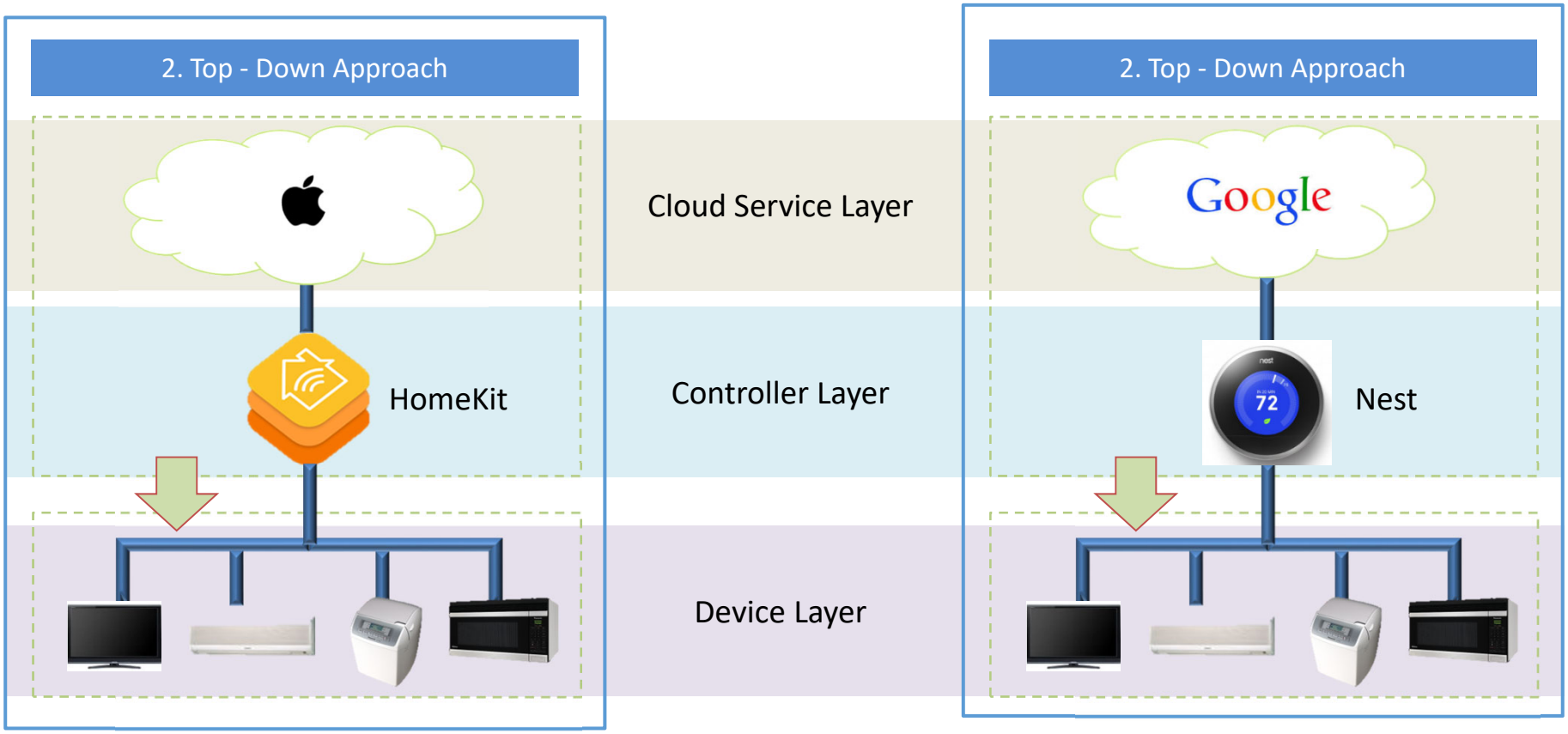
EMS is getting hot at the demand side

- Demand Side Energy Management System [D-EMS]:
  - The power meter connects and provides both, Demand and Supply Side control functions
  - Monitor and control multiple and different devices on IP network
  - Develop services‥Demand response[DR], Virtual Power Plant[VPP]



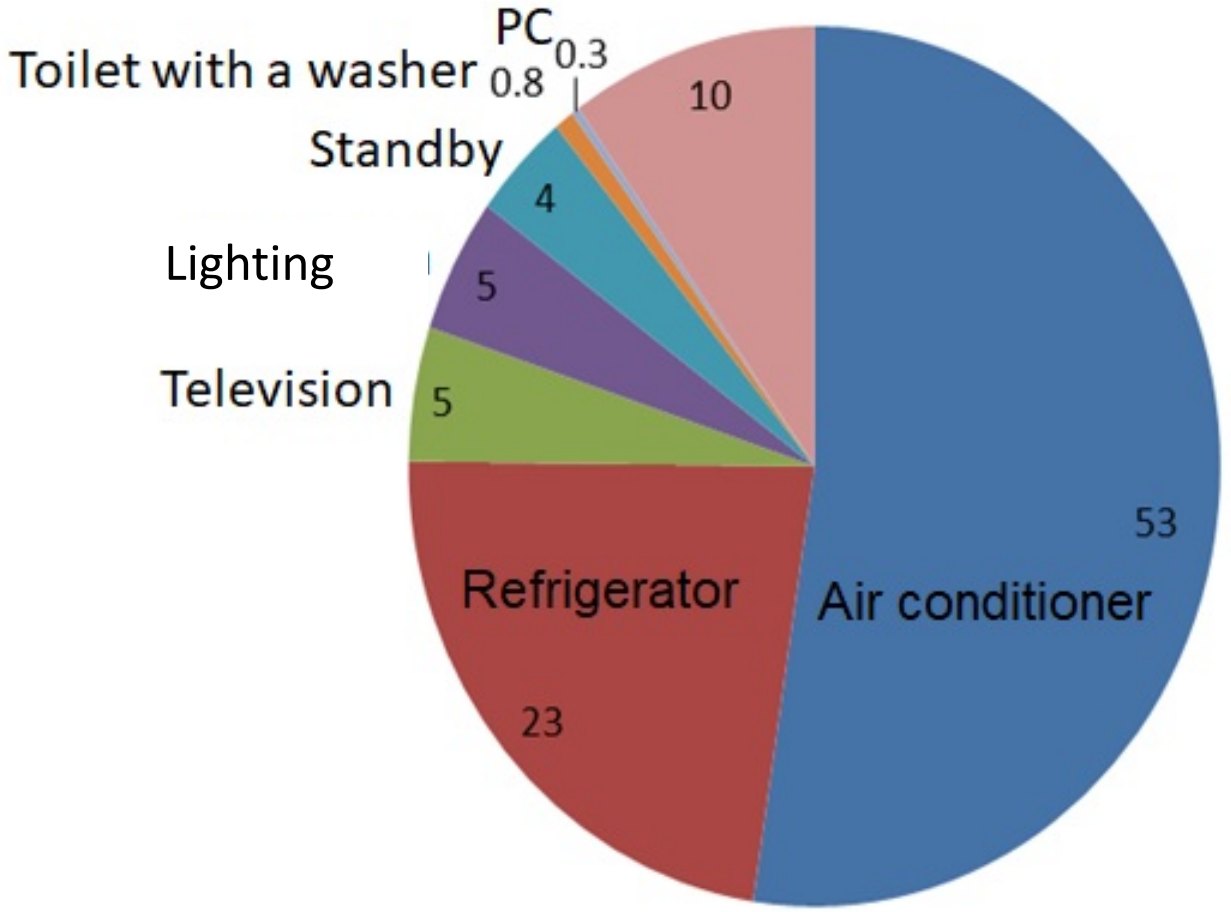
EMS is getting hot at the demand side: Google and Apple

- In providing a thermostat with the internet access, Nest controls a demand side, included life log data.
- https://nest.com/thermostat/meet-nest-thermostat/



50 % electricity is used by air conditioning at the peak time

- At 2pm in a household in Tokyo, half of electric demand is made by air conditioning. That situation is not only in Japan. To challenge global warming that SDGs in UN has placed the top agenda , demand side control is necessary, not only making efficient at the demand side.

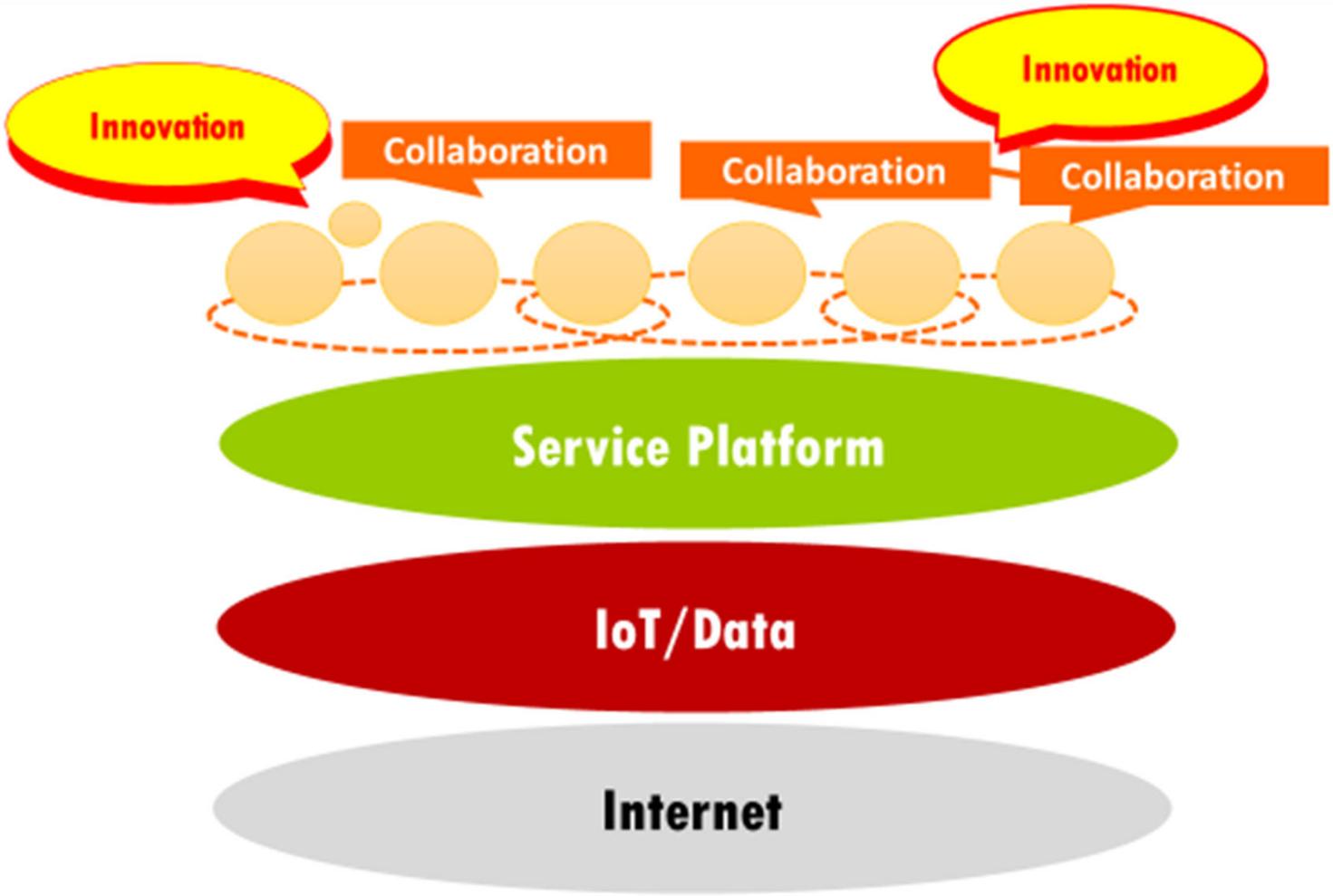


Close VS Open

Look back the experience
of the internet.

Everything on the internet

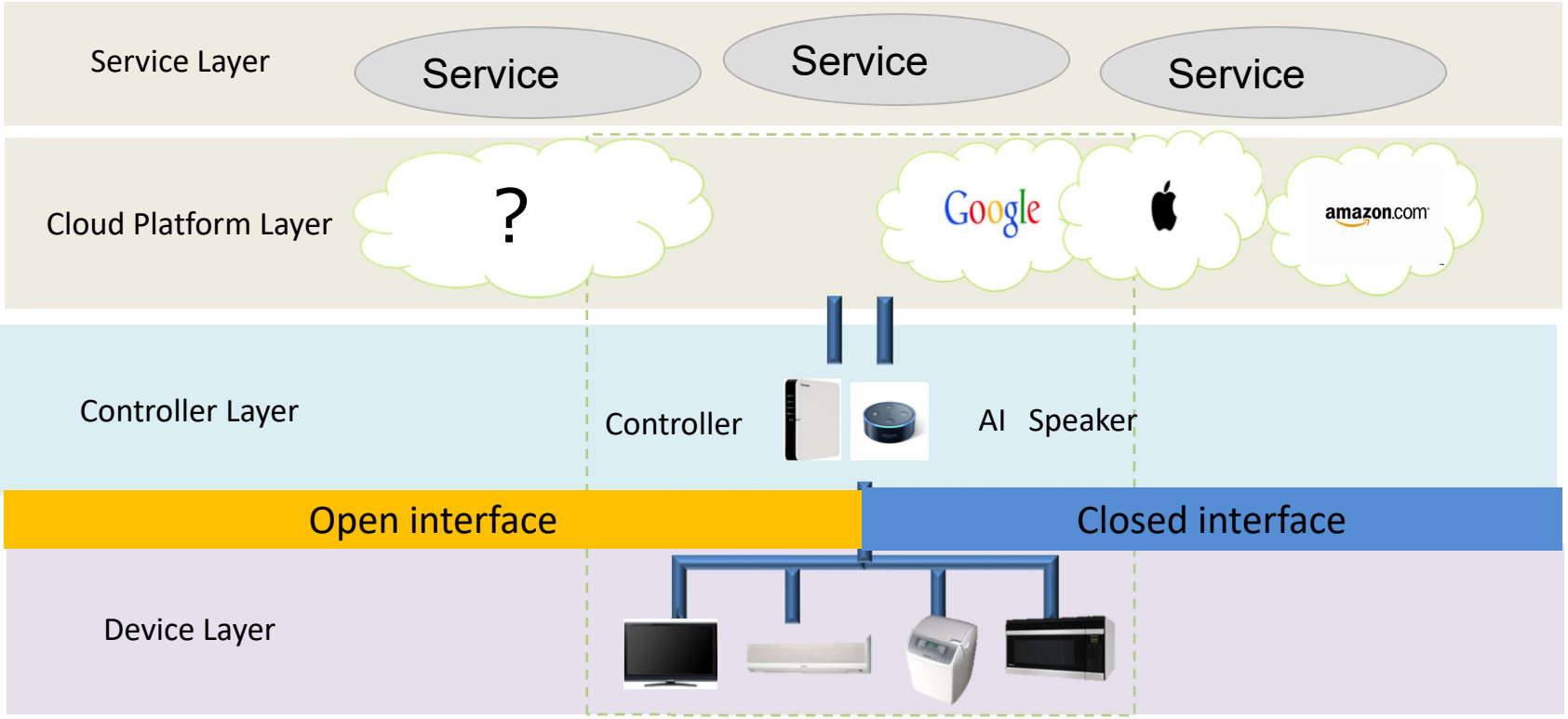
- To drive the innovative service with promising “Anshin”, which means safety and comfort in Japanese, Trust is necessary condition on IoT service.



Source: Presentation by Dr. Jun Murai at FCCJ

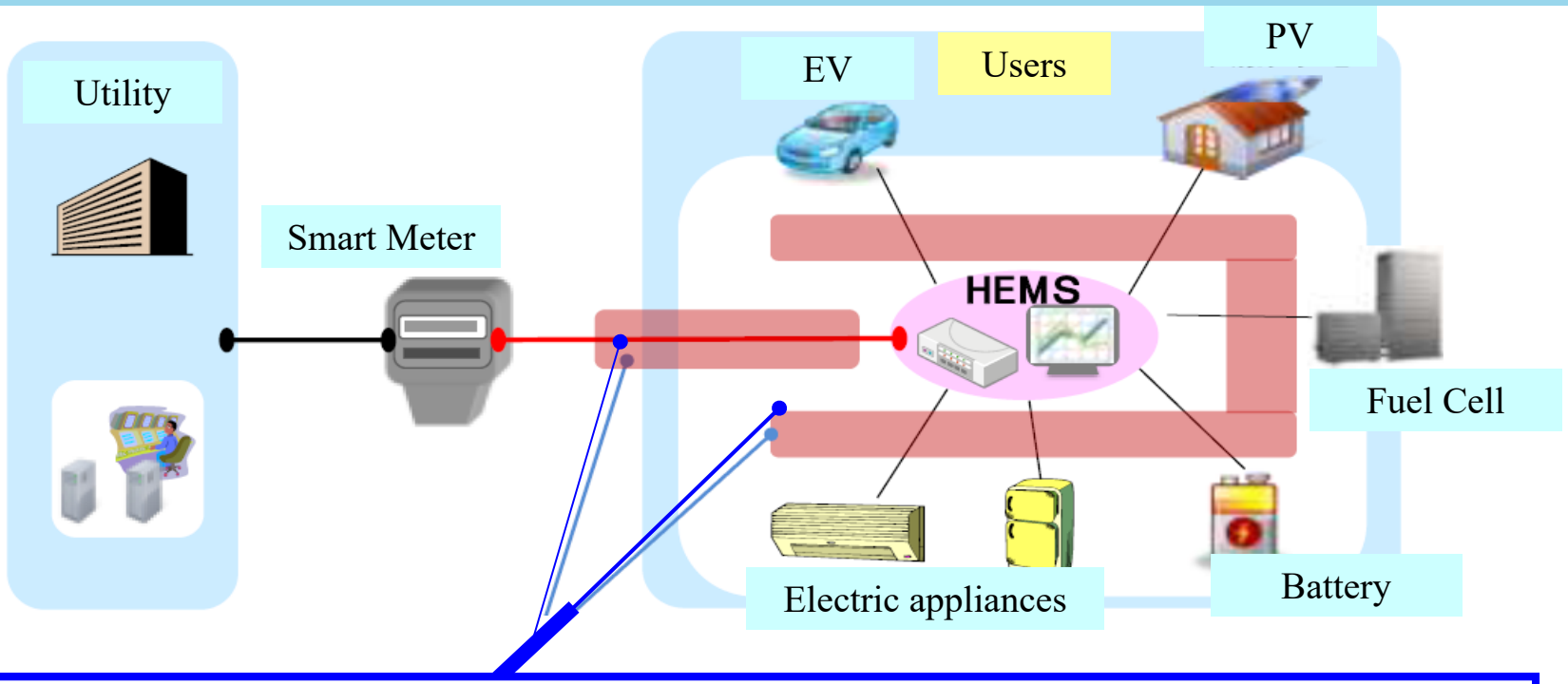
Discussion in the approach: open approach

- In DSM Systems, an Open approach enables the various devices to speak the same protocol, equivalent of TCP/IP in the internet world.
- The proposal from Japan is to create an autonomous energy and data control system using the IEC 14543-4-3 protocol.



Japan addressed the EMS and followed “Open Standard” as ISO/IEC14543-4-3

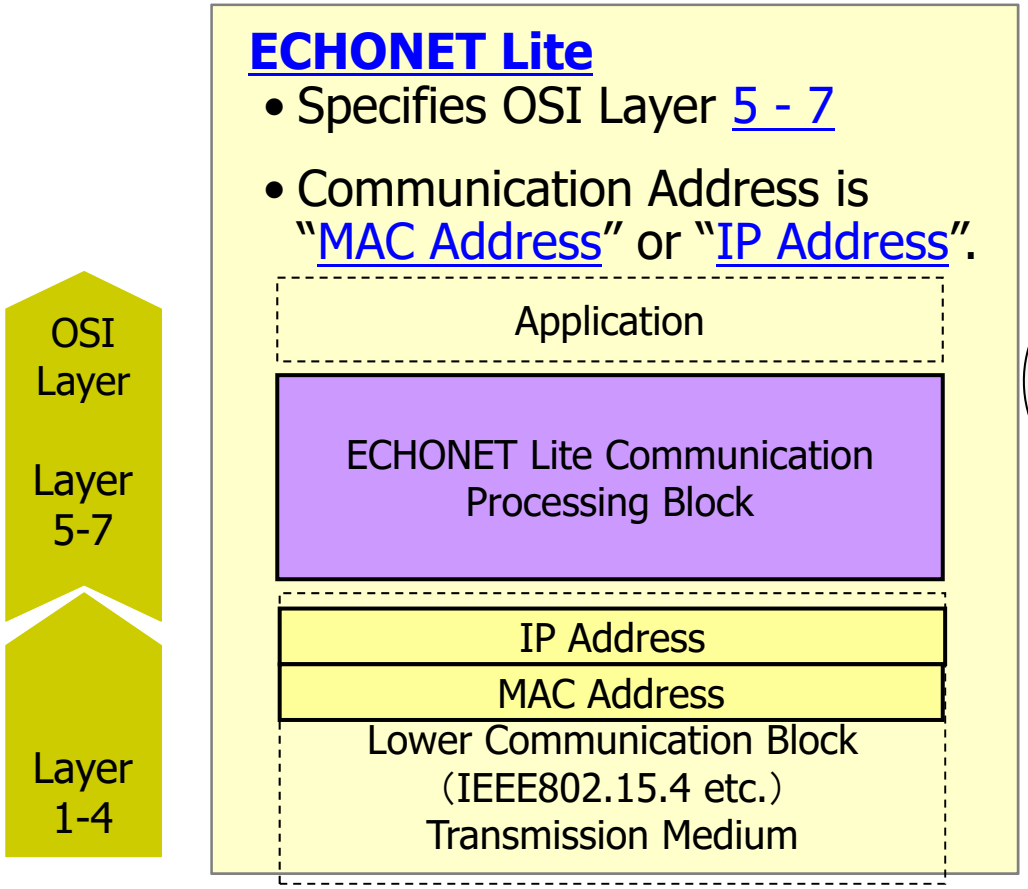
- Japanese Government and Industry liaison has proposed ISO/IEC14543-4-3, to be the enabler of the demand side management, around HEMS. Internet of Things over this international standard, ECHONET Lite in Japan, has provided a common language for 100s of devices: home appliances, power meter, EV, and PV.

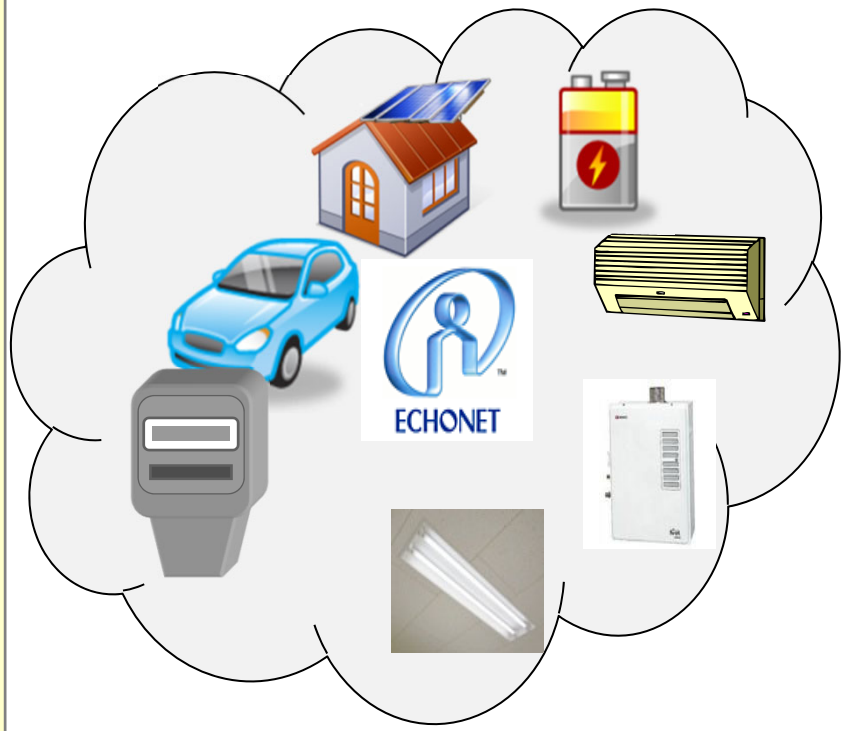


- IEC 14543-4-3 is recommended as the standard interface for connecting appliances and smart meter.
- Communication protocol between HEMS and devices should be based on IP.

ECHONET Lite as an open standard on IoT

- **IP based, Media Free, Open Standard, and IEC Standard**
  - **ECHONET Lite is IP based interface and interoperable to any standardized medias.**
- **Third party's certification program [Ongoing]**
  - **ECHONET-Lite, owned by ECHONET Consortium, has become open interface since on Dec 21, 2011.**





ECHONET is an International Standard

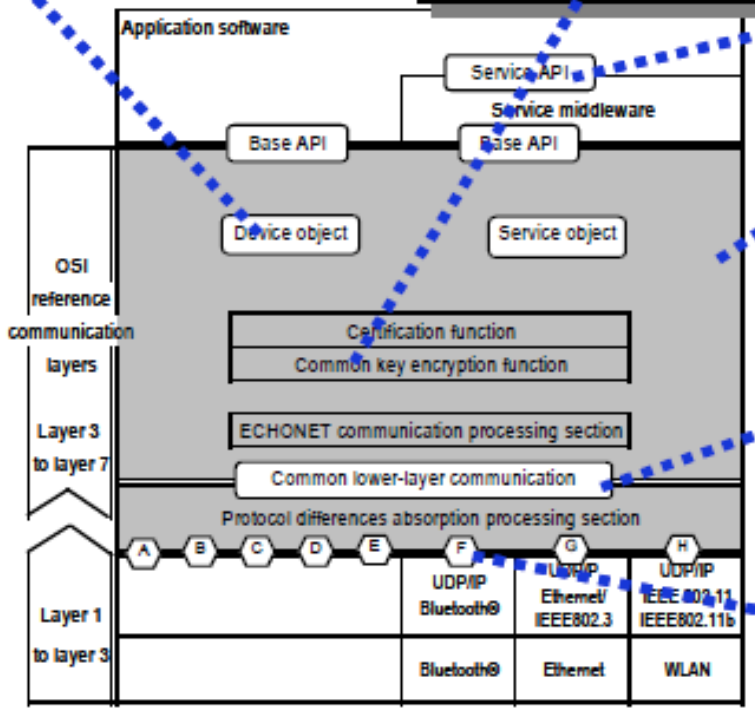
Keep Updating Device Objects

ECHONET device object
Interface for equipment maintenance
IEC TC100
Reference No. IEC62394
Published: 2006/6

Secure communication layer
Secure communication for home appliances
ISO/IEC JTC 1/SC 25/WG 1
Reference No. ISO/IEC24767-1
ISO/IEC24767-2
Published: 2008/9

Middleware adapter interface
IEC TC100
Reference No. IEC62480
Published: 2008/5

ISO/IEC14543-4-3 is for ECHONETLite



ECHONET communication middleware - upper section
ISO/IEC JTC 1/SC 25/WG 1
Reference No. ISO/IEC14543-4-1
Published: 2008/5

ECHONET communication middleware - lower section
ISO/IEC JTC 1/SC 25/WG 1
Reference No. ISO/IEC14543-4-2
Published: 2008/5

Application of TCP/IP™ to home network - cooperation with AV/PC equipment
IEC TC100
Reference No. IEC62457
Published: 2007/9

Variety of ISO/IEC14543-4-3 devices

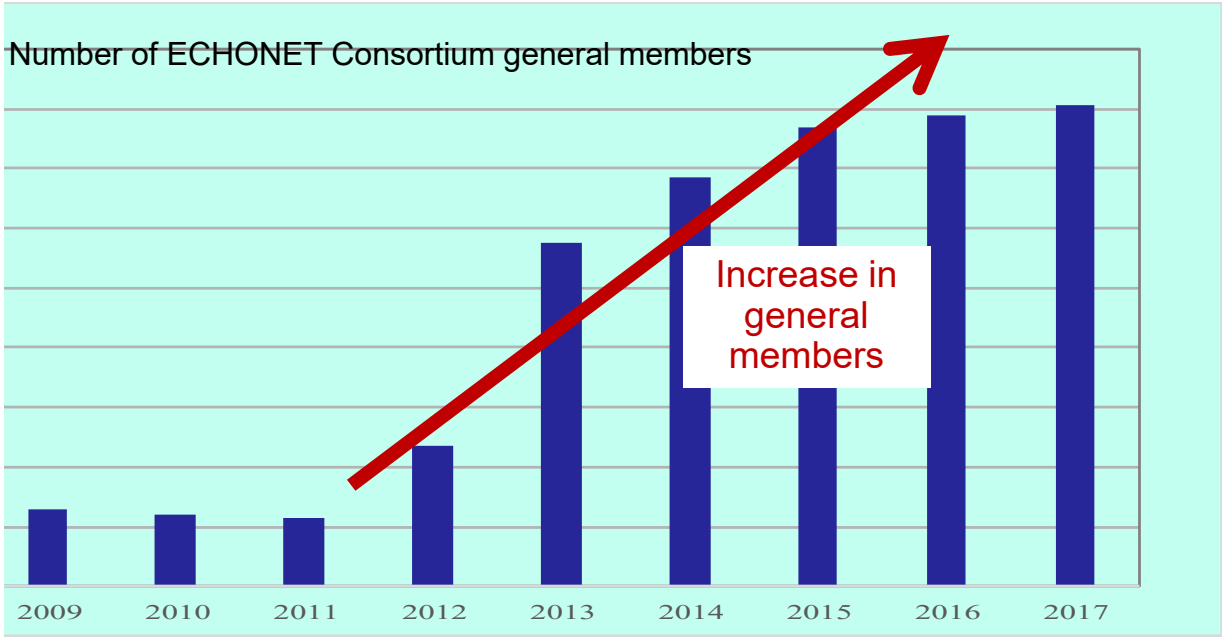
Over 100 classes of Device Object in 7 class groups are defined

Sensor Related	Fire Sensor, Human Body Detection Sensor, Temperature Sensor, etc.
HVAC Related	Air Conditioner, Fan, Ventilator, Air Purifier, Hot Carpet, Fan Heater, etc.
Facility Related	Blind, Lighting, Water Heater, Home Elevator, Gas Meter, Watt-Hour Meter, Fuel Cell, Storage Battery, PV, EVPS, etc.
Cooking Related	Refrigerator, Microwave Oven, Washing Machine, Rice Cooker, etc.
Health Related	Weighing Scales, Clinical Thermometer, Blood Pressure Meter, etc.
Controller Related	Controller, PDA, etc.
Audio-Visual Related	TV, Display monitor, etc.

Number of registered members

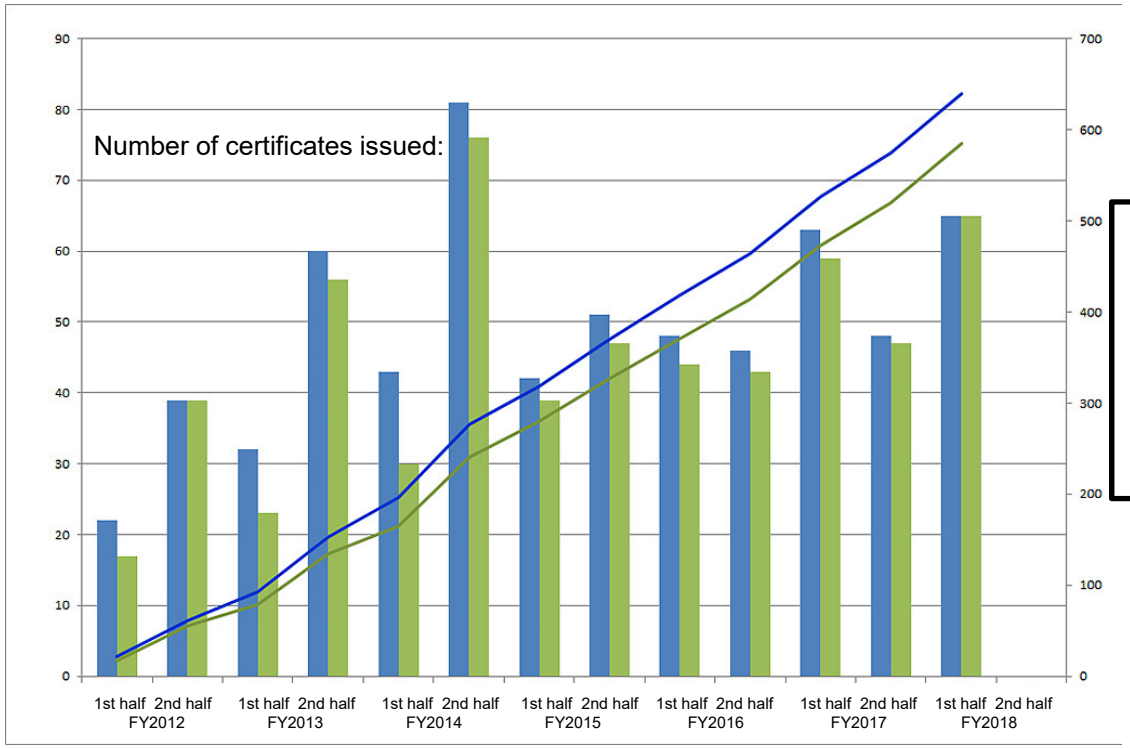
- Companies and academic institutions who support ISO/IEC14543-4-3 have formed up ECHONET Consortium.
- The members are increasing and getting international:
- 22 in 2011 and 282 in 2018

- **Sharp, TEPCO, Toshiba, NTT, Hitachi, Panasonic, Mitsubishi Electric**
- **Tokyo GAS, OSAKA GAS**
- **Toyota, Denso, Honda, NISSAN**
- **NEC, Omron, Daikin**
- **Soft Bank**
- **LG Electronics Inc.**
- **Freescale Semiconductor, Inc.**
- **Taiwan Smart Grid Industry**
- **SMA in Germany and so on**



Market penetration: certified ISO/IEC14543-4-3 devices in Asia

Number of shipped devices from 2012 onward
Number of certified ISO/IEC14543-4-3 devices: 17 million units (more than 500 types)
Smart meters implementing route B: more than 27 million units



Annual number of devices shipped (except smart electric meters):

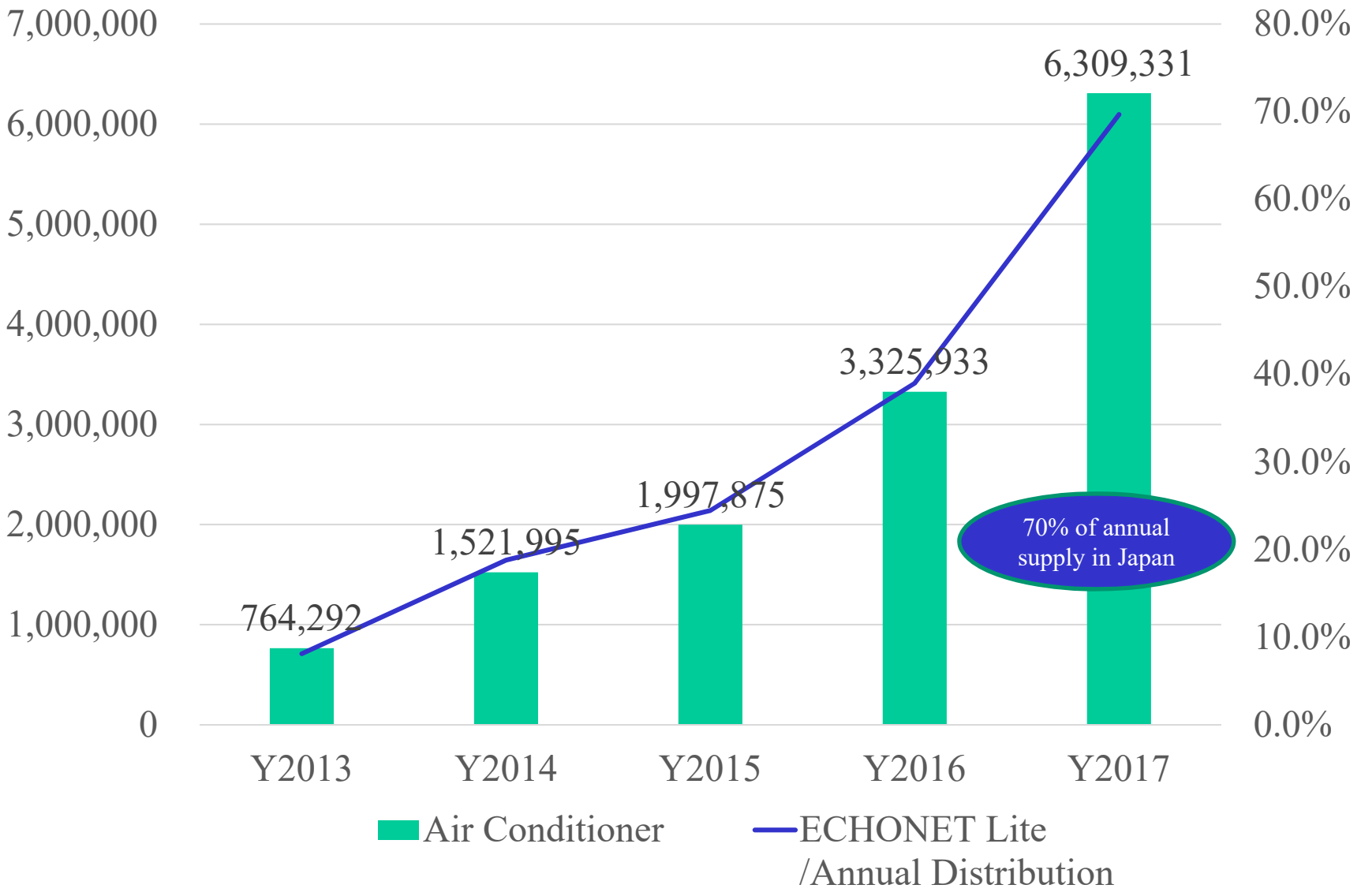
FY2013: 1,104,414
FY2014: 2,082,234
FY2015: 2,639,749
FY2016: 4,053,476
FY2017: 7,524,332

FY2017: Number of major devices shipped:
Air conditioners: 63,090,000 units
Water heaters: 3,720,000 units
Controllers: 480,000 units

Market penetration: ISO/IEC14543-4-3 certified product in Asia

- **Over 14 million air conditioners talked ECHONET Lite in 2017**

Market penetration: certified ISO/IEC14543-4-3 devices in Asia



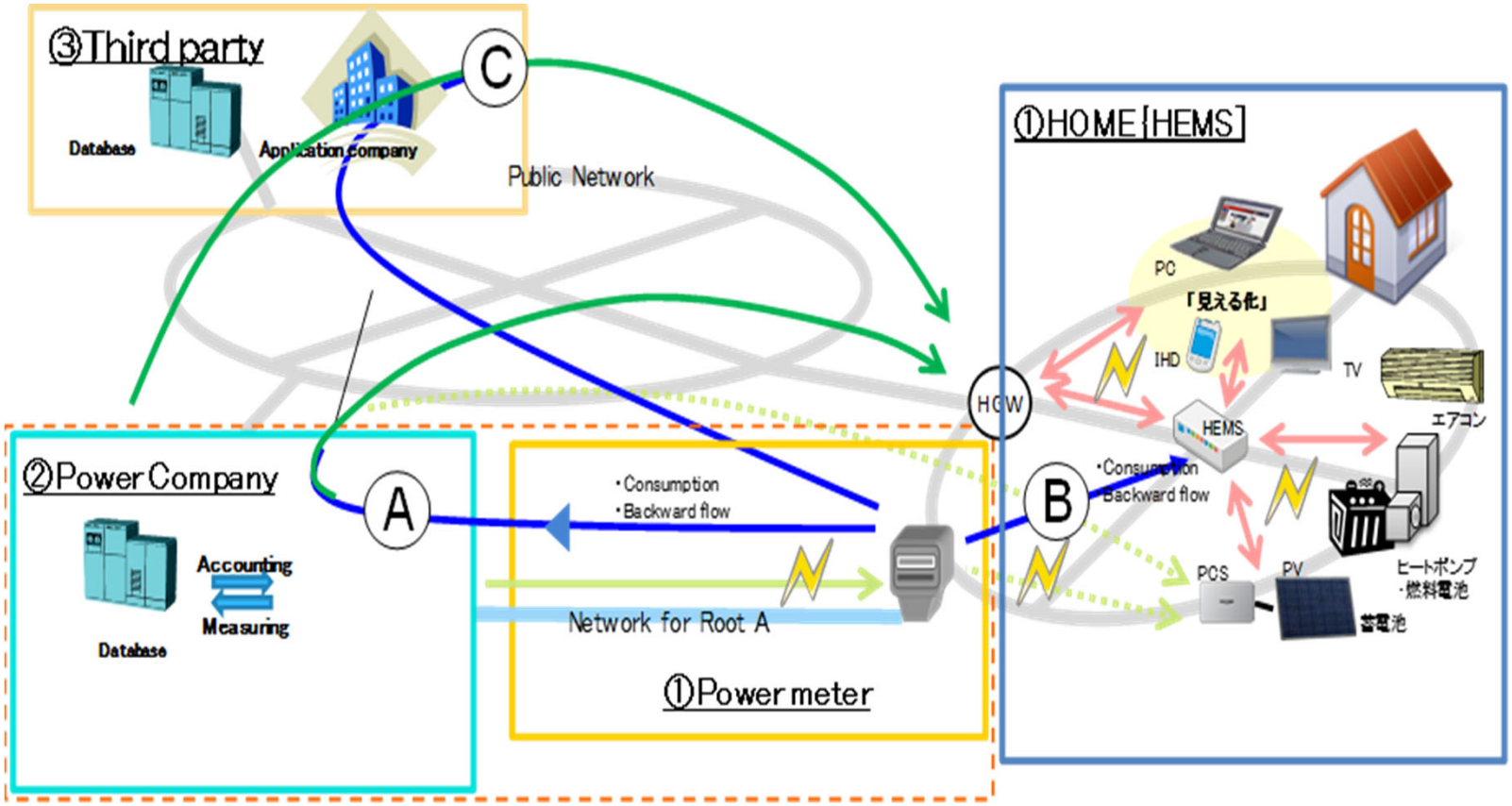
Every household has a smart meter in Japan

- Every power meter has two communication interfaces: A root for AMI and B root for users. Japan's nationwide power meters, exceeded 72 millions, speak ECHONET Lite, which is an international common language certified by IEC , over IPv6 architecture

- Automatic Meter Reading
  - every 30 minutes
  - active energy import and export
- Can store interval data for 45 days
- Measuring power, current, voltage
- Two-way communication
- On-demand meter reading
  - Remote disconnect, connect
  - Remote configuration/query (breaker capacity, demand limit, SM attributes, SM stats, etc.)

Smart Meter and Related Systems

- Every home and building has a smart meter, which is a networkable power meter. Installation was started in Tokyo in Sep2014, and is complete by 2022.

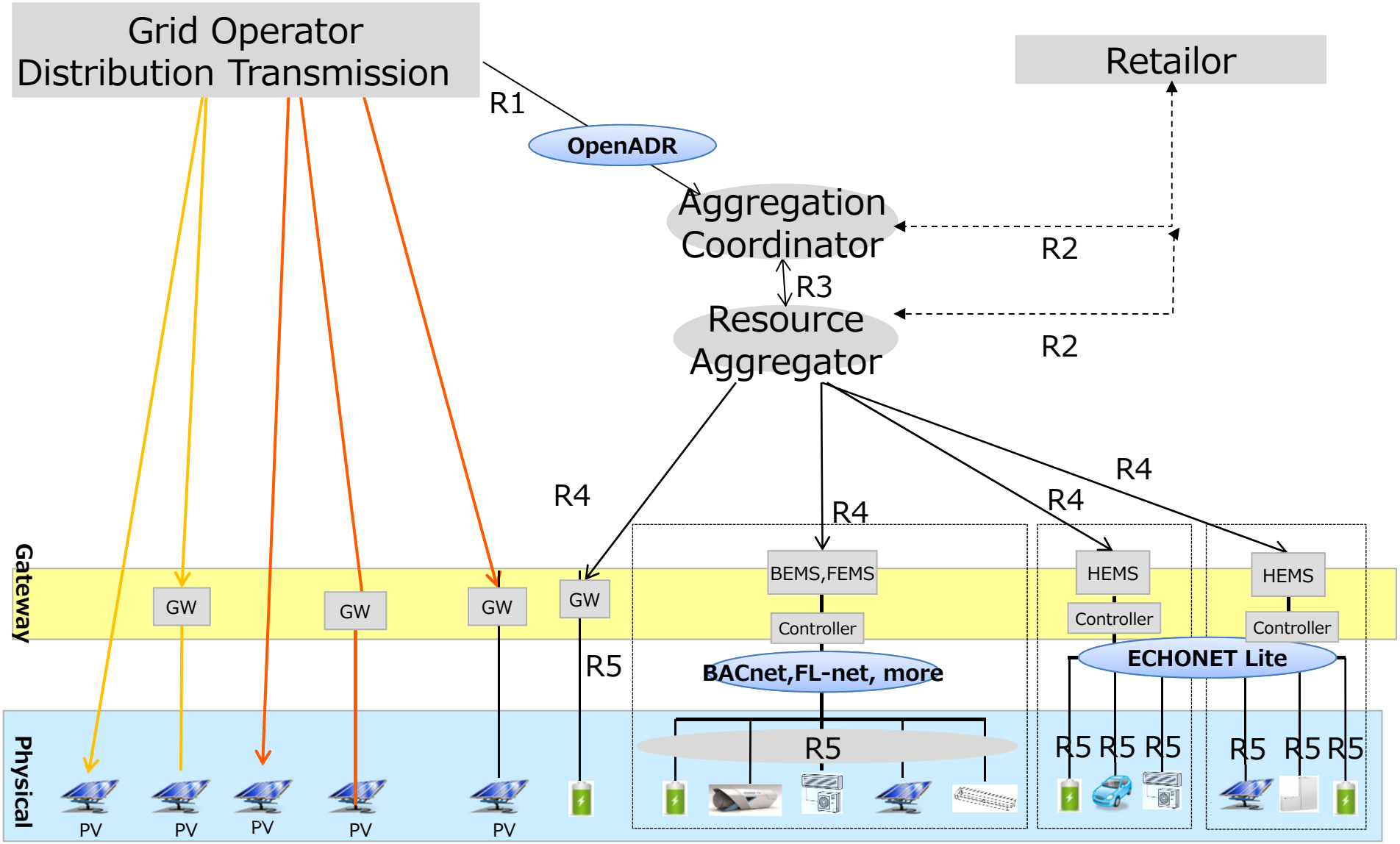


(Source : Source: Masaki Umejima et al.(2014)"ECHONET Lite enables Demand Side Energy Management-IP based and IEC's open standardized interface for home appliances-", W3C Workshop on the Web of Things Enablers and services for an open Web of Devices, 25–26 June 2014, Berlin, Germany)

What is ERAB? It is Japan's VPP system

- The energy resource aggregation business "ERAB" is a business framework in which consumers' energy resources, e.g., storage batteries, solar energy, and the demand response program, are integrally controlled, are seemingly functioned as one power plant, and are traded in electricity markets or on a negotiation basis.
- The Ministry of Economy, Trade and Industry (METI) has addressed this Japan's VPP initiative by forming up the Study Working Groups and subsidizing the pilot studies

Overview of Japan's VPP

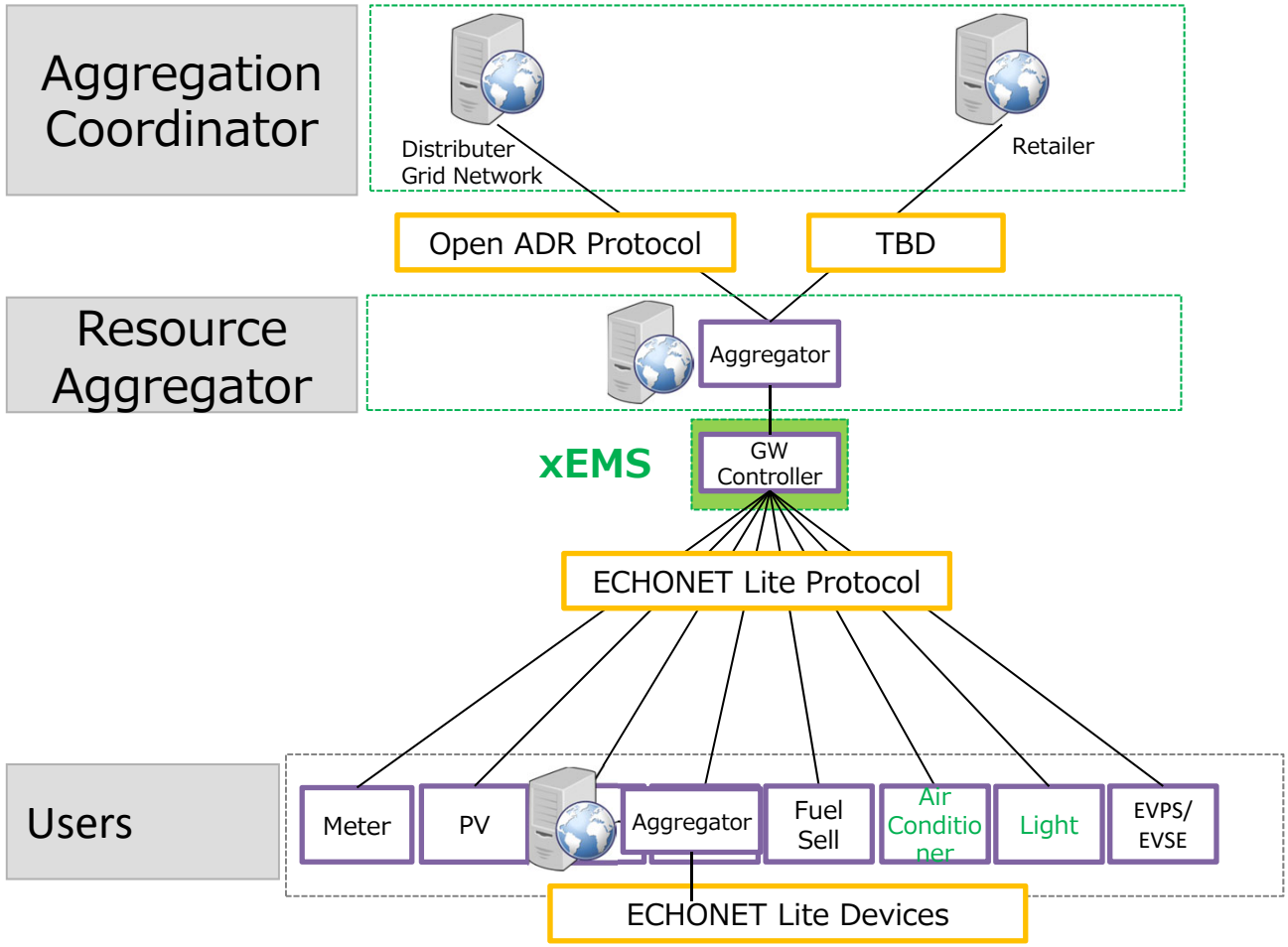


Nationwide retail stores can be a power plant

- Air conditioners an battery can be the enabler of VPP. “Trusted integration” and “interoperability among systems” are the necessary conditions of it.

Overview of Japan's VPP

- How do the energy resources at the demand side, which are fragmented in a demand side, perform as an one power plant with ensuring trust as the whole system?



引用：資源エネルギー庁第４回ERAB検討会日本電機工業会提出資料より著者編集

Overview of Japan's VPP

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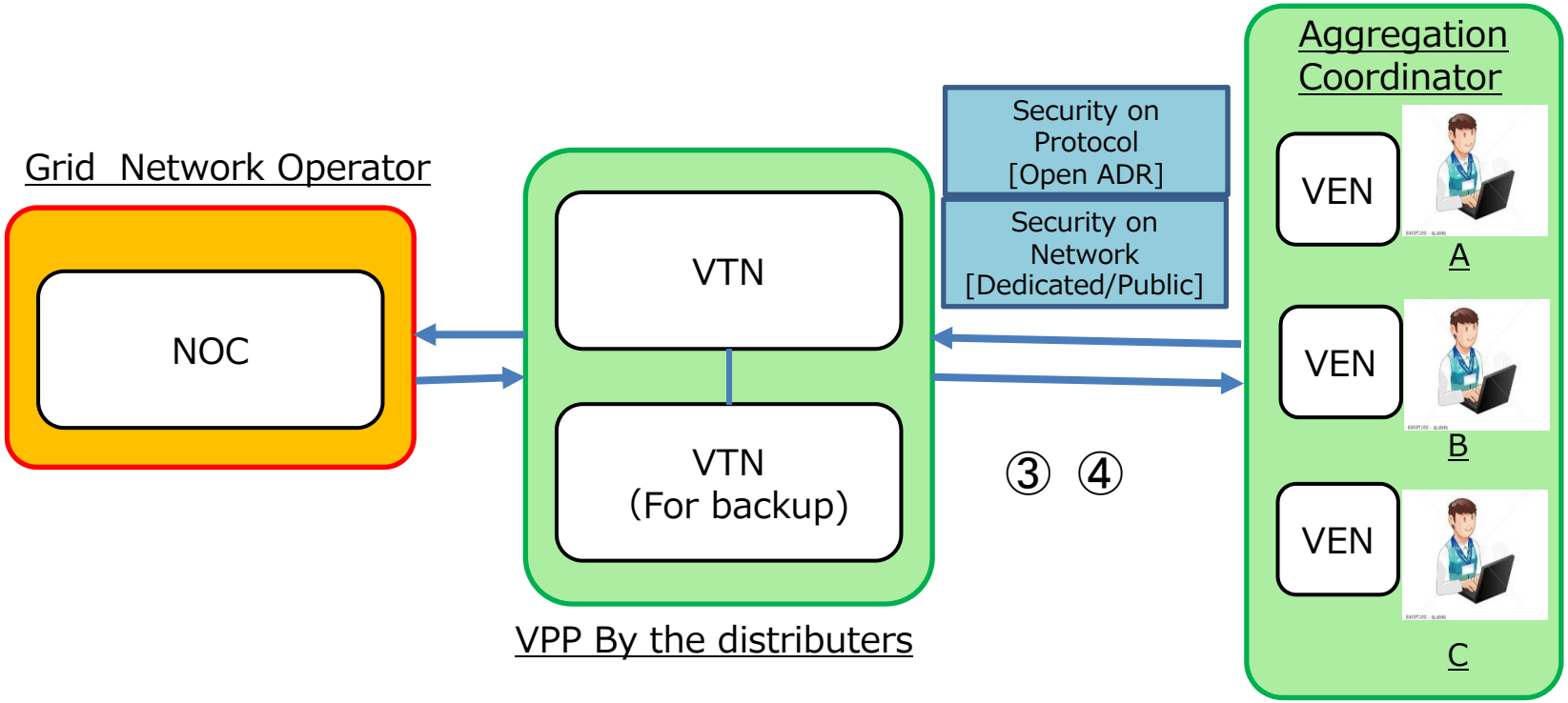
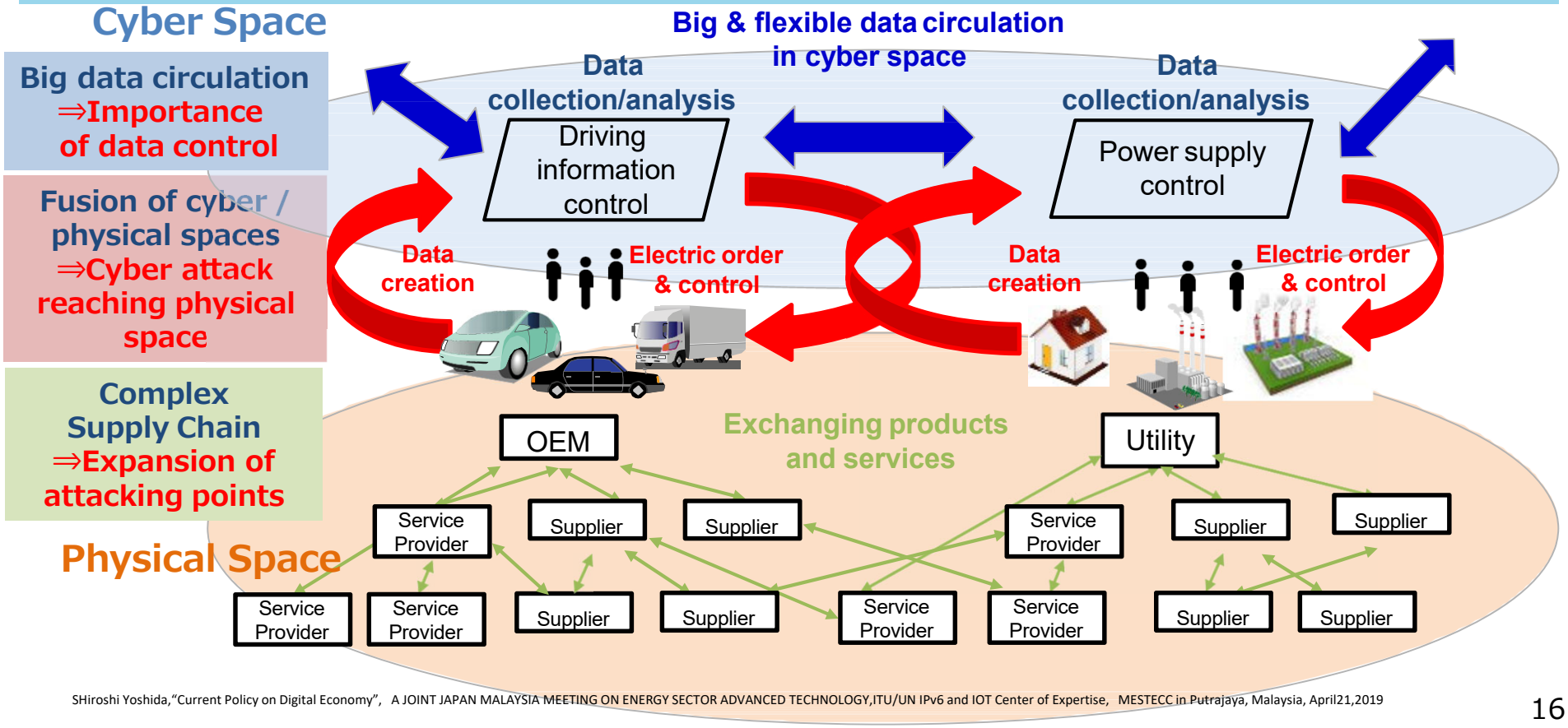


Transforming Society through Cyber/Physical Fusion

- A new society, “Society 5.0”, where cyber and physical spaces will be highly integrated, is coming.
- Products, services and data will be connected flexibly and complexly.
- Supply Chain is transforming from linear/fixed style to non-linear/flexible style.
- Cyber threat is also expanding according to this structural change.



The Cyber/Physical Security Framework

～for the Value Creation Process in Society5.0's supply chain ～

- In "Society 5.0" which is realized by IoT and AI, supply chain is transforming from traditional linear style to non-linear style where various kinds of connections exist.
- We defined this Society 5.0's new supply chain as "value creation process".
- We are developing "The Cyber/Physical Security Framework" to show the security guidance which corresponds to the extended concept of supply chain.

- "The Cyber/Physical Security Framework" grasps the industrial society where value is created as **Three Layers** composed of **Six Elements**, which comprehensively washout the risk points and the corresponding security measures

◆Three Layers

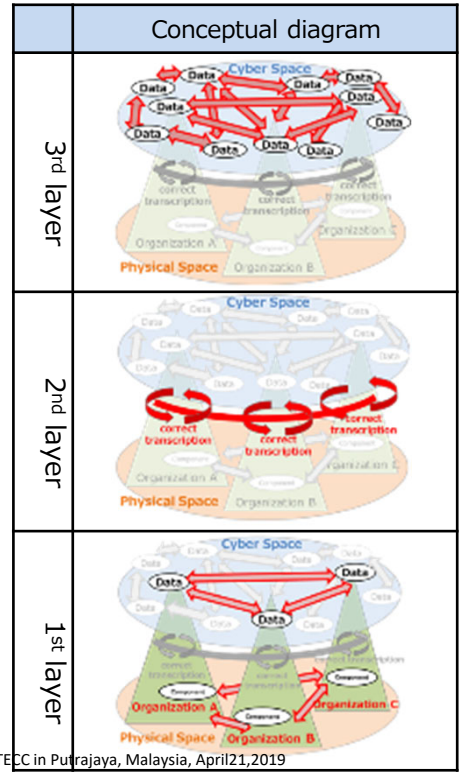
3rd layer: Connection in cyberspace

2nd layer: Connection between physical space and cyber space

1st layer: Connection between companies (conventional supply chain)

◆Six Elements

- Organization, people, component, data, procedure, system



Purpose of Three Layers' Approach

- Layers' approach would be good to articulate and control complicated risks of the new supply chain, "Value Creation Process".
- Each layer has a unique role to protect specific values for trustworthiness.

The Third Layer (Data circulation)

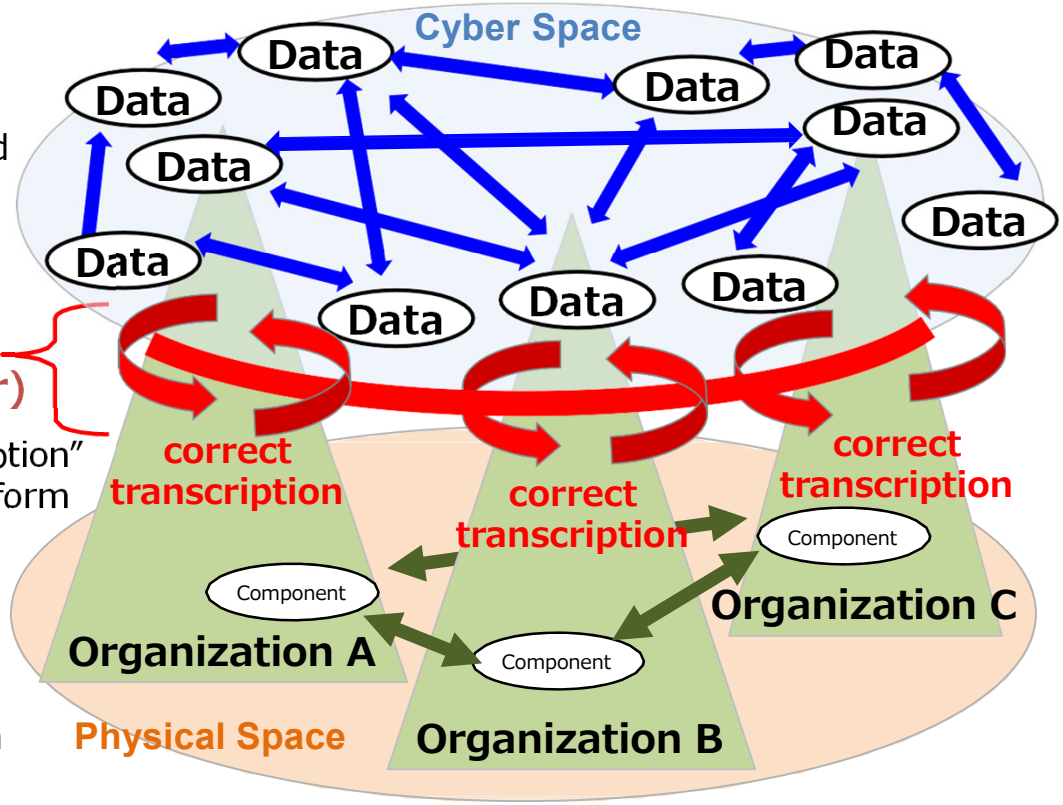
- Trustworthiness of data that freely circulate and are processed or created to produce services

The Second Layer (Cyber to physical/Physical to cyber)

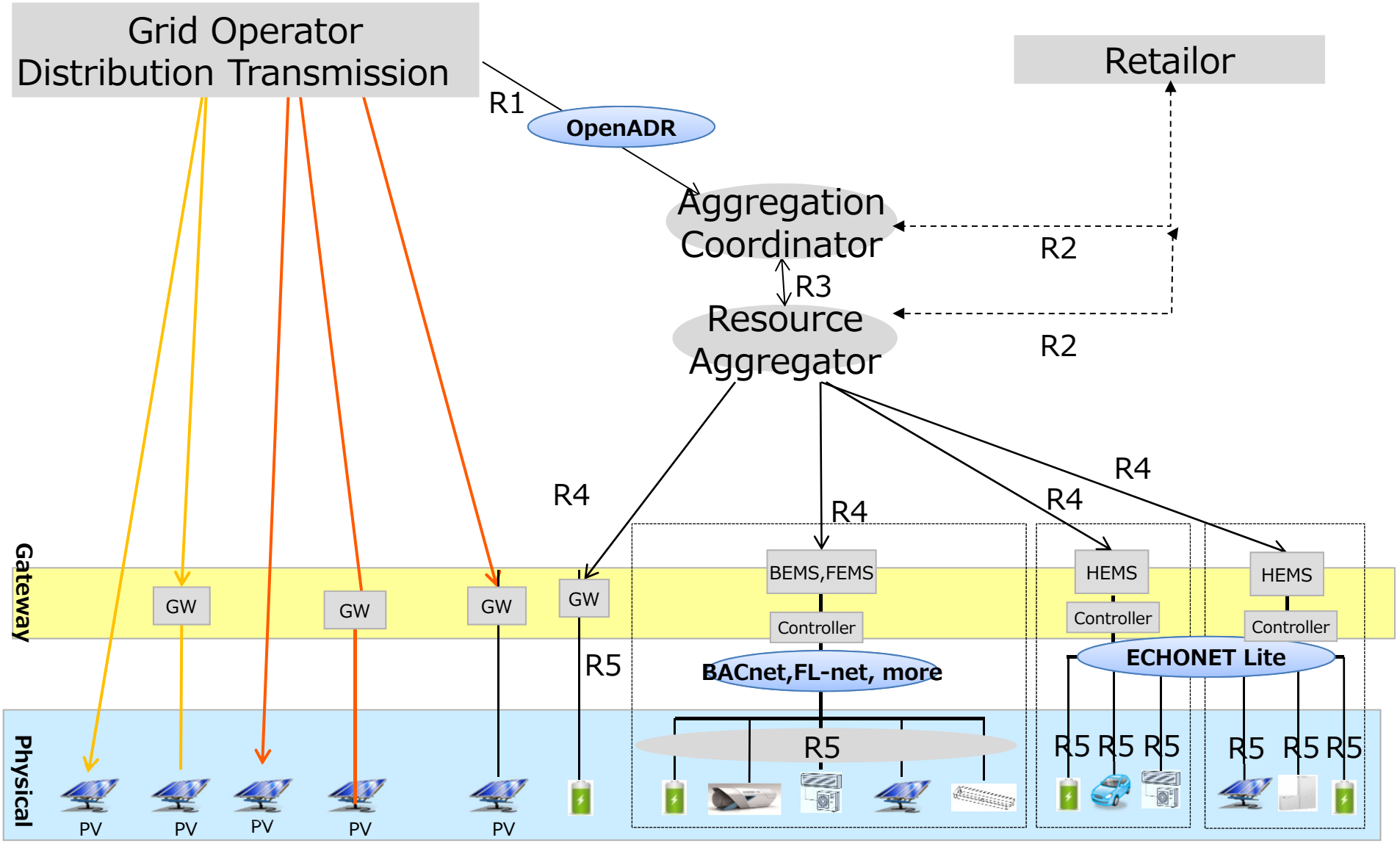
- Trustworthiness of function for "correct transcription" from cyber to physical / from physical to cyber form

The First Layer (Relationship among Organizations)

- Trustworthiness of each organization based on appropriate management



Three Layers' Approach and Security in the ERAB system



Cybersecurity in the ERAB framework

- In 2019, Cybersecurity Working Group on ERAB will release the guideline to express the ideal approaches to cybersecurity in the ERAB framework, highlighting the continuous improvement through a PDCA cycle.
- The guideline will require the ERAB business to introduce systems for device authorization, communication encryption and other cybersecurity means.
- And the guidelines will require a resource aggregator to regulate the security implementation of resource aggregators that are responsible the security at GW and device level.