

# **Wireless network customization technologies to enhance the future wireless-grid applications**

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Fumihide Kojima, Ph. D. (Eng.)

Wireless Systems Laboratory,

Wireless Networks Research Center,

National Institute of Information and Communications Technology

TEL: +81-46-847-5084

E-mail: [f-kojima@nict.go.jp](mailto:f-kojima@nict.go.jp)

ASEAN IVO FORUM 2018

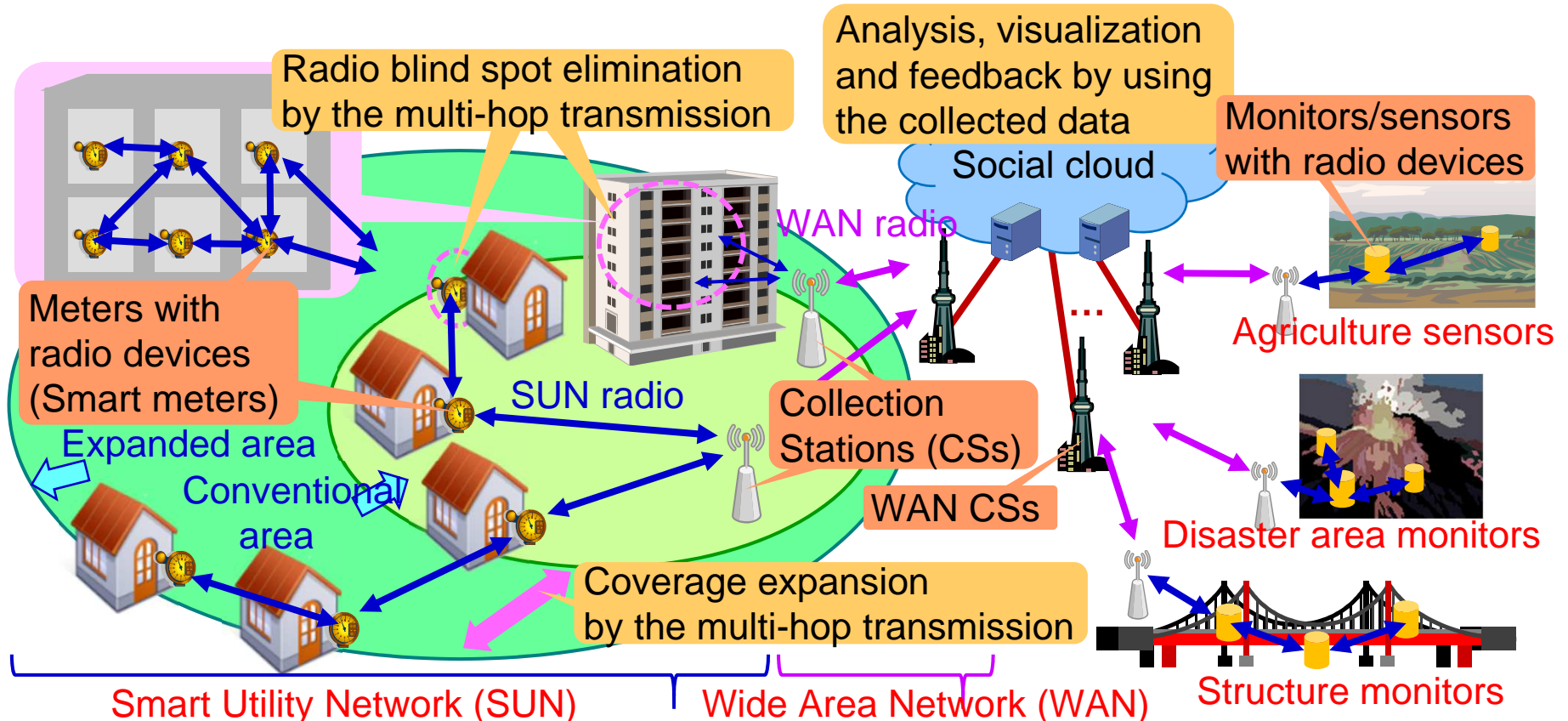
- NICT has conducted R&D, standardization and promotion activities on **Wireless Network Customization Technologies** to enable flexible radio device mesh topology (namely, **Wireless-Grid**) that is essential for future IoT society
  - Three major mesh categories:
    - ▶ High capacity data collection network
    - ▶ Ultra low-energy operation network
    - ▶ Reinforced mesh network
  - Further enhancements in the future:
    - ▶ Specification customizations
    - ▶ Harmonization/coexistence/cooperation with the other systems
- Hope NICT's R&D promote the system customization activities along with ASEAN IVO projects in the future!**

# Concept of smart utility network

- SUN means a network constructed by Electricity/Gas/Water meters equipping radio devices that can effectively and automatically relay data frames to the collection station, which is expected to further support large amount of monitoring/sensing applications

## SUN's technical requirements

- Low-energy performance
- Multi-hop transmission capability



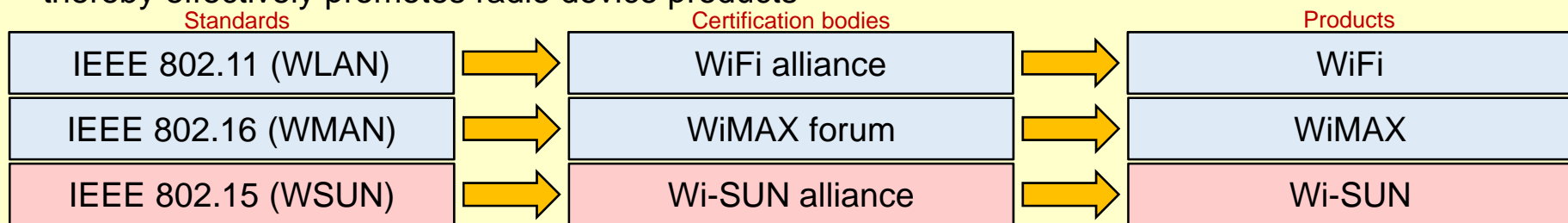
- NICT has established “Wi-SUN,” the world first **certification body** of SUN devices, in order to **effectively promote** the IEEE 802.15.4g compliant devices by holding the conformance and interoperability tests

## □ Standardization in IEEE 802

- NICT has proposed the required **PHY and MAC specifications for SUN** with Gas companies and meter vendors in Japan. And, the proposed specifications have been included in **IEEE 802.15.4g/4e** standards

## □ What is Wi-SUN alliance

- World first global certification body that certifies IEEE 802.15.4g compliant devices
- Established in January 2012, mainly led by IEEE 802.15.4g standardization contributors. **NICT is one of promoter members**
- Its certification guarantees **conformance and interoperability** that is not guaranteed by standards thereby effectively promotes radio device products

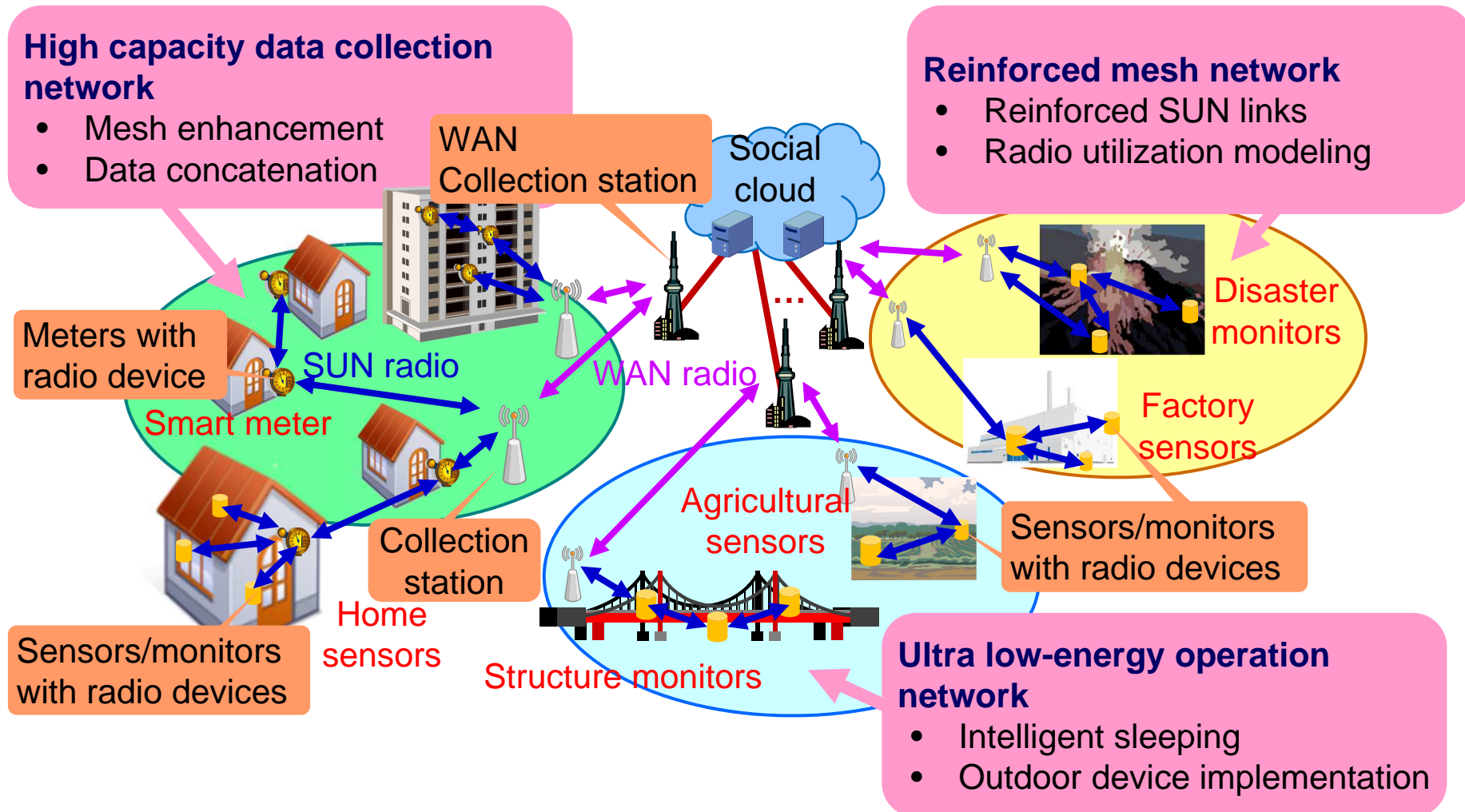


## □ Achievements

- Certification profile for **ECHONET Lite (a higher-layer communication protocol for home energy management systems)** has been selected for 10 major electric power companies in Japan, which means application to more than 80 million houses

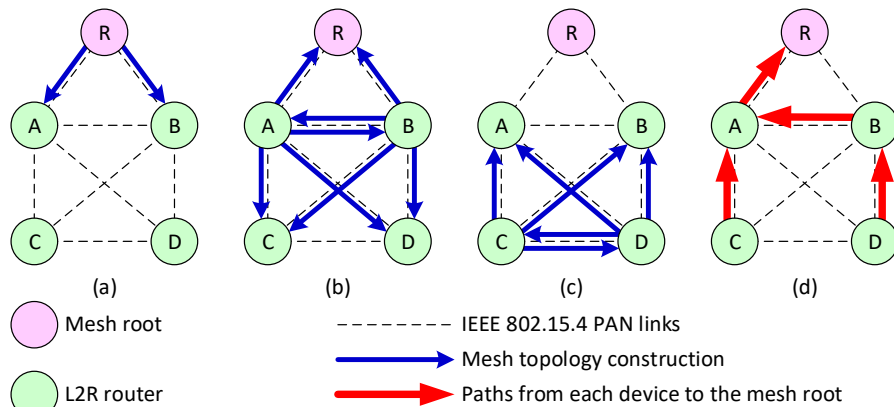
# Further wireless-grid applications

- NICT has studied on further wireless grid applications promoted by the suitable certifications, such as applications to advanced home energy management systems and fishery fields. Wireless grid also becomes one of the promising technology for IoT applications in the future

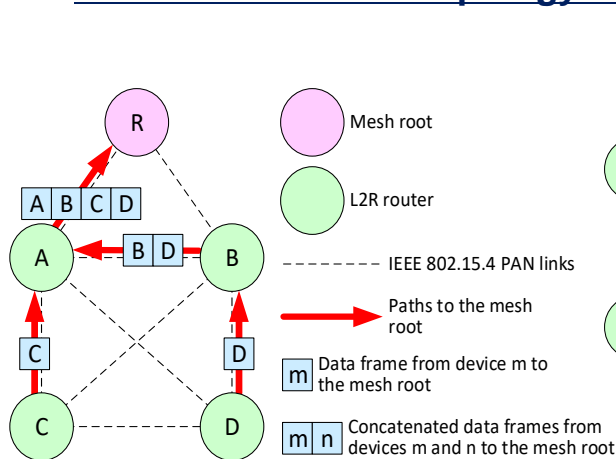


# Large scale mesh by L2R control

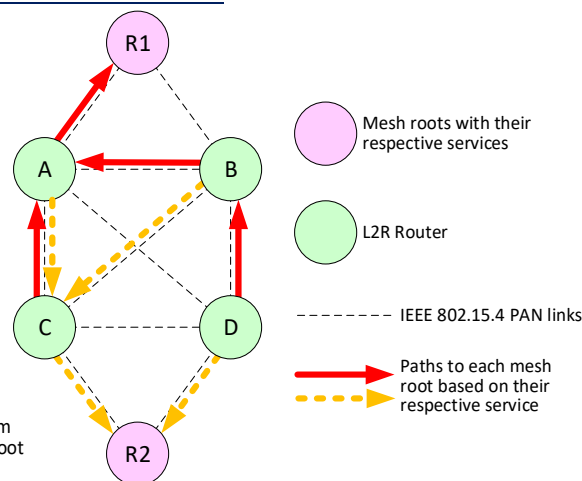
- NICT has proposed L2R (Layer 2 Routing) deploying IEs (Information Elements) on MAC layer for large scale mesh topologies for the smart-home/ building/ factory, which is accepted in the IEEE 802.15.10



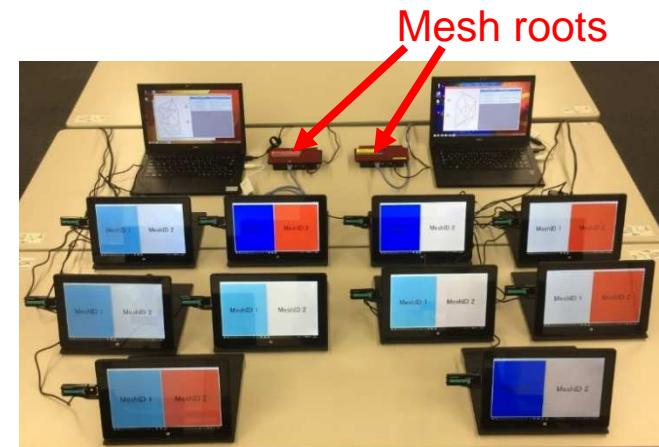
## Autonomous mesh topology construction



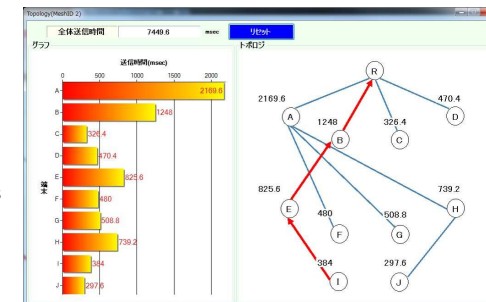
## Data concatenation



## Support for multiple services



Routers

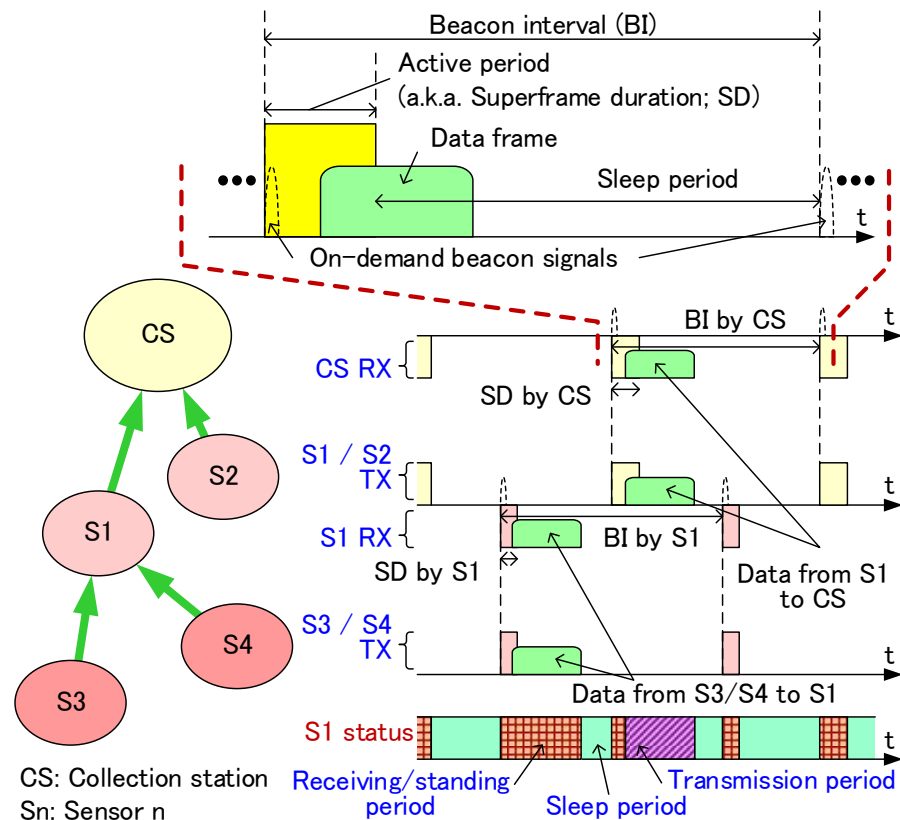


## Routing tests for large scale mesh

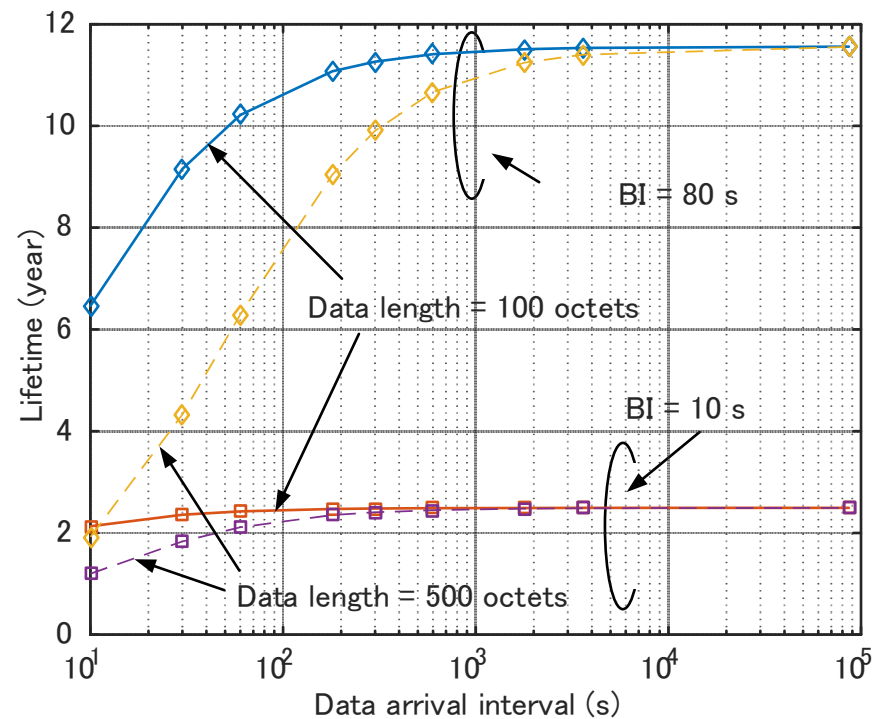


# LE-Superframe performance analysis

- Ultra low-energy operations (battery driven 10 year operation, by exploiting sleep period) especially for the outdoor use are studied, developed and tested



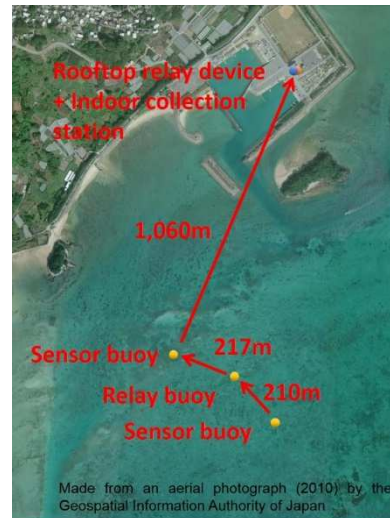
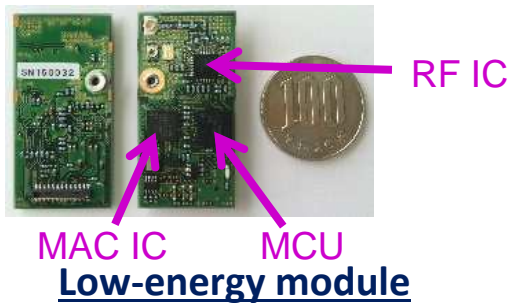
**Concept of low-energy multi-hop communications**



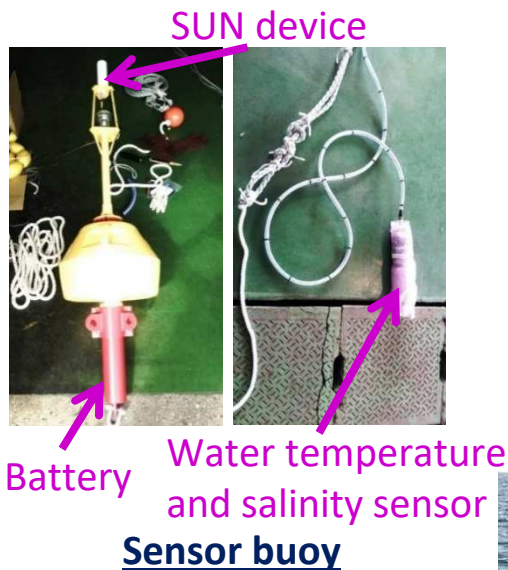
**Lifetime estimation**

# Proof tests in fishery and agriculture apps

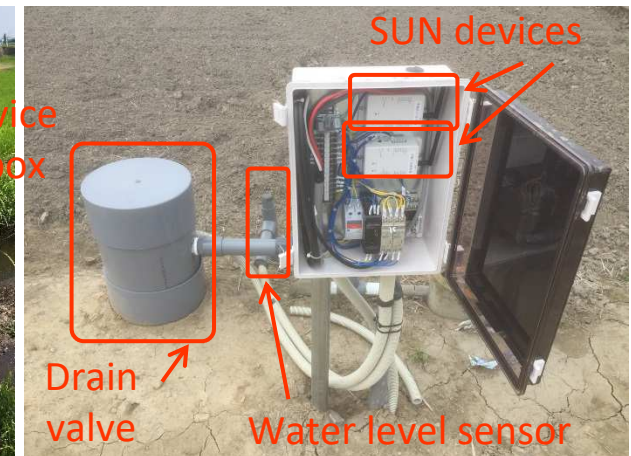
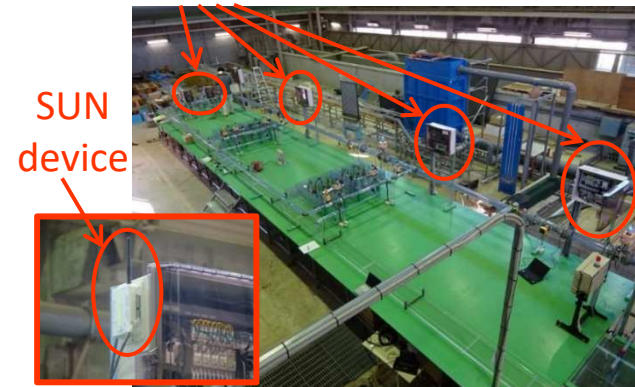
- Low-energy SUN devices are deployed in the **Mozuku seaweed** monitoring, and water management in the **rice fields**



**Sensor buoy allocation for monitoring**



Low-energy device connected PLCs



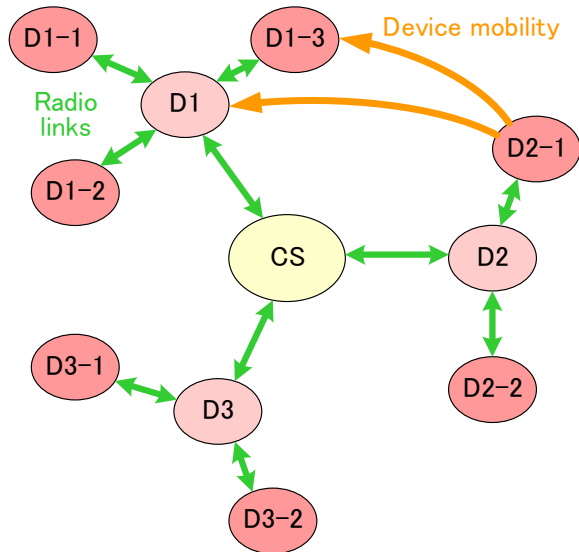
Water level sensor  
**Water management tests in the laboratory and in the rice field**

This work was supported by Cabinet Office, Government of Japan, Cross-ministerial Strategic Innovation Promotion Program (SIP), "Technologies for creating next-generation agriculture, forestry and fisheries" (funding agency: Bio-oriented Technology Research Advancement Institution, NARO).



# Mobility supported environmental sensor

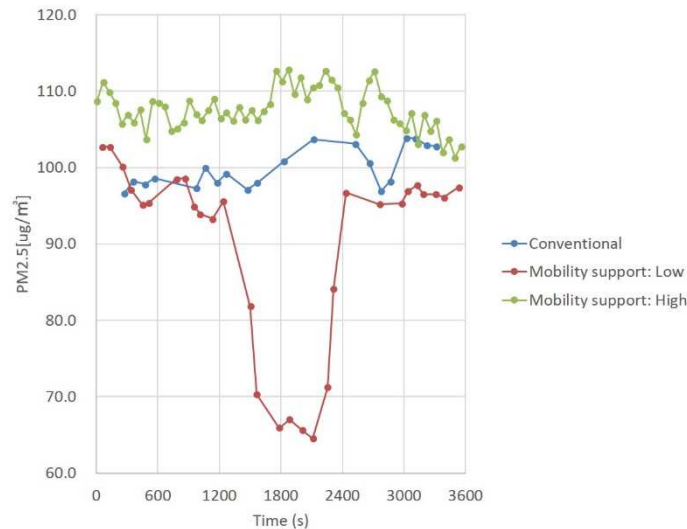
- Developed the environmental sensor equipping low-energy SUN device
  - Mobility support assuming portable environmental sensing
    - Quick topology reconstructing according to the location changes
  - Sensors: PM2.5, CO, CO2, air pressure, temperature, humidity



Concept of topology reconstructing



Developed sensor and sensing results (PM2.5)



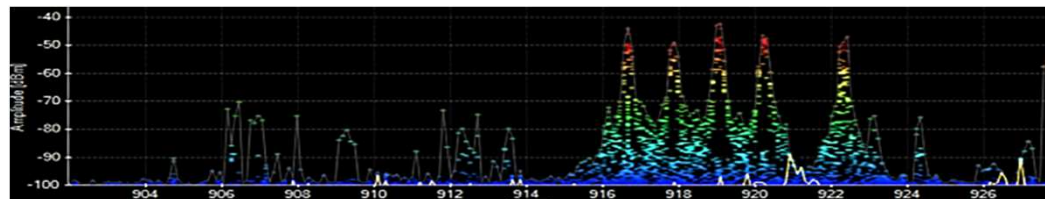
Environment monitoring tests to investigate mobility support capability

# Reinforced mesh network in the factory

- NICT has investigated the applicability of radio signals on the several frequency bands including SUN's to the factory use that realizes flexible manufacturing-line deployments



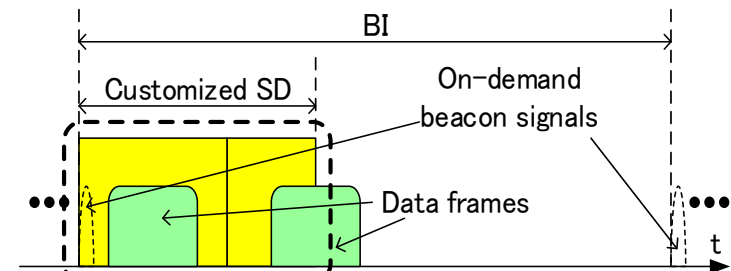
Experimental setup for radio signal monitoring in the factory



An example of monitored signals in the factory area (920 MHz)

# Future possible enhancements

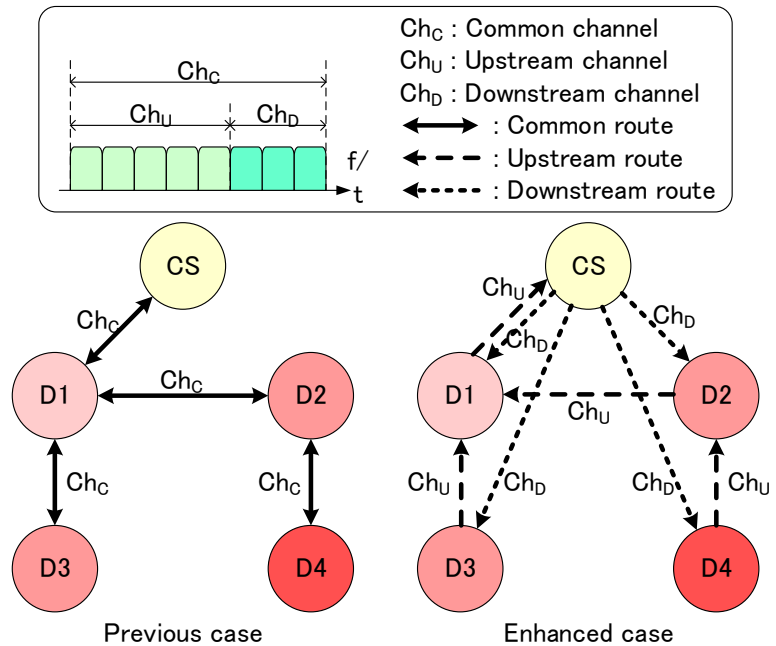
- NICT is considering about further enhancements for the wireless-grid systems
  - ▶ Specification customizations according to the assumed applications
  - ▶ Harmonization/coexistence/cooperation with the other wireless systems



Customized SD enables:

- Non-uniform SD length deployment
- Internal partitioning for several frame types

## SD customization



## Separate management of upstream and downstream frame forwarding (w/ concept of dynamic resource allocation in the current SUN network)