Project Title: IoT Open Innovation Platform

Background : The widespread usage of smart phones and smart devices in the network today has transformed the network into a connected web of smart devices.

These devices are made smart by the applications developed to provide huge benefits and services to the users. This is the Internet of Things (IoT).

To stay competitive and to be able to capture the potential IoT market, it is important to have the IoT platform and acceleration tools to facilitate the rapid development and adoption of IoT solutions for public and private markets, especially in new upcoming developing ASEAN countries. A common platform would allow integration of data and services from different systems. Thus allowing the combined operation of many different heterogeneous IoT systems onto one common open platform, the IoT open innovation platform.

Targets:

Complete the following:

1) IoT Open Innovation Platform,
2) Sensory and gateway systems for POC,
3) POC project in Aquaponics and supporting Peat Forest project and
4) Establishment of the ASEAN IVO IOT HUB.

Speaker: Boon Choong Foo
Senior Director
MIMOS BHD
Malaysia

Project Title: IoT Open Innovation Platform

Project Members :

Name	Position/Degree	Department, Institution, Country
Boon Choong Foo	Senior Director	MIMOS BHD, Malaysia
Looi Chin Teong	Senior Staff	MIMOS BHD, Malaysia
Dr. Kiyoshi Hamaguchi	Director General	NICT, Japan
Dr. Fumihide Kojima	Director	NICT, Japan
Dr. Thu Ngo-Quynh	Department Head	HUST, Vietnam
Dr. Dinh Van Dzung	Deputy Director	VNU, Vietnam
Dr. Sun Sumei	Department Head	I2R, Singapore

Project Duration : 3 years. April, 2016 – March 2019

IoT 4 Layers Architecture

Application Layer

Platform Layer

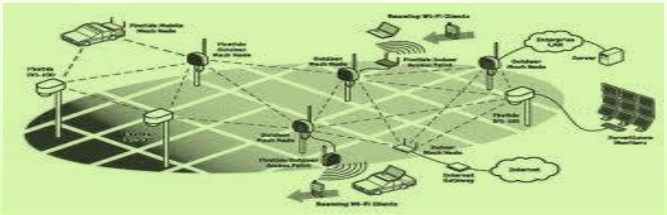
- Application enablement platform
- Platform middleware
- Platform ownership
- Rapid development platform

mist

MIMOS Internet Services of Things

Network Layer

- Wired and wireless connectivity
- Edge middleware
- Pervasive network



Sensor (& Actuator) Layer

- Sensors & actuators
- Embedded middleware
- Mobile devices

IoT 4 Layers Architecture

Application Layer

Objective 2: Develop Proof of Concepts (POC) applications in Rural Healthcare, Environmental & Aquaculture

Platform Layer

- Application enablement platform
- Platform middleware
- Platform ownership
- Rapid development platform

Objective 1: To provide software enablement platform that is flexible and cost effective in the interest of research and development in IoT solutions for ASEAN markets.

Network Layer

- Wired and wireless connectivity
- Edge middleware
- Pervasive network

Wi SUN LoRa™ Wi Fi™

Objective 3: Develop sensors, devices & gateways for POC applications in Rural Healthcare, Environmental & Aquaculture

Sensor (& Actuator) Layer

- Sensors & actuators
- Embedded middleware
- Mobile devices

Project Activities: Progress in 2016

- Planning Meeting – July 28–29, 2016; Hanoi
  - Proof of Concept (POC) in Aquaculture, Environment and Healthcare were proposed.
  - Visits to IoT users:
    - Vietnam Posts and Telecommunications (VNPT) Technology IoT Center,
    - HOA LAC HI-TECK PARK (HHTP)

- MIST, IoT open innovation platform identified to provide the medium of collaboration in market deployment and technical development.
  - Mi-MIST 1.0 released in August 2016.
  - BK-IoT platform to interface with MIST.

- MIST training workshop – Sept 27-29, 2016;
- Hanoi
  - Training by MIMOS provided to HUST and VNU in Sept 2016.

Training Workshop in Hanoi, Sept 27-29, 2016.

Project Activities: Progress in 2017

- System Deployment Workshop
  Feb 15-16, 2017; Kuala Lumpur
  - Project planning for POC system and deployment.
  - High level architecture review.
- Equipment list and architecture for POC defined – Q2, 2017

System Deployment Workshop
Feb 15-16, 2017; Kuala Lumpur

- Procurement of equipment and devices – Q3, 2017
- Development of sensory and gateway systems for POC applications– Q3, 2017
  - HUST completed an IoT based AQI Monitoring and Notifying System prototype.
  - HUST completed CoAP/UDP/IPv6 Protocol Stack on ARDUINO MEGA under Contiki/Linux.
  - HUST completed a Communication Protocol based on Orchestra Scheduler of TSCH that can provide different levels of QoS.
- MIST, IoT open innovation platform PaaS (Cloud version) – Q4, 2017

Project Activities: Progress in 2018

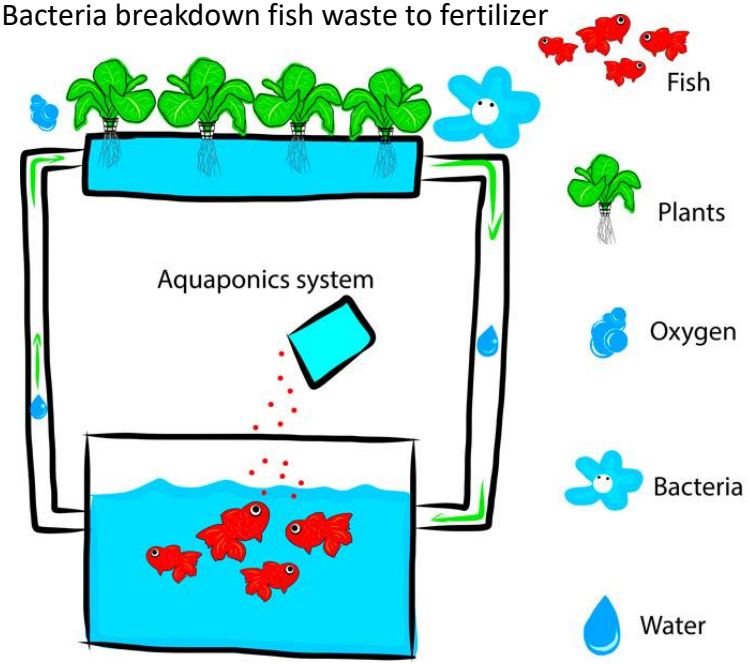
- IoT Solutions Workshop – Sept 25-27, 2018; Hanoi
  - IoT Open Innovation Platform training to staffs from Hanoi University of Science and Technology; and Vietnam National University related to healthcare solution.
  - IoT healthcare Solutions review
  - Latest installation of MIST IoT software platform for healthcare solution.
- Project equipment received – Q2 & Q3, 2018
- MIST, IoT open innovation platform (new version) – Q3, 2018
- Establishment of the ASEAN IVO IoT Hub at MIMOS, BITX Lab – Q4, 2018
- IoT Solutions – Q3 2018, Q1 2019
  - Collaborating with HomeGrown, a Malaysian company, to provide aquaponics monitoring system for their aquaponics organic farms.
  - Collaborating with MIMOS, UPM, BAU, UTB, PTIT, INTROP, NICT and JIRCAS; on using the ASEAN IVO IoT Hub to collect and analyse data on peat forests in Indonesia, Vietnam, Malaysia and Brunei. (NAPC: Networked ASEAN Peat Swamp Forest Communities)

R&D results: Aquaponics Organic Farming (POC)

HOMEGROWN FARMS SEMENYIH
Local . Organic . Sustainable

Aquaponic: a system that combines conventional aquaculture (raising aquatic animals such as fish or prawns in tanks) with hydroponics (cultivating plants in water) in a symbiotic environment.

Bacteria breakdown fish waste to fertilizer



Important parameters are measured and aggregated on IoT Platform for monitoring and analytics for trends and improvement.

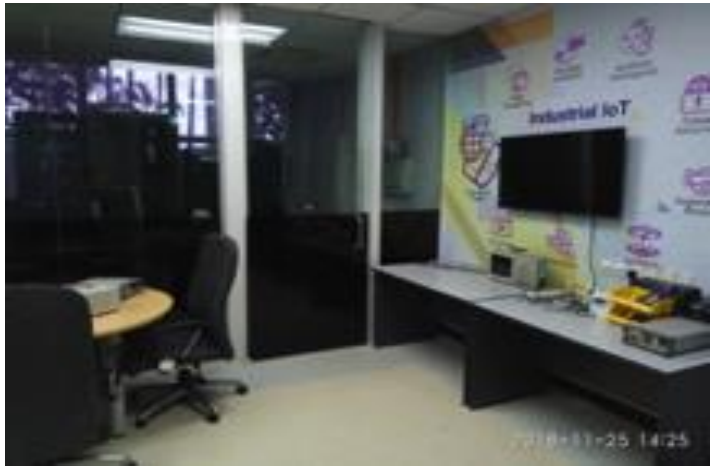
1. pH
2. Dissolves Oxygen
3. Temperature
4. Nitrates
5. Ammonia
6. Water levels
7. Water flow sensor

Plants

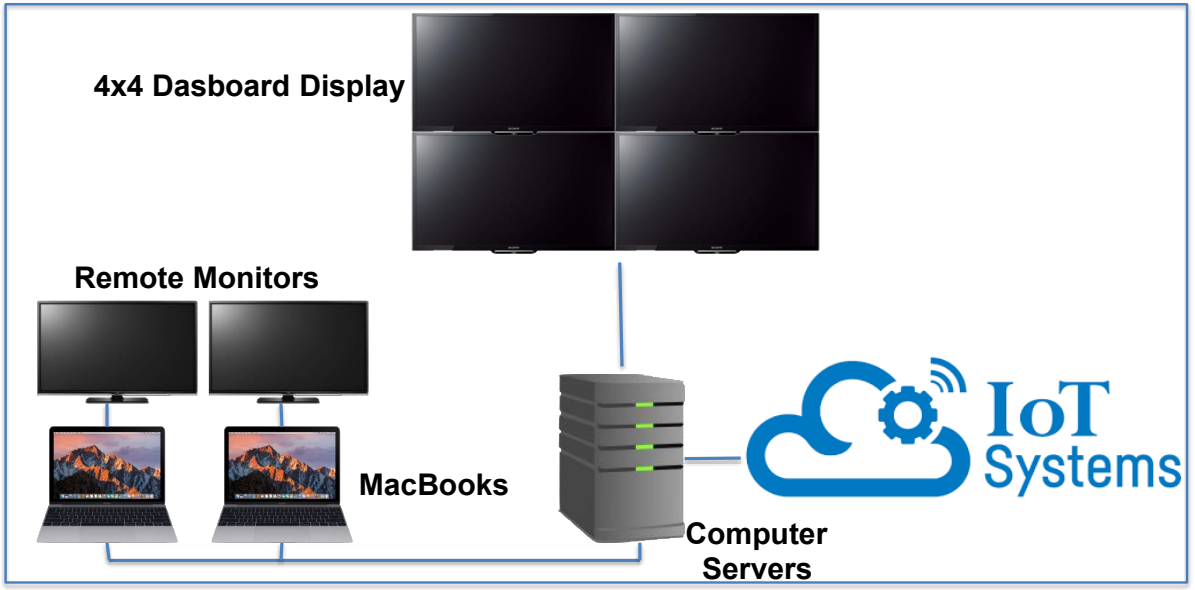
New farms under construction

R&D results: ASEAN IVO IoT HUB

MIST, IoT open innovation platform (new version) was released in Q3, 2018. The ASEAN IVO IoT Hub at MIMOS was completed in Q4, 2018.



The IoT HUB can provide complimentary cloud IoT platform services for ASEAN IVO members to develop IoT applications and dashboards.



R&D results: IoT-based AQI Monitoring and Notifying System

- **Functions:**
  - **Measuring following parameters**
    - SO_2, CO, NO_x, O_3, $PM_{10,}$ PM2.5, µg/m^3
  - **Transmit these parameters to the System**
  - **Based on Vietnamese Regulation, calculating AQI Index**
  - **Notifying different Client's Subsets**
    - Sensitive People (Old People and Children)
    - Non-sensitive People
- **Our System implemented at HUST:**
  - **Measuring Box:**
    - Sensor Hardware Platform: ARDUINO MEGA
    - Sensing Components: CO – MQ7, PM – GP2
    - Sensing Components: Module Wifi ESP 8266: sends Data to Server through 802.11
  - **Server:**
    - MQTT Broker: MQTT Mosquito
    - MQTT Client: MQTT Pahoo
  - **Clients** (Sensitive and Non-Sensitive Clients)

AQI	Quality of Air	Actions	Colour
0-50	Good	Not influence to health	Blue
51-100	Average	Sensitive people (old people and children) should limit outdoor activities	Yellow
101-200	Bad	Sensitive people (old people and children) should limit outdoor activities	Orange
201-300	Very Bad	Sensitive people (old people and children) should stay at home. Other should limit outdoor activities	Red
>300	Dangerous	Every people should stay at home	Brown

Contact: Assoc. Prof. Thu Ngo-Quynh, HUST thunq@soict.hust.edu.vn

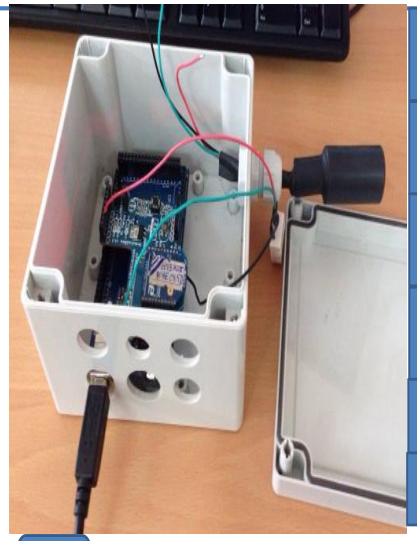
R&D results: CoAP/UDP/IPv6 Protocol Stack

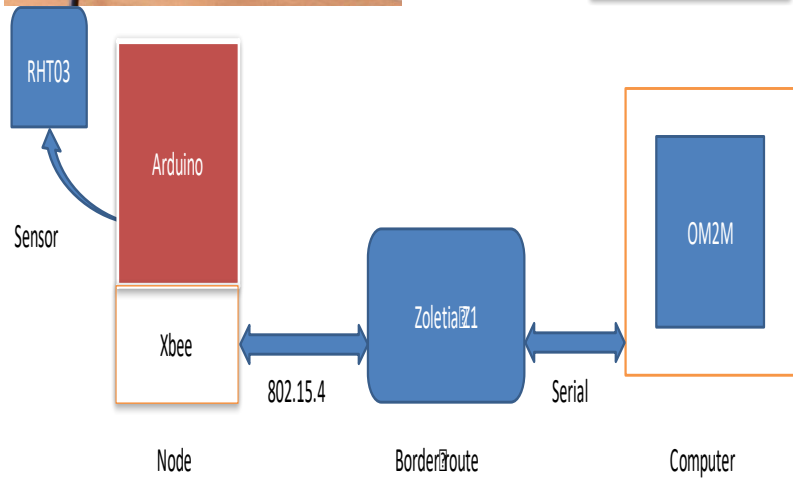
- **Enabling Low-Power Low-Cost Smart Agriculture, Smart City Application**
  - Selected Protocol Stack selected:
  - CoAP/UDP/IPv6-RPL/6LoWPAN/802.15.4 – CSMA/CA
- **Based on IPv6-IoT Protocol Stack**
- **Selected Operating System: Contiki/Linux**
- **Selected Hardware Sensor: ARDUINO MEGA**
  - is compatible with different sensing components
  - Is compatible with different actuators

→ **Necessary to build CoAP/UDP/IPv6-RPL/6LoWPAN/ 802.15.4 under Contiki, running on top of ARDUINO MEGA**

→ **Built System at HUST:**

- ARDUINO MEGA
- CoAP/UDP/RPL/802.15.4





Successful data transmission between ARDUINO MEGA and Server

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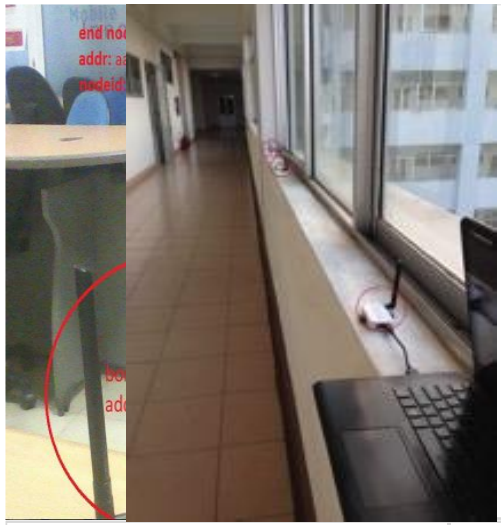
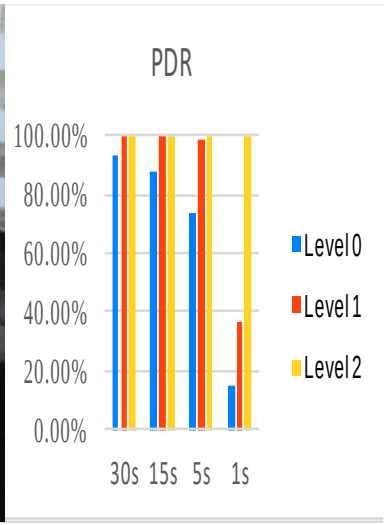
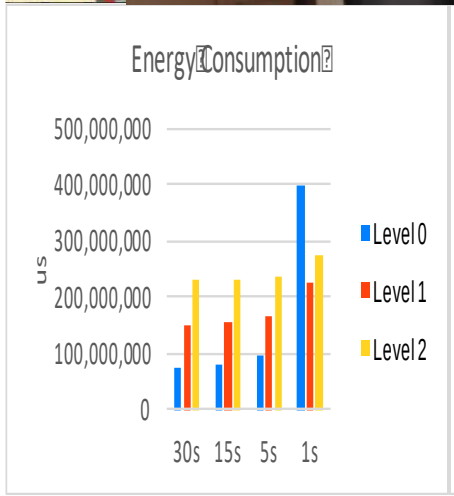
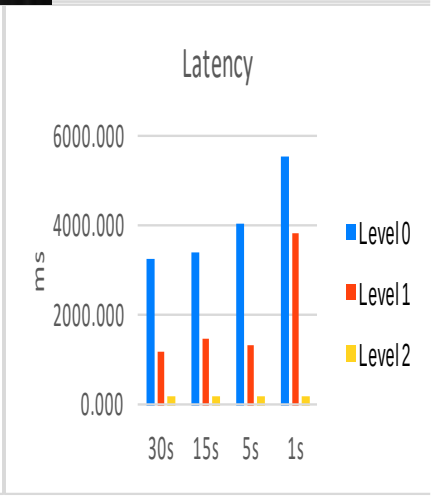
R&D results: Providing Different QoS Levels by Communication Protocol

- It is important to provide different QoS Levels in WSN
- In CSMA/CA 802.15.4 WSN: difficult to control QoS Levels
- **Our proposition:** Communication Protocol that provides
  - 3 Levels: QoS 0, 1 and 2
  - TSCH-based (802.15.4e)
- **Simulative Evaluation:**
  - Contiki/Linux Z1/Zolertia
  - Different QoS Levels
- **Implementation in a Labtest:**
  - Multihop (2 hops)









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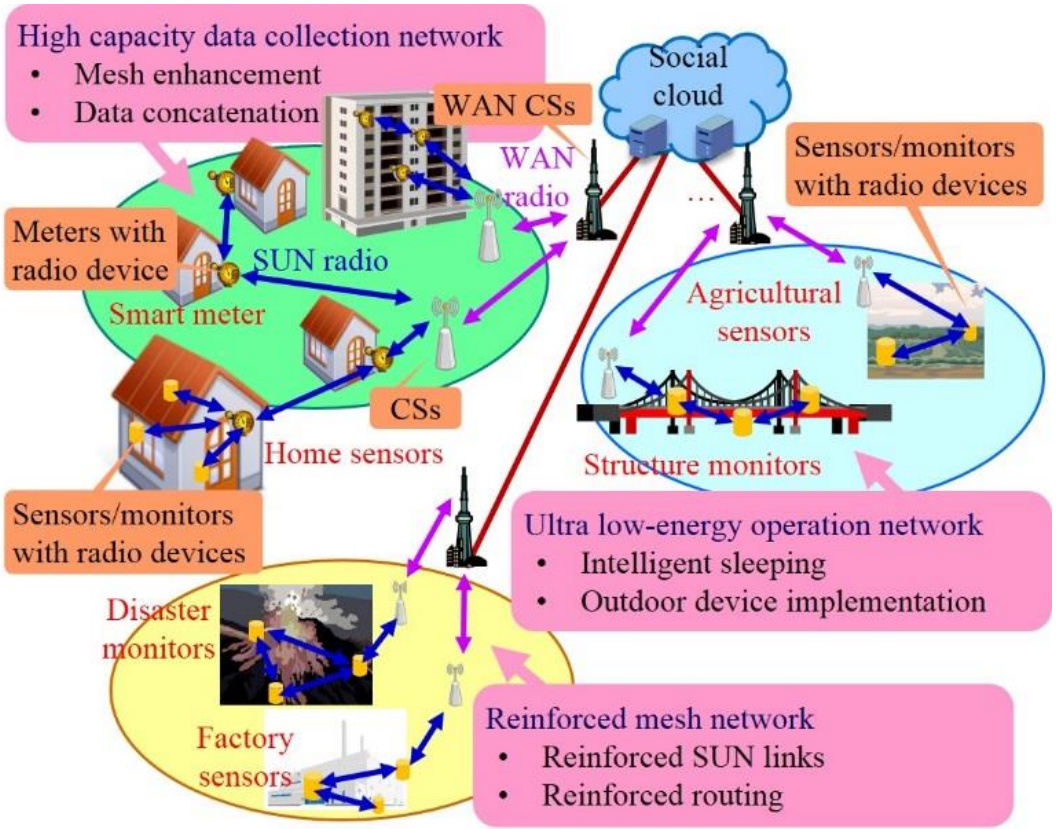
R&D results: SUN Wireless Grid System

NICT has evaluated the performance of the wireless grid concept that is defined as a grid like topology made up by several radio devices.

Focused on three fundamental categories of such diversified functions to support the several diversified applications.

The three fundamental categories are:

- The high-capacity data collection network
- The ultra low-energy operation network
- The reinforced mesh network



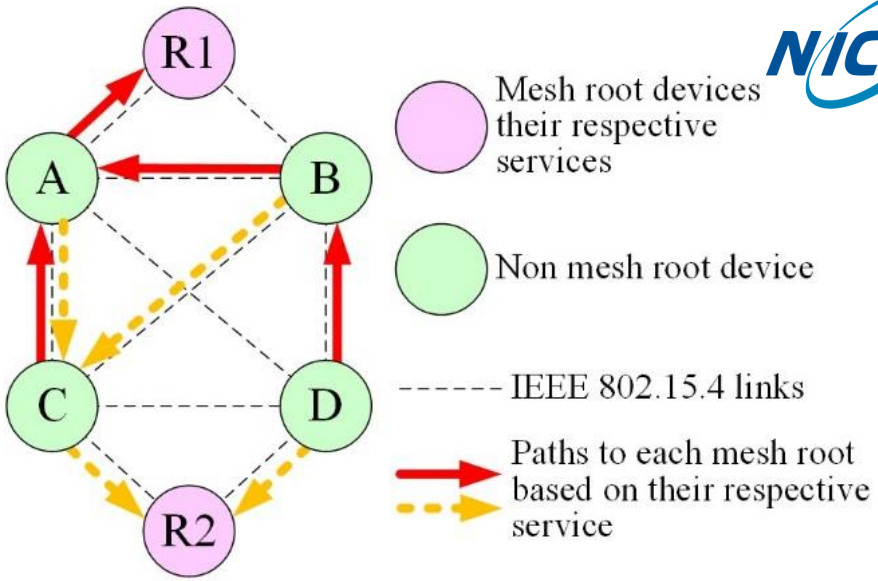
Fundamental categories for assumed wireless grid system exploiting SUN systems

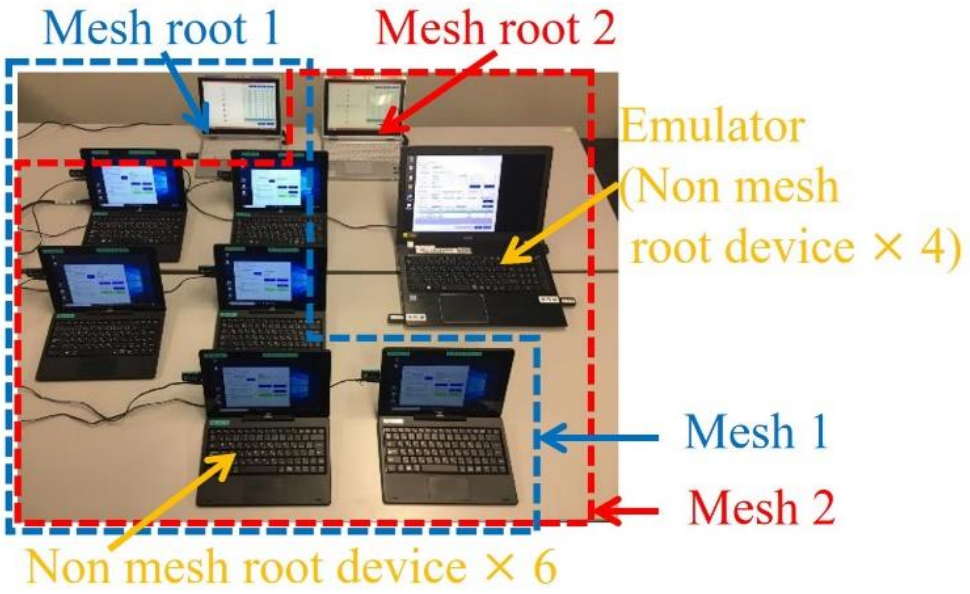
R&D results: Multiple services supporting function to employ several L2R mesh in a single PAN

NICT have contributed in the detailed wireless grid implementations to realize the harmonized mesh activities by massive radio device cooperation as well as performance evaluations through the experiments employing the developed SUN radio devices.

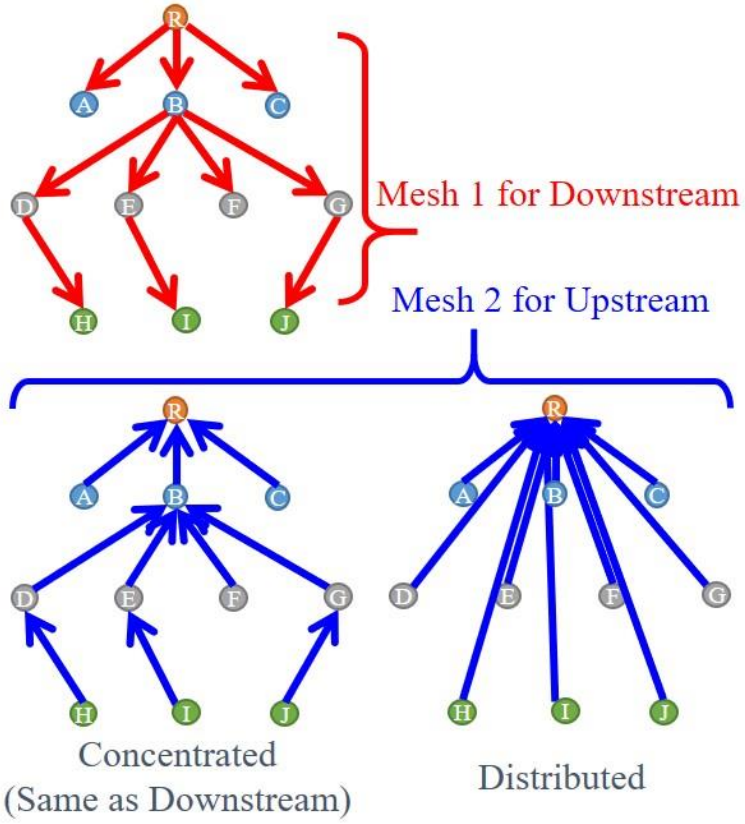
Several L2R meshes can be defined in a single PAN, and each of those meshes is customized according to the assumed service.

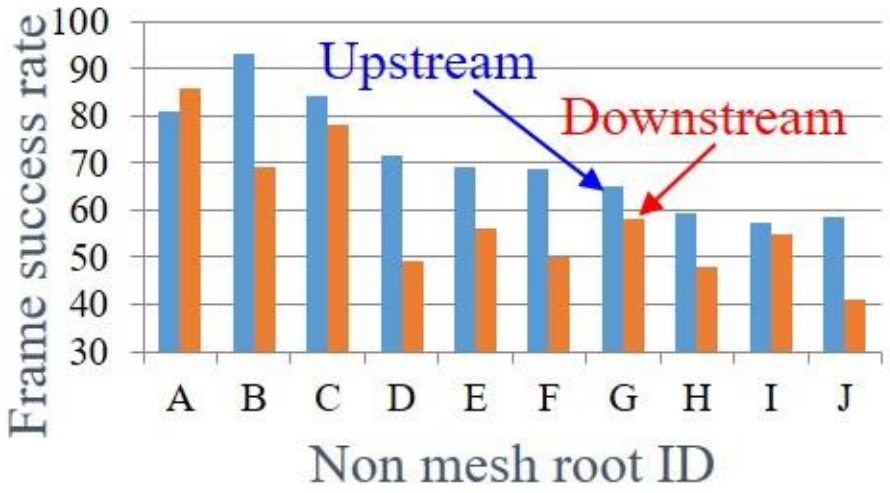
The setup includes several SUN devices that can behave as both mesh root and non mesh root devices. Besides the physical SUN devices, the setup includes SUN device emulators each of which can emulate up to several tens of SUN devices.



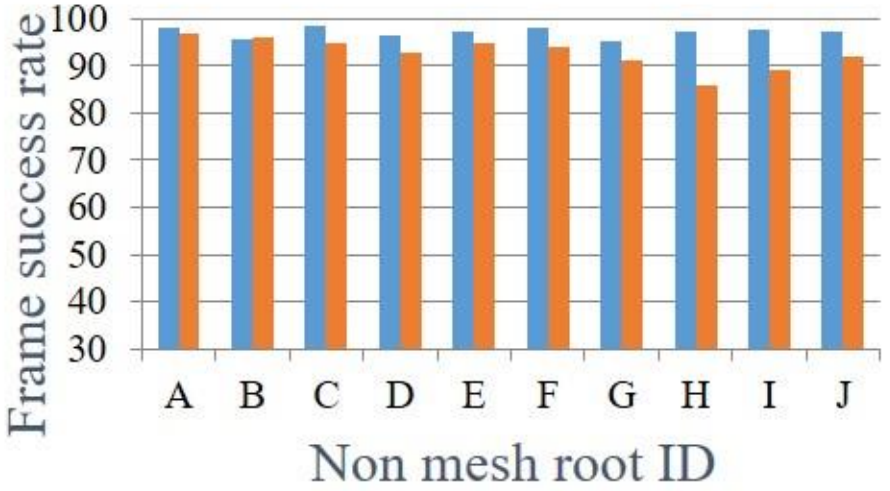


R&D results: L2R control performance evaluation





(a) Concentrated case



(b) Distributed case

The results show Distributed case that provides distributed flow to the higher traffic can improve both upstream and downstream performance processed by L2R control.

Societal Impact:

- The provision of an open innovation platform enables the usage by research institutes, academic and commercial entities in ASEAN, especially in countries where project funding is an issue and the purchasing capacity is limited compared to countries outside the ASEAN region. This platform and the supporting connectivity solutions can be used either from the cloud or on premise, giving flexibility to deployment and commercial commitment.

- Small POC projects in aquaculture and agriculture in Malaysia are using the platform for dashboard and data collections.

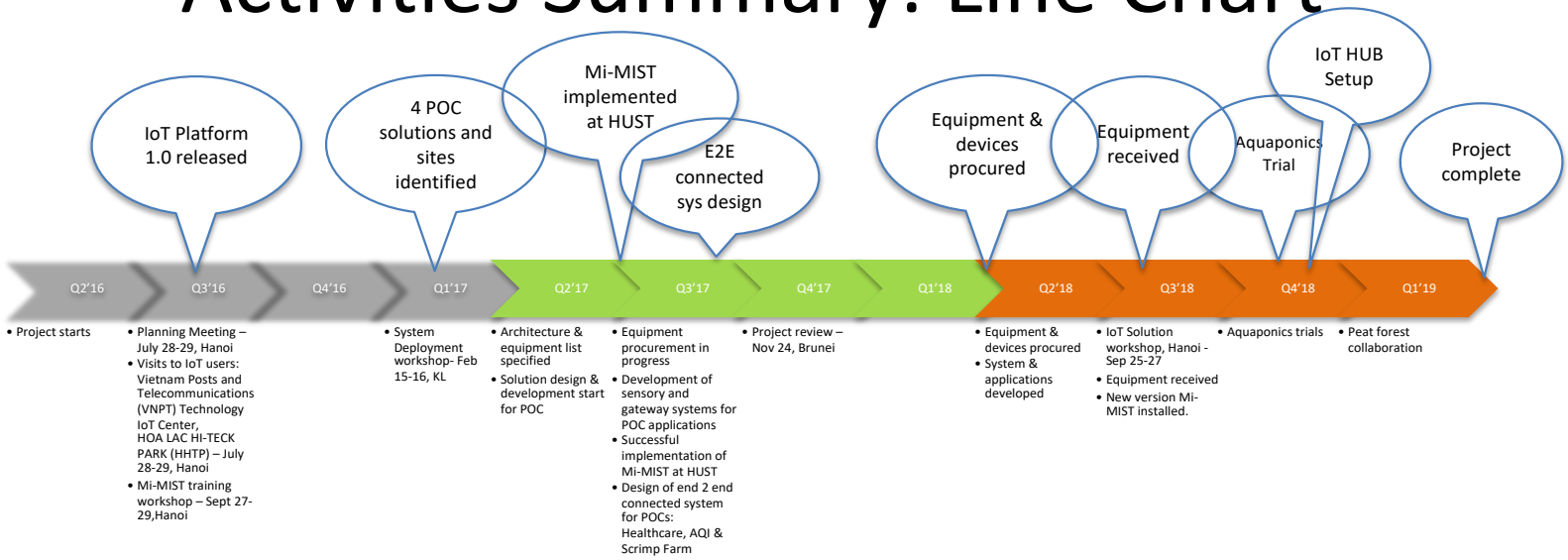
- The ASEAN IVO IOT HUB is an example where projects can be developed utilizing services provided on the HUB. This cloud-based solution is provided complimentary to ASEAN IVO project members to minimize development and operations expenses. Members with an approved ASEAN IVO project funding can subscribe to the complimentary services provided.

- Talent is also an important requirement in the development and adoption of IoT solutions. This platform can be used to educate the growing talent resources in the ASEAN region to learn about IoT and practice development work. Platform is used to educate trainees in training sessions at MIMOS.

- 1 patent filed in Malaysia by MIMOS.

Summary and Recommendation

Activities Summary: Line Chart



Challenges:

1. Long procurement duration and logistics complexity to purchase and obtain equipment and devices.
2. Short of development resources. Requires funding.

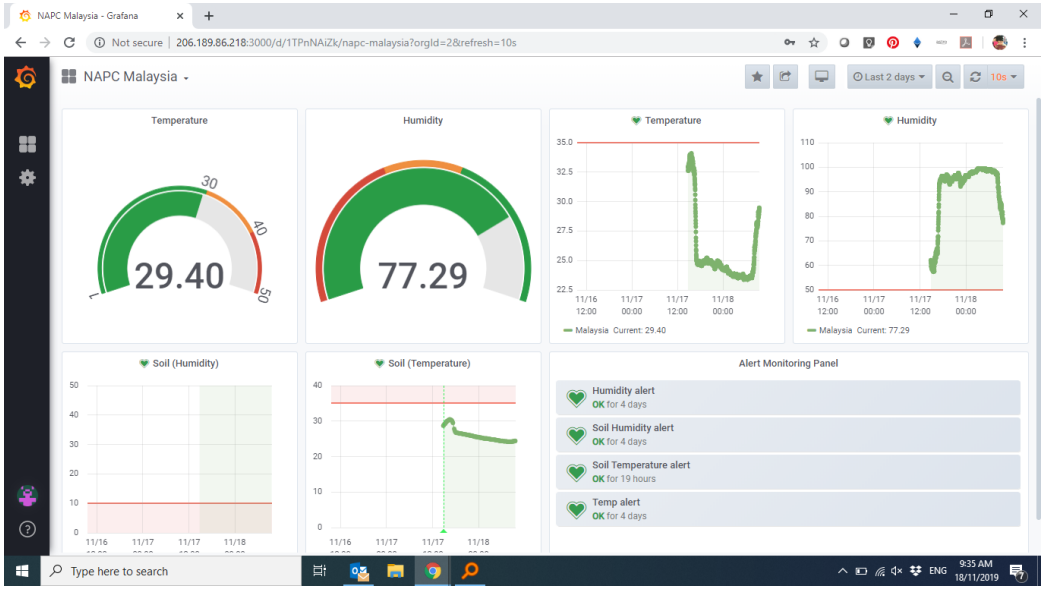
Recommendation:

1. Simplify equipment purchase procedure.
2. Provide funding for research and development resources.

Outcomes:

The outcomes of the project are as follow:

1. Release and availability of the IoT Open Innovation Platform software.
2. Software platform training to partners in using the platform for application development related to healthcare.
3. Wireless grid technology employing SUN demonstrated by NICT and its potential in a mesh connected wireless grid network.
4. POC systems were identified. Aquaponics and Peat Forest POCs are still on going. Expected to be completed in 2020.
5. ASEAN IVO IoT HUB established to provide complimentary services to ASEAN IVO project members.



NAPC Dashboard

Future prospects:

The platform will be made available at ASEAN IVO IOT HUB for ASEAN IVO project members. Training can be provided. There are plans to further enhance the platform with recommendation from users and customized project proposals.

IoT solutions can be designed and deployed utilizing some of the network and connectivity evaluations like SUN grid network and sensor gateway connectivity.