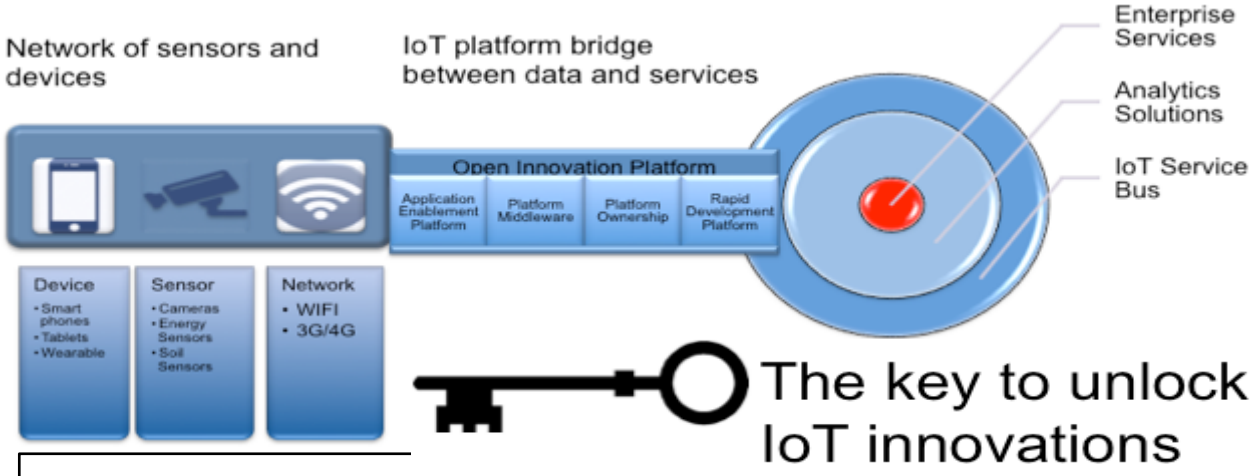
Project Title: IoT Open Innovation Platform

NICT ASEAN IVO FORUM 2017

Introduction :

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.



Application enablement platform provides abstraction layer to connect to the different devices available. Application dashboard tool to generate information visualization via easy to use interface.

Platform middleware provides the necessary integration by adopting common standards. Devices and sensors from different systems and protocols can be connected to the same platform, thus providing connectivity and functionality between heterogeneous platforms.

Platform scalability includes private cloud and embedded cloud adoption to provide platform ownership. Services need not be provided from an external party cloud services.

Rapid development platform provides the facility to develop and test applications rapidly.

Project Members :

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IoT 4 Layers Architecture

Application Layer

Platform Layer

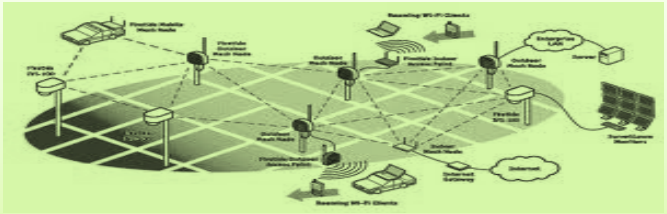
- Application enablement platform
- Platform middleware
- Platform ownership
- Rapid development platform

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

Purpose & Objectives

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

Sensor (& Actuator) Layer

- Sensors & actuators
- Embedded middleware
- Mobile devices

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

2017: Rural Healthcare POC System

National Institute of Information & Communications Technology, Japan

Hanoi Institute of Science and Technology

MIMOS BHD

Applications Hub

- IoT platform as a service
- Health care dashboard services

Data Hub

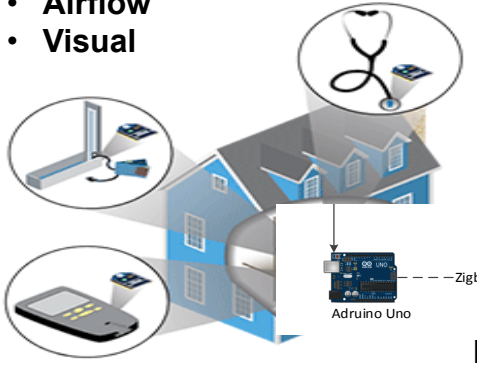
- IoT data storage system
- IoT security platform
- IoT data service hub

Communication Hub: MQTT

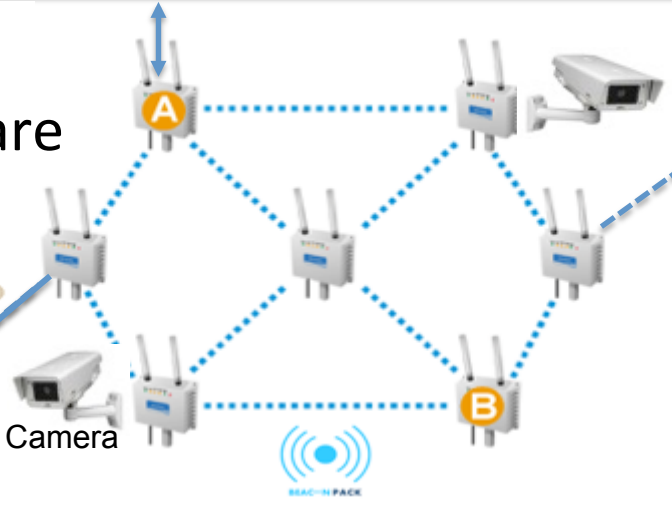
eHealth solutions

- **Glucometer**
- **Blood pressure**
- **Airflow**
- **Visual**

Rural Healthcare System



Remote Gateway



Camera

Online Consultation

2017: Air Quality Index Monitoring POC

National Institute of Information & Communications Technology, Japan

Hanoi Institute of Science and Technology

MIMOS BHD

Applications Hub

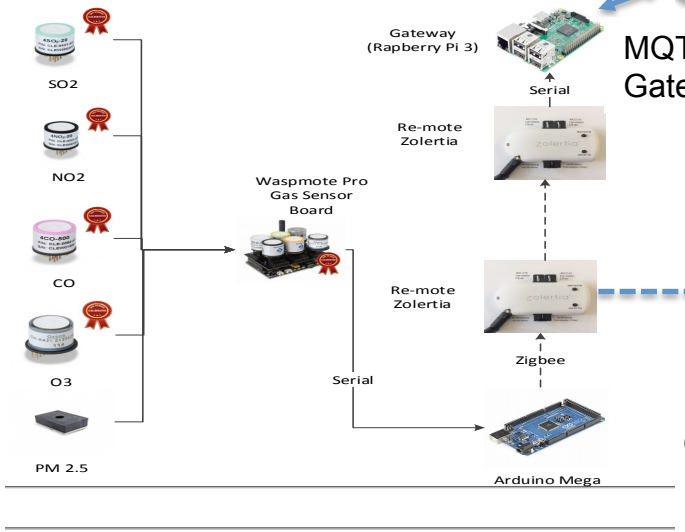
- IoT platform as a service
- Air quality monitoring dashboard services

Data Hub

- IoT data storage system
- IoT security platform
- IoT data service hub

Communication Hub: MQTT

Air Quality Monitoring System



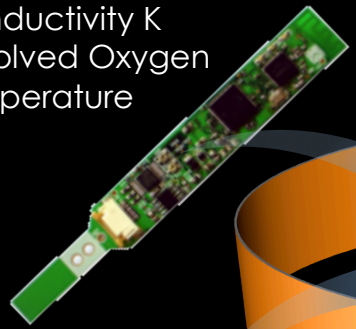
Aquaculture Scrimp Farming POC

National Institute of Information & Communications Technology, Japan

Hanoi Institute of Science and Technology

MIMOS BHD

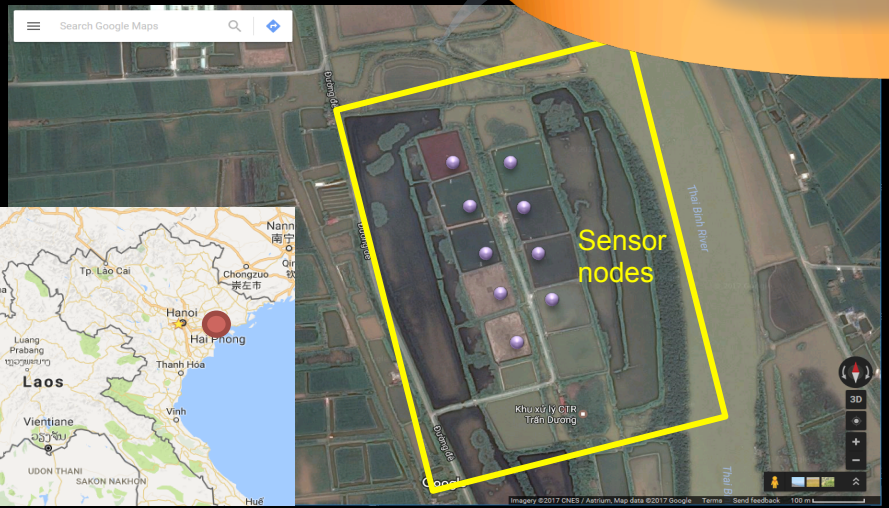
Oxidation Reduction Potential
Conductivity K
Dissolved Oxygen
Temperature
PH



Wireless Data Gateway

IoT Open Innovation Platform

Improving Yields



Shrimp farm,70-hectares in Tien Lang, Hai Phong, Vietnam

Hoa Lac Hi-Tech Park Smart City POC

National Institute of Information & Communications Technology, Japan

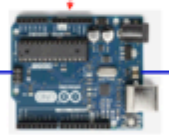
Vietnam National University

MIMOS BHD

Sensors - IoT Devices - IoT Gateway – IoT Platform

- Nova PM sensor SDS011 - PM-2.5 air quality detection
- Temperature, humidity sensors
- Motion sensor
- Distance Ranging Sensor
- ...

(Not yet supported by IVO)



IoT Devices

(Arduino based)

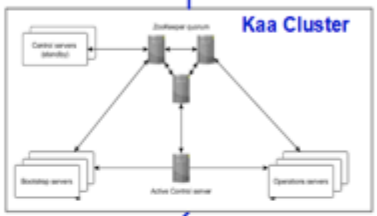
Sensor Networks

Kaa C++ SDK for Raspberry Pi 3

IoT Gateway

(Raspberry Pi 3 based)

Internet



(Not yet tested)

MIMOS IoT Platform

HHTP HOA LAC HI-TECH PARK ©

Smart City Apps

VNU Proof of Concepts

Project Progress in 2016

- Planning Meeting – July 28–29, 2016; Hanoi
  - 3 sites in Vietnam identified for 2017 Proof of Concept (POC) in Aquaculture, Environment and Healthcare.
    - Hanoi (Rural/Suburban Healthcare)
    - Haiphong/Bac Lieu (Aquaculture Scrimp Farming)
    - Hatinh (River & Ocean monitoring, Environmental)
  - Visits to IoT users:
    - Vietnam Posts and Telecommunications (VNPT) Technology IoT Center,
    - HOA LAC HI-TECK PARK (HHTP)

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

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

Project Progress 2017

- System Deployment Workshop − Feb 15-16, 2017; Kuala Lumpur
  - 4 POC systems in Vietnam defined for 2017 Proof of Concept (POC) in Aquaculture, Environment and Healthcare.
  - Project planning for POC system and deployment.
  - High level architecture review.

- Equipment list and architecture for POC defined − Q2, 2017
- 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 Reinforcement Learning and 802.15.4e TSCH that can adapt to different traffic patterns of applications.
  - HUST completed a Communication Protocol based on Orchestra Scheduler of TSCH that can provide different levels of QoS.
- Mi-Mist, IoT open innovation platform PaaS (Cloud version) − Q4, 017
  - Mi-MIST 2.0 developed by MIMOS and schedule for release in January 2018

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

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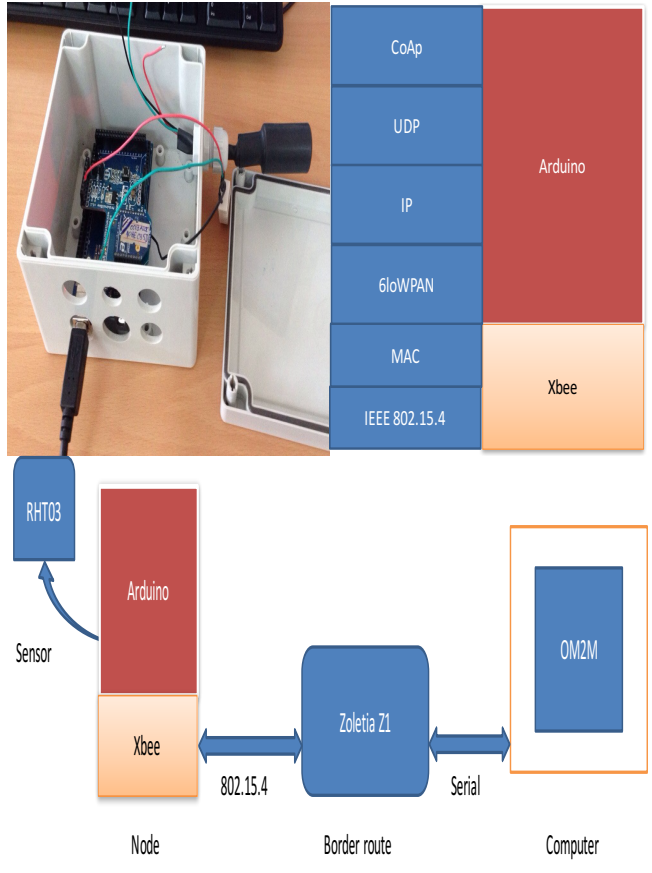
CoAP/UDP/IPv6 Protocol Stack

- **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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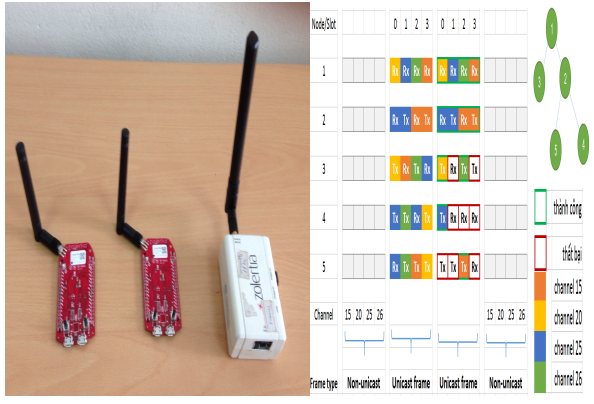
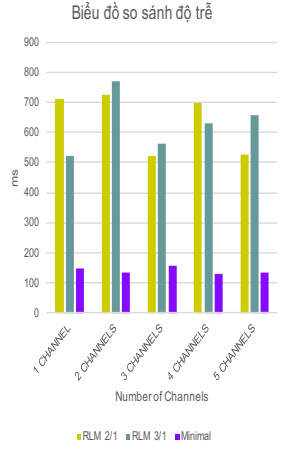
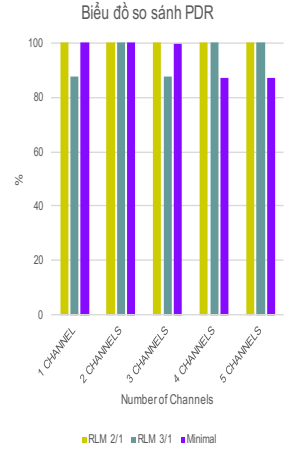
TSCH-based Adaptive Communication Protocol

- **A TSCH-based WSN that can:**
  - Adapt to predefined traffic of application and to additional traffic of application
  - Based on a new standard 802.15.4e
  - Wireless but provides Wired-like QoS Performance (90% Packet Delivery Rate)
    - ✓ Running TSCH within 200 initial frames
    - ✓ Calculate successful and unsuccessful transmission probabilities
    - ✓ Based on this result, defining an appropriate transmission sequence at each node
    - ✓ Successful Implementation for CoAP/UDP/RPL/6LoWPAN/6TiSCH/ 802.15.4e
    - ✓ Contiki/Linux
- Successful simulative evaluation and implementation in real testbed
  - Cooja/Contiki Z1/Zolertia
  - REMote/Zolertia - Multihops







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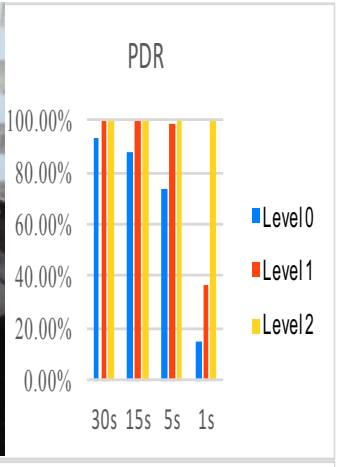
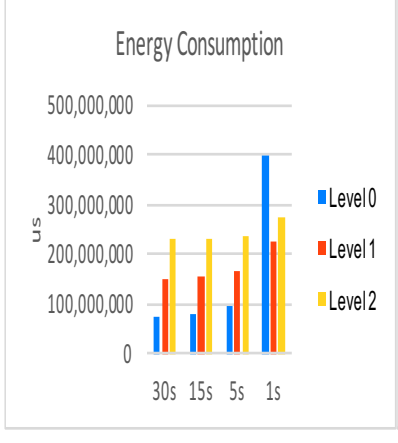
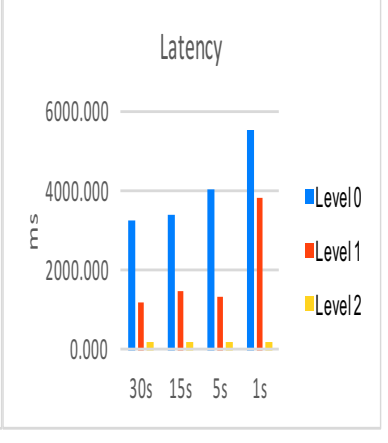
Providing Different QoS Levels by Communication Protocol

- 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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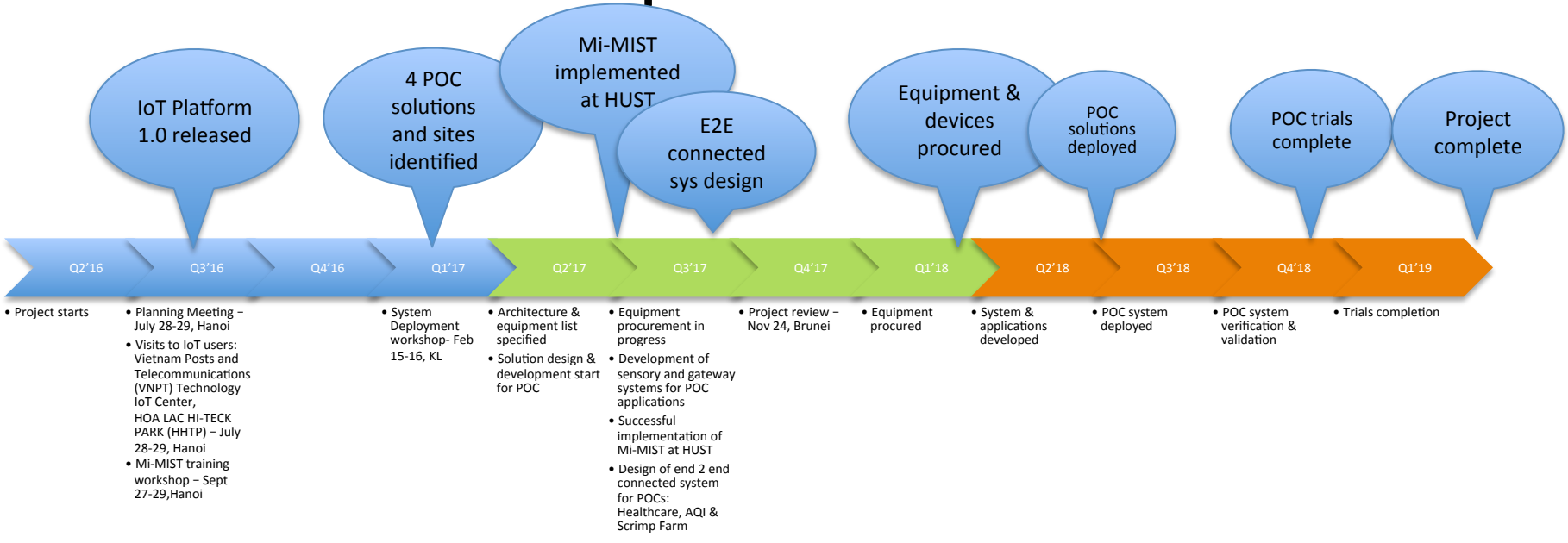
Activities Update: Line Chart



Challenges:

1. Long procurement duration and logistics complexity to purchase and obtain equipment and devices.

Recommendation:

1. Extend the project duration for another year to cater for the delayed POC deployment and testing activities.
2. Move the balance project funds to 2018-2019 year term.