Study and Evaluation of Heterogeneous Network for Smart Community and Smart City Applications

ASEAN IVO Forum 2018

Nov 28, 2018

Chulalongkorn University (CU), Thailand
MIMOS, Malaysia
Universiti Tunku Abdul Rahman (UTAR), Malaysia

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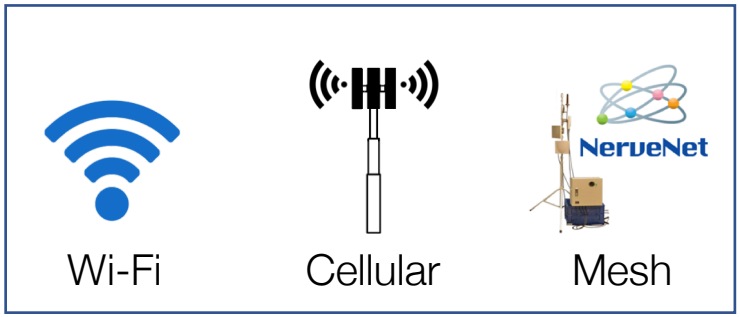
Project Theme

Smart Society

ICT applications on heterogeneous network for smart community and smart city

Smart City
Chula



Multilateral verification on Heterogeneous Network

Smart Community
MIMOS

Vehicular Cloud System

Chulalongkorn University (CU)

Project Update

Summary

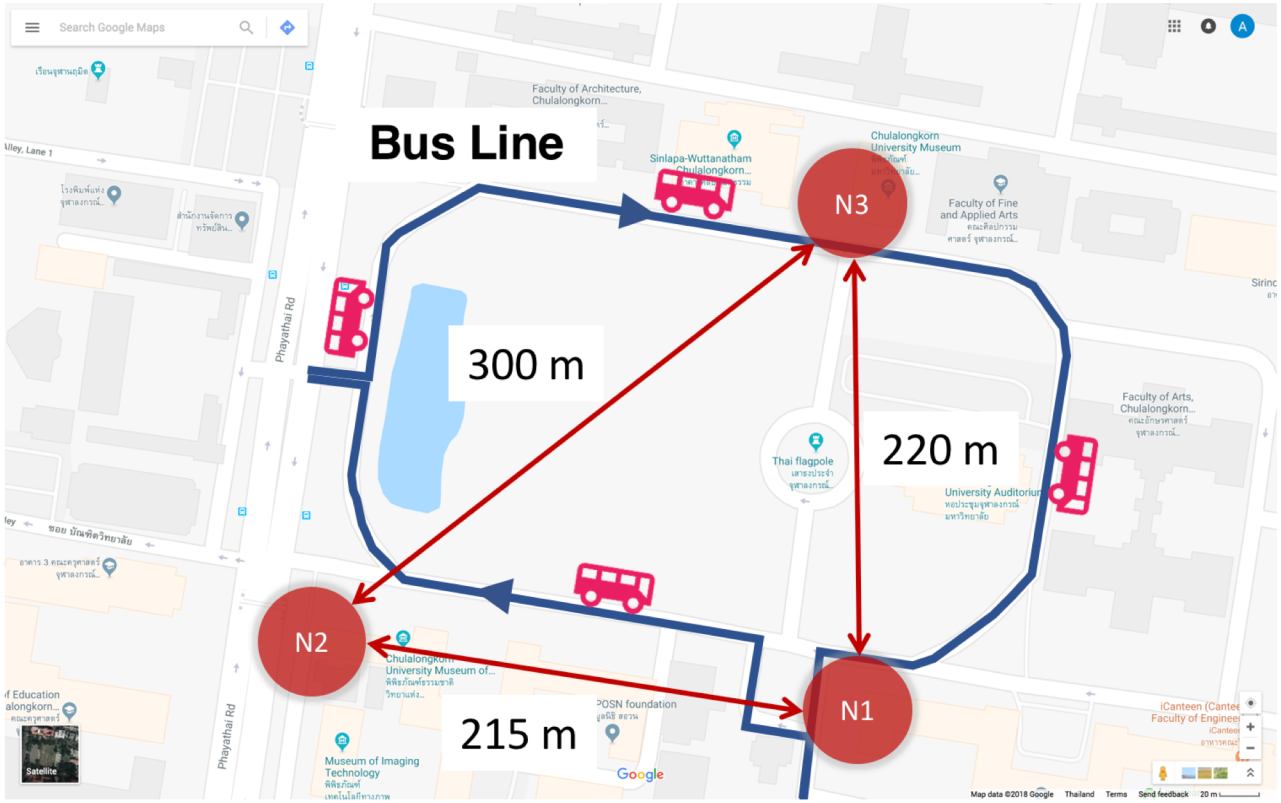
Tasks (January – November 2018)

- Heterogeneous Network Middleware Deployment and Testing
- Communication Testing (On-Site)
- Application Design and Implementation for NerveNet
- 4th Workshop Meeting @Malaysia
- Application Deployment and Testing
- Infrastructure Installation and Performance Evaluation (On-Site)
- Publication Preparing and Submitting on an International Conference
  - VTC2019-Fall
    - Submit papers for review: 25 February 2019
    - Regular paper acceptance notification: 3 May 2019

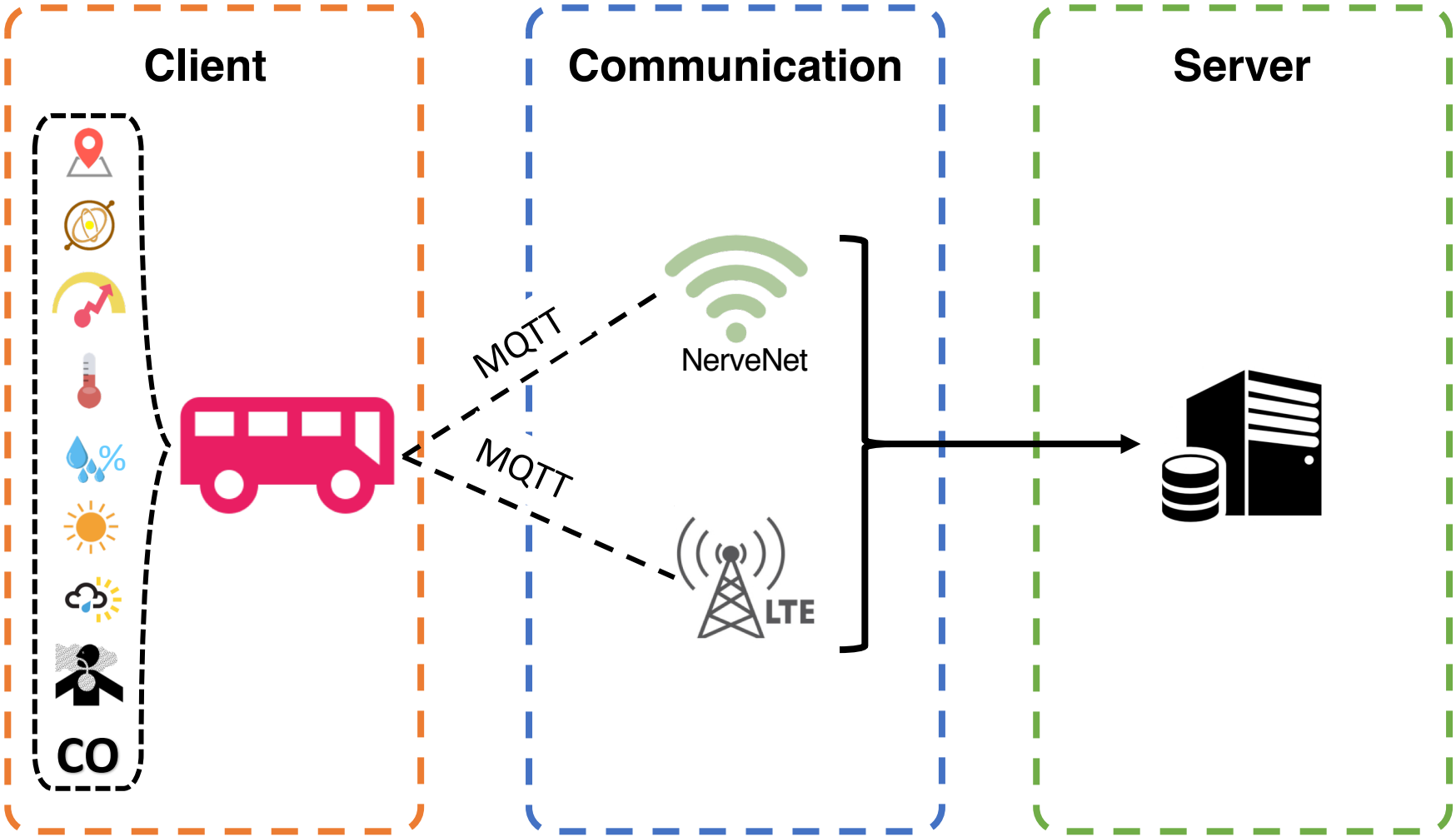
Objective

To measure the throughput, packet delivery ratio, load ratio, and end-to-end delay of the system with mobile client

Testing scenario

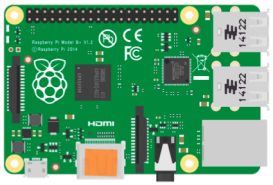


Scenario

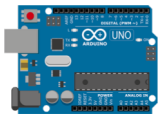


Equipment

Processing Units



Raspberry Pi



Arduino

Sensor Units

Acceleration

Temperature

Dust

UV

Rotation

Humidity

Gas

Rain

Communication Units

Access Point

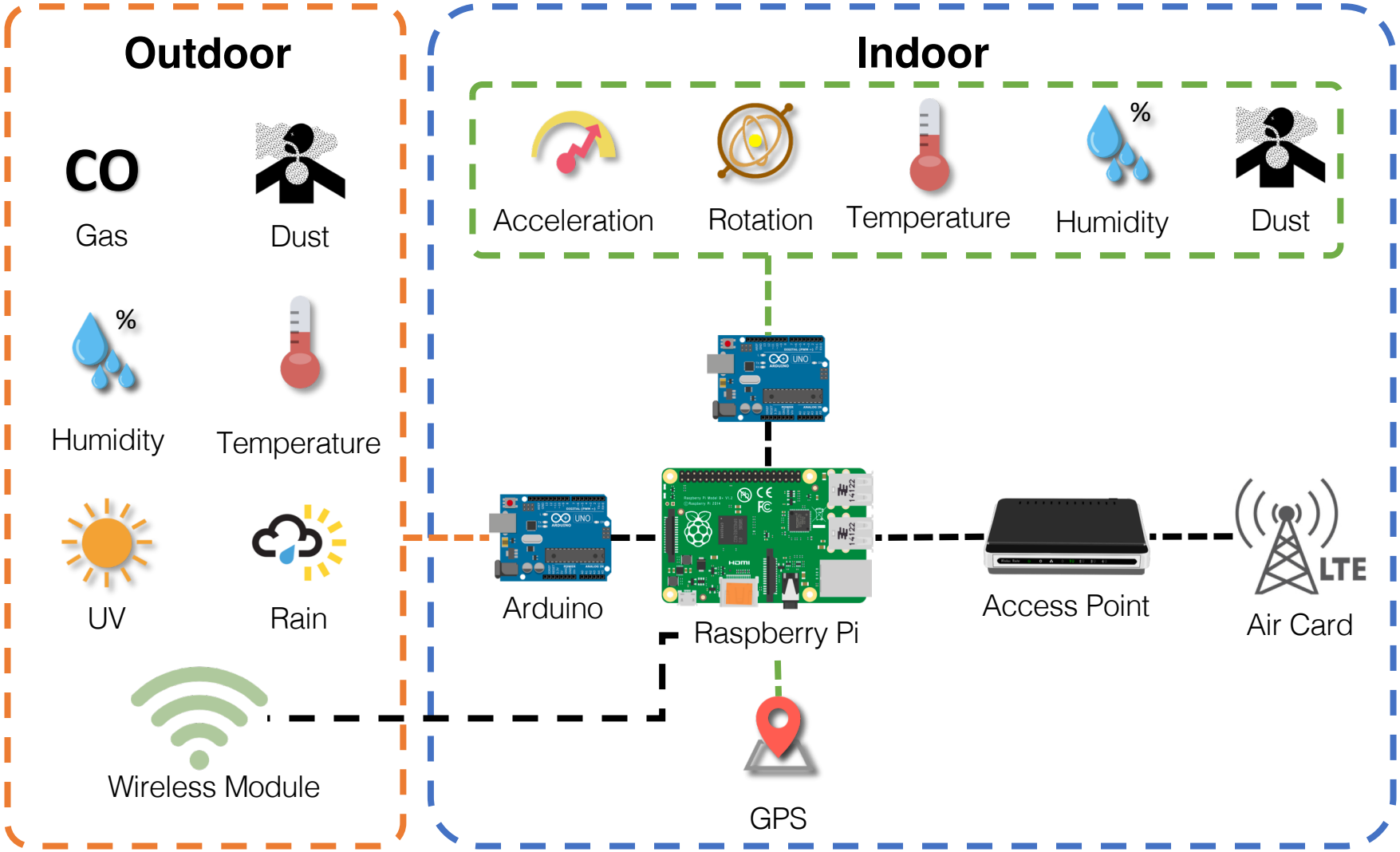
Wireless Module

Air Card

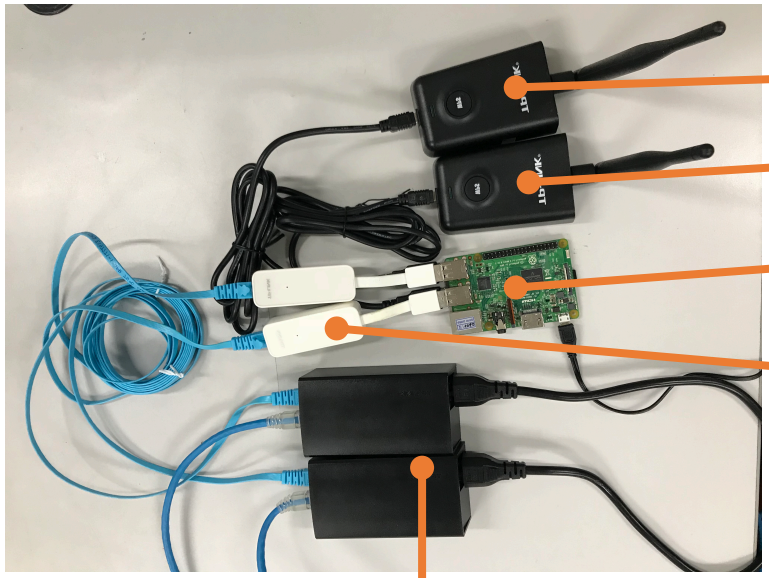
GPS

Deployment Structure

Equipment (Client – CU Shuttle Bus)



Equipment (Base Station Node 1 - Gateway)



Wireless Module (Hotspot)

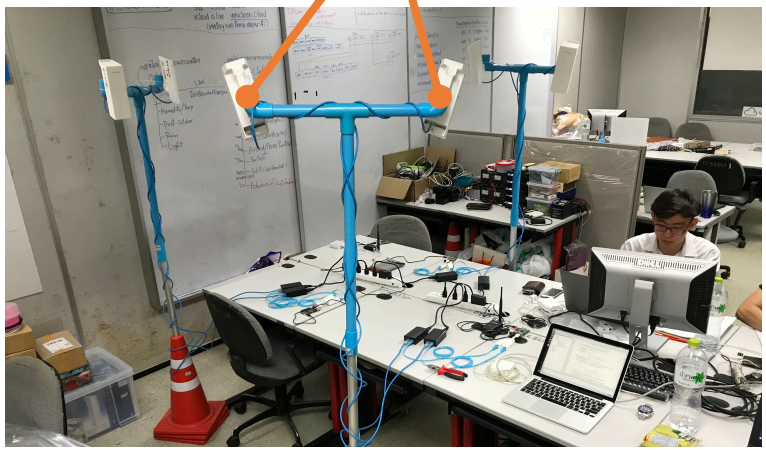
Wireless Module (Internet Gateway)

Raspberry Pi 3

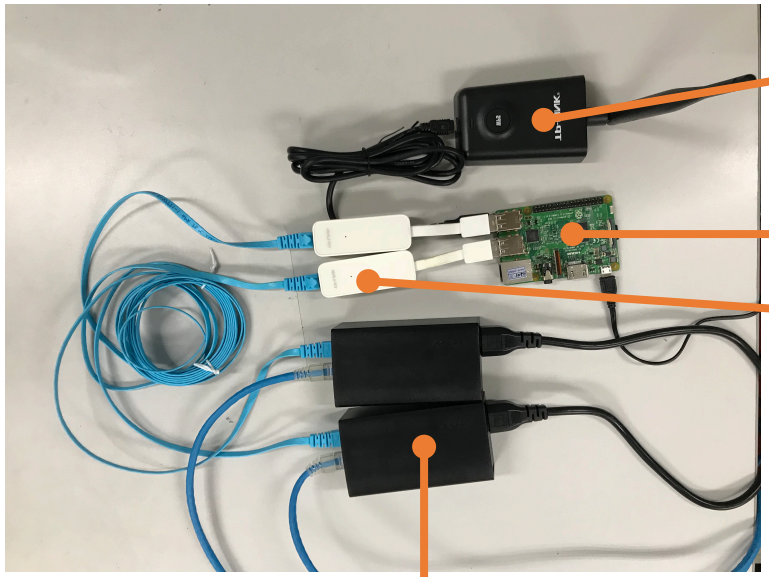
Ethernet to USB Adapter

Antennas' Wireless Module

Antennas' Power Adapter



Equipment (Base Station Node 2 & Node 3)



Wireless Module (Hotspot)

Raspberry Pi 3

Ethernet to USB Adapter

Antennas' Power Adapter

Antennas' Wireless Module

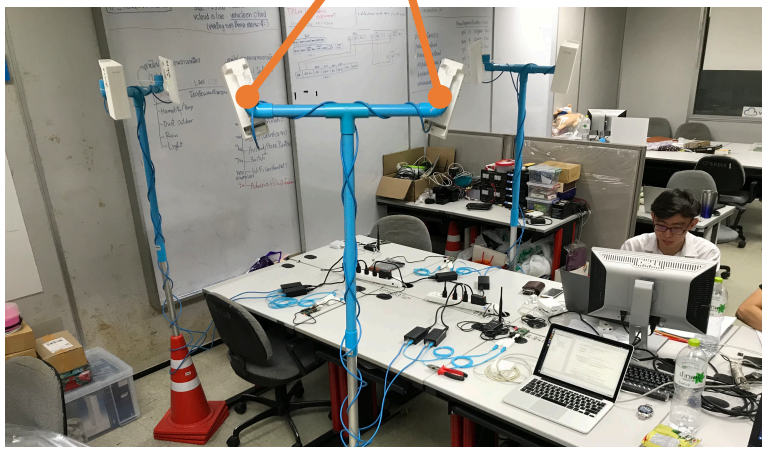


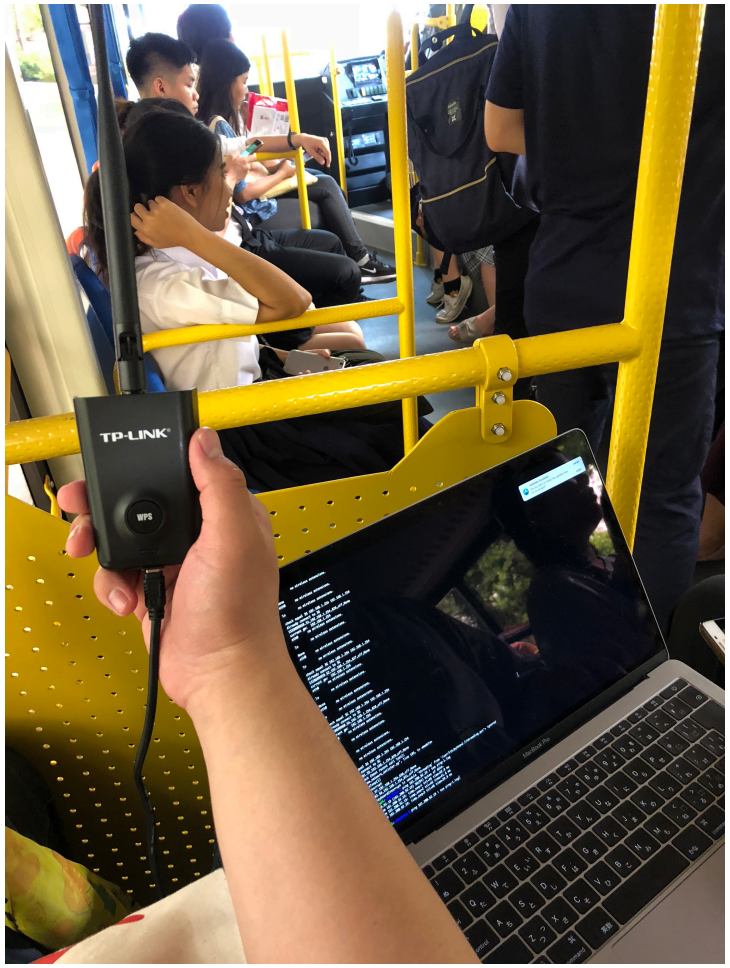
Photo taken at each node

Base Station 1

Base Station 2

Base Station 3

Photo taken at Client



Experiment I

Objective

- To measure PDR, delay and available bandwidth between each communication device

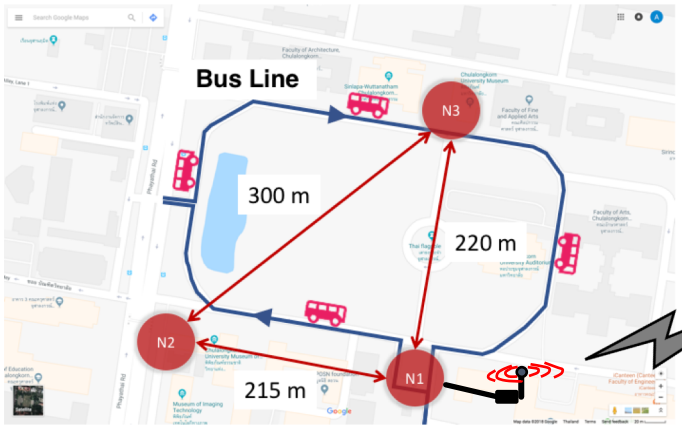
Setting

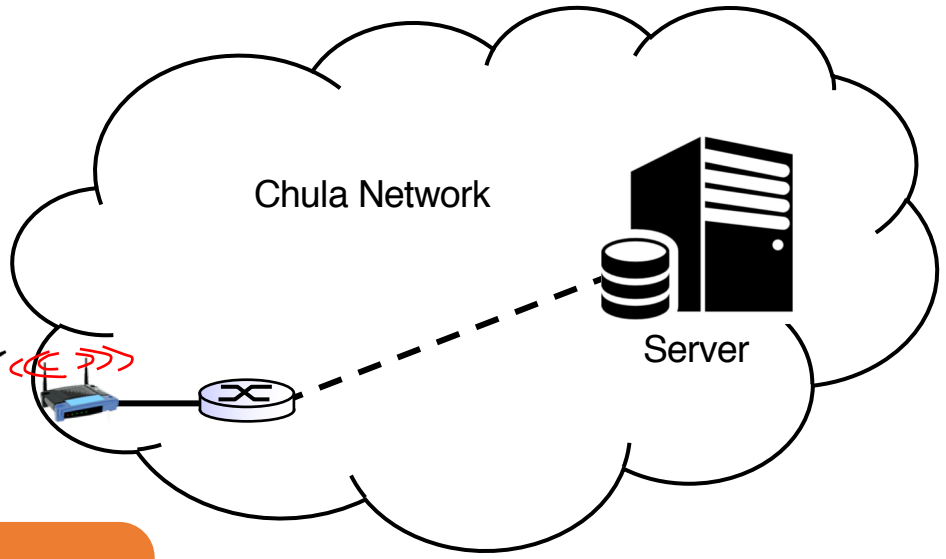
- Generate Ping traffic every 1 second to measure PDR and delay between source and destination

- Use iPerf to generate TCP traffic to measure available bandwidth from source to destination

Testing result

PDR, delay and available bandwidth measured at application





Available Bandwidth	
NerveNet Links	N1/N2/N3 to Server
~96 Mbps	~ 37 Mbps

Packet Delivery Ratio
~1

Min Delay		
NerveNet Links	N1 to Server	N2/N3 to Server
~2 ms	~1 ms	~3 ms

Experiment II

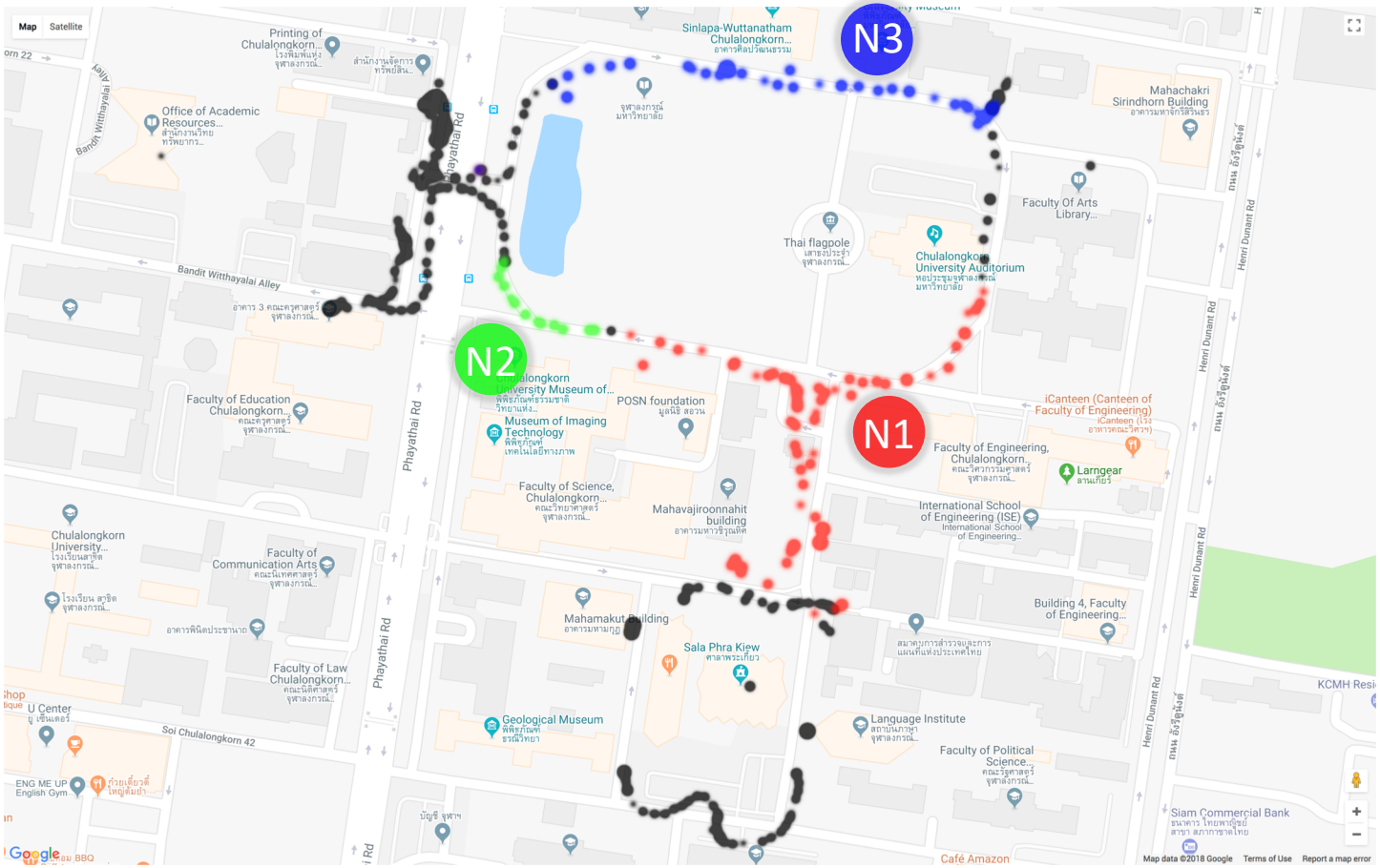
Objective

- To measure load ratio of LTE and NerveNet

Setting

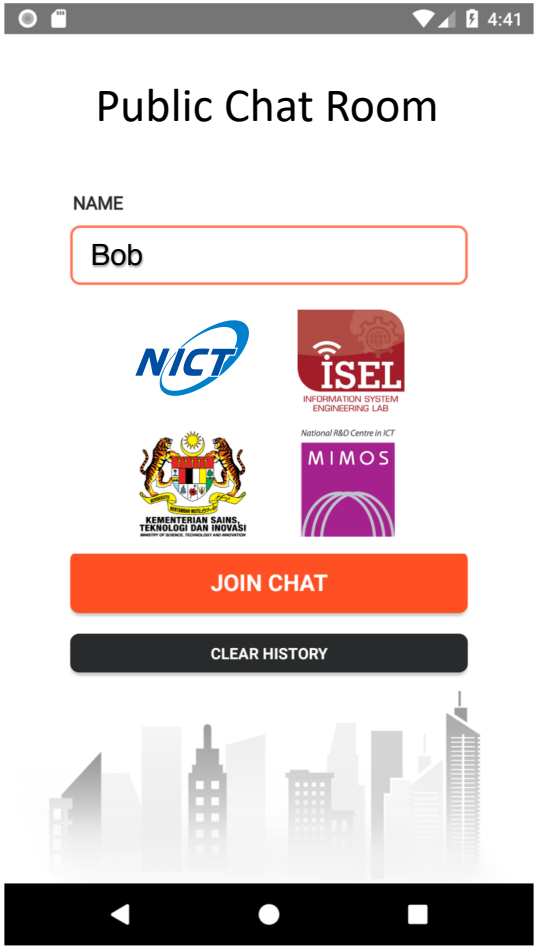
- Generate MQTT traffic every 1 second from client to server
- Observe amount of data packets at server whether they arrive via LTE or NerveNet

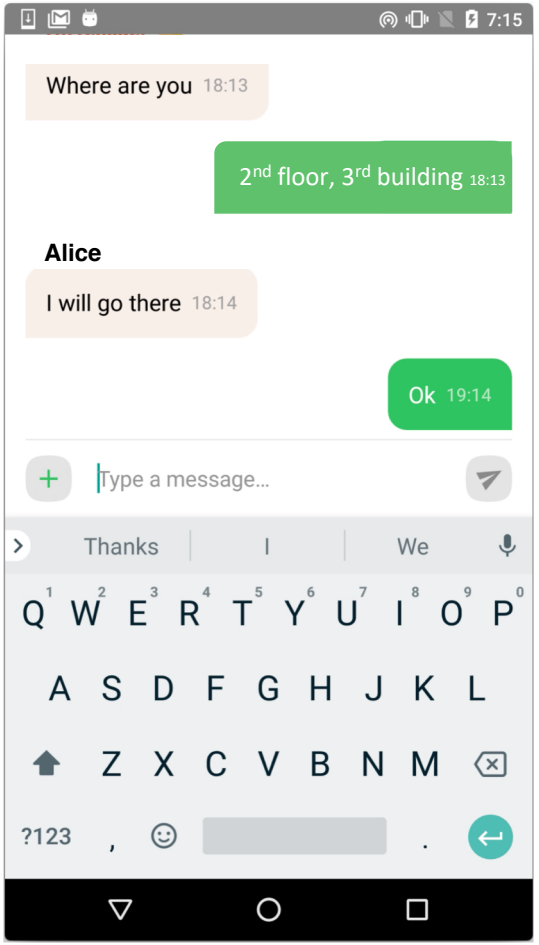
Load Ratio : NerveNet - Heat Map of Connectivity



■ LTE ■ N1 ■ N2 ■ N3

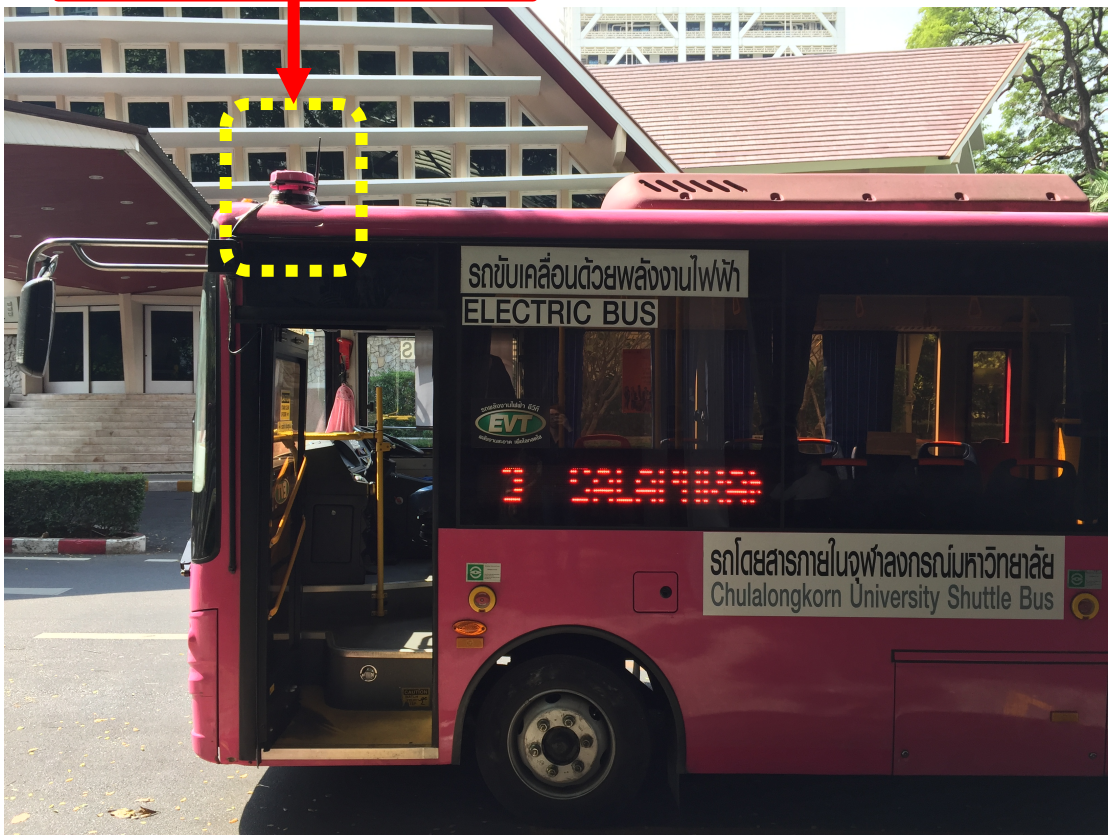
Public Chat Room



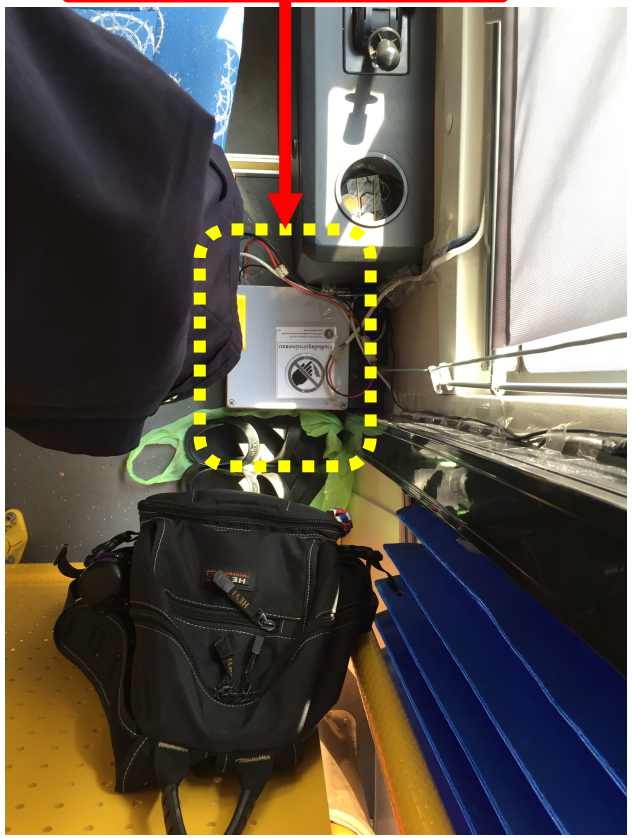


Prototype Equipment

Outdoor Equipment



Indoor Equipment



Project Timeline

Schedule	Details	Status
June – December 2017	• Study on NerveNet System • Study on Mesh Network Protocol for NerveNet • NerveNet Routing Protocol Deployment and Testing	100% done
January – June 2018	• Heterogeneous Network Middleware Deployment and Testing • Communication Testing (On-Site) • Application Design and Implementation for NerveNet	100% done

June – December 2018	• **Application Deployment and Testing**
	• **Infrastructure Installation and Performance Evaluation (On-Site)**
	• **Publication Preparing and Submitting on an International Conference**
	• **Target VTC2019-Fall**
	  • **Submit papers for review: 25 February 2019**
	  • **Regular paper acceptance notification: 3 May 2019**
		70% done

January – May 2019	• Publication Preparing and Submitting on an International Conference • Results Analysis and Discussion • Project Report • Publication Presentation at an International Conference	

PROJECT UPDATE (NICT)

Study and evaluation of heterogeneous network for smart community and smart city applications

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Summary of Updates

- Completed the integration of **NerveNet** with **MIMOS wireless presentation system** (**WPS**)
- Tested the integrated setup in the following sessions:
  - 4th NICT project meeting at Aloft Hotel, KL, Malaysia (19 June 2018)
  - Student activity meeting at UTAR, KL, Malaysia (22 Oct 2018)
- Collected various performance metrics/values from the testing of integrated system conducted in UTAR
- Completed the first draft of the performance results
- Identifying suitable conference to present results/paper
- Writing paper for publication in international conference

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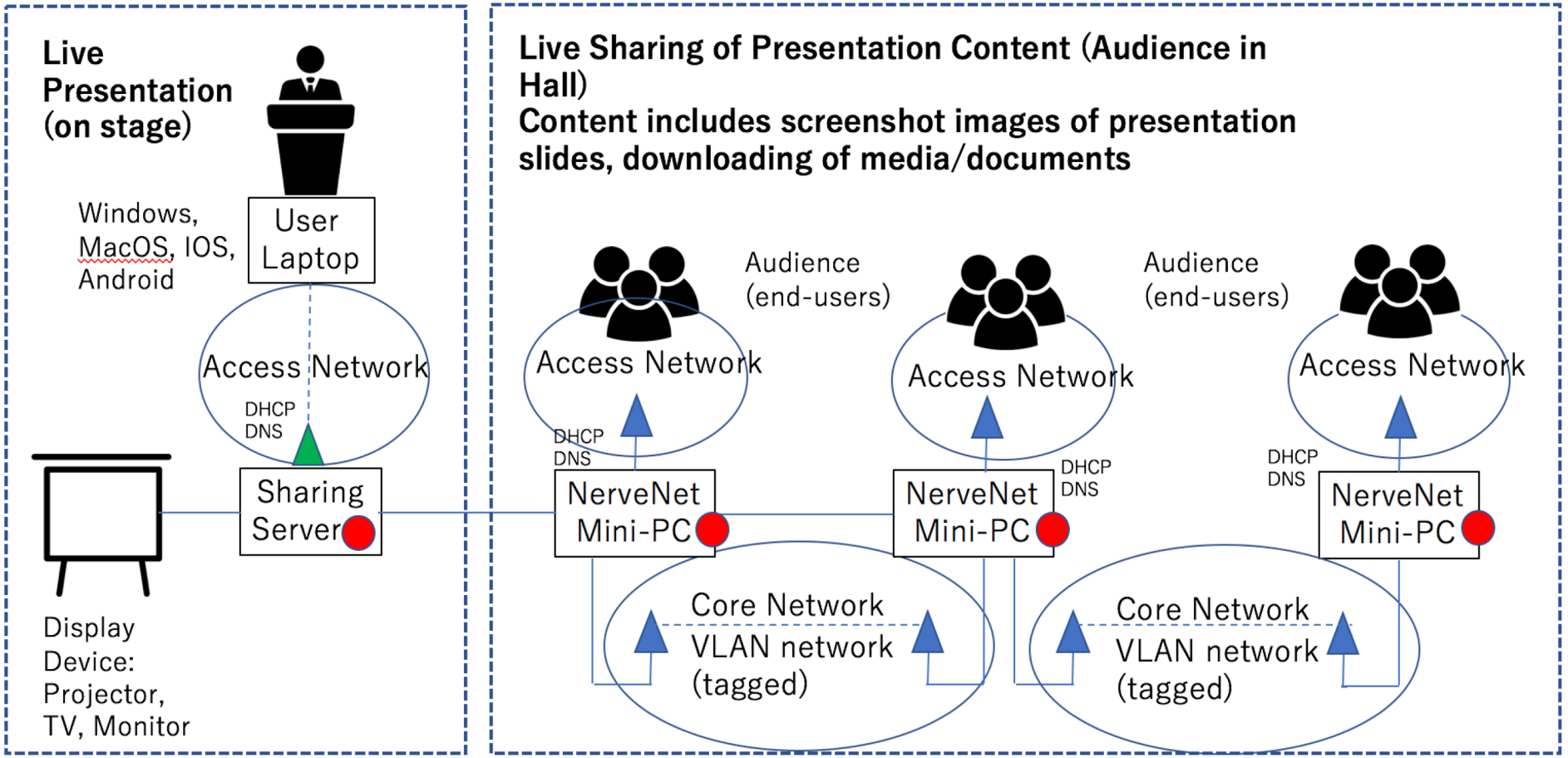
Use Case: Instant Sharing of Presentation Content

Objective: To deliver presentation more effectively to a bigger size of audience, enriched with multimedia/interactive services



Co-locate Sharing server component with NerveNet. Performance is expected to improve due to nearer access to content/service

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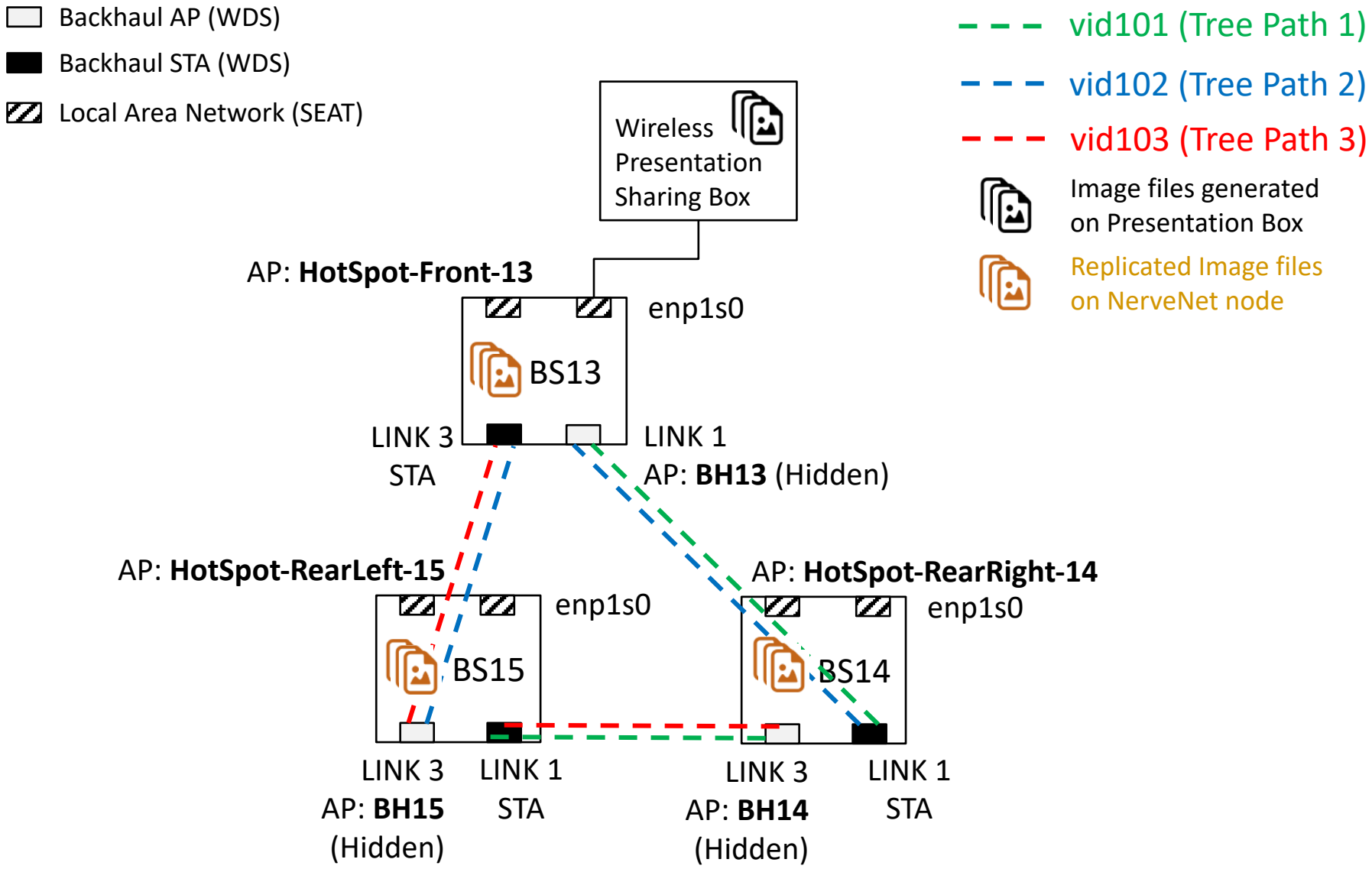
Testbed Setup



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Project Timeline

Schedule	Tasks Description	Status
June – Dec 2017	• Define testbed + equipment • Explore use case of NerveNet + Sharing System • Set up of testbed • Performance verification of testbed	100% Done
Jan – June 2018	• Desktop changes analysis for efficient content delivery • Support of various content sources • Configure NerveNet to support the new use case • Design/Customize/Develop Sharing System to work with new use case	100% Done
June – Dec 2018	• **System/Application Testing** • **Performance Evaluation and analysis** • **System enhancement and fine-tuning of system** • **Publication preparation and submission**	**85% Done**
Jan – May 2019	• Project report & Paper presentation • Identify future work based on results achieved	0%

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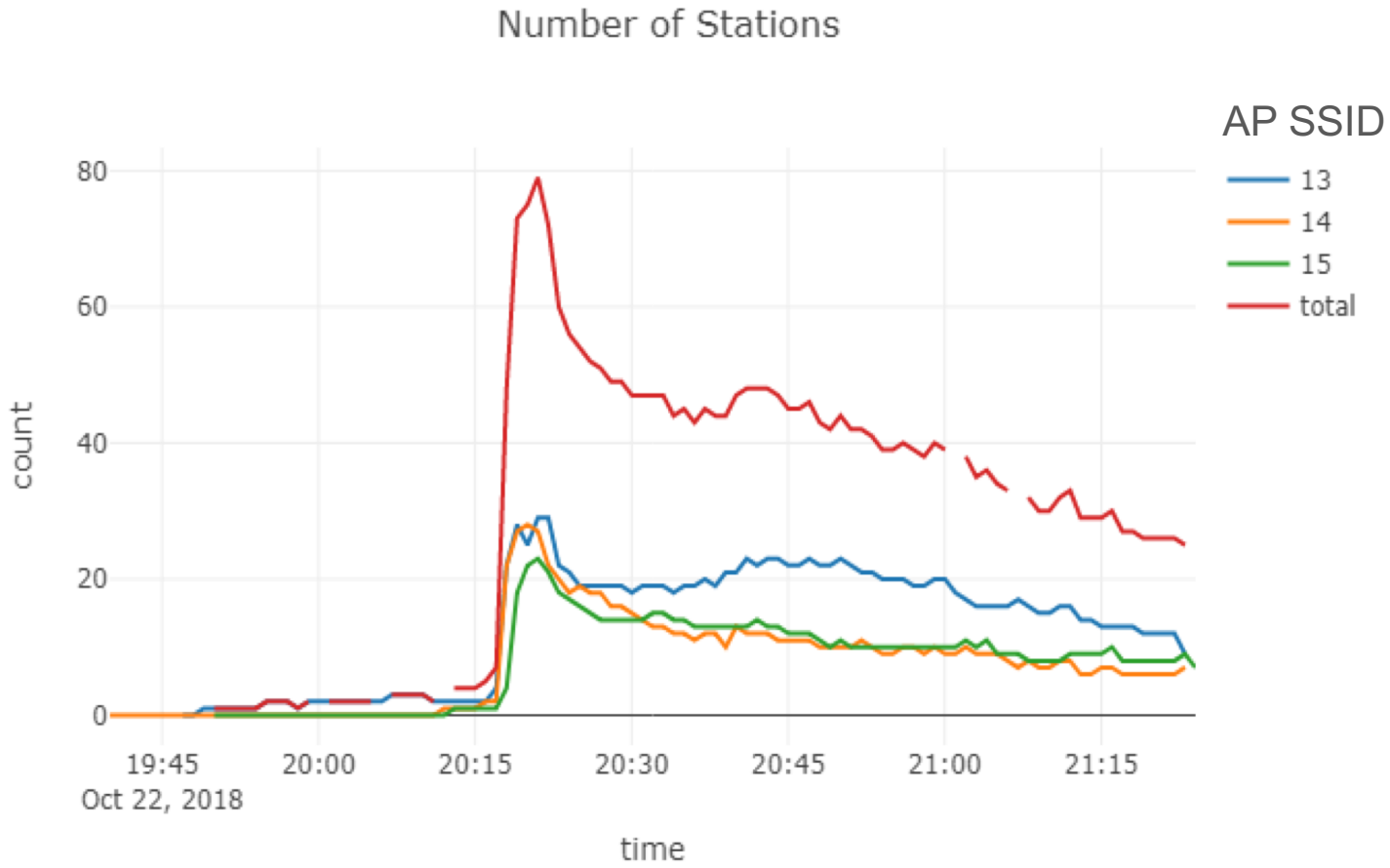
Performance Results (Number of Client Stations)



- Tested with a total of 79 client devices in UTAR
- Client devices were quite evenly distributed, following lecturer's instruction of which AP students should connect to
- NerveNet does not support auto load balancing across nodes

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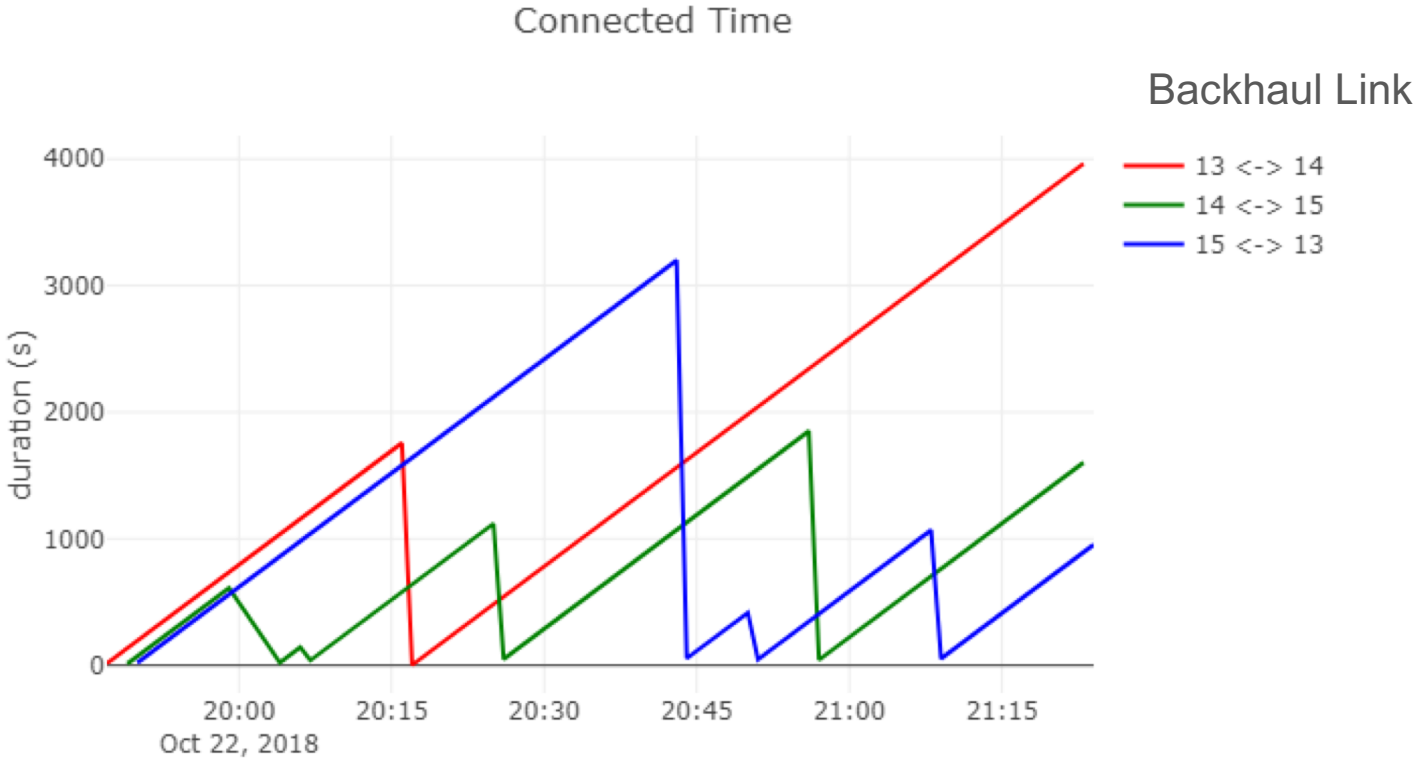
Performance Results (Backhaul Connection Time)



- Backhaul link (13->14), dropped once around 20:15. It reconnected and stay connected for 4000 sec till the end
- Link (14->15) and (15->13) dropped 3-4 times
- Average time to access screen content is 3-4 sec, due to hotspot access operated on 2.4GHz and backhaul disconnections

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Next Step

- Identifying suitable conference to present results/paper
- Writing paper for publication in international conference
- Closing the project by reporting the integration work, setup and performance results in a paper publication

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4th Workshop Meeting

Collaborations

NICT

ISEL
INFORMATION SYSTEM ENGINEERING LAB

EVT
Save Energy Safe The World

KEMENTERIAN SAINS, TEKNOLOGI DAN INOVAS
MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATIO

National R&D Centre in ICT
MIMOS

CHULA ENGINEERING
Foundation toward Innovation
COMPUTER