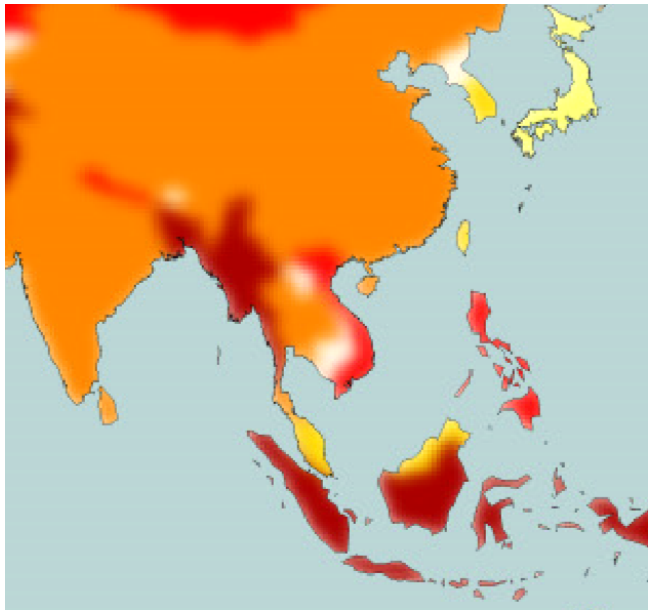
Project Title: ASEAN-Wide Cyber-Security Research Testbed

Background :

According to Microsoft Security Intelligence Report 2019,
Malware Encounter Rate in ASEAN region is very high.

Cyber-Space does not have country borders.
It is necessary to eliminate this situation in order to make the cyber-space safe.



Average Monthly Malware Encounter Rate, 2018
(Microsoft, Security Intelligence Report, 2019)

Targets:

We target the security of the Local Area Networks (LAN)

Enhance the functions of LAN-security monitoring devices and programs, which are currently provided as an open source by LAN-Security Monitoring Project.

Enhancement :

- Anonymization of captured LAN data
- Visualization of data for useful security operation
- Statistical analysis of data
- Improvement of detection algorithms (with ML)
  (*) such as federated learning (proposed by Google)

Speaker:

Assoc.Prof. Sinchai Kamolphiwong (PSU), Assoc. Prof. Hideya Ochiai (UT)

Project Title: ASEAN-Wide Cyber-Security Research Testbed

Project Members :

Full Name		Institution, Country
Sinchai Kamolphiwong		Prince of Songkla University, Thailand
Achmad Basuki		Universitas Brawijaya, Indonesia
Mie Mie Su Thwin		University of Computer Studies Yangon, Myanmar
Aung Htein Maw		University of Information Technology, Myanmar
Hideya Ochiai		The University of Tokyo, Japan
Kuljaree Tantayakul		Prince of Songkla University, Thailand
Touchai Angchuan		Prince of Songkla University, Thailand
Norrathep Rattanavipano		Prince of Songkla University, Thailand
Adhitya Bhawiyuga		Universitas Brawijaya, Indonesia
Raden Arief Setyawan		Universitas Brawijaya, Indonesia
Zhiqing Zhang		The University of Tokyo, Japan
Yuwei Sun		The University of Tokyo, Japan
Chirupphapa Pawissakan		The University of Tokyo, Japan

Project Duration :

2 Years: 2020-2022

Project Budget:

2020-2021: 33,050 USD
2021-2022: 12,345 USD

Project Title: ASEAN-Wide Cyber-Security Research Testbed

According to survey study, malware encounter rates in ASEAN region are very high. In order to make it a real-world public testbed for cyber-security studies, this project is going to enhance the functions of the monitoring devices provided by LAN-security monitoring project by installing around hundred newly-developed security devices across ASEAN countries. To that end, we are going to develop (i) vulnerability assessment of remote local-area networks, (ii) visualization of data for useful security operation, (iii) improvement of detection algorithms and statistical analysis including the application of federated learning, and (iv) anonymization of captured data for publicizing the data.

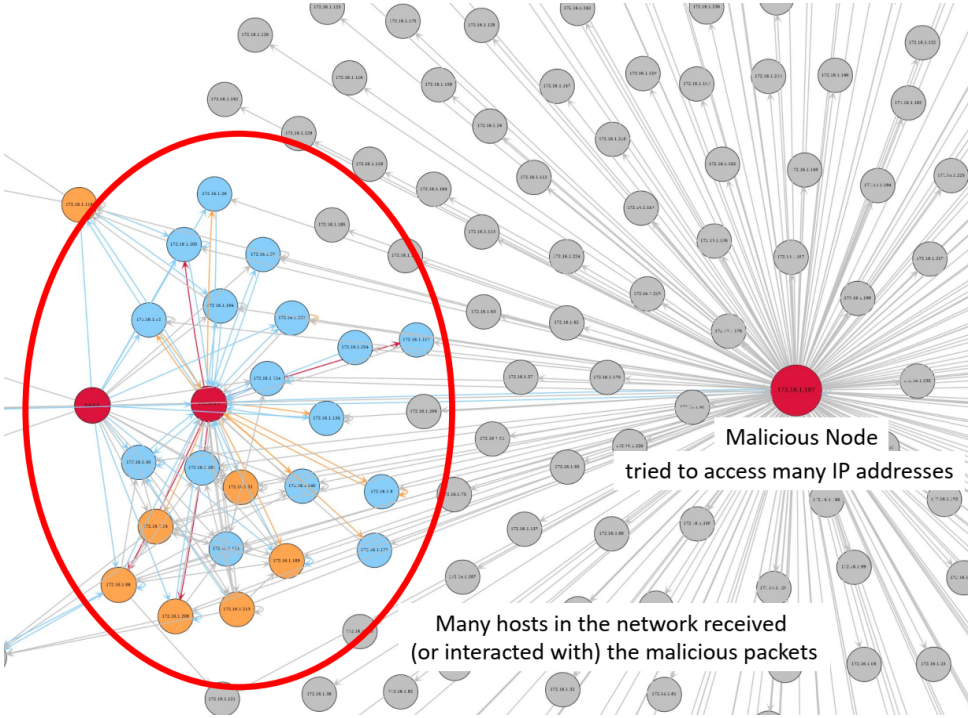
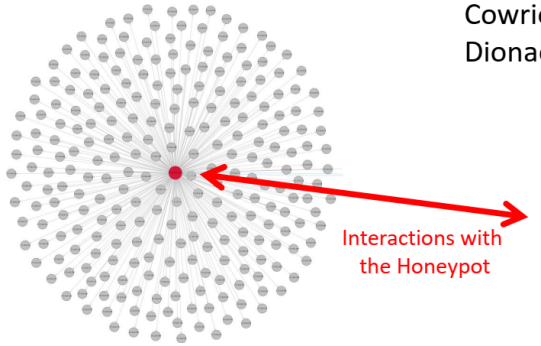


Fig 1.Visualized connection graph of a LAN. In this case, it is easier to read the node's IP addresses. However, sometimes it become too complex to read them.

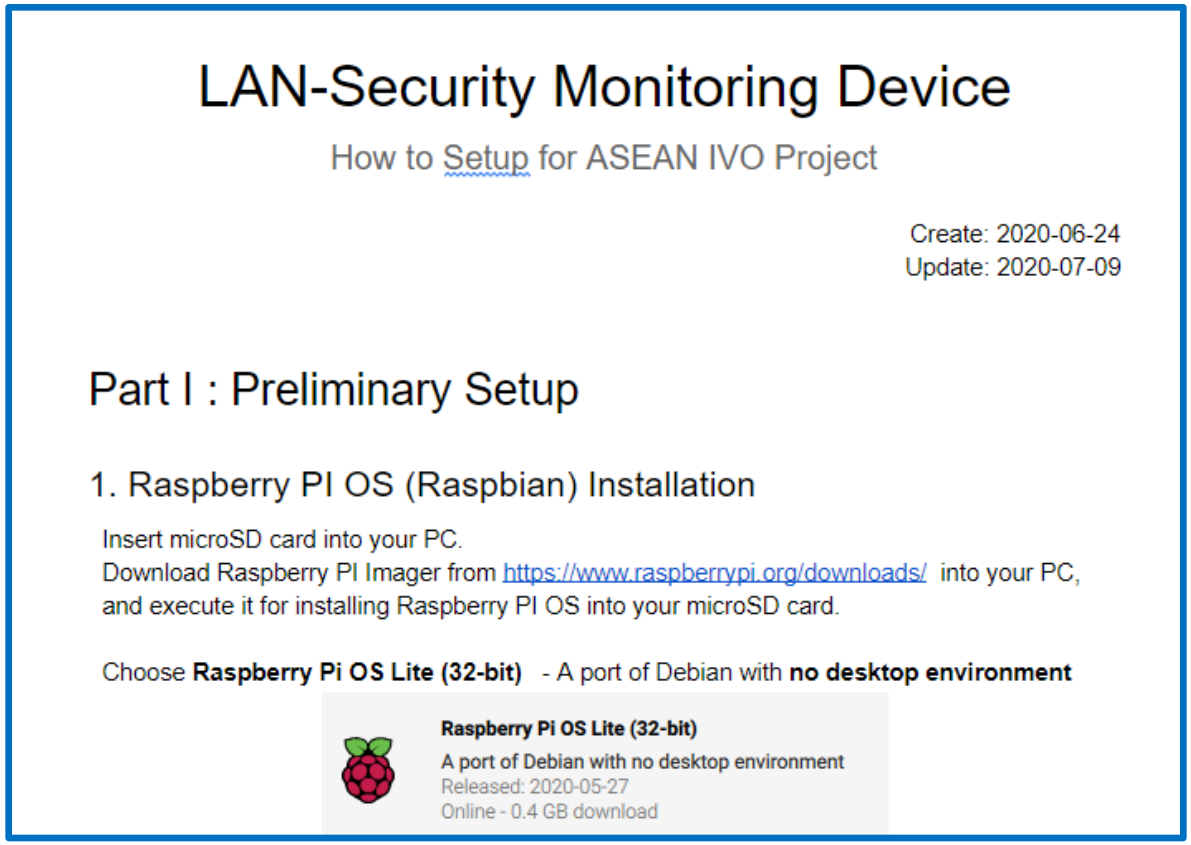
Fig. 2: Monitoring node of LAN-security monitoring project



Project Activities: On-line workshop:
Preparation of Monitoring Node Deployment

July 9th, 2020

1. We developed a manual of installing LAN security monitoring device for ASEAN IVO Project.



LAN-Security Monitoring Device

How to Setup for ASEAN IVO Project

Create: 2020-06-24
Update: 2020-07-09

Part I : Preliminary Setup

1. Raspberry PI OS (Raspbian) Installation

Insert microSD card into your PC.
Download Raspberry PI Imager from https://www.raspberrypi.org/downloads/ into your PC, and execute it for installing Raspberry PI OS into your microSD card.

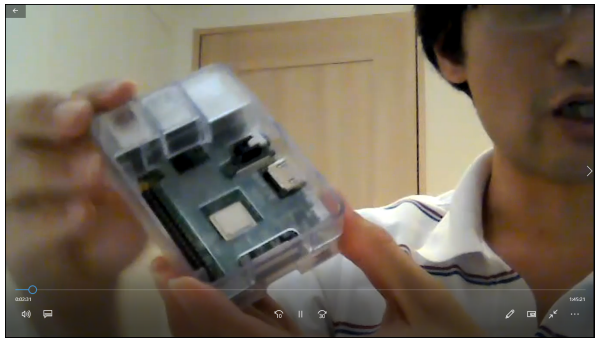
Choose **Raspberry Pi OS Lite (32-bit)** - A port of Debian with **no desktop environment**

Raspberry Pi OS Lite (32-bit)
A port of Debian with no desktop environment
Released: 2020-05-27
Online - 0.4 GB download

10 pages

2. We setup a data collection server in June.

3. We had an online workshop for installation of monitoring device.



July 9th, 2020

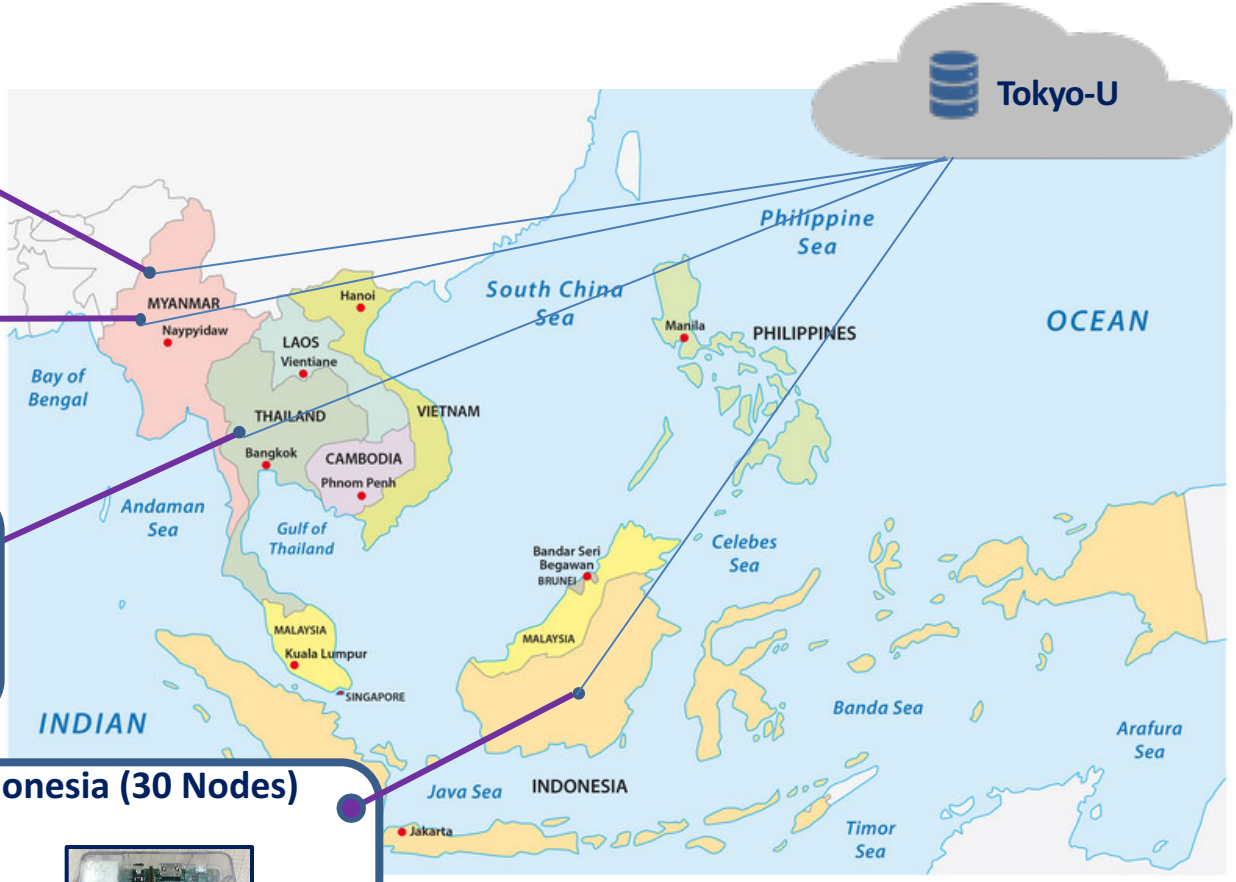
Sensor nodes installation

* Myanmar-UIT (20 Nodes)

* Myanmar-UCSY (30 Nodes)

Thailand-PSU (40 Nodes)

Indonesia (30 Nodes)

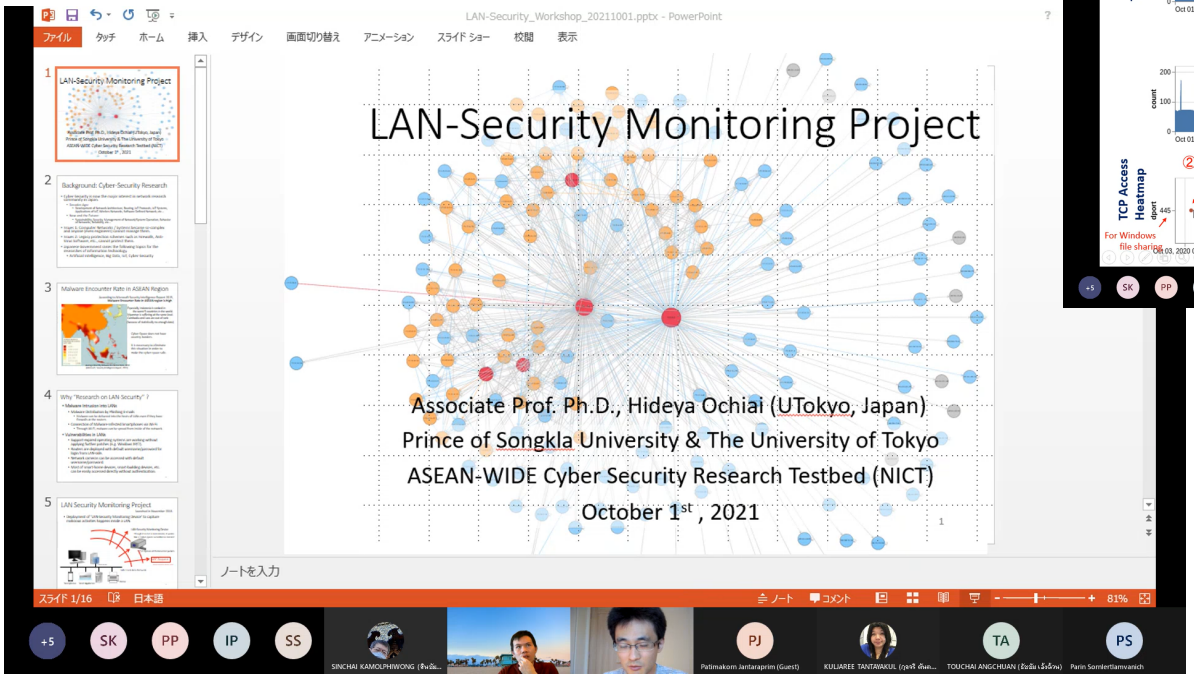


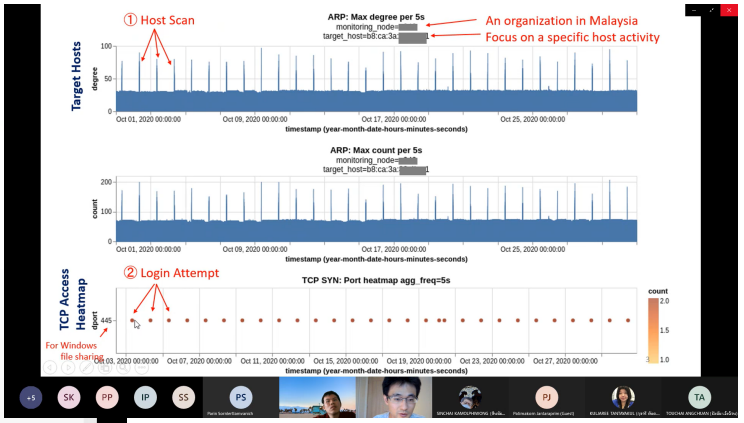
Project Activities: Online workshop:

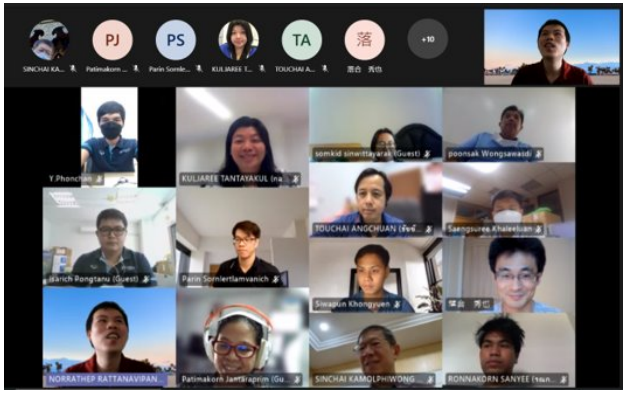
"LAN Security Monitoring Device"

October 1st, 2021

We organized an online workshop for distribution and installation of the LAN security monitoring nodes.





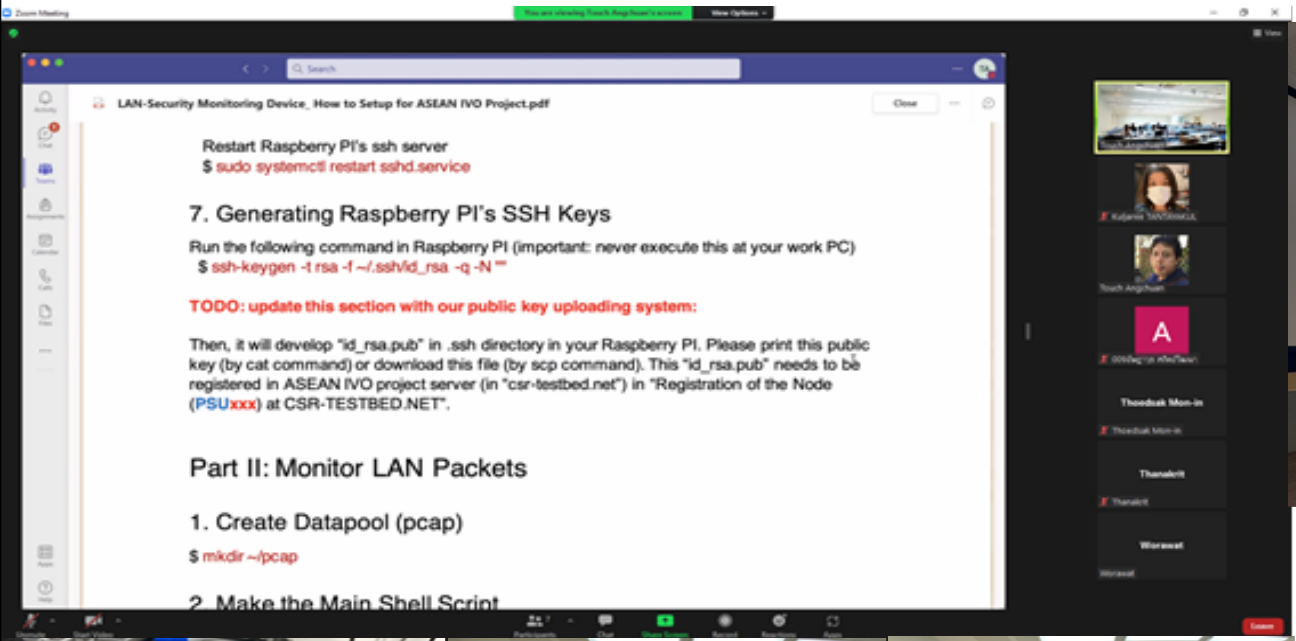


Project Activities: Hybrid workshop on ECTI CARD 2022

"LAN Security Monitoring Device"

February 17th, 2022

We organized a hybrid workshop for distribution and installation of the LAN security monitoring nodes.

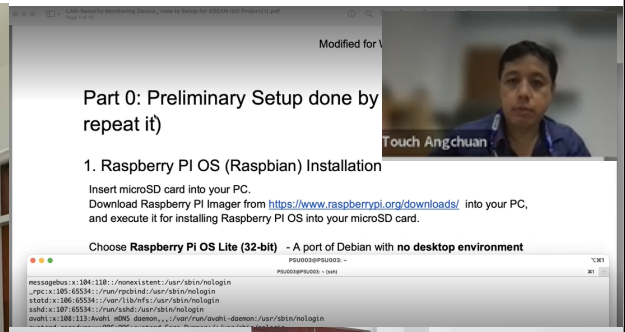


Project Activities: Hybrid Workshop on WUNCA 41st

"LAN Security Monitoring Device"

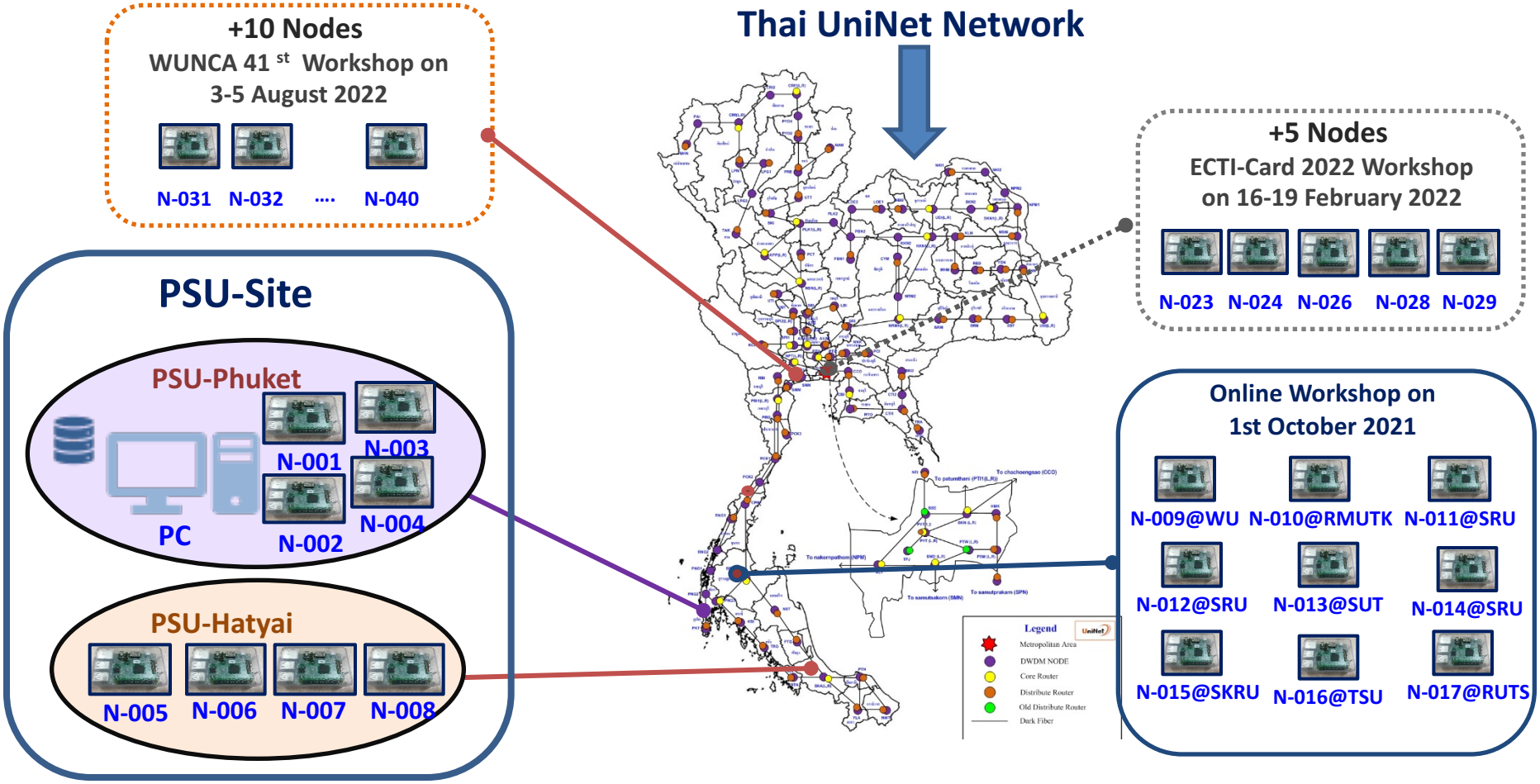
August 5th, 2022

We organized a hybrid workshop for distribution and installation of the LAN security monitoring nodes.



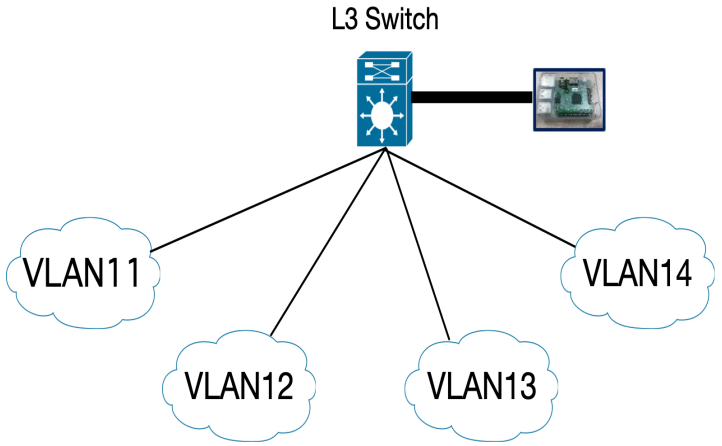
Sensor nodes installation

Distribute the sensor nodes installation in 27 nodes in 24 Thai Universities



Sensor nodes installation in Campus Network (multiple VLAN)

In order to deploy one LAN security monitoring node per one network in VLAN environment. This work propose a solution that use only one node connected to L3 switch through VLAN trunk.



Network configuration file (/etc/network/iface.d/eth0 in AIVO-node can be shown as:

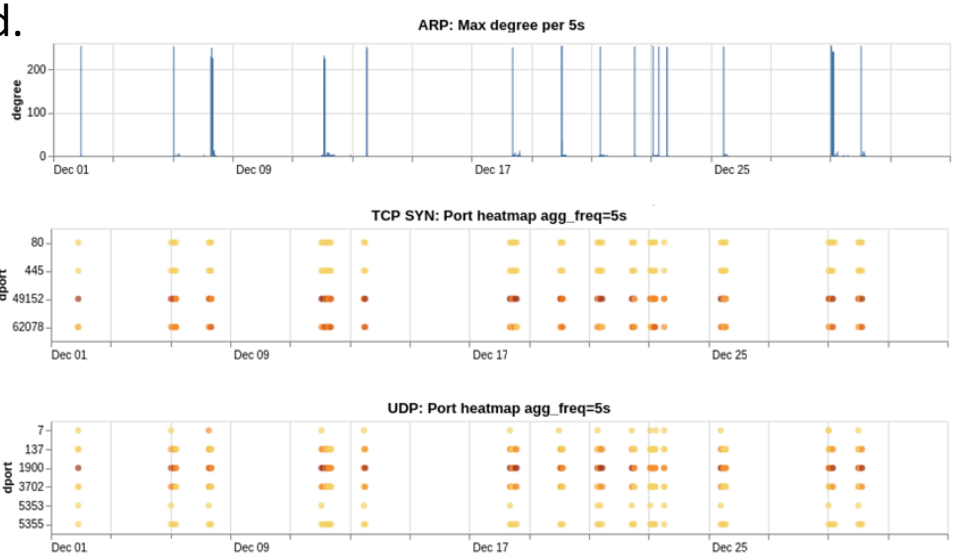
```
auto lo inet loopback
iface lo inet loopback

#management vlan
auto eth0
iface eth0 inet static
        address 172.30.80.8
        netmask 255.255.255.0
        gateway 172.30.80.1
auto eth0.11
iface eth0.11 inet manual
        vlan-raw-device eth0
        address 172.30.11.8
        netmask 255.255.255.0
```

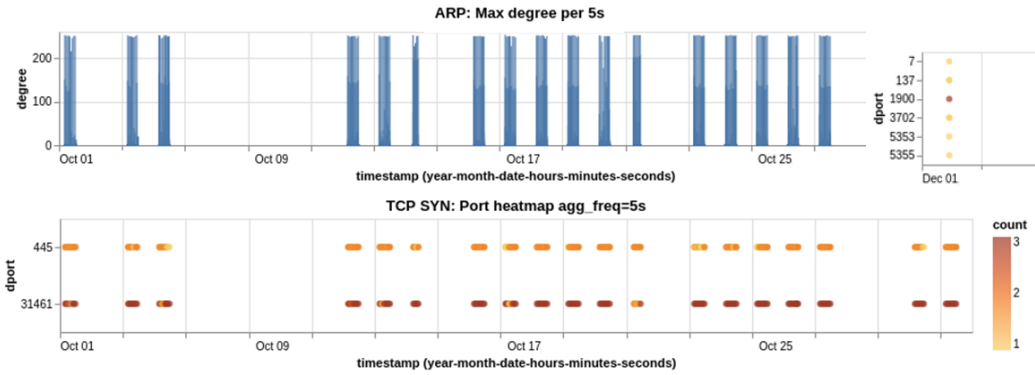
```
auto eth0.12
iface eth0.12 inet manual
        vlan-raw-device eth0
        address 172.30.12.8
        netmask 255.255.255.0
auto eth0.13
iface eth0.13 inet manual
        vlan-raw-device eth0
        address 172.30.13.8
        netmask 255.255.255.0
auto eth0.14
iface eth0.14 inet manual
        vlan-raw-device eth0
        address 172.30.14.8
        netmask 255.255.255.0
```

(1) Visualization of Suspicious Behavior of a Local Area Network

As the LAN's traffic is complex for normal network system operators and IoT system operators, suspicious behavior is usually invisible. We have designed a dashboard that visualizes host activities, especially suspicious cases based on the packet capture at the monitoring node. It shows how it made ARP scan, and how it accessed the monitoring node with TCP/UDPs by heat map. Through this user-interface, the system operators can check suspicious behavior and make security actions such as isolation of the node from the network if necessary. The network researchers can make further categorization using the signatures created on the dashboard.



Suspicious Access Patterns
with ARP scan and TCP port access.



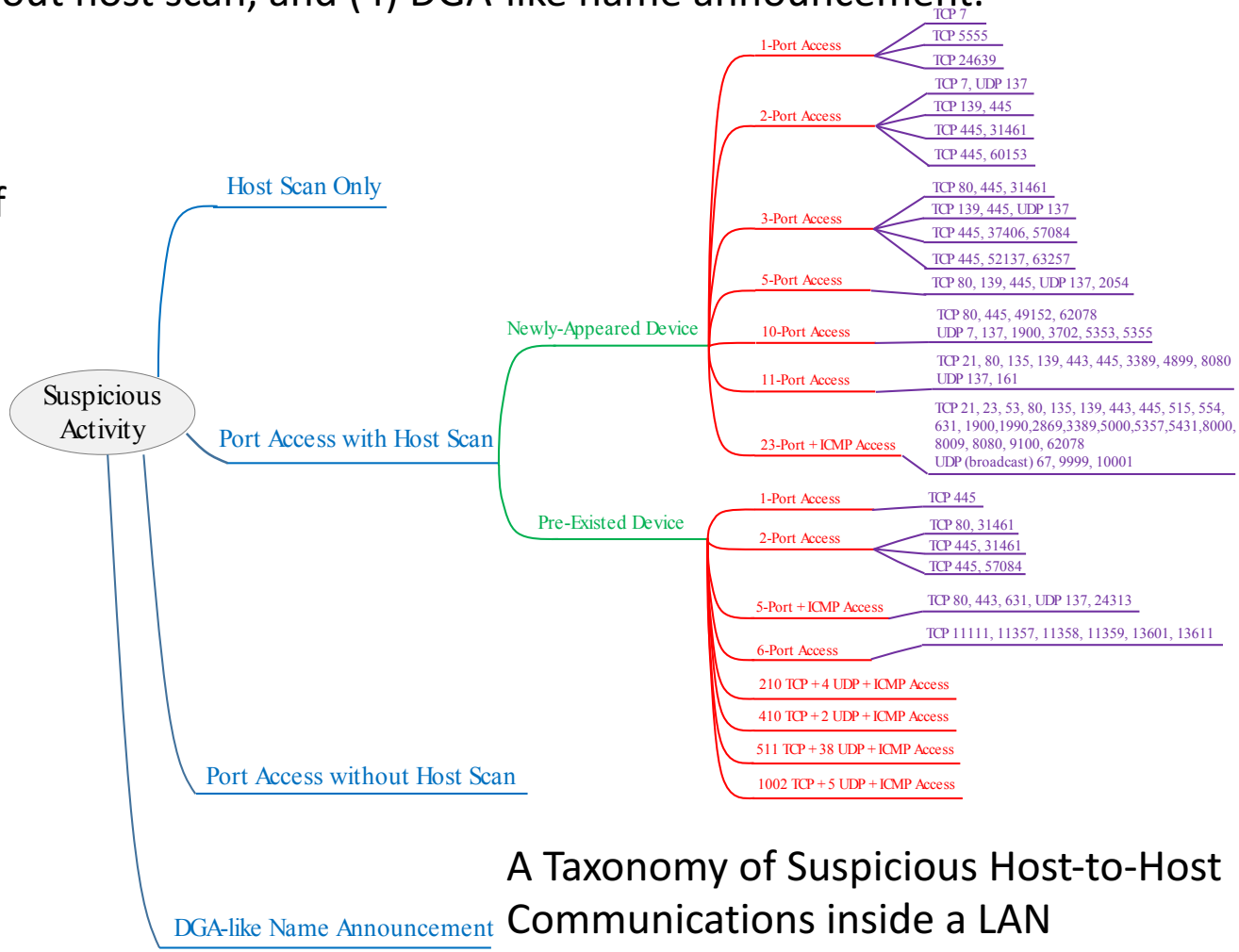
Suspicious Access Patterns with ARP scan and TCP/UDP port access.

(2) A Taxonomy of Suspicious Host-to-Host Communications

From the observations of port access patterns and ARP features, we drafted a taxonomy of suspicious host-to-host communications inside a local area network. We discovered that the suspicious behavior can be categorized as (1) Host Scan Only, (2) Port access with host scan, (3) Port access without host scan, and (4) DGA-like name announcement.

These suspicious behaviors can be further divided into sub categories. The edge of the categories can identify the pattern of combination accesses, which may come from the same malware.

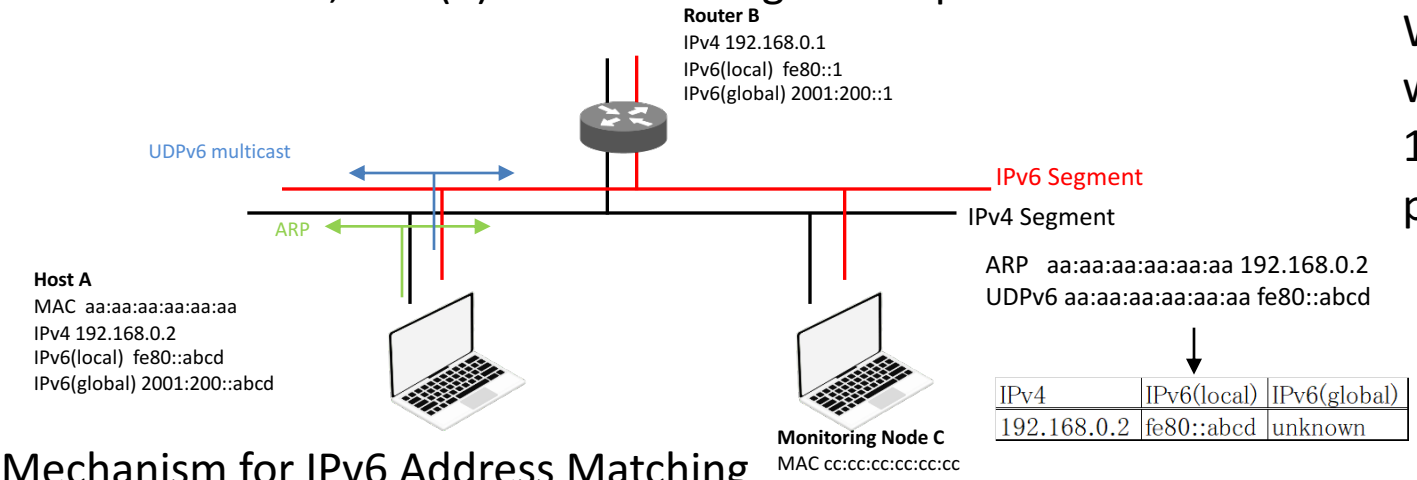
While developing this taxonomy, we also found same suspicious activities are appeared in many local area networks.



A Taxonomy of Suspicious Host-to-Host Communications inside a LAN

(3) Traffic Redirection of IPv6 Segment for Further Analysis

In a Local Area Network, even without IPv6 network configurations, hosts joined in a LAN automatically have IPv6 link-local addresses and can make interactions between them as a peer-to-peer manner. As IPv6 channel can be a security hole (even in IPv4 only network), we have developed a traffic redirection method (1) for identifying suspicious hosts in IPv6 address domain, and (2) for monitoring the suspicious traffic.



With this method, we could find 103 IPv4-IPv6 address pairs for 155 hosts.

Mechanism for IPv6 Address Matching

MAC address — Assigned IPv4, IPv6 Addresses

```
a8:[redacted]:0c ['192.168.[redacted].230', 'fe80::[redacted]:a203']
a8:[redacted]:67 ['192.168.[redacted].142', 'fe80::[redacted]:ab15']
50:[redacted]:07 ['192.168.[redacted].48']
00:[redacted]:89 ['192.168.[redacted].157']
98:[redacted]:cb ['192.168.[redacted].203']
a0:[redacted]:25 ['192.168.[redacted].37']
b4:[redacted]:df ['192.168.[redacted].166', 'fe80::[redacted]:71c6']
00:[redacted]:82 ['192.168.[redacted].167', 'fe80::[redacted]:d650']
84:[redacted]:d9 ['fe80::[redacted]:66d9']
```

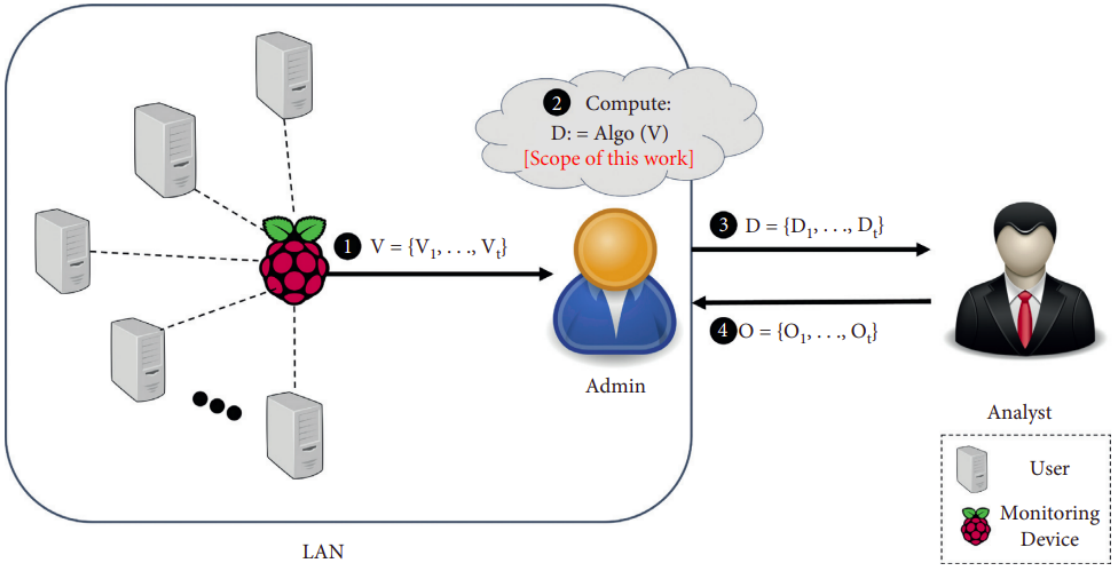
IPv4-IPv6 address pairs found

IPv4-only hosts found

An IPv6-only host found

Discovered IPv4-IPv6 Pairs

(4) Anonymization of captured data via Differential Privacy



We anonymize captured ARP data by applying differential mechanisms on ARP-degree data. We consider two mechanisms:

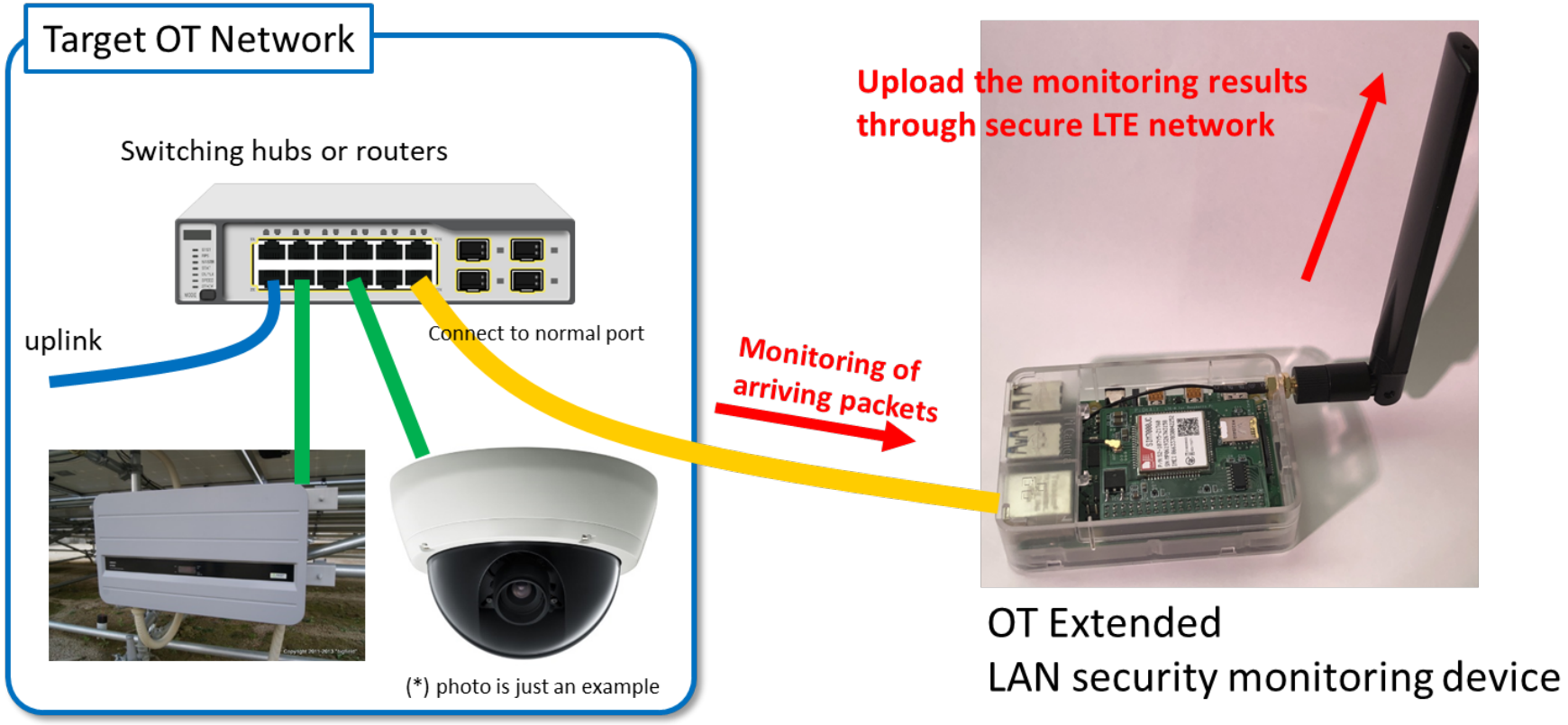
- Naïve approach – perturbing ARP-degree data directly
- Histogram-based approach – transforming ARP-degree data into histogram and perturbing histogram

Our finding: these mechanisms provide the following privacy guarantee:

- Naïve approach – hide user relationship
- Histogram-based approach – hide presence of individual users

(5) LTE-Support for OT-extended Monitoring

- LAN is also used in many OT (Operational technology) network, which is sometimes isolated from the Internet but malware can be intruded.
- We have developed LTE-support for LAN-monitoring system.



Scientific Contribution:

Please fill in the following table if your members gave presentations at an international conference or published papers in scientific journals.

Presentations at International Conferences:

No:	Paper title:	Author names	Affiliation	Conference name:	The date of the conference	The venue of the conference
1	Releasing ARP Data with Differential Privacy Guarantees For LAN Anomaly Detection	Norrathep Rattanavipanon, Donlapark Ponnoprat, Hideya Ochiai, Kuljaree Tantayakul, Touchai Angchuan, Sinchai Kamolphiwong	Prince of Songkla University, Chiang Mai University, The University of Tokyo	International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON)	19/05/2021	Virtual

Scientific Contribution:

Please fill in the following table if your members gave presentations at an international conference or published papers in scientific journals.

Published Journal Papers:

No:	Paper title:	Author names	Affiliation	Journal name:	The publisher of the Journal	The volume number and Pages
1	Detecting Anomalous LAN Activities under Differential Privacy	Norrathep Rattanavipanon, Donlapark Ponnoprat, Hideya Ochiai, Kuljaree Tantayakul, Touchai Angchuan, Sinchai Kamolphiwong	Prince of Songkla University, Chiang Mai University, The University of Tokyo	Security and Communication Networks	Hindawi	2022

Societal Impact:

How does our project create the social impacts:

1) We are doing hand on workshops to train and share our knowledge to people in academic networks, expect to be around a hundred of them,

   We hope that our network will be expanded

2) We expect to publish 1 technical journals (submitted) by early of next year (2023), and
3) Anonymization of captured data for publicizing the data.

Conclusion:

The finding of our project will be:

(i) vulnerability assessment of remote local-area networks,

(ii) visualization of data for useful security operation,

(iii) improvement of detection algorithms and statistical analysis including the application of federated learning, and

(iv) anonymization of captured data for publicizing the data

Future works:

1. Scientific and Technological:

   (i) vulnerability assessment of remote local-area networks,

   (ii) improvement of detection algorithms and statistical analysis including the application of federated learning, and

   (iii) some publications and knowledge sharing

2. Application development

   visualization of data for useful security operation,

3. We expect to publish 1 technical journals (submitted) by early of next year (2023), and

Future Work: Technical Workshop

January, 2022, Hand-on Technical Workshop@WUNCA 42, Thaksin University, Phatthalung, Thailand

One full day hand-on technical workshop

Organizing Team:

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Kuljaree Tantayakul Prince of Songkla University,Thailand kuljaree.t@phuket.psu.ac.th
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