ASEAN IVO PROJECT

Research and development on short distance communication and imaging for applications in ASEAN region

Project Report

(April 2016 – November 2018)

Project Information

Project Title: Research and development on short distance communication and imaging for applications in ASEAN region

Project Members: 10

- Posts and Telecommunications Institute of Technology (PTIT, Vietnam),
- HCM city Department of Information and Communications (DIC, Vietnam),
- Radio Frequency Department (RFD, Vietnam),
- Chiang Mai University (CMU, Thailand),
- Chulalongkorn University (CU, Thailand),
- Suranaree University of Technology (SUT, Thailand),
- Universiti Teknologi Malaysia (UTM, Malaysia),
- Telekom Malaysia R&D (TMRD, Malaysia),
- Indonesian Institute of Science (LIPI, Indonesia),
- Telkom Indonesia (TI, Indonesia).
- National Institute of Information and Communications Technology (NICT, Japan)

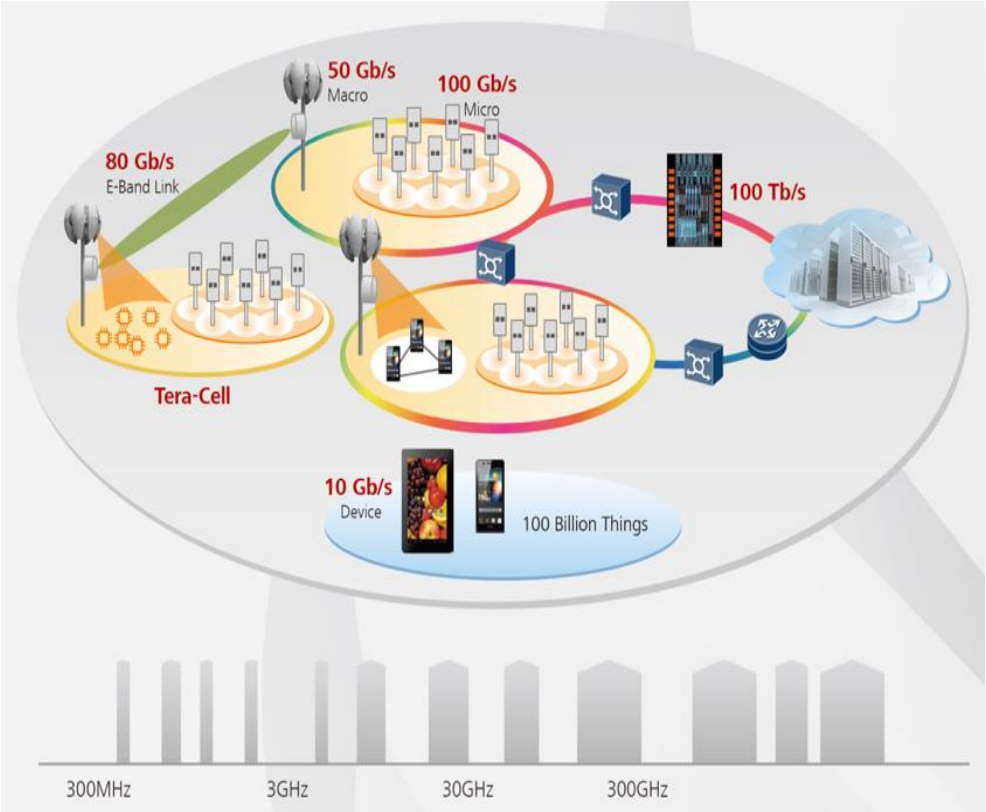
The project period: 36 months starting from April 2016 with project funding USD 90K.

Overview

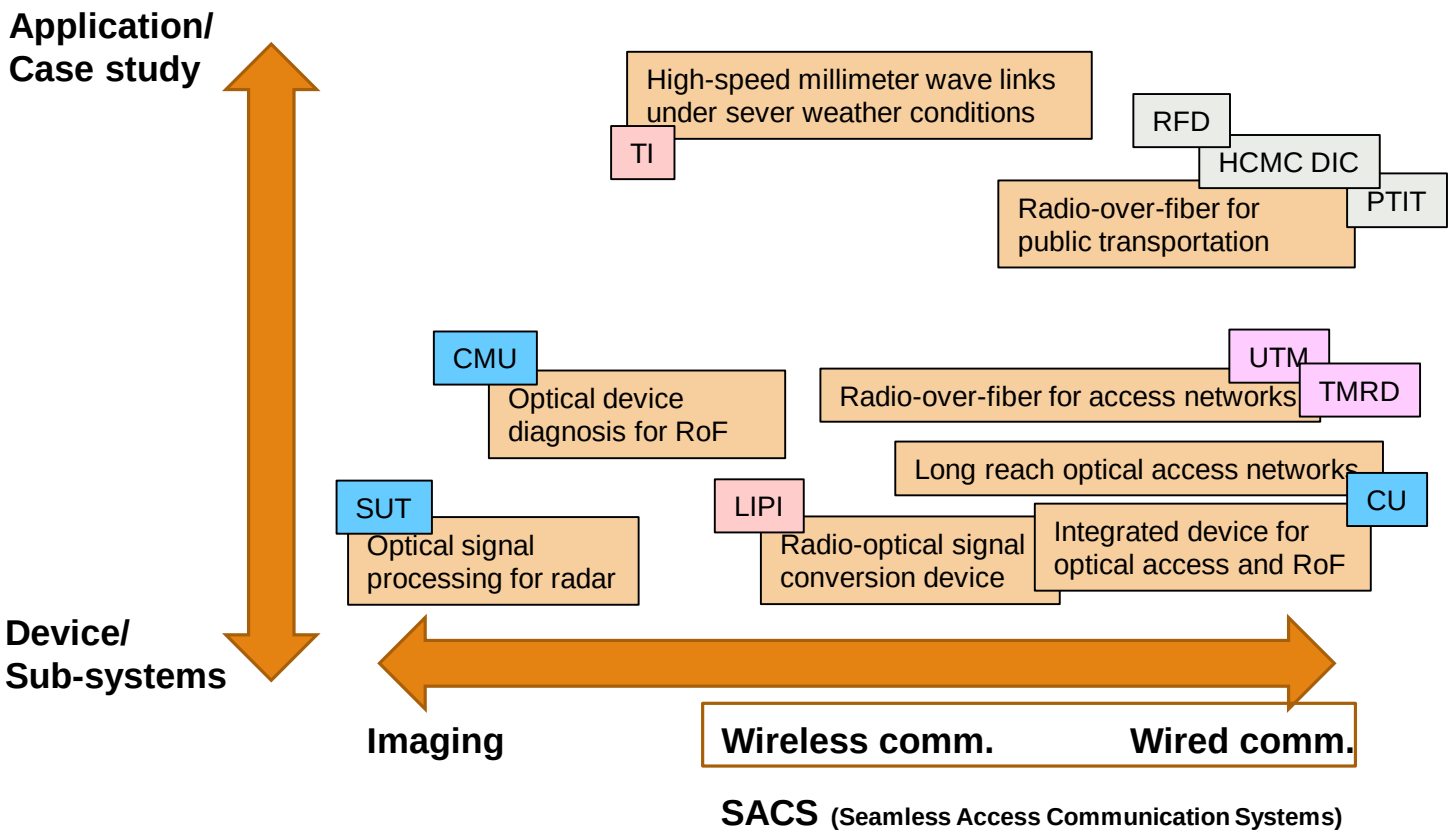
Future access communication will be relied on short-distance communication technology (<5 km) :

- millimeter-wave radio
- free space optics
- optical fiber links

high connectivity and high throughput of 10 Gb/s to end users



Overview of consortium structure



Overview of consortium structure

Ha Long bay, Vietnam,

Jul. 28, 2016

The R&D items that the institutes will do in the project are as follows:

- **PTIT, HCMC DIC**: field trial on railway communication system
- **NICT**: field trial test collaborated with ASEAN institutes
- **UTM, TMRD**: radio over fiber system implemented to PON network (frequency subject to change)
- **CMU**: IQ modulation by integrated LD without any external modulator
- **Chula-U**: evaluation of device/subsystem with integrated optical circuits
- **LIPI**: optimization of E/O converter for MWP link
- **TI**: Survey and input to standardization bodies related on FWS under severe weather conditions

Project Activities: First Year Timeline

The first year

Feb. 15, 2016
Meeting for Project Preparation and Submission

Jun. 2, 2016
Project Acceptance

Jul. 27, 2016
Kickoff meeting at Ha Long Bay

Dec. 2016
Field trial site check
(NICT & PTIT)

Jan. 2017
The trial field test at HCMC

Feb. 2017
Workshop on Convergence of radio and optical technologies at Chiang Mai University
(all members)

Kickoff meeting

Kickoff meeting

Workshop on CRO

Project Activities: Second Year Timeline

The second year

N o w

April 14, 2017
Approved for the second year

May, 2017
IVO meeting in Bangkok

Nov. 2, 2017
Special Session on "Linear Cell Technology" in ISAP 2017, Phuket, Thailand

Nov. 29, 2017
NICT workshop at ISEE 2017 and ASEAN IVO Project meeting

Jan. 8, 2018
Filed experiments in HCMC (Path loss curve)

IVO meeting in Bangkok

ISAP 2017 SS on "Linear Cell Technolgoy"

Project Activities: Third Year Timeline

The third year

NOW

April 13, 2018
Approved for the third year
27,000 USD

Feb. 22, 2018
6th International Workshop on CRO, Malaysia

Aug. 7, 2018
Project meeting, Matsue, Japan

CRO workshop in Malaysia

Project meeting in Matsue

R&D target

- **Target #1**: **Evaluation** of the short-distance communication and imaging technologies independently first.
- **Target #2**: **Design, evaluation, testing and demonstration** of developed devices and subsystems are performed by each institute with their expertise.
- **Target #3**: **Integration** of these technologies will be also discussed in the project through the meetings, the seminars or the workshops.
- **Target #4**: **Sharing** the knowledge by publishing the paper and presenting the advanced research results in conferences:
- **Target #5**: **Providing** contributions to international standardization bodies for societies in the ASEAN region

R&D target

- **Target #1**: **Evaluation** of the short-distance communication and imaging technologies independently first.
- **Target #2**: **Design, evaluation, testing and demonstration** of developed devices and subsystems are performed by each institute with their expertise.

Field trial of mm-wave radio system in HCMC, Vietnam

The first Field trial of mm-wave radio system in HCMC, Vietnam

Investigators

- PTITHCM, HCMC DIC, NICT

PTIT HCM

Purpose of Field Trial

- To investigate the possibility of millimeter-wave radio communication for urban railway systems as a backhaul network to 4G and future 5G mobile communications.

Duration: Jan. 2, 2017 – Jan. 10, 2017

Vietnam side:

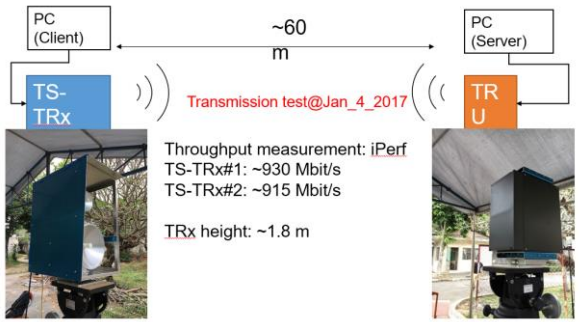
Dr. Quoc Cuong [HCMC DIC]
Prof. Vo Nguyen Quoc Bao [PTIT]
Mr. Pham Minh Quang [PTIT]
Ms. Nguyen Phuong Thao [PTIT]
Prof. Tan Hanh [PTIT]
Ms. Pham Thi Dan Ngoc [PTIT]
Mr. Nguyen Toan Van [PTIT]

Japan side:

Prof. Tetsuya Kawanishi [NICT/Waseda-U]
Dr. Naruto Yonemoto [ENRI]
Mr. Nobuhiko Shibagaki [Hitachi]
Mr. Kyosuke Ishikawa [HiKE]
Mr. Wataru Sawada [HiKE]
Mr. Kosei Naito [Variable Energy]
Dr. Pham Tien Dat [NICT]
Mr. Kenichi Kashima [HiKE]
Dr. Yosuke Sato [HiKE]
Mr. Yudai Takahashi [Link Techn

The first field trial of mm-wave radio system in HCMC, Vietnam

- Two investigation sites:
  - **Site #1**: PTIT campus in District 9, Ho Chi Minh City
  - **Site #2**: Van Thanh Station, Metro line #1, Binh Thanh District, Ho Chi Minh City



- Planned experiments have been successfully done.
- The field trial clarifies issues of configuration of cells and possible suggestion for direction how to configure for railway systems
- The current transceiver system is not enough for railway systems. It will be optimized and redesigned.

The first field trial of mm-wave radio system in HCMC, Vietnam

The second field trial of mm-wave radio system in HCMC, Vietnam

Investigators

- PTITHCM, HCMC DIC, NICT

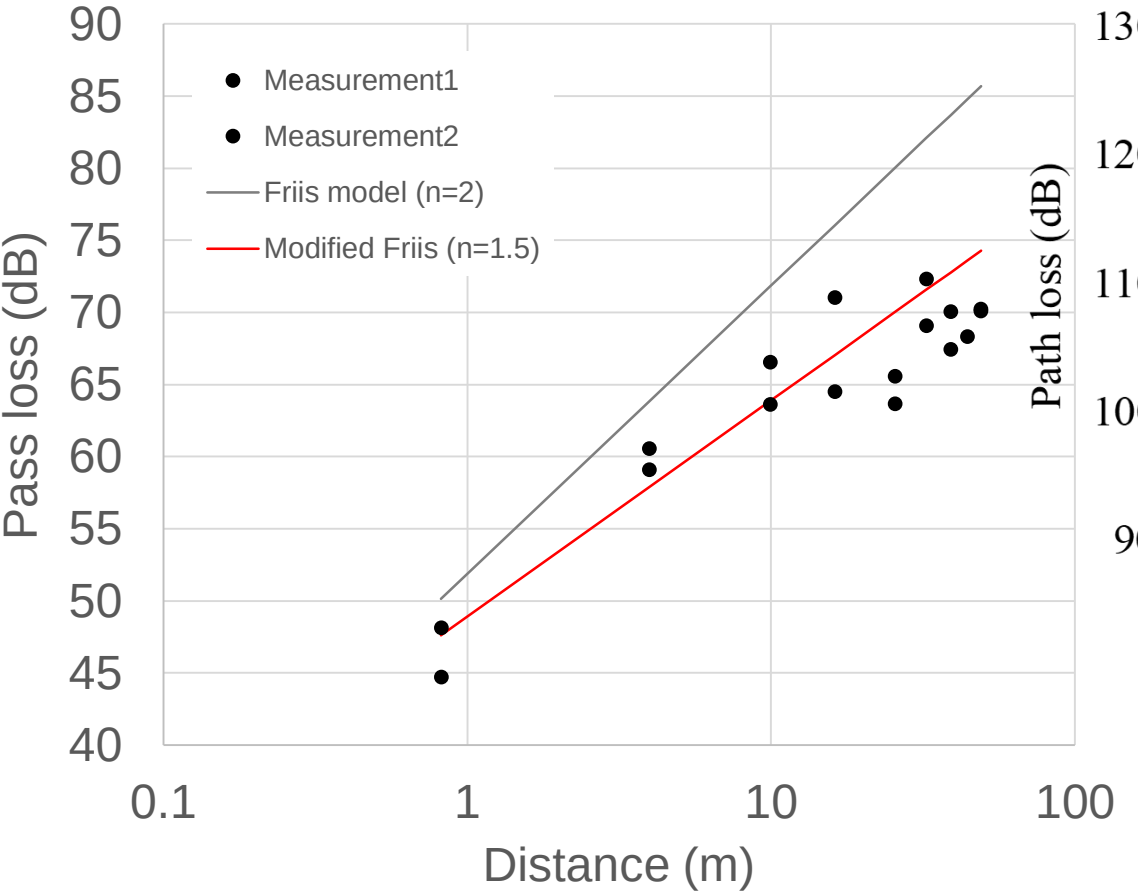
PTIT HCM

Purpose of Field Trial

Propagation characteristic measurement for clear understandings. In January 2018, radio propagation characteristics will be measured for understanding fundamental properties in the millimeter-wave bands.

Duration: Jan. 8, 2018 – Jan. 12, 2018

The second field trial of mm-wave radio system in HCMC, Vietnam



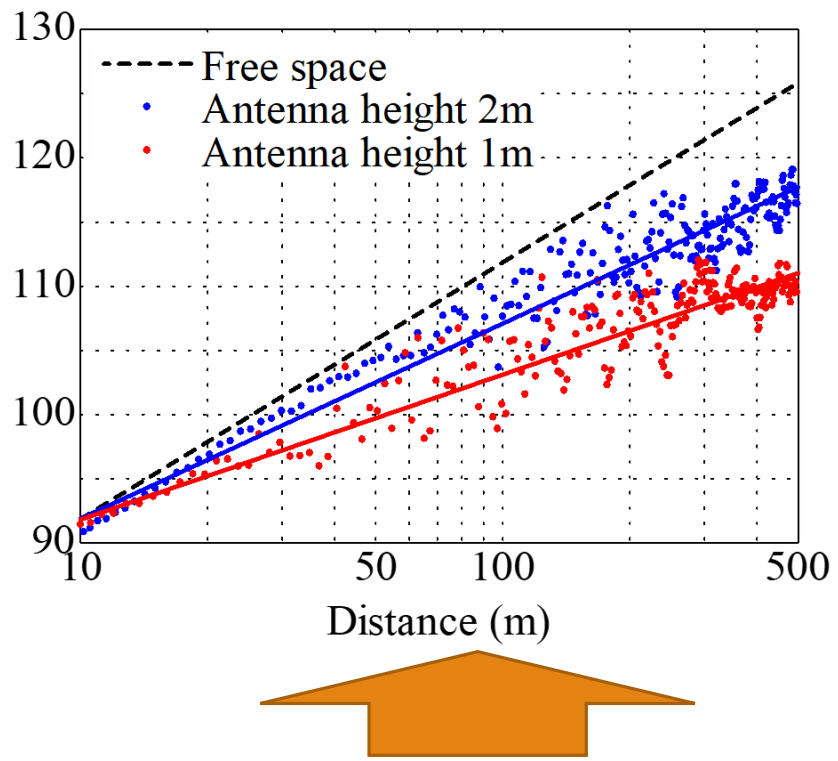


Figure from New elements towards a REVISION TO RECOMMENDATION ITU-R P.1411-8

R&D target

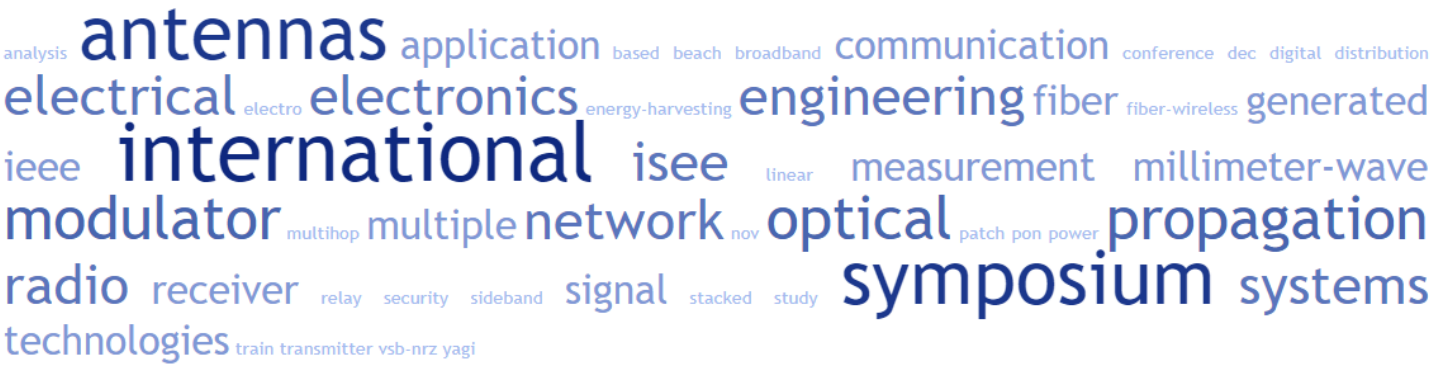
- **Target #3**: **Integration** of these technologies will be also discussed in the project through the meetings, the seminars or the workshops.
  - ✓ **Event 1**: Project Kickoff meeting collocated with IEEE ICCE 2016, July 27 – 29, 2016 at Novotel, Ha Long, Vietnam.
  - ✓ **Event 2**: Workshop on Convergence of radio and optical technologies at Chiang Mai University, February 27th, 2017, The Empress Hotel, Chiang Mai, Thailand
  - ✓ **Event 3**: IVO Project meeting in Bangkok, May 3, 2017, Hotel Pullman Bangkok Grande Sukhumvit Asok, Bangkok, Thailand
  - ✓ **Event 4**: Special Session "*Linear Cell Technology*" on ISAP 2017, Nov. 2, 2017, Phuket Graceland Resort & Spa, Phuket, Thailand
  - ✓ **Event 5**: Special Session on ISEE 2017, Nov. 2017, Ho Chi Minh City University of Technology, Ho Chi Minh City, Vietnam
  - ✓ **Event 6**: The 6th International Workshop on CRO, Feb. 22, 2018, Malaysia
  - ✓ **Event 7**: The first fiscal year of 2018 Project meeting, Matsue, Japan

R&D target

- **Target #4**: **Sharing** the knowledge by publishing the paper and presenting the advanced research results in conferences:

PTIT	NICT	LIPI	UTM
2 papers	5 papers (2 joint papers with PTIT)	2 papers	1 papers

10 international conference and some technical reports



R&D target

- **Target #5**: **Providing** contributions to international standardization bodies for societies in the ASEAN region
  - Propose preliminary work item on Millimeter-Wave Radio over Fiber Backbone for Train Communication Networks
  - Study on Rain Attenuation Effects to millimeter wave in Indonesia: Dr. Hazim Ahmadi (in the next APT-AWG meeting)

Project Activities: Outcome

- Activity on field trial for railway communication system: HCMC
  - Field experiments in PTIT HCM Campus
    - 2 TRx on the ground to 1 TRx on the car
    - Success (RSSI/Throughput measured)
  - Field experiment in Line #1 Van Thanh Park
    - Between 2 TRxs on the ground: partially success (measured but a little bit inconsistency)
- Activities on standardizations
  - Propose preliminary work Items on millimeter-wave radio over fiber backbone for train communication networks
  - Study on Rain Attenuation Effects to millimeter wave in Indonesia: Dr. Hazim Ahmadi (in the next APT-AWG meeting)

Project Activities: Outcome

- Publications: 10 international conference papers in Flagships conferences and some technical reports
  - [1] Atsushi Kanno, Pham Tien Dat, Naokatsu Yamamoto, Tetsuya Kawanishi, Naruto Yonemoto, Vo Nguyen Quoc Bao, Tan Hanh, Le Quoc Cuong, Kenichi Kashima, Nobuhiko Shibagaki, Radio over fiber signal generation and distribution and its application to train communication network, CLEO-PR, OECC and PGC 2017, Singapore, 2017
  - [2] P. Mekbunwan, U. Mankong, K. Inagaki, A. Kanno and T. Kawanishi, "Digital Coherent Transmitter Using Electro absorption Modulator Integrated Laser," in 2015 IEEE International Topical Meeting on Microwave Photonics (MWP), Long Beach, USA, 31 Oct – 3 Nov 2016.
  - [3] Atsushi Kanno, Pham Tien Dat, Naokatsu Yamamoto1, Tetsuya Kawanishi, "Radio over Fiber Network Technologies for Linear Cell Systems in Millimeter-Wave Bands", 2017 International Symposium on Antennas and Propagation
  - [4] Tetsuya Kawanishi, Hideki Hayashi, Keizo Inagaki, Atsushi Kanno, Naokatsu Yamamoto, "Instantaneous Frequency Measurement for Broadband Radio Signals Using Optical Single Sideband Modulation", 2017 International Symposium on Antennas and Propagation
  - [5] Nguyen Toan Van, Tran Trung Duy, Tan Hanh, and Vo Nguyen Quoc Bao, "Outage Analysis of Energy-Harvesting based Multihop Cognitive Relay Networks with Multiple Primary Receivers and Multiple Power Beacons", 2017 International Symposium on Antennas and Propagation
  - [6] Yusuf Nur Wijayanto, Yahya Sukri, Fajri Darwis, Atsushi Kanno, Hiroshi Murata, Tetsuya Kawanishi, Dadin Mahmudin, Pamungkas Daud, Purwoko Adhi, 28GHz Microstrip Yagi Antenna Stacked with Optical Modulator for 5G Wireless Communication, 2017 International Symposium on Antennas and Propagation
  - [7] Sevia Idrus, Demonstration of Receiver Generated Optical Doubinary and VSB-NRZ for Next-Generation PON, The 2017 International Symposium on Electrical and Electronics Engineering (ISEE 201
  - [8] Vo Nguyen Quoc Bao, Le Quoc Cuong, Tran Trung Duy, "A Study on WiFi Hotspot Model for Vietnam Cities " The 2017 International Symposium on Electrical and Electronics Engineering (ISEE 2017)
  - [9] Atsushi Kanno, Converged Fiber-Wireless Technologies for Future Access and Radar Systems, The 2017 International Symposium on Electrical and Electronics Engineering (ISEE 2017)
  - [10] Yusuf Nur Wijayanto, Atsushi Kanno, Hiroshi Murata, Tetsuya Kawanishi, Purwoko Adhi, W-Band Millimeter-Wave Patch Antennas on Optical Modulator for Runway Security Systems, 2017 IEEE Conference on Antenna Measurements and Applications, Dec. 4-6, Tsukuba, Japan

Project conclusion

- **The research project has provided basic guidelines for**
  - Design of photonic integrated devices
  - Millimeter-wave propagation, channelization, and its availability
  - Device evaluation technique
  - Feasibility of short-distance communication by both optical and radio technology in access networks numerically and experimentally
  - Feasibility of short-distance imaging by optical and radio, and their combination techniques
  - New hardware implementations for short-distance communication and imaging based on radio-over-fiber and its related technologies.

- **The collaboration among ASEAN institutes including universities, manufactures, operators and government**
  - Increasing the number of research scientists, engineers in the field of the convergence of radio and optical technologies for realization of 5G networks.
  - Enhancing civil security and safety by imaging as well as to increase user experiences in future networks.

- **Harmonizing the fundamental research** based on the seeds for innovative technologies and strong demands from the operators, and finally, the institutes and governments can organize for international standardizations by these outputs.

Thank you