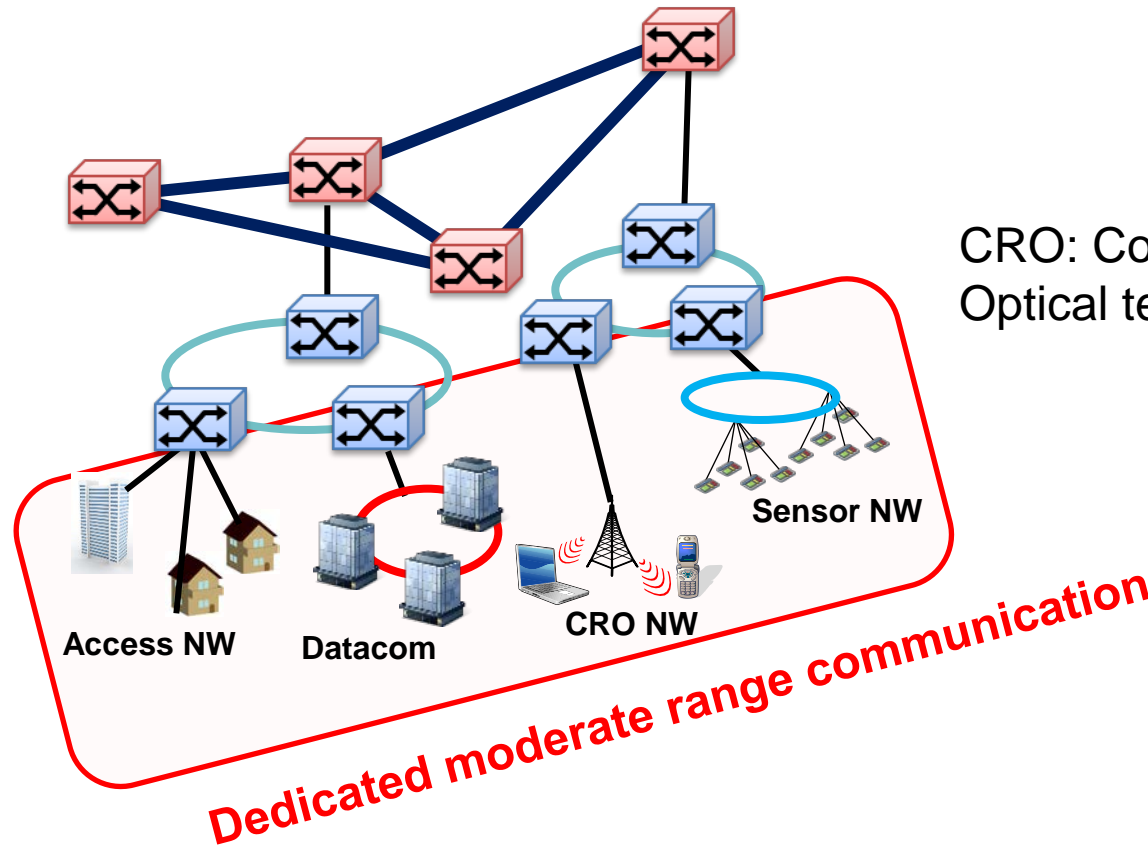


Dedicated Moderate Range Communications for Future Infrastructure

Tetsuya Kawanishi,
Photonic Network Research Institute, NICT

Dedicated Moderate Range Communications



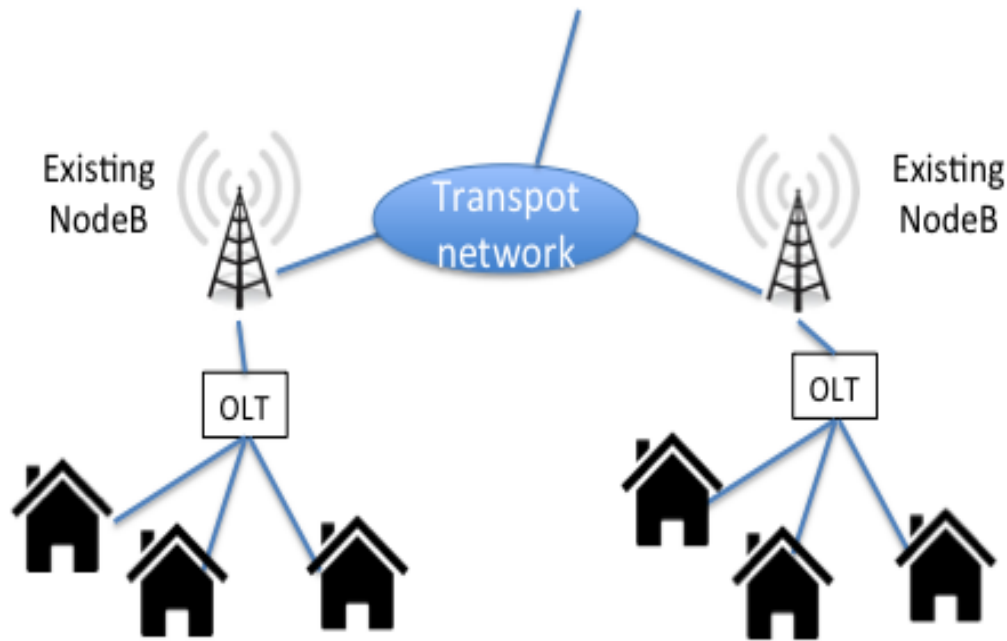
CRO: Convergence of Radio and Optical technologies

Dedicated (OMOTENASHI): Flexible services based variety of transmission media

Moderate Range: 1m – 10km

Communications: Transmission of digital data, waveforms for sensing and radio communications to gather information from environment directly

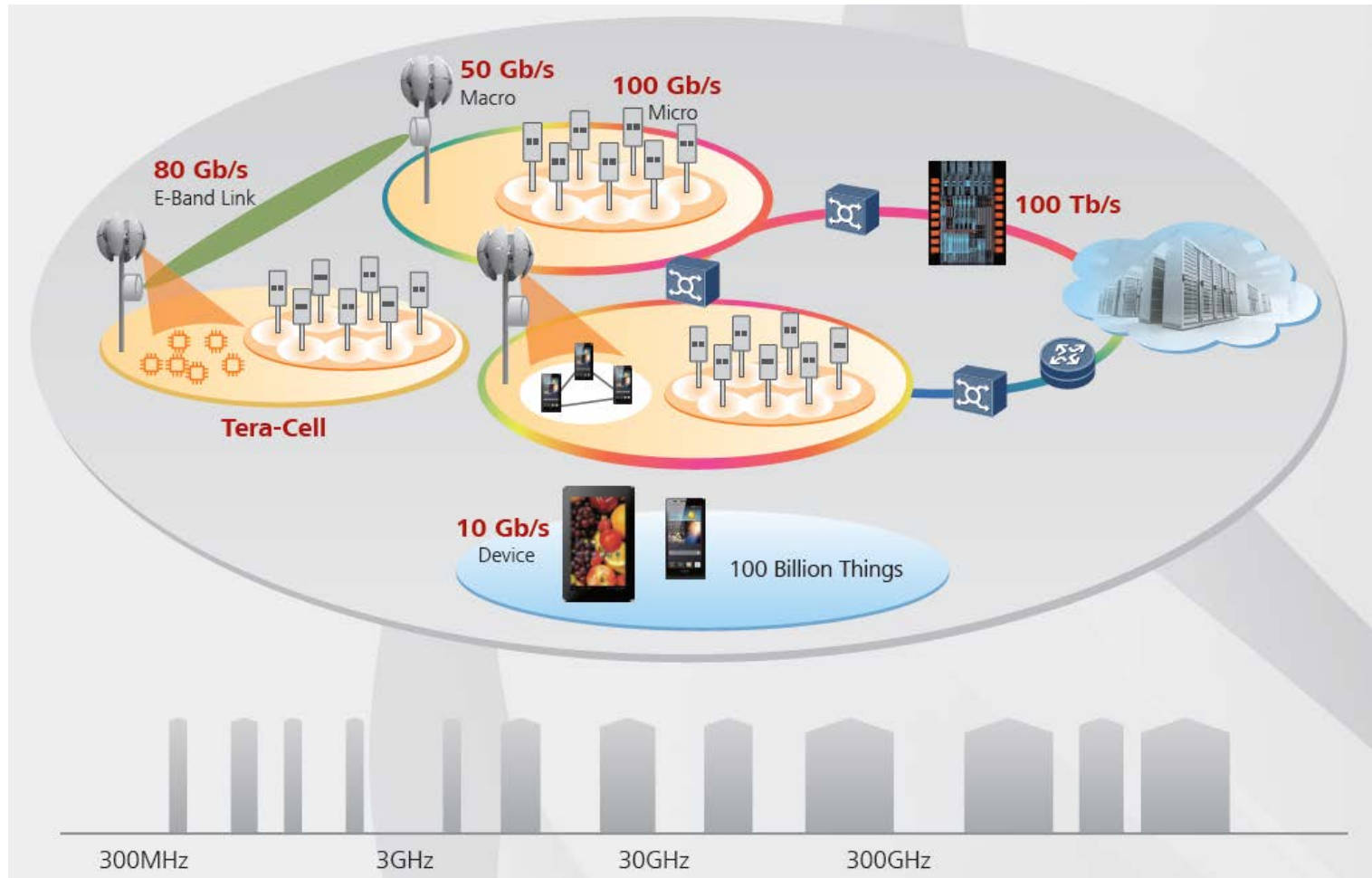
Mobile network based FTTH Case in Thailand



Reproduced from AIS Technology day presentation, 21 May 2014

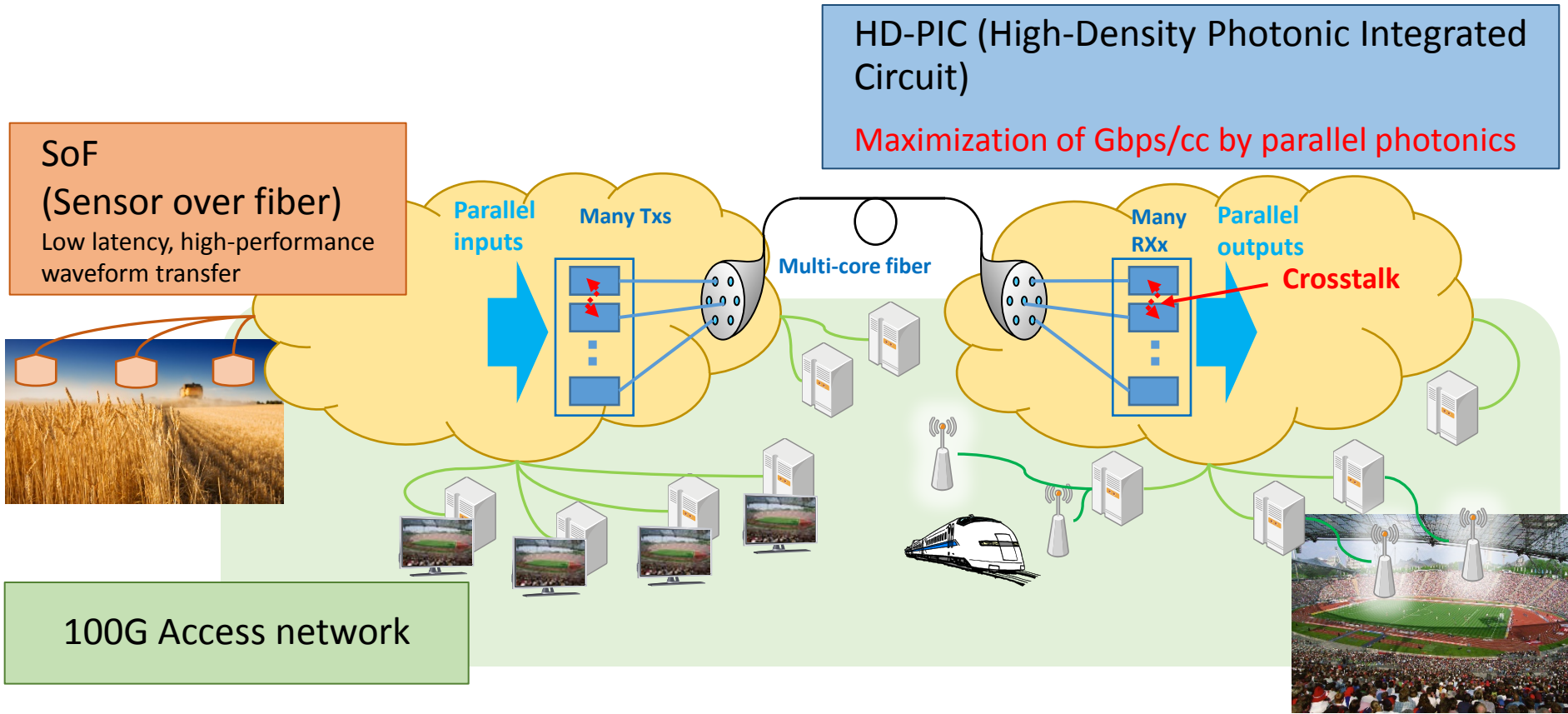
Ways of network evolution and requirements for networks depend on country, region and applications.

5G Network based on transmission media



Huawei whitepaper 5G: A Technology Vision

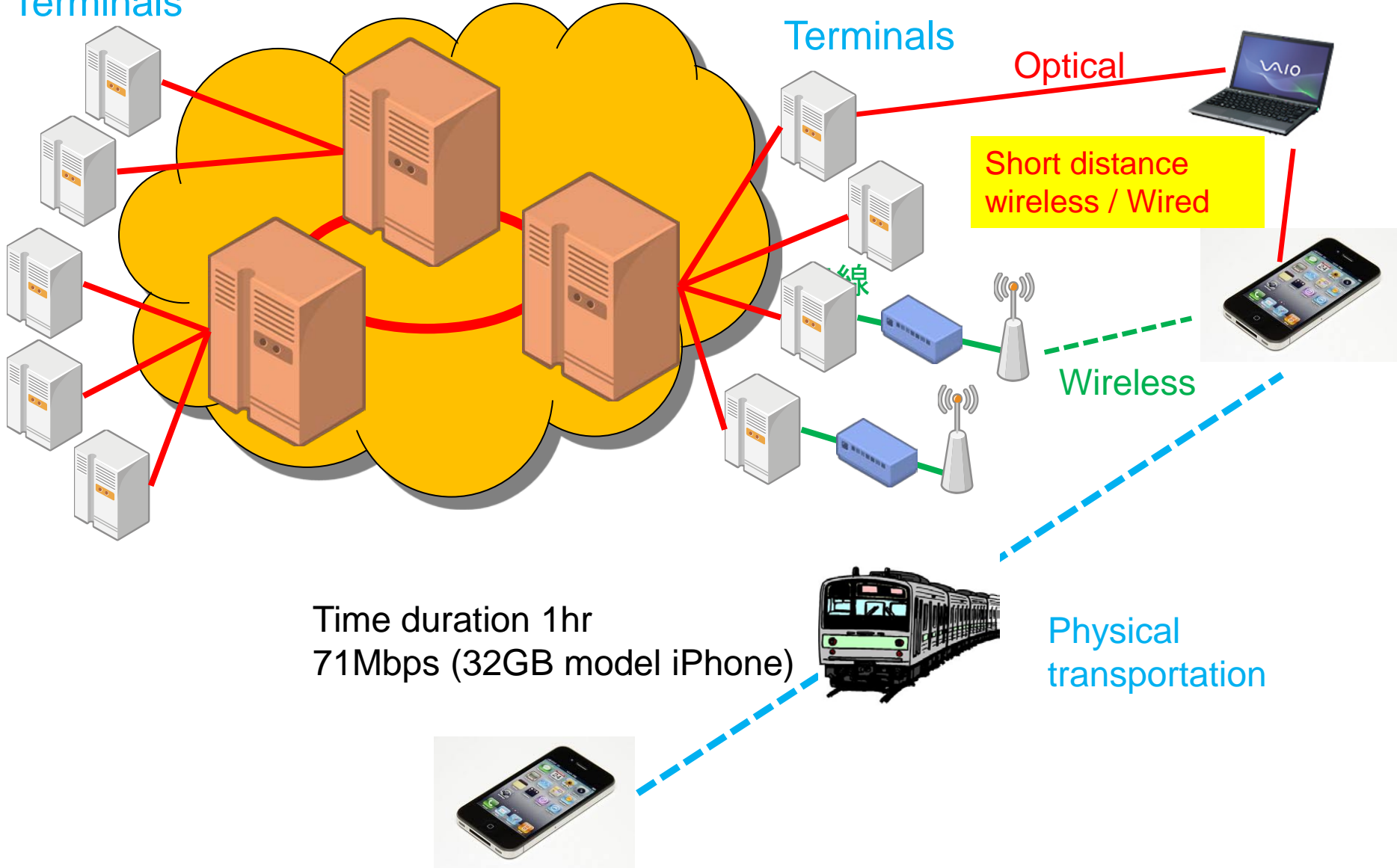
Technical challenges towards DMRC



Variety of transmission media

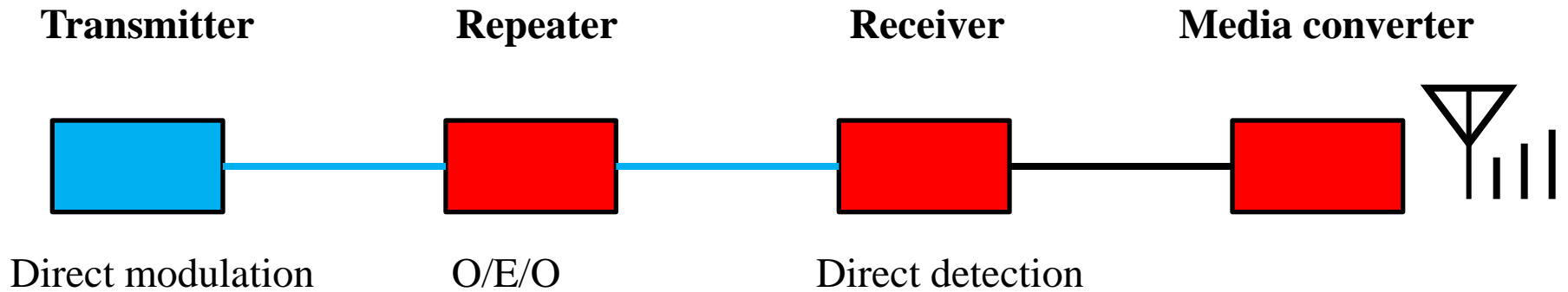
Combinations of optical, wireless and storage

Terminals



Transparency of links

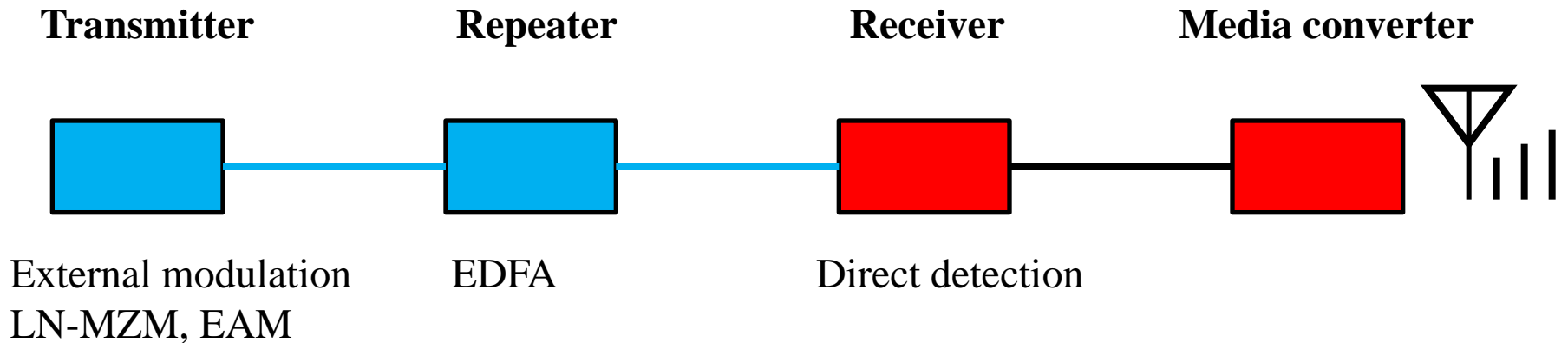
Optical link w/o optical amplifiers



No direct physical waveform links between Tx and Rx

Transparency of links

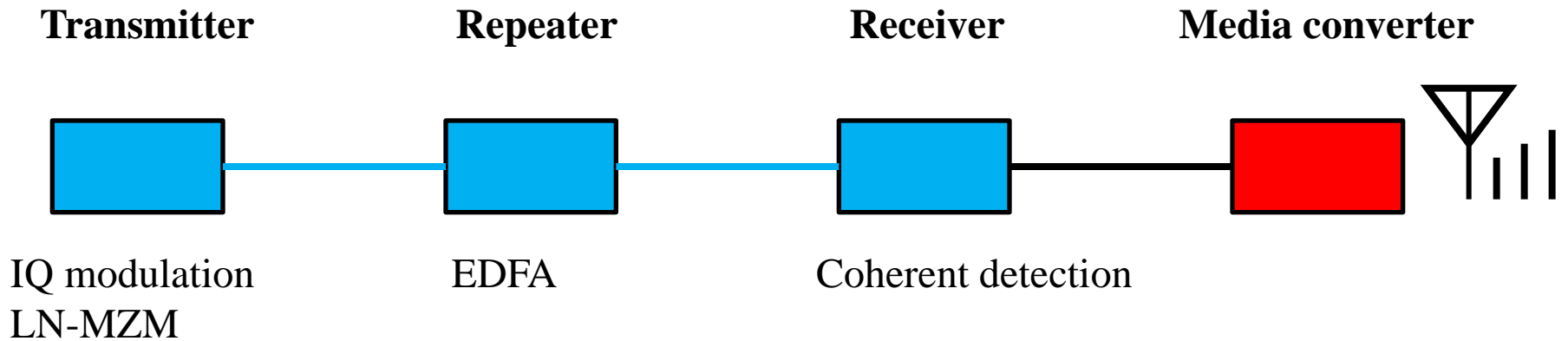
Optical link w/ optical amplifiers (EDFAs)



Tx and Rx have direct physical optical links

Transparency of links

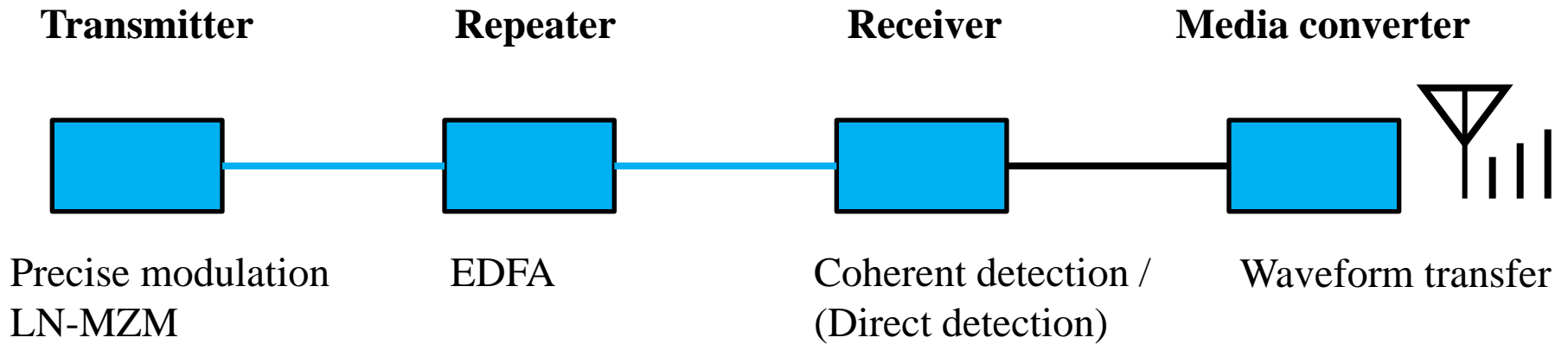
Optical link w/ EDFA and digital coherent



Electric circuits inside receivers are directly and coherently connected to optical links

Transparency of links

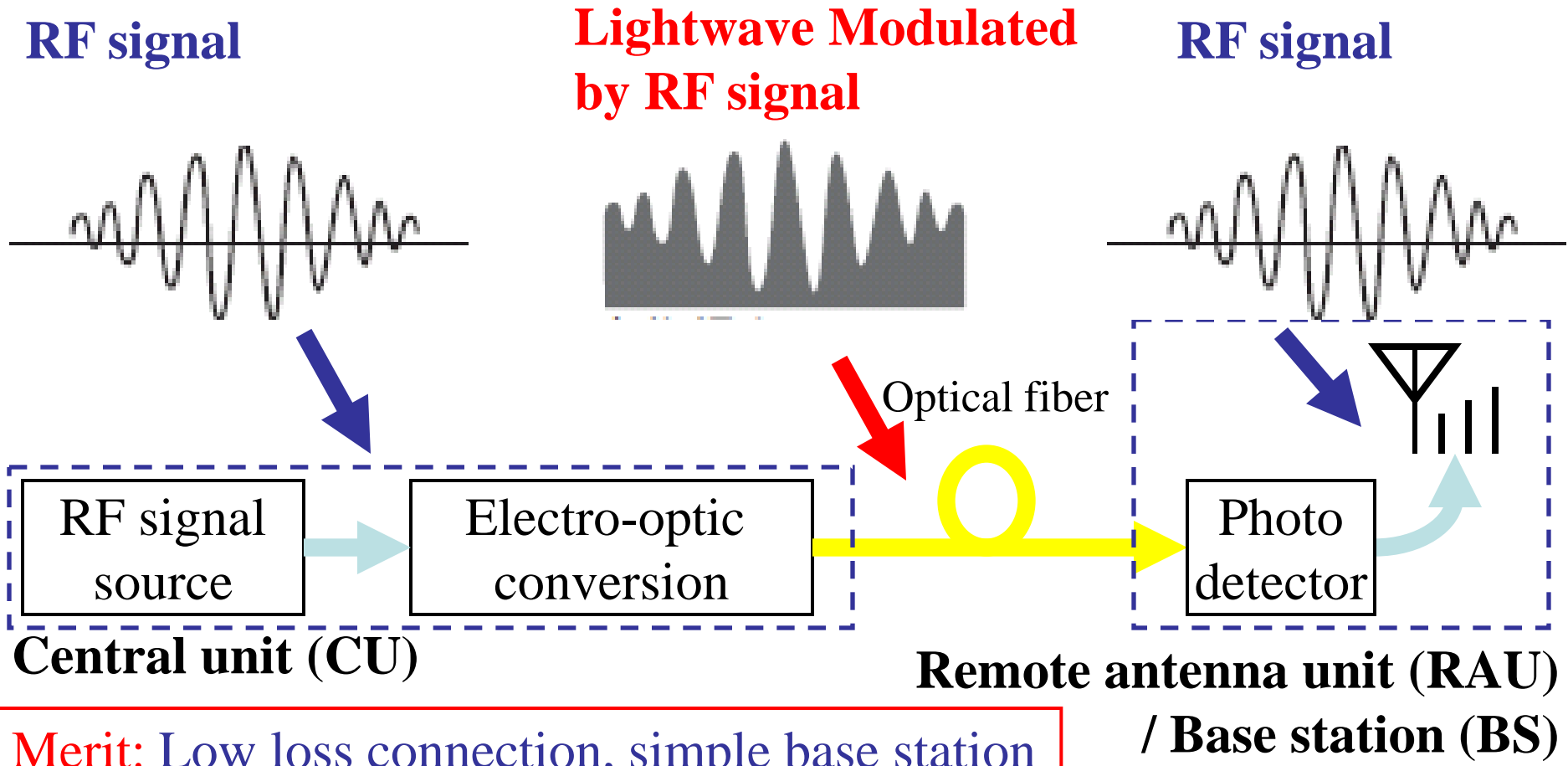
Transparent waveform transfer



Lightwave in fibers are transferred into the are directly via RoF

Basic concept of Radio-on-fiber (RoF) system

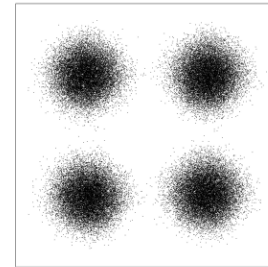
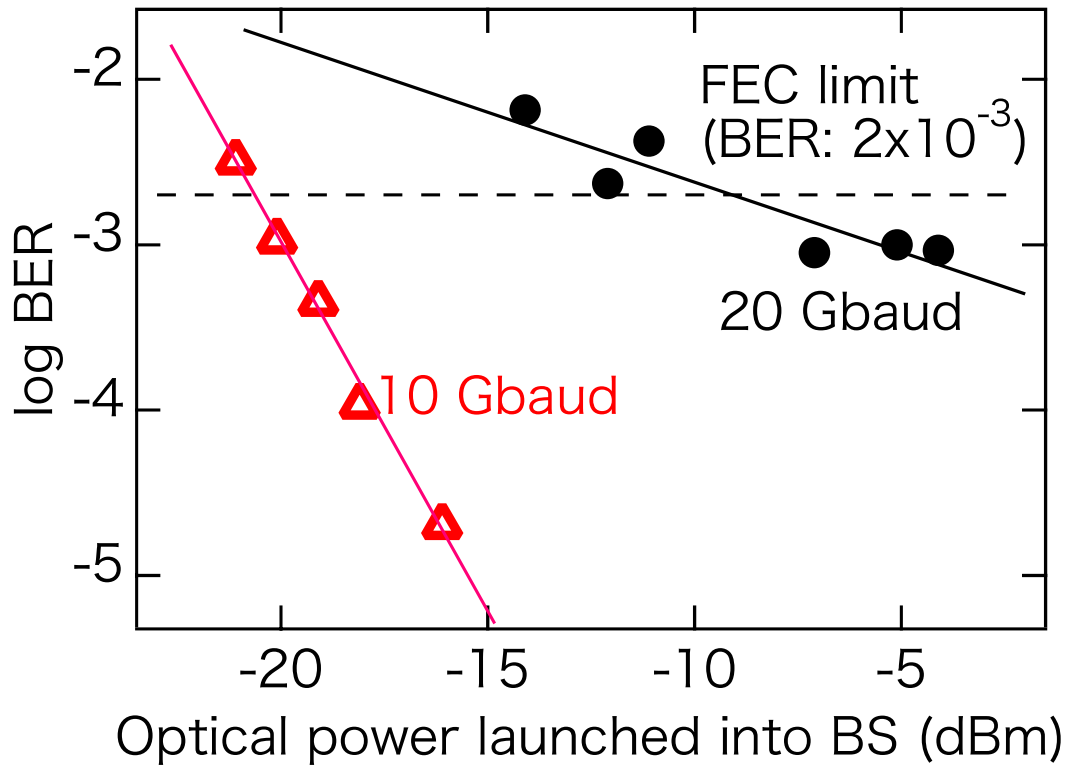
RF signal is transmitted via optical fiber from central to antenna



Merit: Low loss connection, simple base station

Observed BERs (74.4 Gb/s in 20 Gbaud)

A. Kanno, Opt. Express, 20, 29395 (2012).



d

High-Capacity MMW-RoF Backhaul for Railways

1–10-Gb/s signal transport to high-speed trains

Central office
Signal generation and location detection

- Radio-over-Fiber (RoF)-based signal transport
- High-speed O/E and E/O devices
- Flexible/high-speed WSS

Adaptive routing for signal delivery to suitable sites.

Activated cell

WSS-based WDM routing

Activate radio head

WDM-RoF Network

Millimeter-wave high-capacity radio (>1 Gb/s)

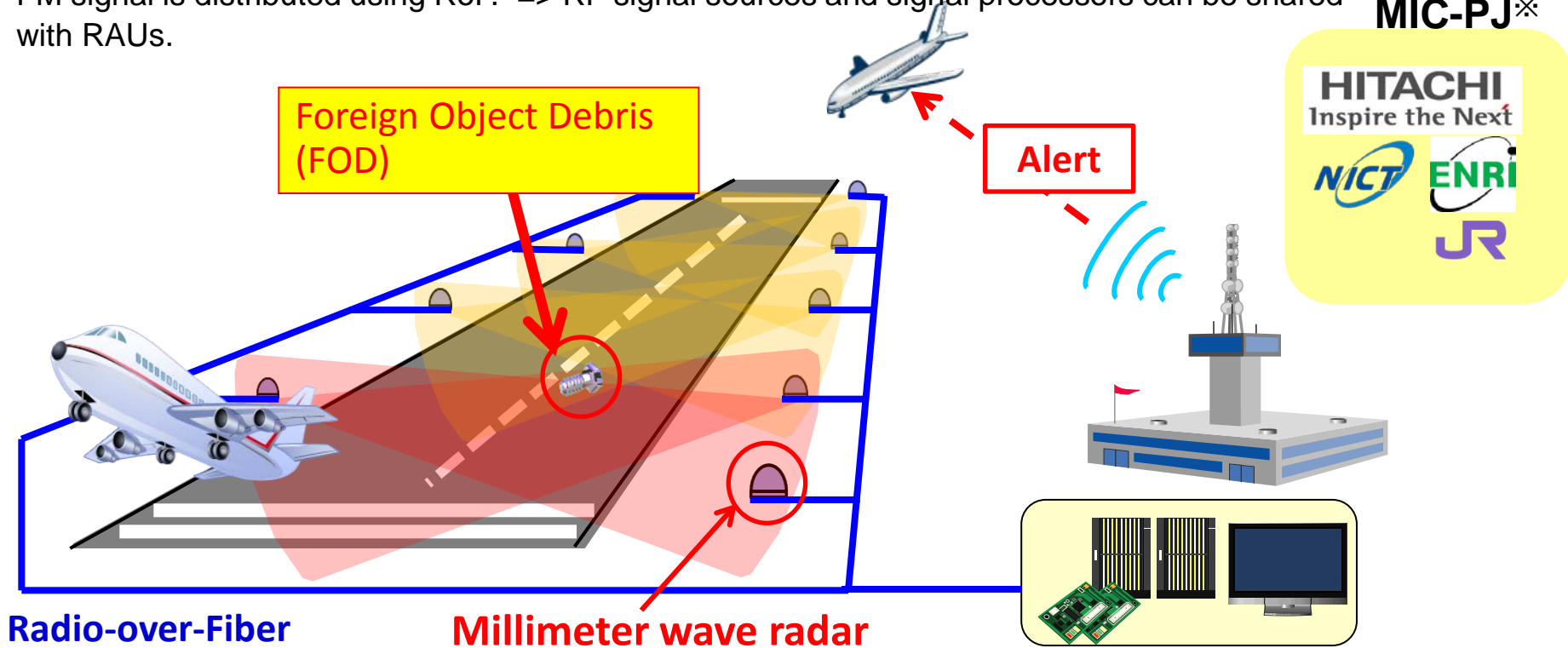


High-speed signal transport and adaptive routing with tracking the location of the trains.

An example of SoF (Sensor on fiber)

FOD Detection using Millimeter-wave RoF for Airport Runways

W-band FM-CW radar with many small RAUs. => Low-cost semiconductor amplifiers can be used.
 FM signal is distributed using RoF. => RF signal sources and signal processors can be shared with RAUs.



MIC-PJ※

HITACHI
Inspire the Next

NICT ENRI
JR

- **Low operation cost**
- **Low radio-wave emission**
- **Scalability:**
 - **High-performance systems for busy airports**
 - **Low-cost systems for local airports**
- **Agile scan capability**

※This research was conducted as part of the project entitled “Research and development of high-precision imaging technology using 90 GHz band linear cells,” with funding from “Research and Development to Expand Radio Frequency Resources” supported by the Ministry of Internal Affairs and Communications, Japan.

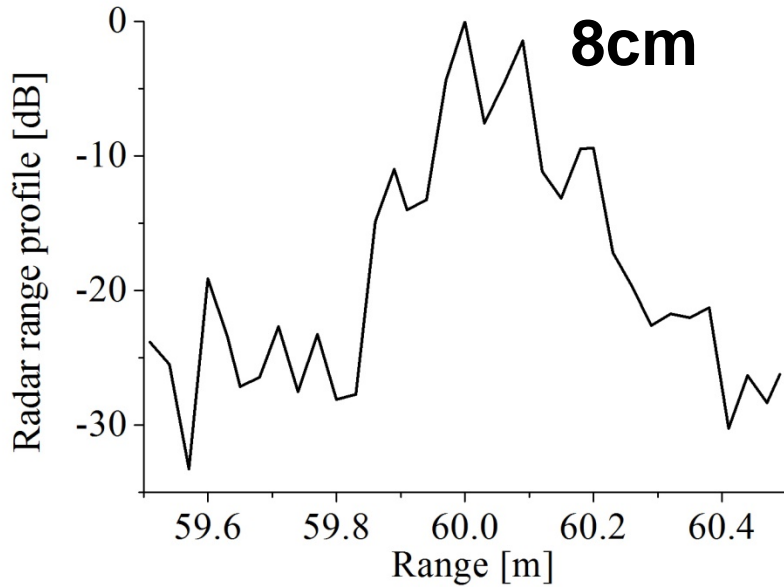


FOD Experiment @CU Saraburi

2015 July @Churalonkong University Saraburi
Campus

CU,NiCT,ENRI and Hitachi Ltd.

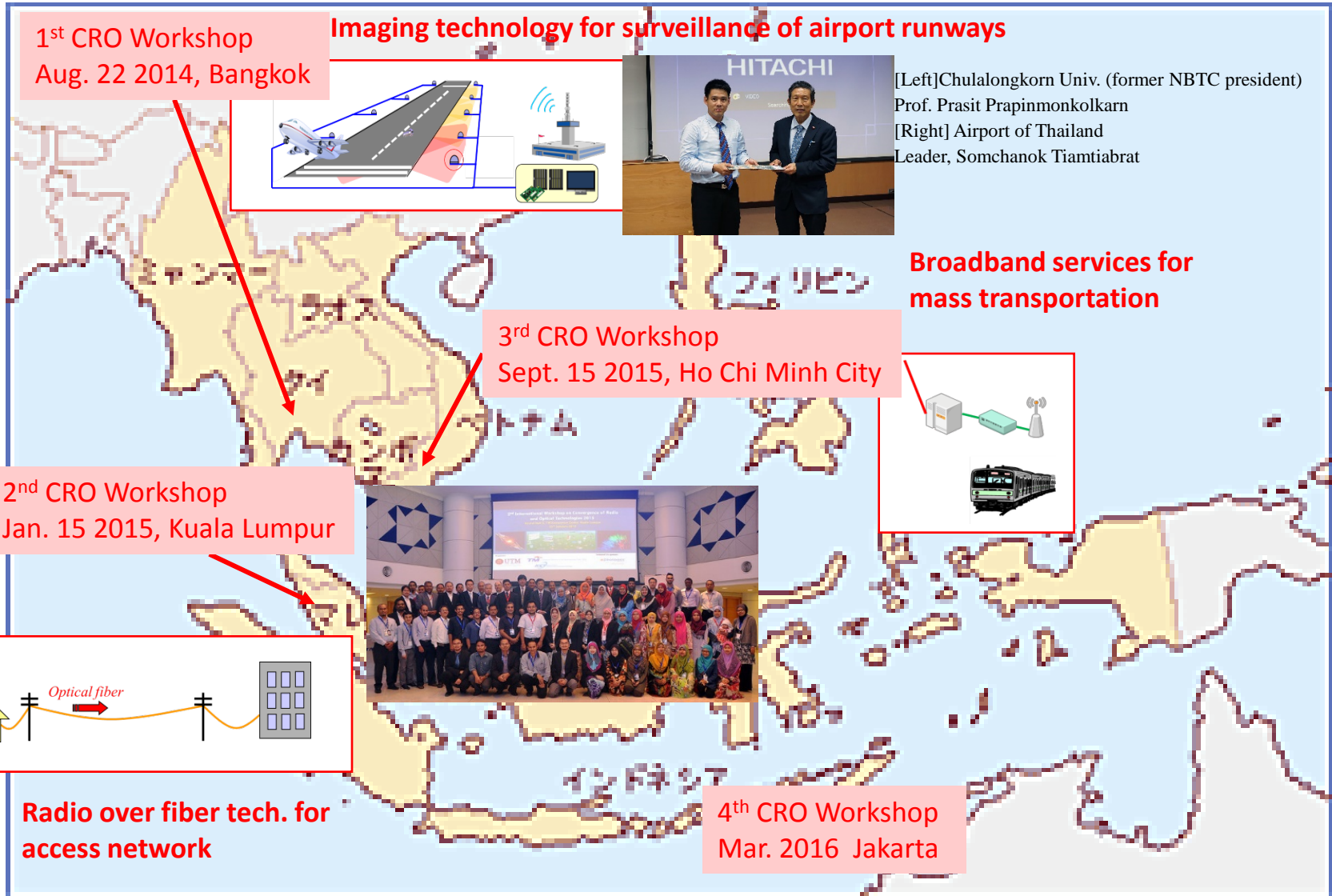
Range Resolution



CRO Workshop


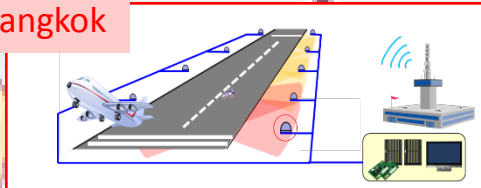
(Workshop on Convergence of radio and optical technologies)

The workshop focuses on hardware-oriented technology in every a half year.




1st CRO Workshop
Aug. 22 2014, Bangkok

Imaging technology for surveillance of airport runways

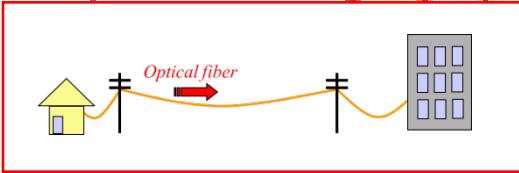


[Left] Chulalongkorn Univ. (former NBTC president)
Prof. Prasit Prapinmonkolkarn
[Right] Airport of Thailand
Leader, Somchanok Tiamtiabrat

2nd CRO Workshop
Jan. 15 2015, Kuala Lumpur

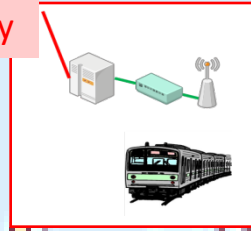


Radio over fiber tech. for access network



3rd CRO Workshop
Sept. 15 2015, Ho Chi Minh City

Broadband services for mass transportation



4th CRO Workshop
Mar. 2016 Jakarta

Collaborations with ASEAN countries

Lightwave devices laboratory at NICT

Thailand

Chulalongkorn Univ. (CU)
Chiang-Mai Univ. (CMU)
Suranaree Univ. Technol. (SUT)
Airport of Thailand (AOT)

Integrated photonic circuits / FOD radar
Techniques for ICT measurements
Photonic signal processing
Application of imaging tech. to airport

Vietnam

Post&Telecom Institute of Technol.
Hanoi Univ. Science and Technol.

Application of RoF to transport
Application of RoF to transport

Malaysia

Telekom Malaysia R&D
Universiti Teknologi Malaysia

RoF for access network
Stable RoF signal generation

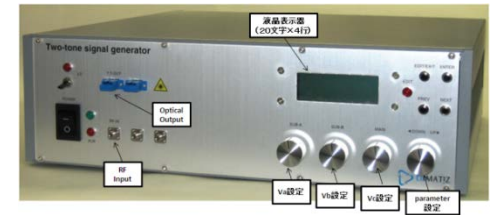
Singapore

Institute of Infocomm Research (I2R) Optical switch for datacom

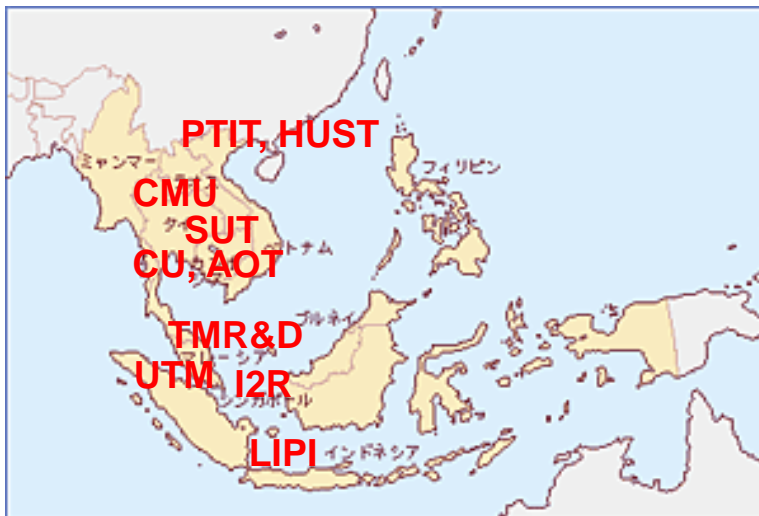
Indonesia

Institute Technology of Science (LIPI) Sensing by RoF

Frequency response meas. system



ASEAN countries has many big industries of photonics components.



Standardization activities in APT
(APT: Asia Pacific Telecommunity)

CMU TMR&D

ASTAP (APT Standardization Program)

Millimeter-wave RoF, ICT measurements

AWG (APT Wireless Group)

Fixed wireless system

Summary on DMRC including SoF

- Examples of possible issues:
 - Digital or analogue waveform transmission can mitigate (incl. Radio-over-Fiber)
 - Investigation on variety of requirements in ASEAN region
- Possible applications:
 - Resilient network
 - Broadband links for high-speed train
 - Safety for public infrastructures (airport, train, etc.)