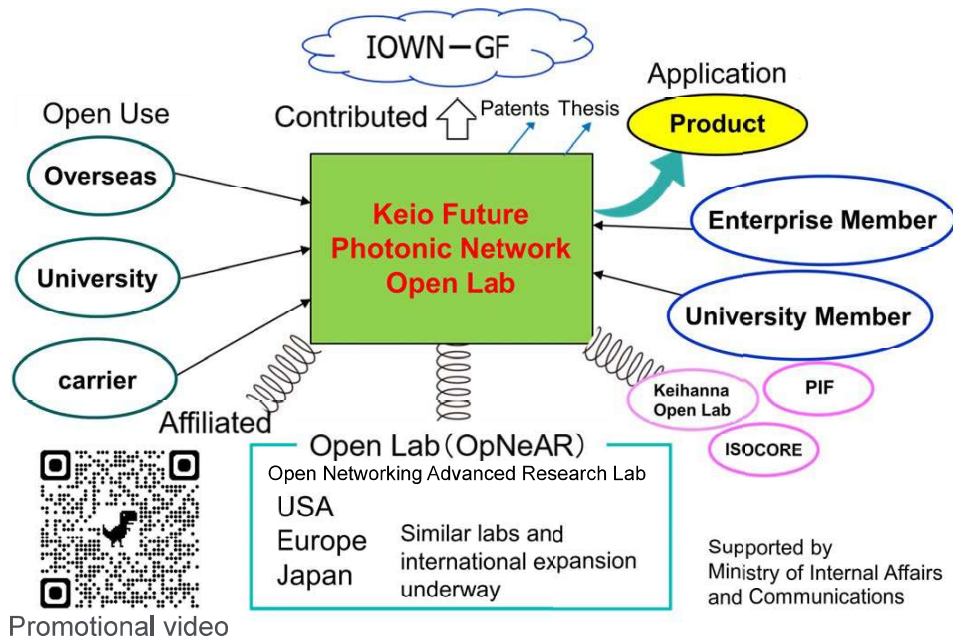


### Future Photonic Network Open Laboratory

#### Features of Open Lab

- **400 Gbps** (initially 10 Gbps) Optical Access Systems (PON/OLT/ONU) will be introduced.
- For the first time in the world, **Hollow Core Fiber (HCF)** will be available!
- Local 5G system has been installed.
- We are working with UTD (University of Texas at Dallas) and UCL (University College London) to create a global open lab.

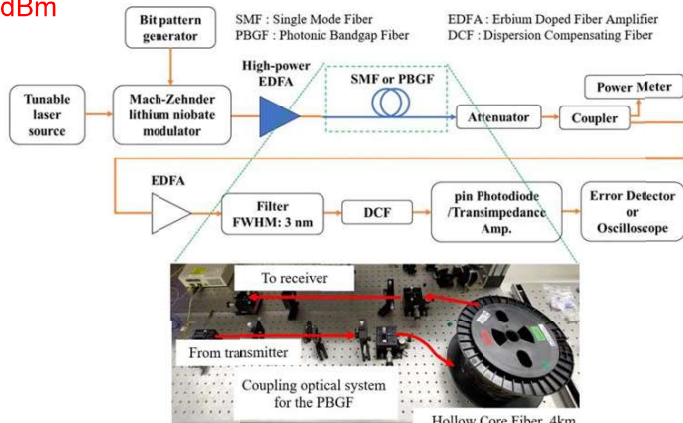


If you are interested, please contact [Prof. Yamanaka](#) or [Prof. Tsuda](#).

### Open Lab Activities

Keio Future Photonic Network Open Lab is conducting research on new access networks using Hollow Core Fiber.

**32Gbit/s IM-DD transmission using a PBGF-HCF was successfully demonstrated with a high launch power of +30.8 dBm**

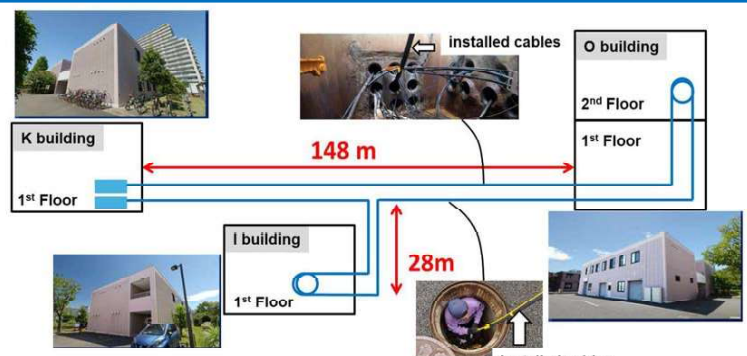


High Power Transmission Using HCF Aiming at Hyper Branching PON

Contact us

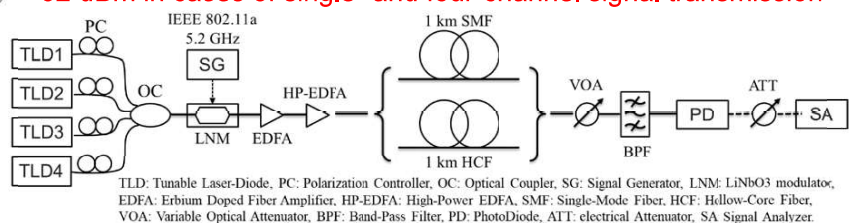
Mail : [yamanaka@keio.jp](mailto:yamanaka@keio.jp)

URL : <https://www.yamanaka.ics.keio.ac.jp/>



HCF installed in K2 campus

**HCF indicated no EVM penalty even at input signal power up to 32 dBm in cases of single- and four-channel signal transmission**



Analog RoF Signal Transmission Using HCF

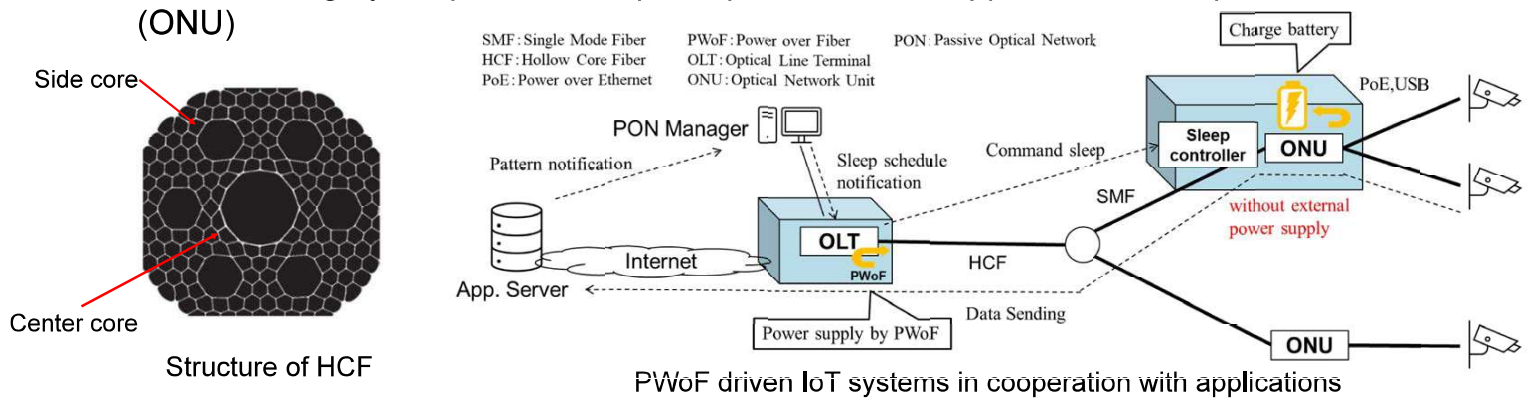
Mail : [tsuda@elec.keio.ac.jp](mailto:tsuda@elec.keio.ac.jp)

URL : <https://www.tsuda.elec.keio.ac.jp/>

This research includes the results of "Research and Development of Advanced Optical Transmission Technologies Contributing to Green Society (JPMI00316)" conducted by the Ministry of Internal Affairs and Communications.

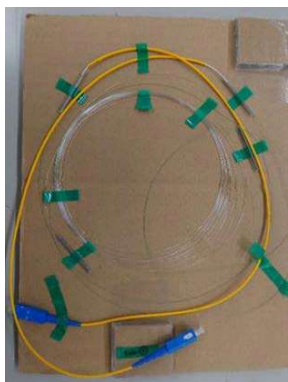
### Realization of location free IoT system driven by Power over Fiber using Hollow Core Fiber

- IoT networks that operate without an external power source must be built to realize a smart society ⇒ **Power over fiber (PWoF)** is expected to transmit light for communication and power supply by one optical fiber
- In order to accommodate a large number of IoT devices with Passive Optical Network (PON), the following two points are being considered
  - High Power Transmission Using Hollow Core Fiber (HCF)
  - Power saving by cooperative deep sleep between IoT application and Optical Network Unit (ONU)

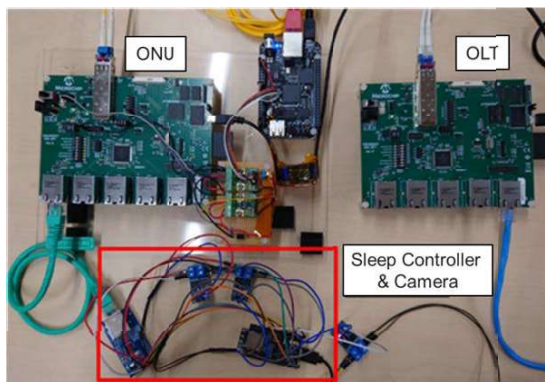


### Prototype IoT system driven by Power over Fiber using Hollow Core Fiber

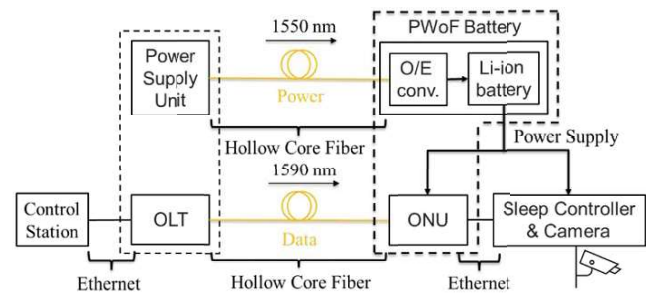
Created an experimental system with the goal of driving an IoT system using only PWoF



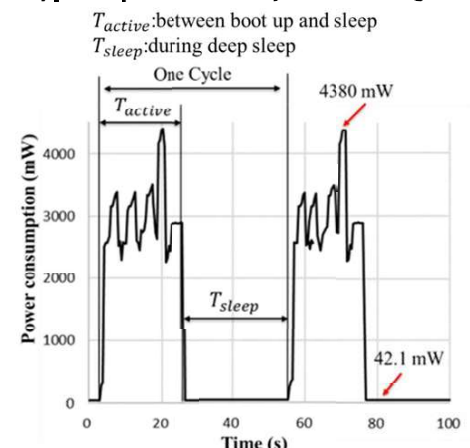
10 m Hollow Core Fiber with SC connector



Prototype ONU, OLT, sleep controller, and IoT application



Prototype experimental system configuration



Experimental result of power consumption in the ONU and Camera

- We have demonstrated an IoT + ONU system that can be driven at 42.1 mW during deep sleep
- In the future, We will study protocol, faster ONU wake-up time, adaptive sleep time adjustment methods, etc

This research includes the results of "Research and Development of Advanced Optical Transmission Technologies Contributing to Green Society (JPMI00316)" conducted by the Ministry of Internal Affairs and Communications.

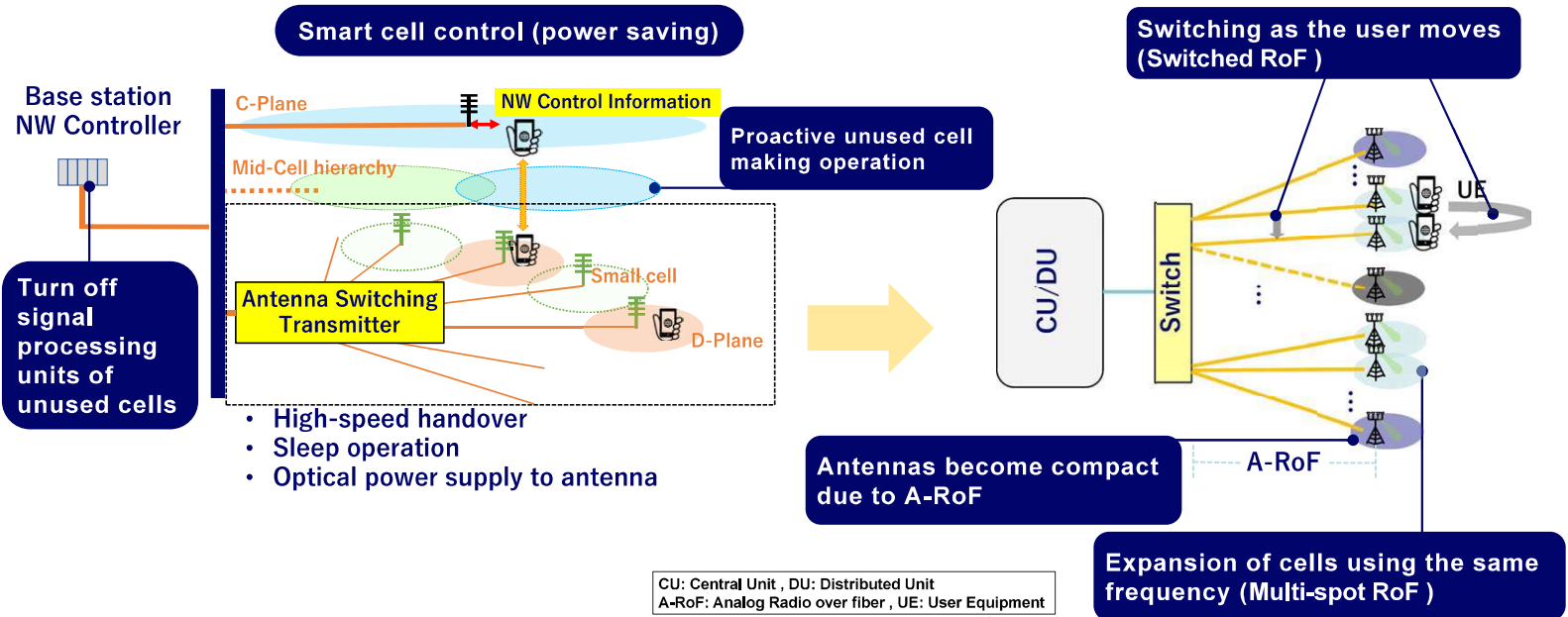
# Multi-spot switched RoF toward Smart Mobile Fronthaul using Hollow Core Fiber

Yamanaka Laboratory, Keio University, Japan

Power-saving B5G wireless base station system with “analog” radio over fiber technology using air-hole core (hollow-core) fibers

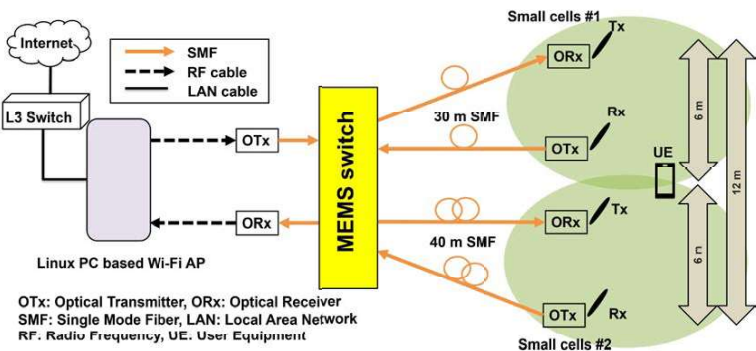
Hierarchical cell structure

Details at the bottom of the hierarchy

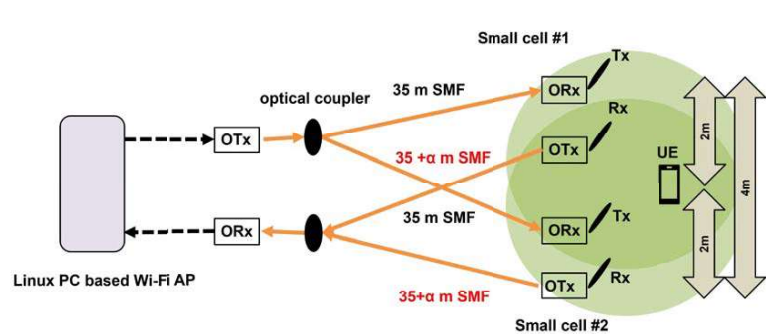


## Basic experiments for “Switched RoF System” and “Multi-spot RoF System” using Linux PC-based WiFi AP as a base station

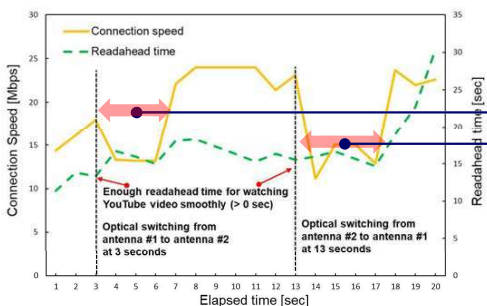
Switched RoF with optical switch inserted (left) and multi-spot RoF with coupler inserted (right)



Experimental setup (Switched RoF System)



Experimental setup (Multi-spot RoF System)



Connection speed and Readahead time while watching YouTube video

Uplink throughput [Mbps]

Count	35m-35m	35m-45m	35m-55m	35m-1km	35m-10km
1	101.0	110.0	108.0	-	-
2	107.0	96.9	104.0	-	-
3	92.0	116.0	97.6	-	-
Avg.	100.0	107.6	103.2	-	-

Communication is not possible when the difference is large.

This work was supported in part by the National Institute of Information and Communications Technology (NICT) (JPJ012368C07101). This research was conducted at the Keio Future Photonic Network Open Lab.

# Autonomous Driving Platform for Realizing Cyber Physical System (CPS) through All-Photonic Network and Server Collaboration

Yamanaka Laboratory, Keio University, Japan

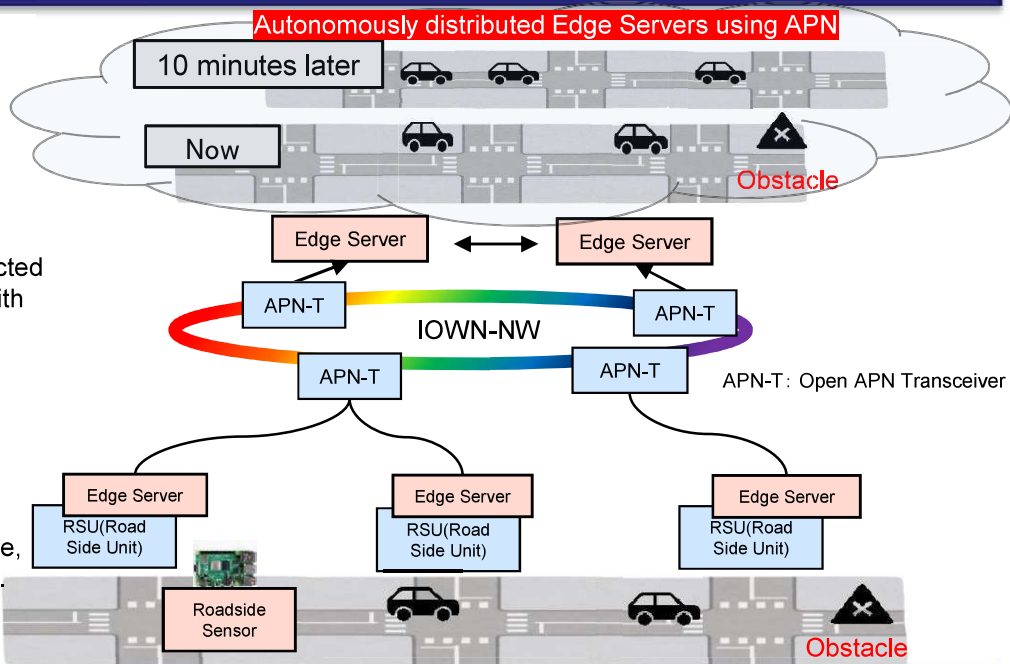
## CPS(Cyber-Physical System)

◆ **CPS (Cyber-Physical System)**  
A system that collects various data from the **physical space** through sensors, analyzes and processes it in the **cyber space** to create knowledge, and then feeds the generated information **back into the physical space**.

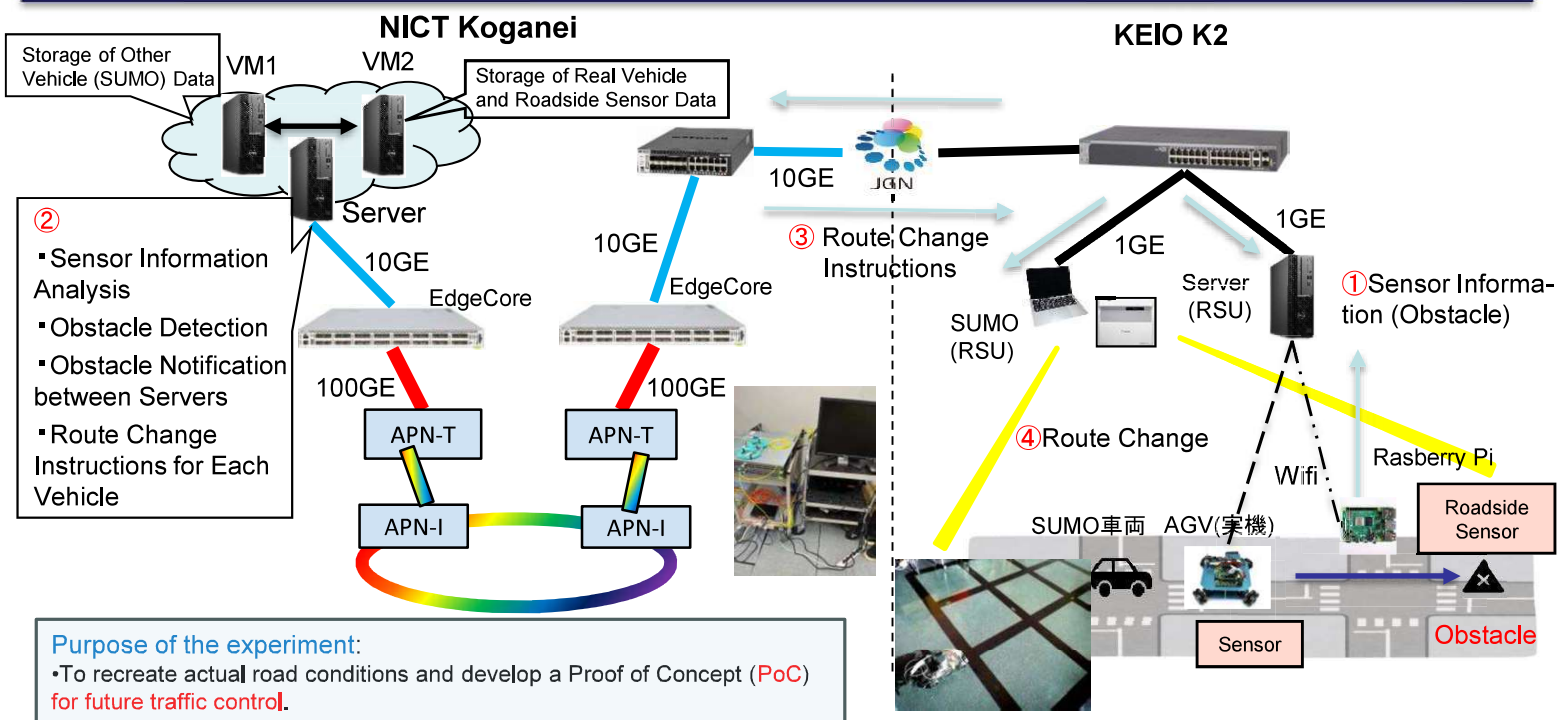
◆ **APN (All-Photonic Network)**  
Data transmission and processing are conducted using **optical networks**. For communication with autonomous vehicles, optical network communication is carried out via **RSUs (Roadside Units)**.

- Advantages:**
- High-speed transmission
  - Low latency
  - Large capacity
- Collaboration between servers is also possible, allowing real-time sharing of traffic conditions.

Future Prediction is Possible through Utilizing CPS



## Experiment Overview



**Purpose of the experiment:**

- To recreate actual road conditions and develop a Proof of Concept (PoC) for future traffic control.
- To coordinate traffic control using autonomously distributed edge servers.

**Researcher's Name**  
**Contact us**

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