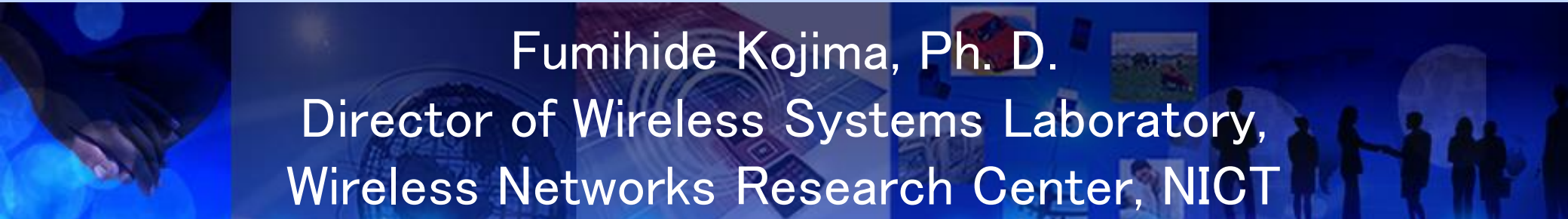
2nd Visions for Future Communications Summit
November 27, 2019

NICT's R&D and Promotion activities on the terrestrial radio system/network designs toward the future



Fumihide Kojima, Ph. D.
Director of Wireless Systems Laboratory,
Wireless Networks Research Center, NICT

The sole national research institute in the field of ICT in Japan

- Cooperating with and supporting industry and academia
- Three roles: Research institute, Research funding agency, Public service agency

Collaboration with Industry - Academia – Government

- Creating new value through ICT
- Building a new ICT society

Public Services:
- Japan Standard Time
- Space Weather Forecast
- Wireless Equipment Testing & Calibration
- Cybersecurity Training

Personnel: ~ 1100
- Researchers: ~ 530
- PhDs: ~ 460

NICT HQ @Koganei, Tokyo

R&D carried out by NICT's researchers

Support for R&D in industry and academia Promotion of ICT industry

Growth of Japanese economy

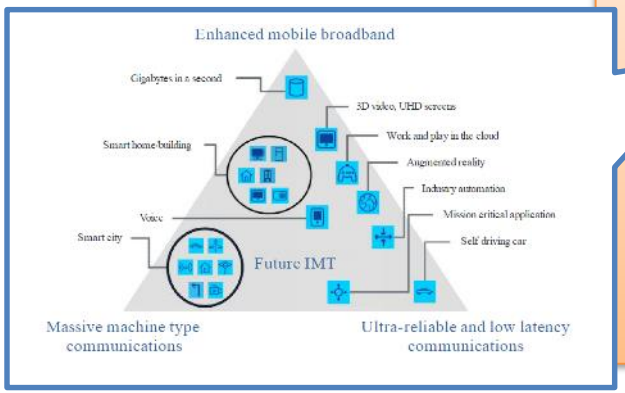
Safety and security for a more convenient life

Contribution to solve major problems of the global community

National ICT Policy

Challenge to provide future radio communication systems

- The effective radio resource utility to satisfy the complicated and diversified demands on 5G and B5G has the highest priority in the NICT's R&D activities on the terrestrial radio communication technologies
  - R&D to provide required Availability and Connectivity for the 5G/B5G network and services:
    - 5G/B5G-Availability by introducing the private microcell structure
    - 5G/B5G-Connectivity by the low-latency and massive-connection access
  - Are potentially supported by auxiliary technologies for further enhancements



R&D on 5G/B5G to satisfy Complicated & Diversified demands by:

- Availability: Private microcell
- Connectivity: Low-latency & massive connection

Supporting Technologies: Wireless grid, Flexible factory, Enhanced reliability

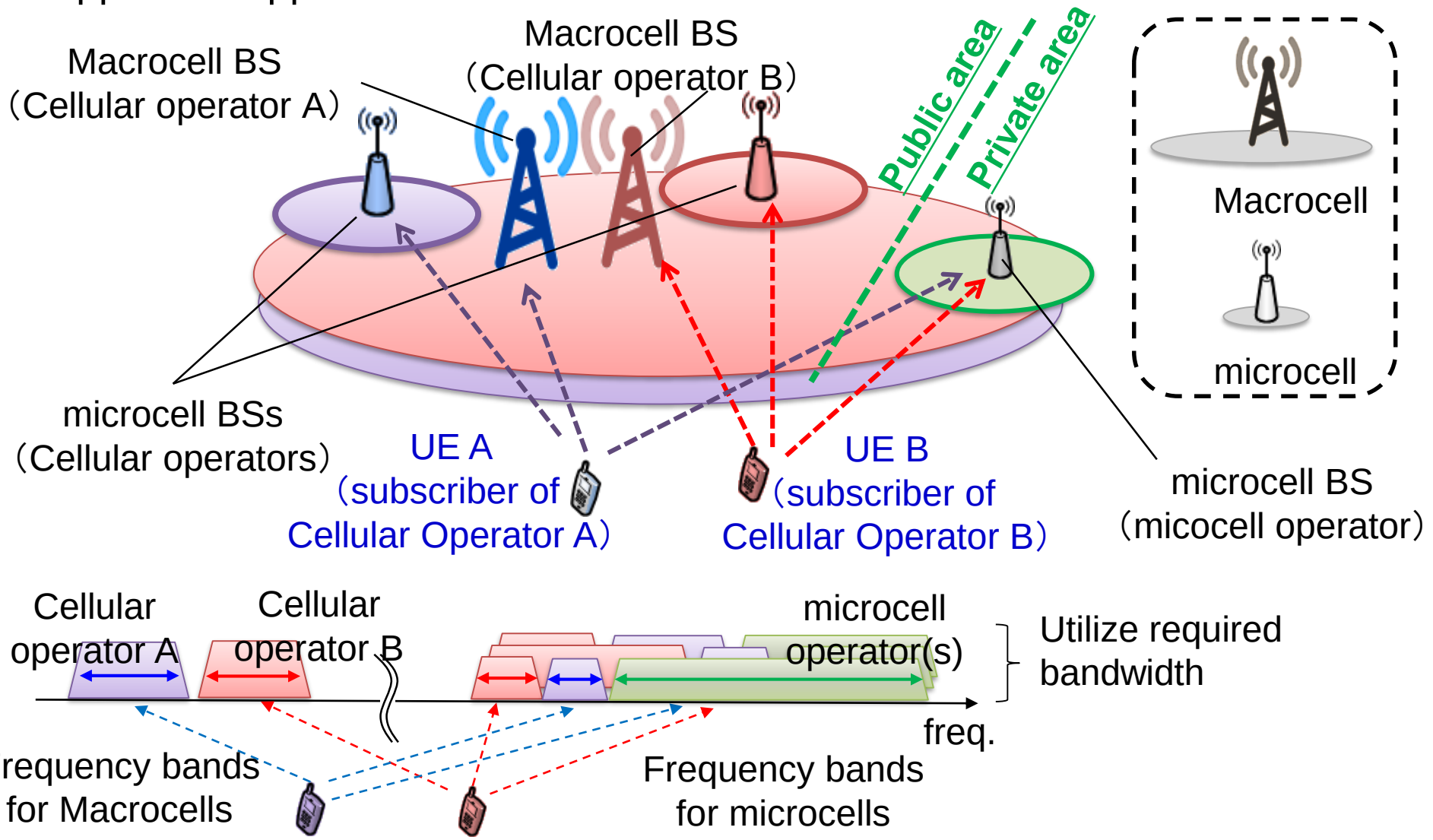
Proof tests, Standardization

Radio resource utilization

Ref. : ITU-R M.2083 : IMT Vision - "Framework and overall objectives of the future development of IMT for 2020 and beyond"

Availability (1): Concept of private microcells

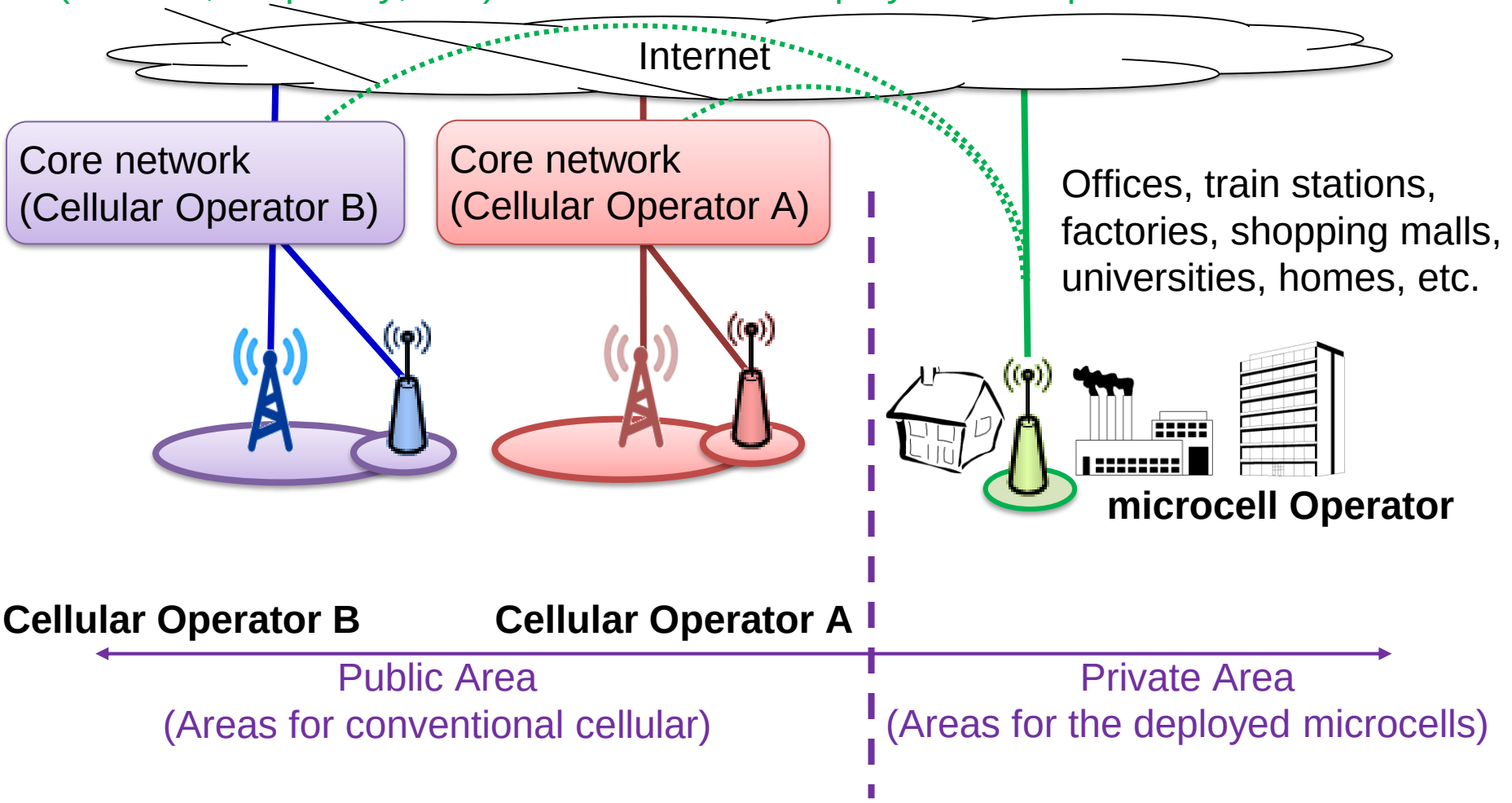
- NICT has employed the private area that is realized by microcell structure to support 5G applications



Availability (2): Information exchange among operators

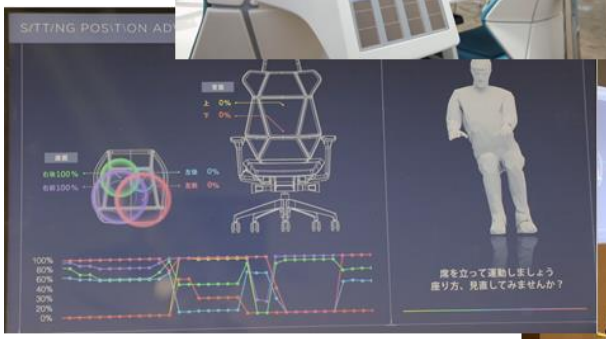
- NICT has studied on the suitable information exchange interface among the microcell operators and cellular operators

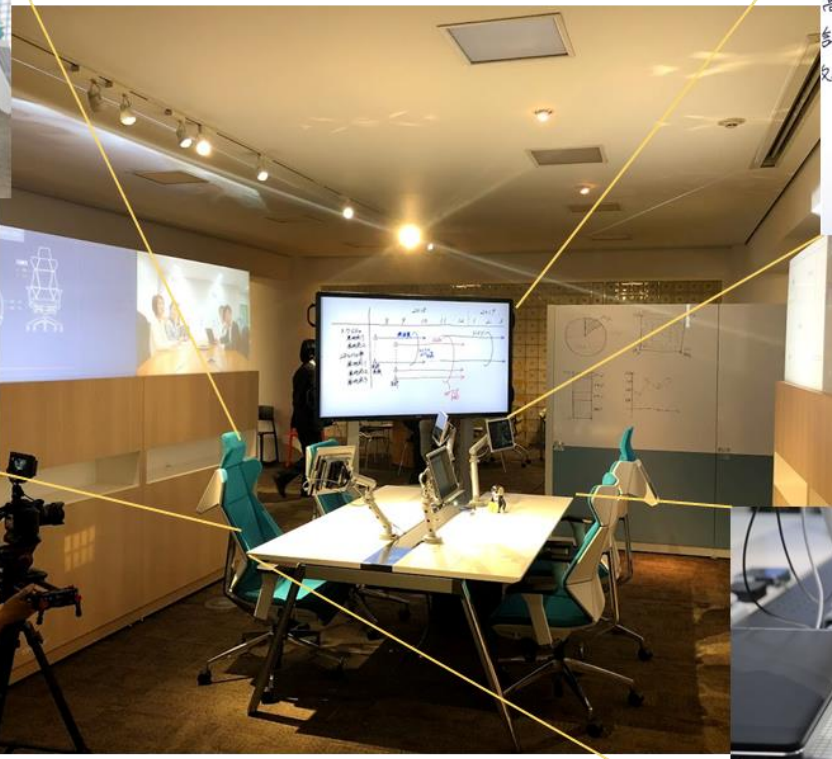
Necessary interface to provide operational information
(location, frequency, etc.) for of microcells deployed in the private area

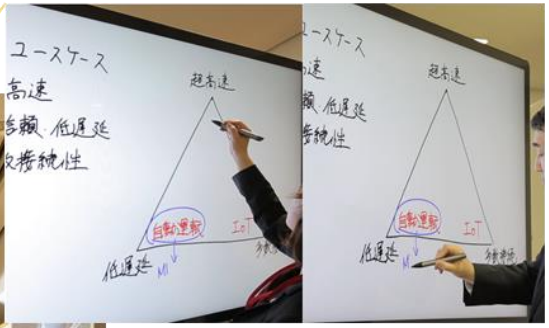


Availability (3): Smart Office Proof Tests

- Proof tests confirm that the smart office environments are effectively realized by introducing 5G/B5G system capabilities







mMTC 2.4GHz

Smart chair

Embed sensors for posture detection with high spec solar panel for battery less operation

※ Bluetooth Low Energy (BLE) is used for smart chair instead of standardized 5G system

URLLC 3.7GHz/28GHz

E-Whiteboard

Smooth communications with remote sites by sharing real-time drawings

eMBB 3.7GHz

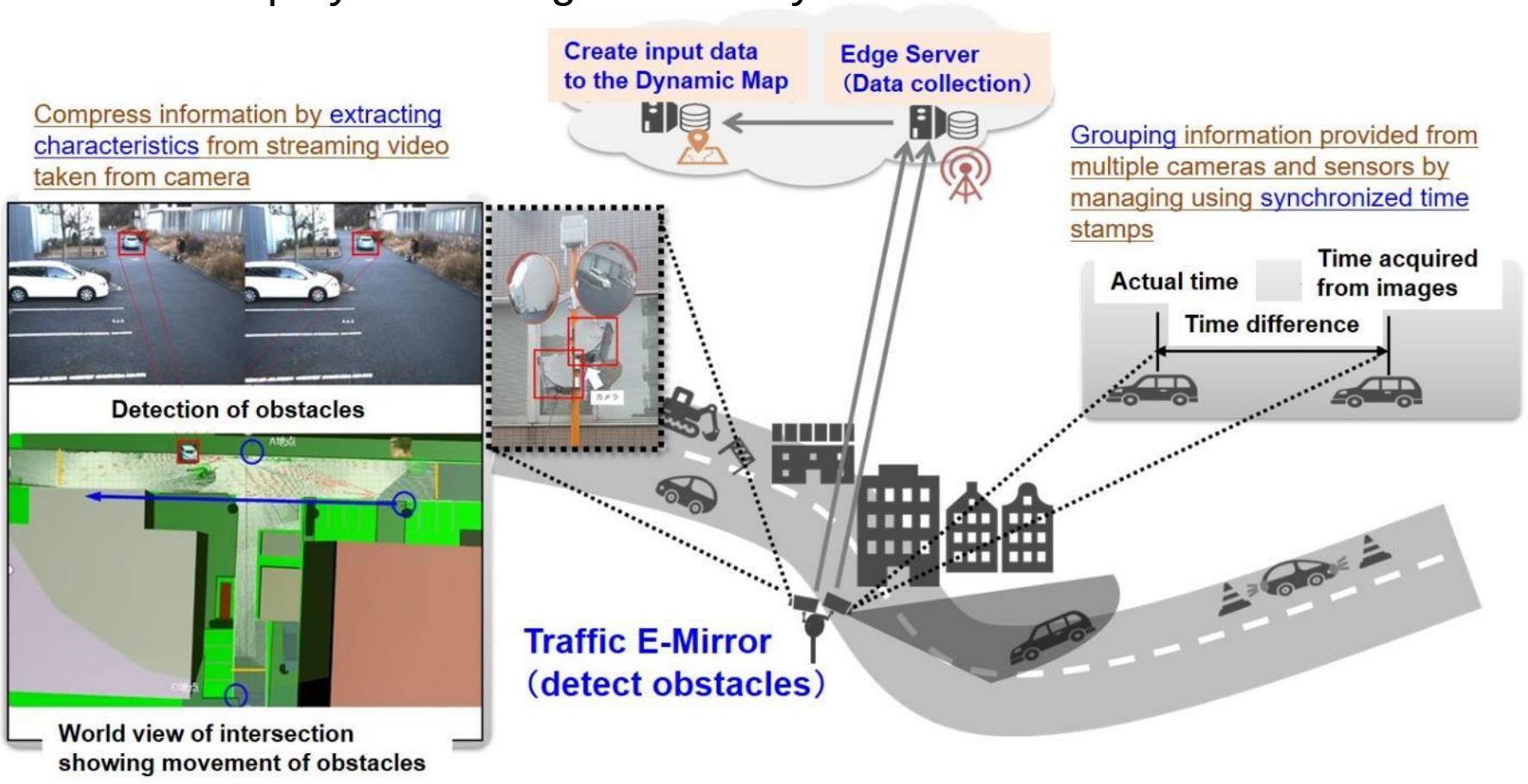
Smart table

Allows devices just on the table to communicate Hence, enables wireless communications without interference from other tables

* 5G systems for eMBB and URLLC are emulated with currently standardized specifications adapted for frequency bands assumed for 5G

Availability (4): ITS Proof Tests

- Proposed microcell structure is evaluated in ITS proof tests that employ the developed traffic e-mirror
  - Secure safety in non-line-of-sight spots
  - Road sensors recognize traffic environment in real-time
  - Flexible deployment using wireless systems

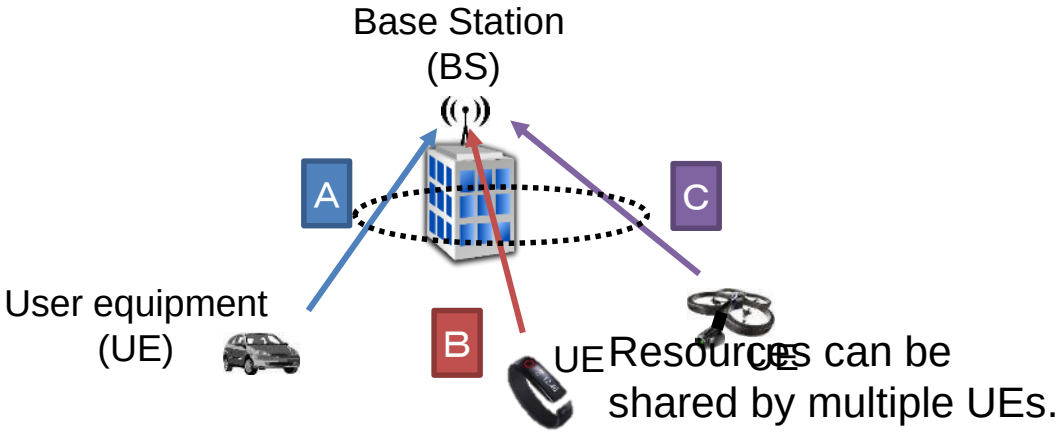


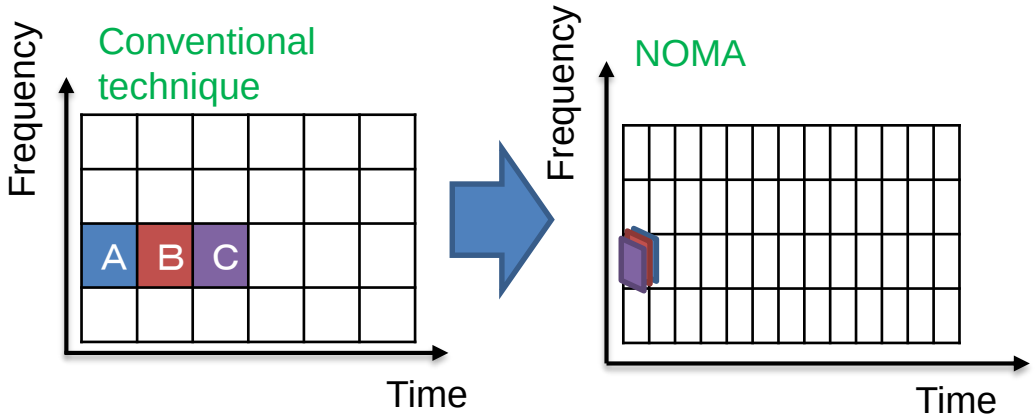
Connectivity (1): The access control scheme, “STABLE”

- NICT has proposed the new access control scheme STABLE (Simultaneous Transmission Access Boosting ultra-Low-latEncy) that enables massive connection and low-latency

Massive connection

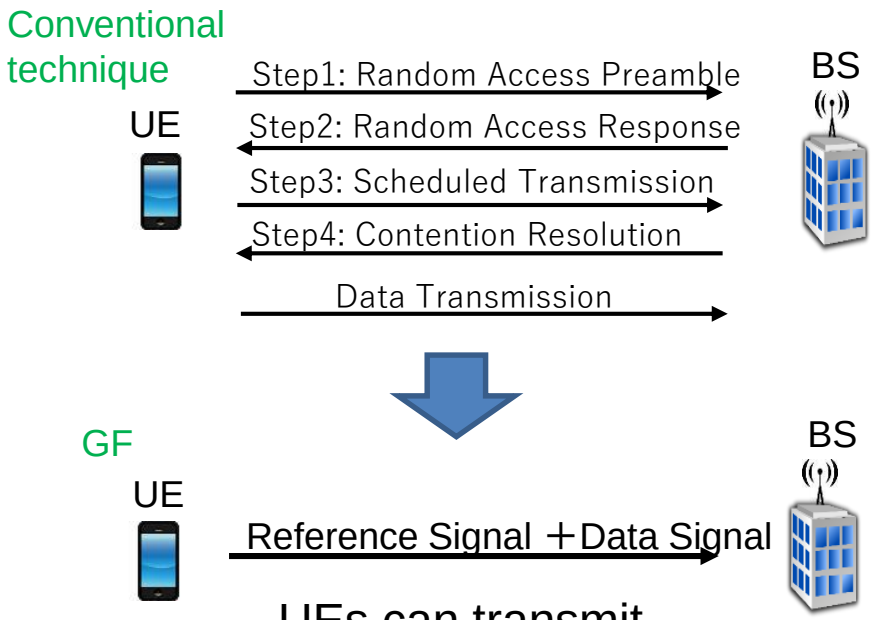
➢ Non-Orthogonal Multiple Access(NOMA)





Low Latency

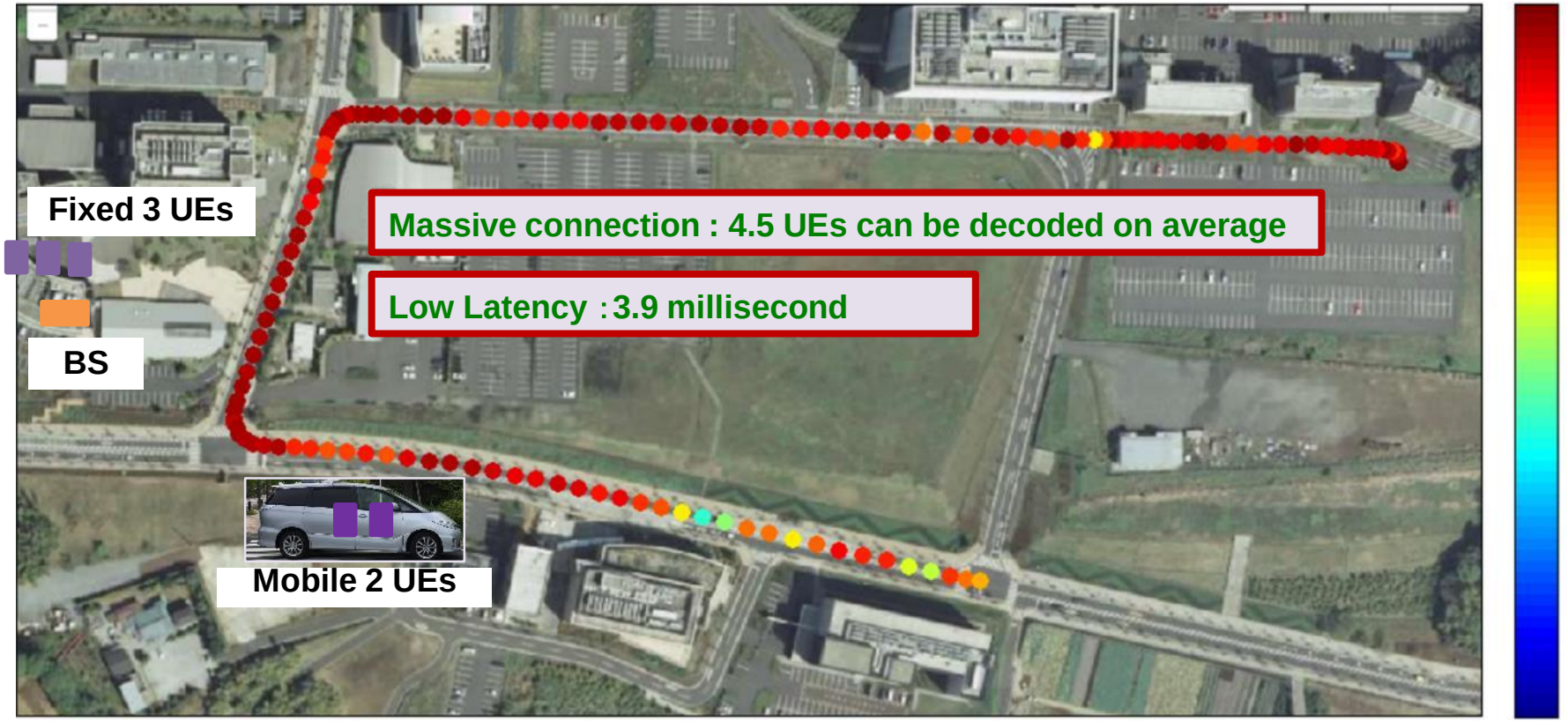
➢ Grant Free (GF)



UEs can transmit signals without grant.

Connectivity (2): Proof tests of “STABLE”

- Massive-connection and low-latency capability of “STABLE” is confirmed in the proof tests in YRP area

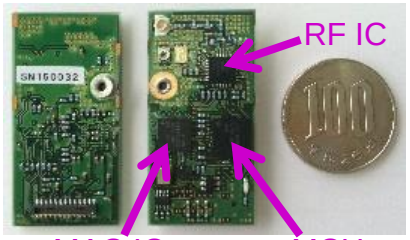


The number of UEs succeeding in simultaneous connection (one second average)

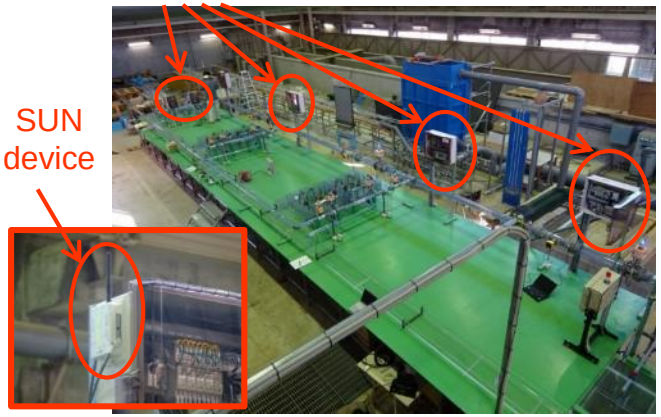
These plots were printed on the picture of the Geospatial Information Authority of Japan

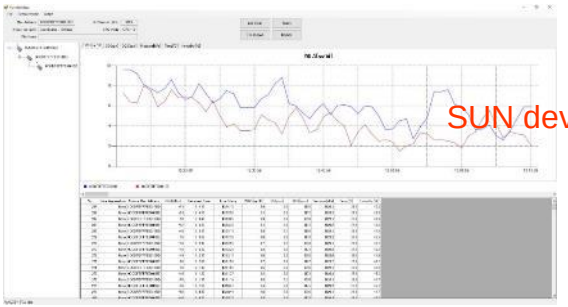
Supporting technologies (1): Wireless grid technology

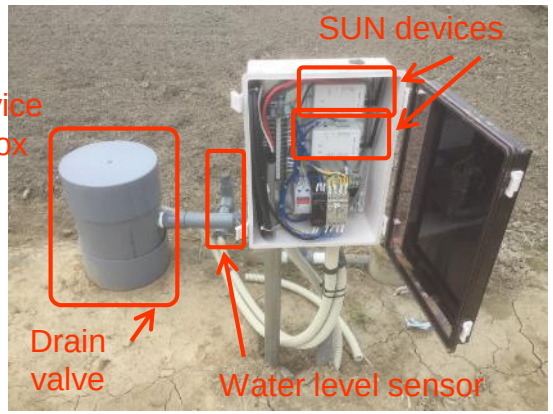
- NICT has studied on the wireless-grid that consists of radio device grid topology and becomes one of the promising technologies for IoT applications in the future
  - Conventional smart meter system (SUN) is effectively exploited



Low-energy module







Proof tests in the laboratory and in the real rice field

Environmental sensing experiments using sensor devices

This work was supported by Cabinet Office, Government of Japan, Cross-ministerial Strategic Innovation Promotion Program (SIP), "Technologies for creating next-generation agriculture, forestry and fisheries" (funding agency: Bio-oriented Technology Research Advancement Institution, NARO).

Supporting technologies (2): Flexible Factory Project

- Efforts to solve real problems in the manufacturing sites
  - Revealing crucial requirements for wireless communications
  - Conducting wireless environment evaluation and wireless packet transmission tests at factories in operation
- Collaborating work since 2015
  - NICT and 14 companies doing field experiments at 8-factories in operation

- Technologies to establish radio communication links under severe conditions of infrastructure and propagation, thereby enlarging radio applicable fields

Regularity

Mission critical application

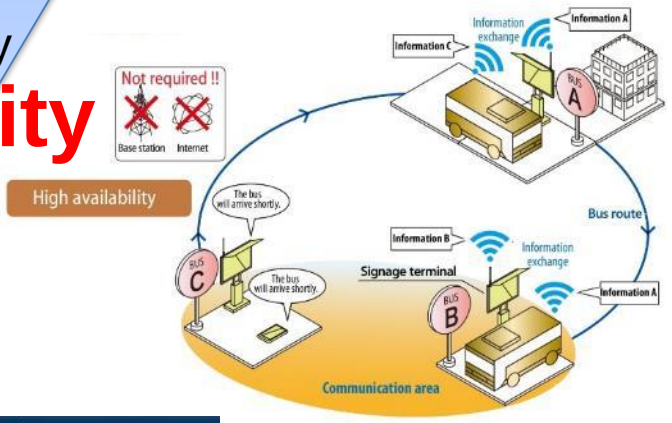
Tele-control of drones or robots

Multi-hop communications with deterministic latency

Availability

Disaster-tolerant networks

Smart city

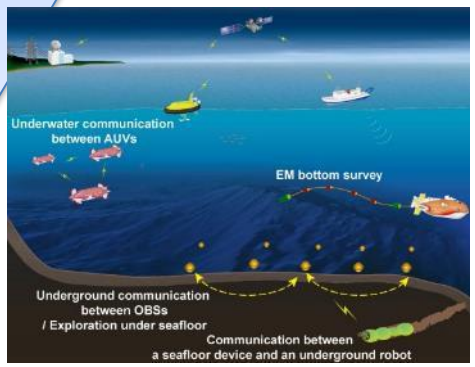


Device-to-device communications

Enhanced Reliability

Connectivity

Restricted wireless communications



Under-seawater communications

Joint research with JAMSTEC

- **The effective radio resource utilization** to satisfy the complicated and diversified demands on 5G/B5G has the highest priority in the NICT's R&D
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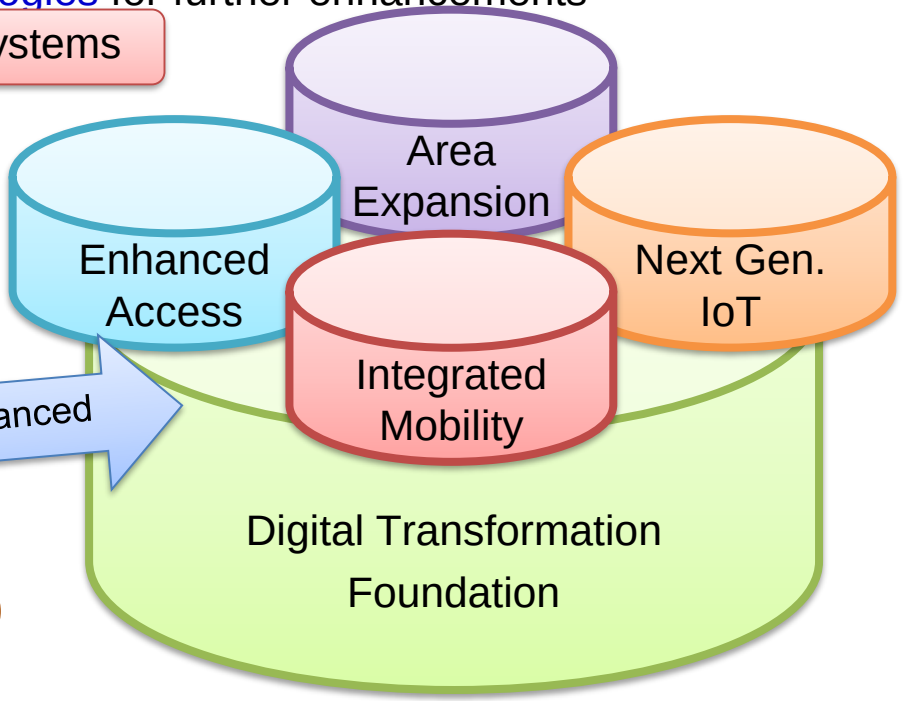
  - Are potentially supported by auxiliary technologies for further enhancements

Cope with Vertical sectors via Physical Cyber Systems

R&D on 5G/B5G to satisfy Complicated & Diversified demands by:

- Availability: Private microcell
- Connectivity: Low-latency & massive connection

Advanced



Supporting Technologies: Wireless grid, Flexible factory, Enhanced reliability

We are now in the standardization and promotion phases based on the preliminary system designs and proof tests.

- FY2018: Spec. finalization, Tests, Collaboration
- FY2019: Standardization, Promotion
- FY2020: Reflected in the social system and the regulation
- FY2021~: R&D on the radio utilization In CPS era