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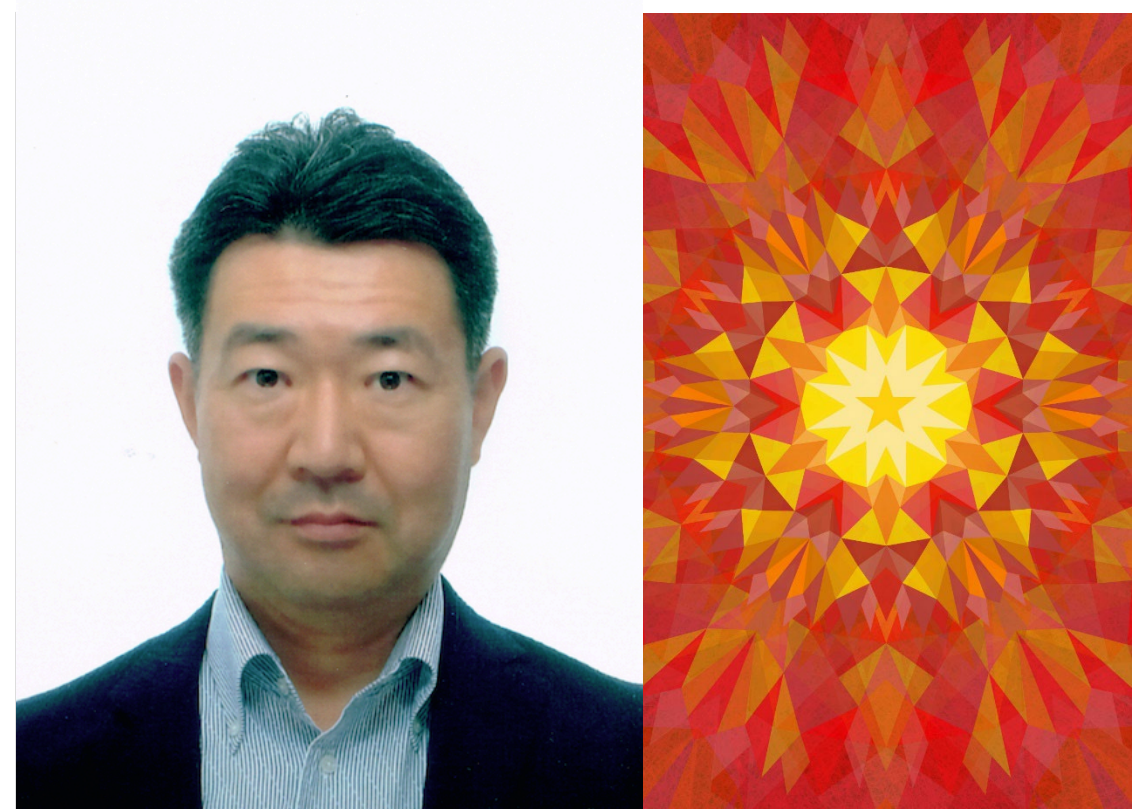
7-11 December 2020

**Beyond 5G/6G Telecommunication
Ensuring Continuity in Business,
Research and Education**

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Vice-Dean of Interfaculty Initiative in Information
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The University of Tokyo

Session: Keynote



In this keynote presentation:

This keynote presentation introduces **perspectives towards Beyond5G/6G** especially focusing on **democratization of telecommunication**, and discusses how to cope with planetary scale issues such as COVID-19 pandemic from the standpoint of the role that future telecommunication should play.

Worldwide Concern **COVID-19** and Significance of Telecommunication

- **Teleworking** such as teleconferencing and remote education has been recognized as **a new normal activity in response to the COVID-19 pandemic infection** that has occurred simultaneously around the world and has instantaneously suspended our social activities.
- The misfortune has made us **re-recognize the need for enhancing and upgrading information communication infrastructure into more robust one.**
- The activity accounts for one of the SDGs, **SDG 9, that is to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.**

Sustainable Development Goals (SDGs) as Common Vision

UTokyo Future Society Initiative

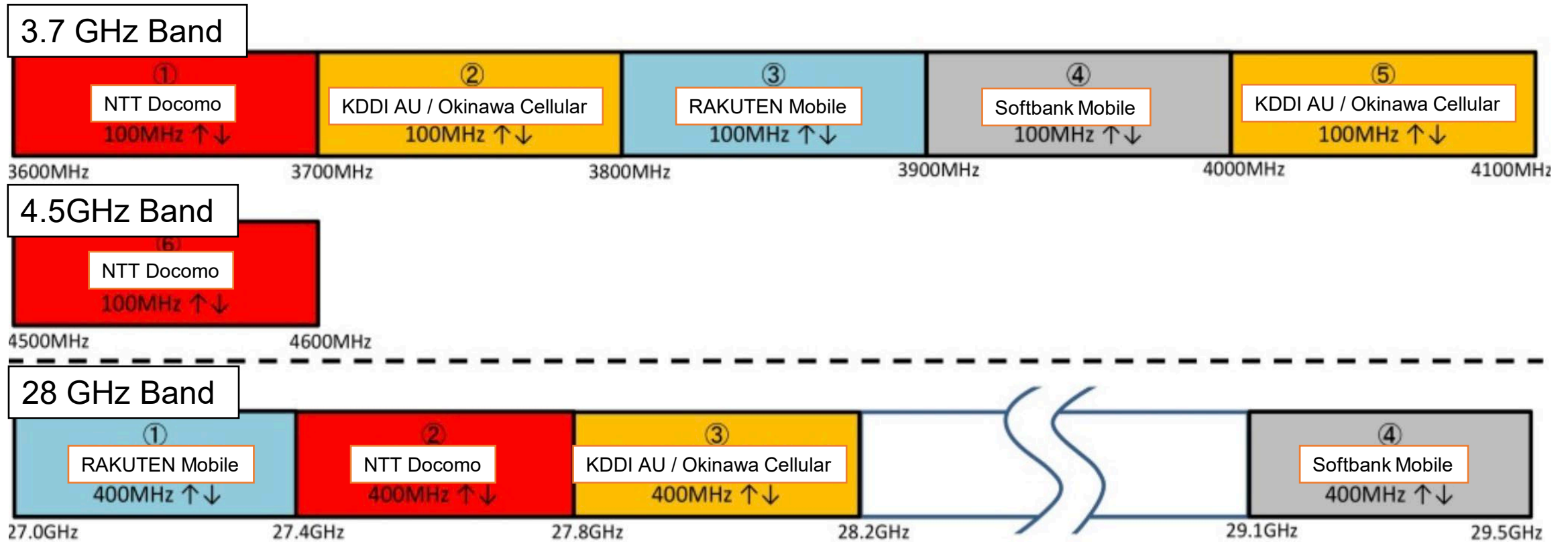


UTokyo FSI promotes SDG-oriented projects in a wide range of fields throughout the University, and showcases them as actions taken by the University as a whole.

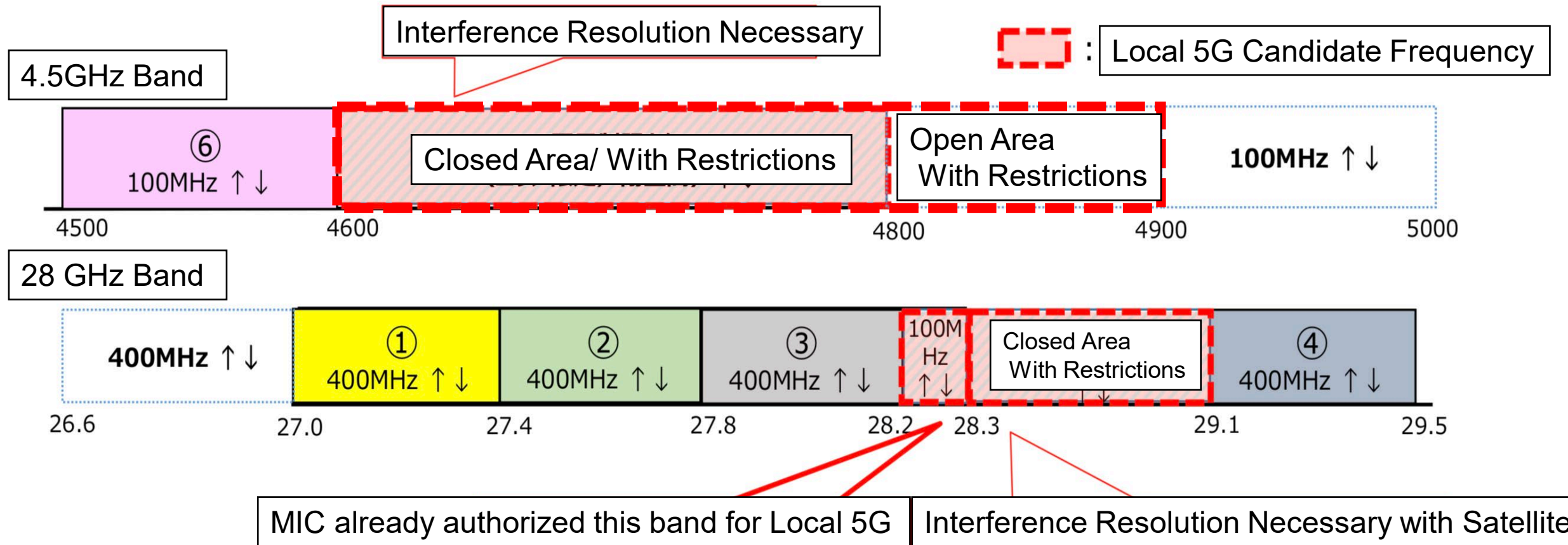
In particular, **in regard to collaboration with the industrial sector, the University utilizes the SDGs as a basic common vision for new business growth.**

5G Frequency Band Allocation

Japan has 4 MNOs (NTT Docomo, KDDI AU, Softbank and RAKUTEN Mobile) today



Local 5G (Private 5G)



“Democratization of Telecommunication”

- **Democratization** :

“The action of making something accessible to everyone.”

→ Make radio frequency license available to everyone (such as in Local 5G)

- **Divergence** and **Inclusiveness** are key drivers for innovations for next generation networking

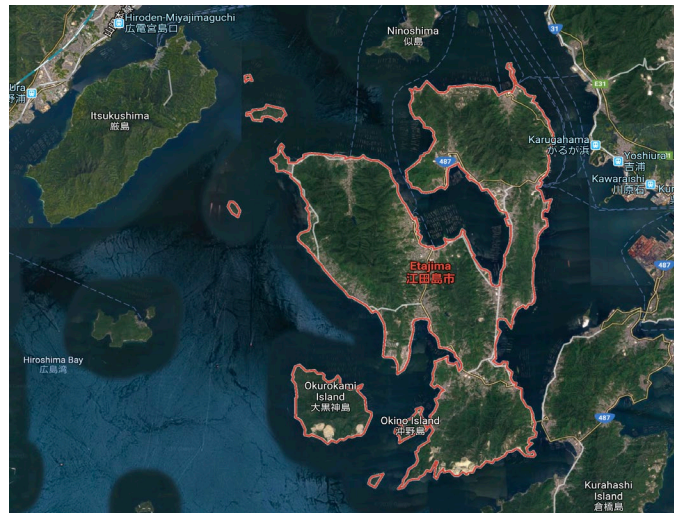
Challenges identified in 5G deployment

- **Timely Deployment** of 5G
- **Mismatch between supply and demand** of 5G
- **Advanced Research Integration** in 5G

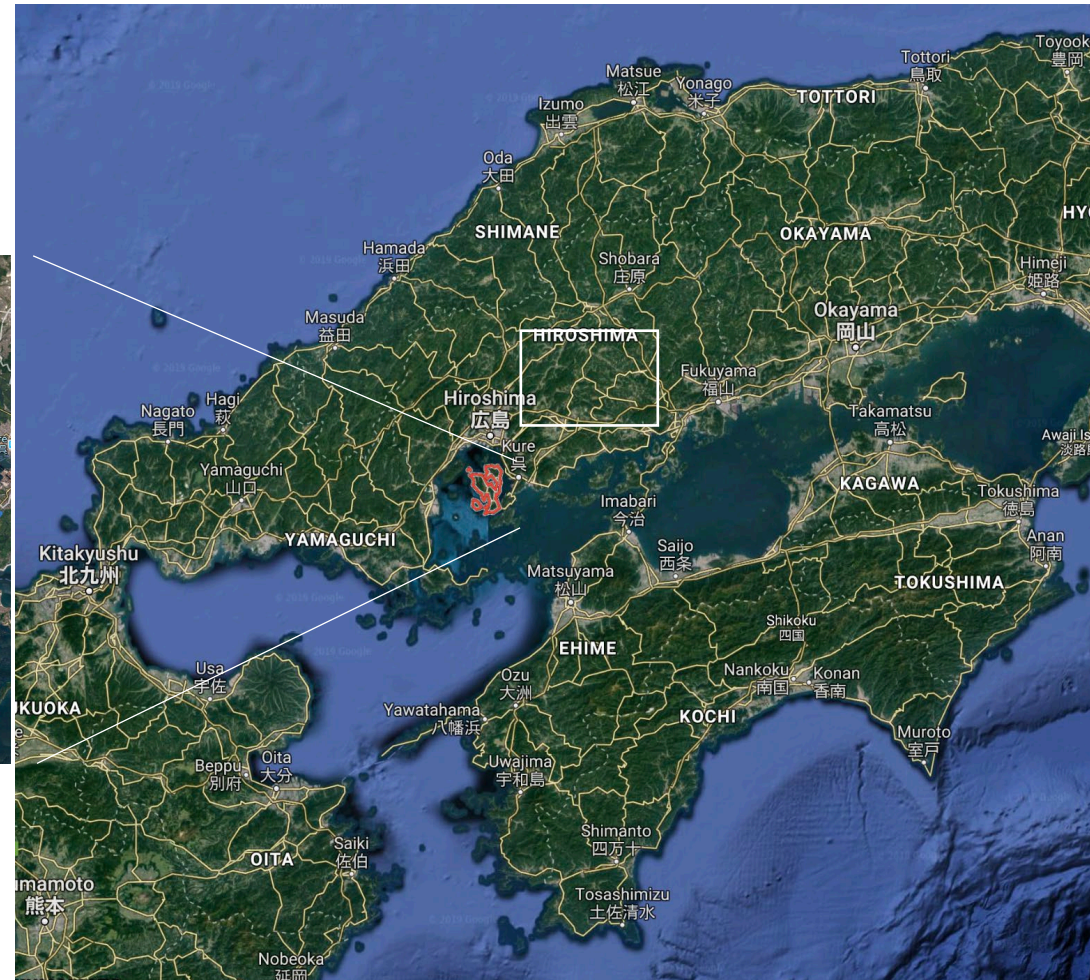
→ Democratization (such as Local 5G approach) is key to solve these!

Example: 5G Application To Local Fishery Business “Oyster Farming”

Etajima-City
Hiroshima Prefecture
Japan

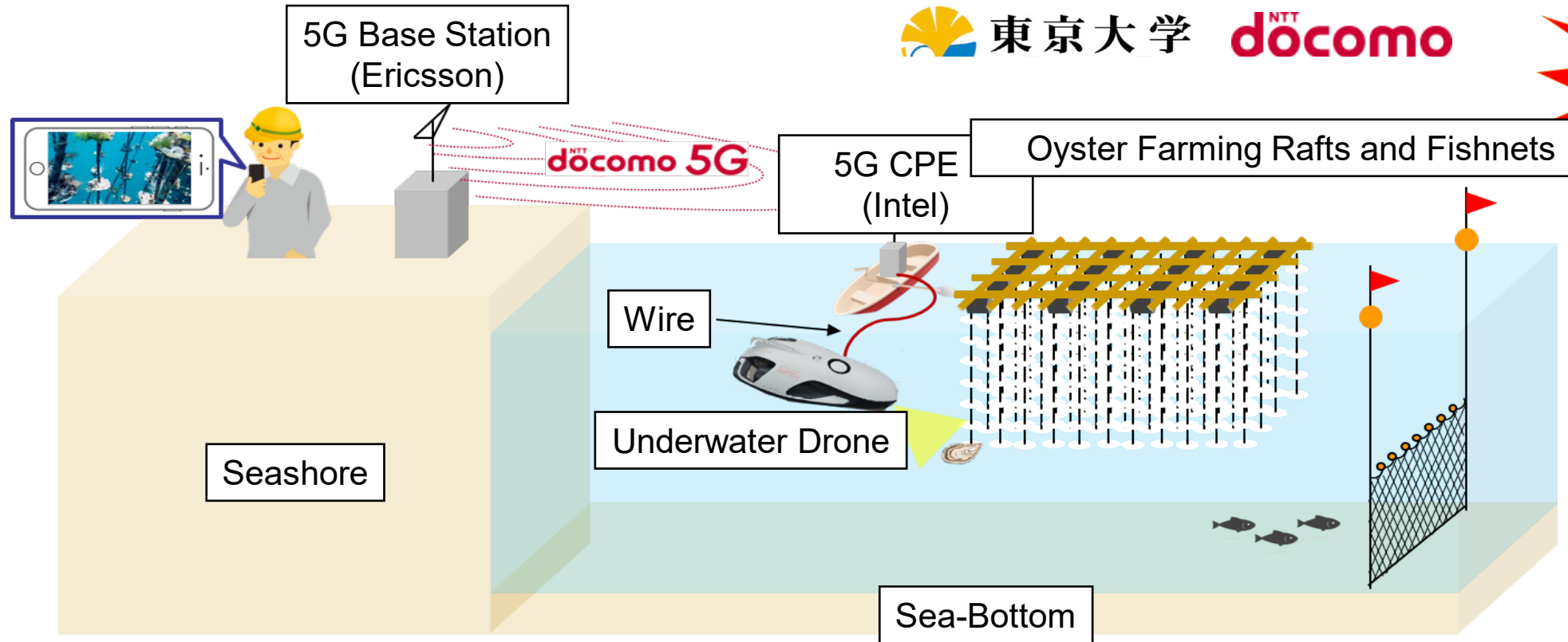


Top in Ranking in Oyster Catches
in Japan



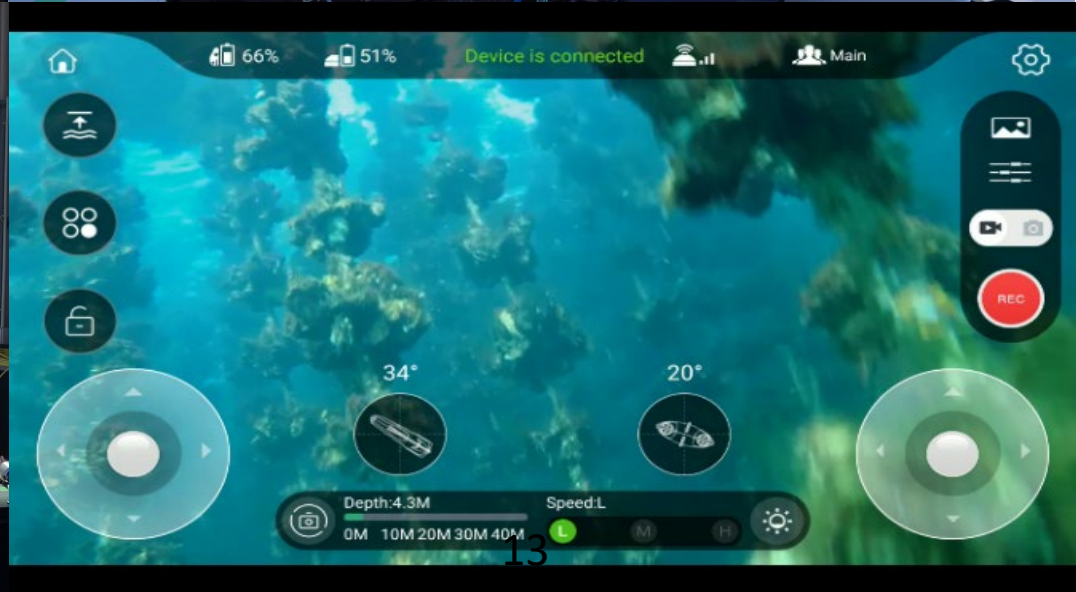
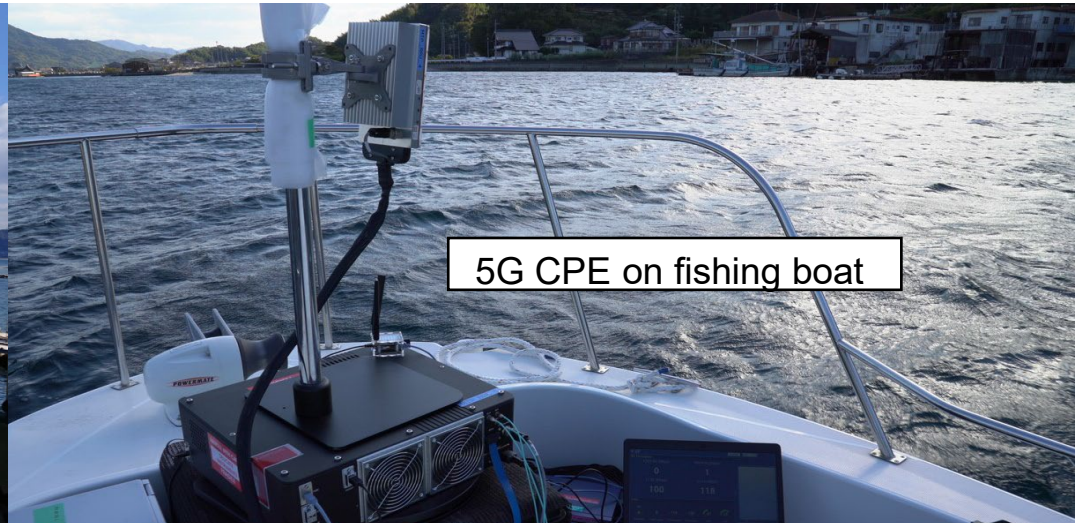
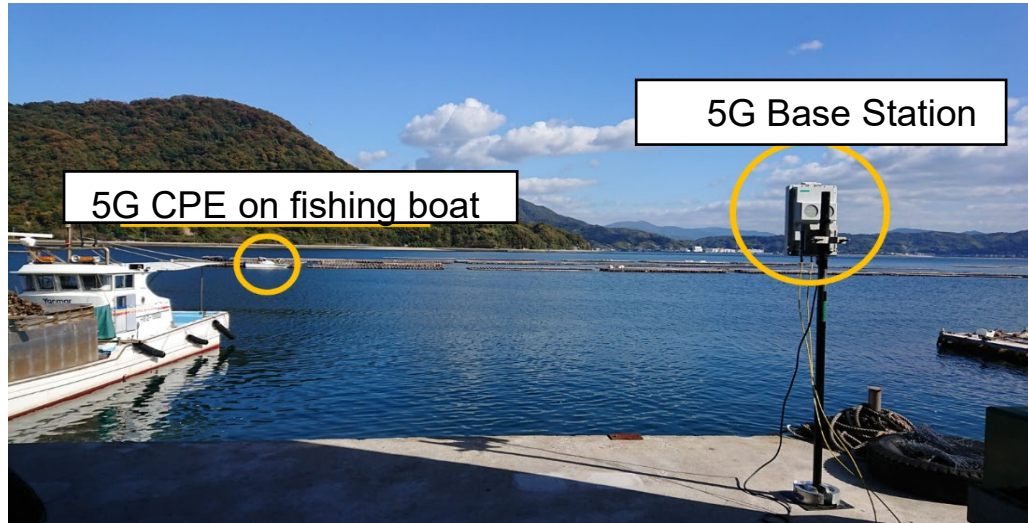
5G Live Video Streaming and Realtime Control of Under-Water Drone

2019/11 Released



- Remote realtime monitoring Oyster Farming Rafts and Fishnets through water-drone
- 5G base station at the seashore and 5G CPE on the fishing boat
- URLLC for controlling under water drone
- eMBB for live video streaming





Sustainable Development Goals (SDGs) as Common Vision

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Challenges identified in 5G deployment

- Timely Deployment of 5G
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When is 5G coming to our region any time soon?

Does any telco deploy 5G in rural area?

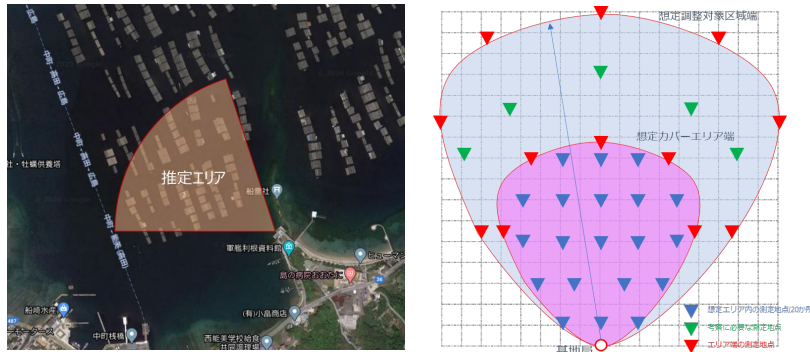
Does any telco deploy our research results?

→ Democratization (such as Local 5G approach) is key to solve these!

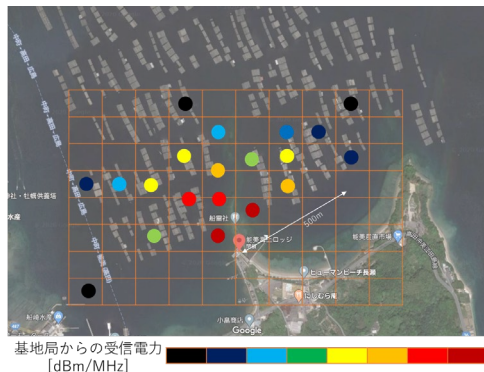
→ We decided to deploy our own democratized 5G (Local5G) in the area

A New Joint Project on Public 5G / Local 5G Cooperation for Fishery Business

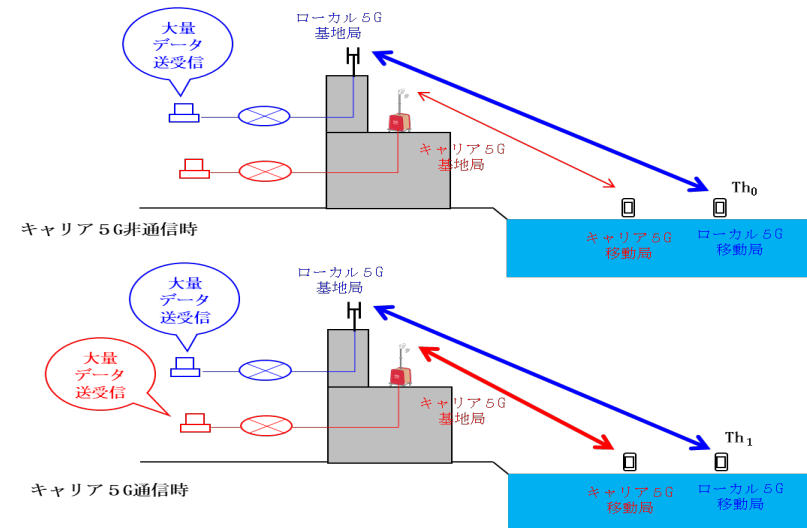
(1) Field Experiments for Signal Reception



(2) Field Experiments for Use Case Scenarios



(3) Coexistence Examination

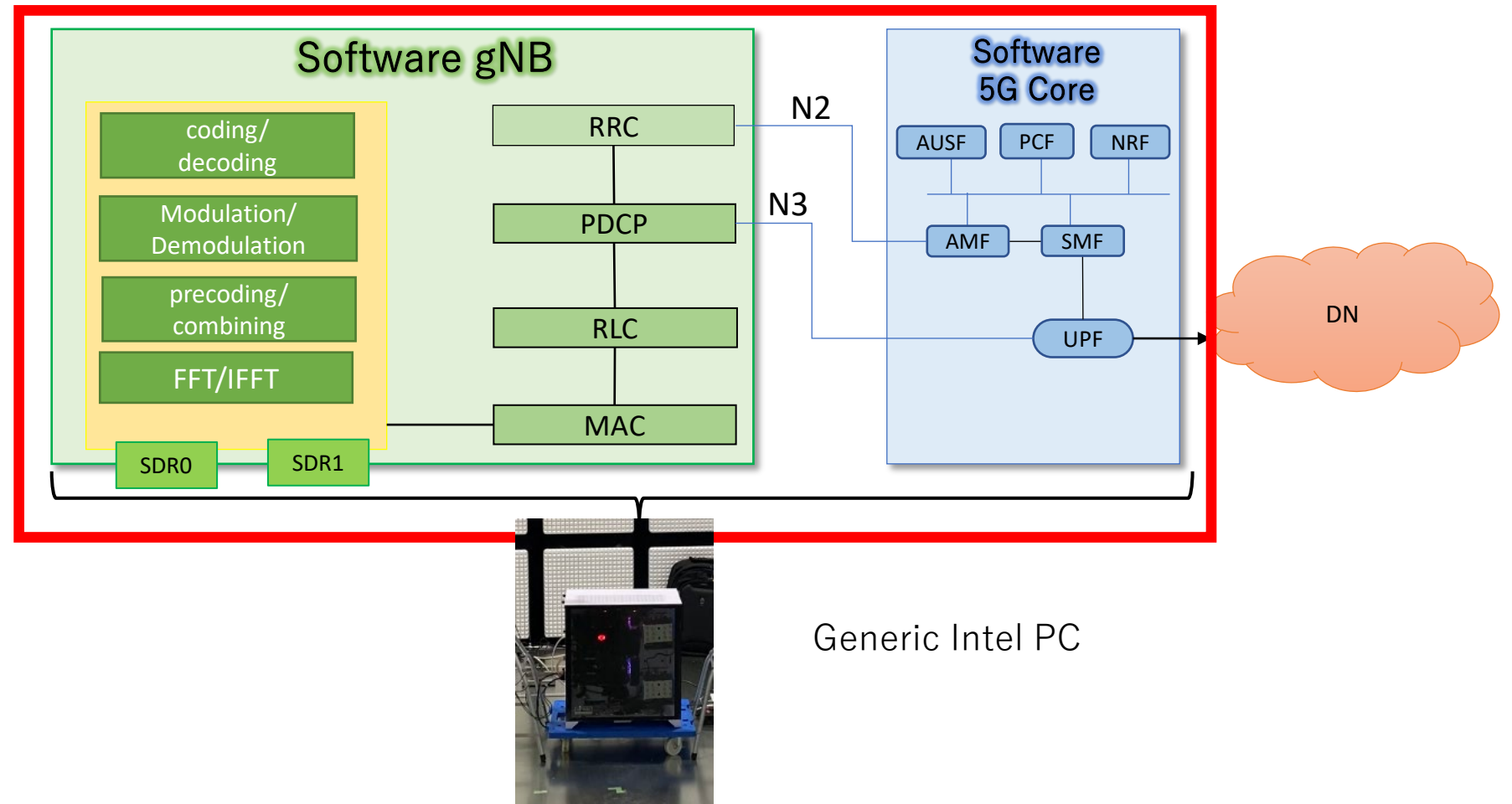
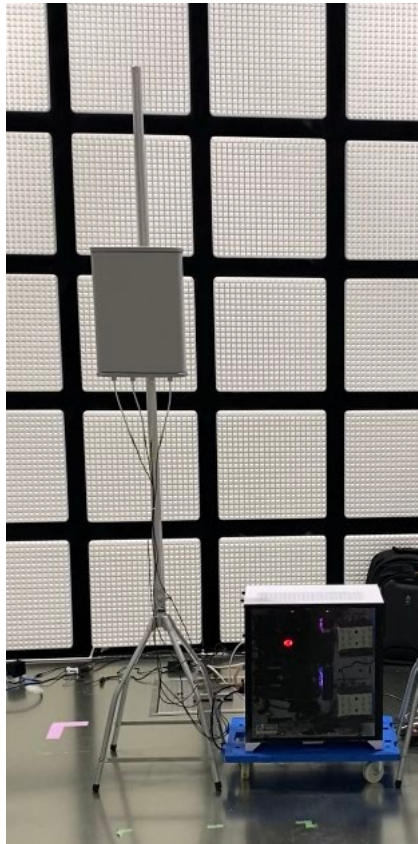


	Local 5G	Public 5G
Pattern1	In Operation	Not in Operation
Pattern 2	In Operation	In Operation
Pattern 3	Not in Operation	In Operation

Challenges in “democratized telecommunication” (Local 5G)

- **Cost reduction** in network infrastructure
- **Customization** capability in network infrastructure
- **Understanding of social challenges**

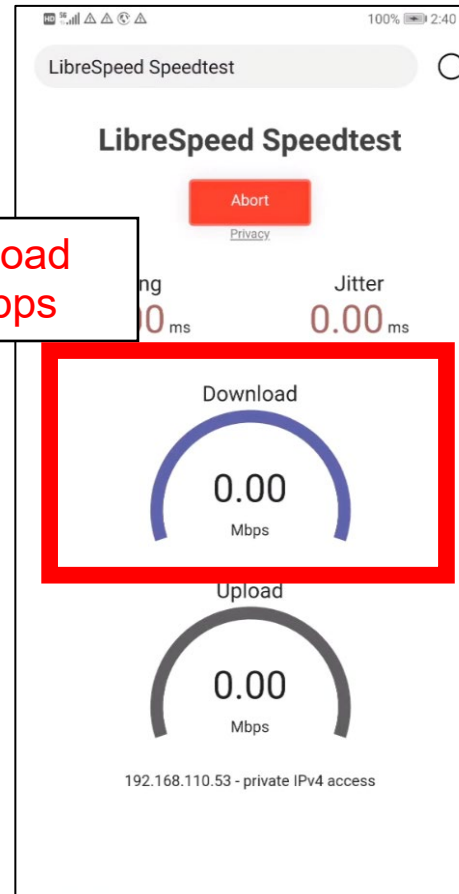
Local 5G In A Box : Cost Reduction



Realizing **Cost Reduction** and **Customization** by Software 5G Base Station

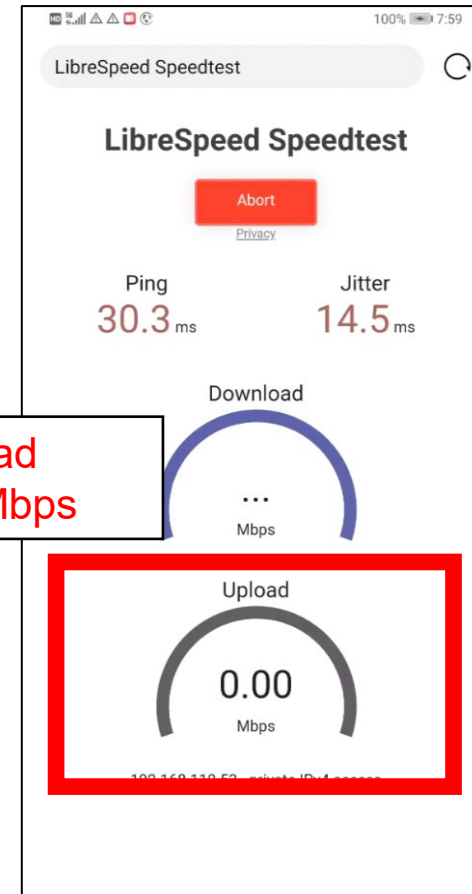


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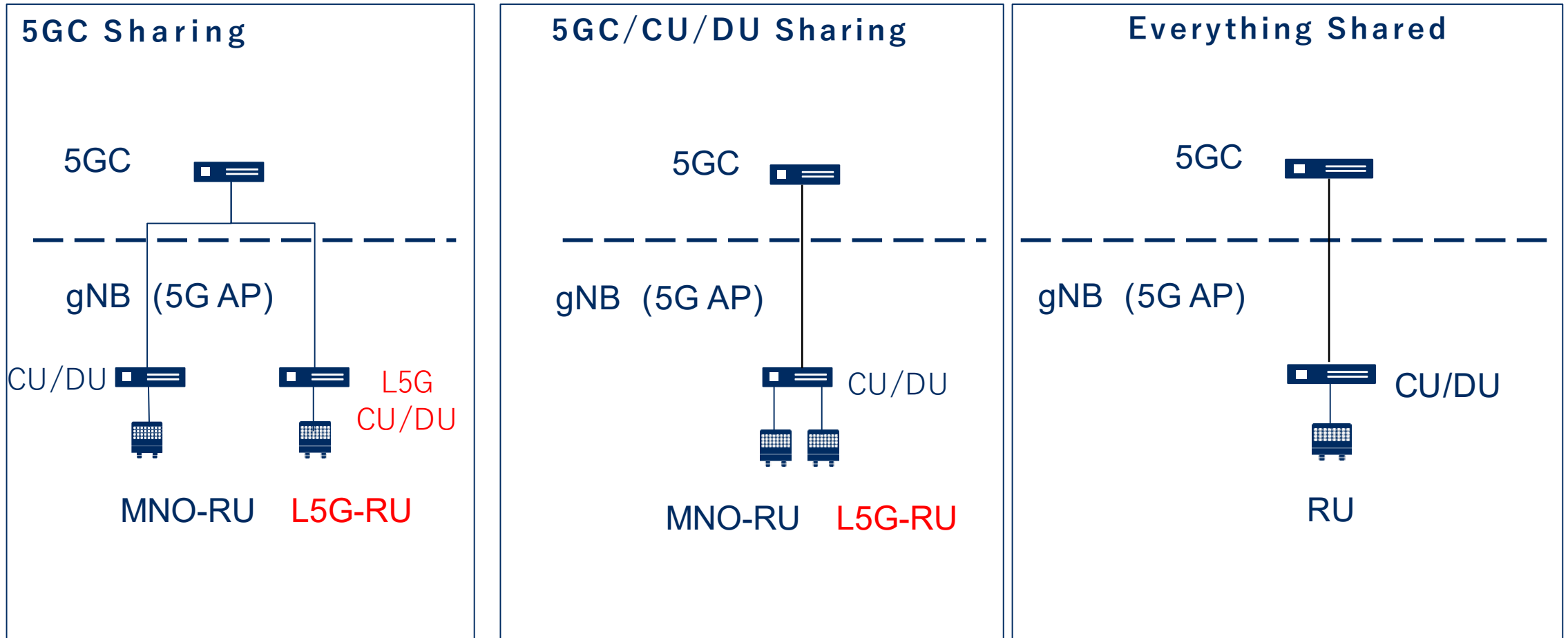
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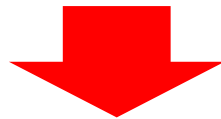
Another way of Cost Reduction: Infrastructure Sharing between Public5G and Local5G



What “Democratization” means to Researchers

NakaoLab’s Research Area

- 「Network Slicing」
- 「Network Softwarization for Low-Cost Infrastructure」
- 「Edge Computing ULRRC Communication」
- 「AI/ML Integration for Network Infrastructure」
- 「Local regions empowered by IoT · AI」



“Democratized telecommunication” serves as “Testbed” of “Customization” for developing/deploying and experimenting with the latest research results

Isolation of Per Application Traffic : Per-Application Network Slicing

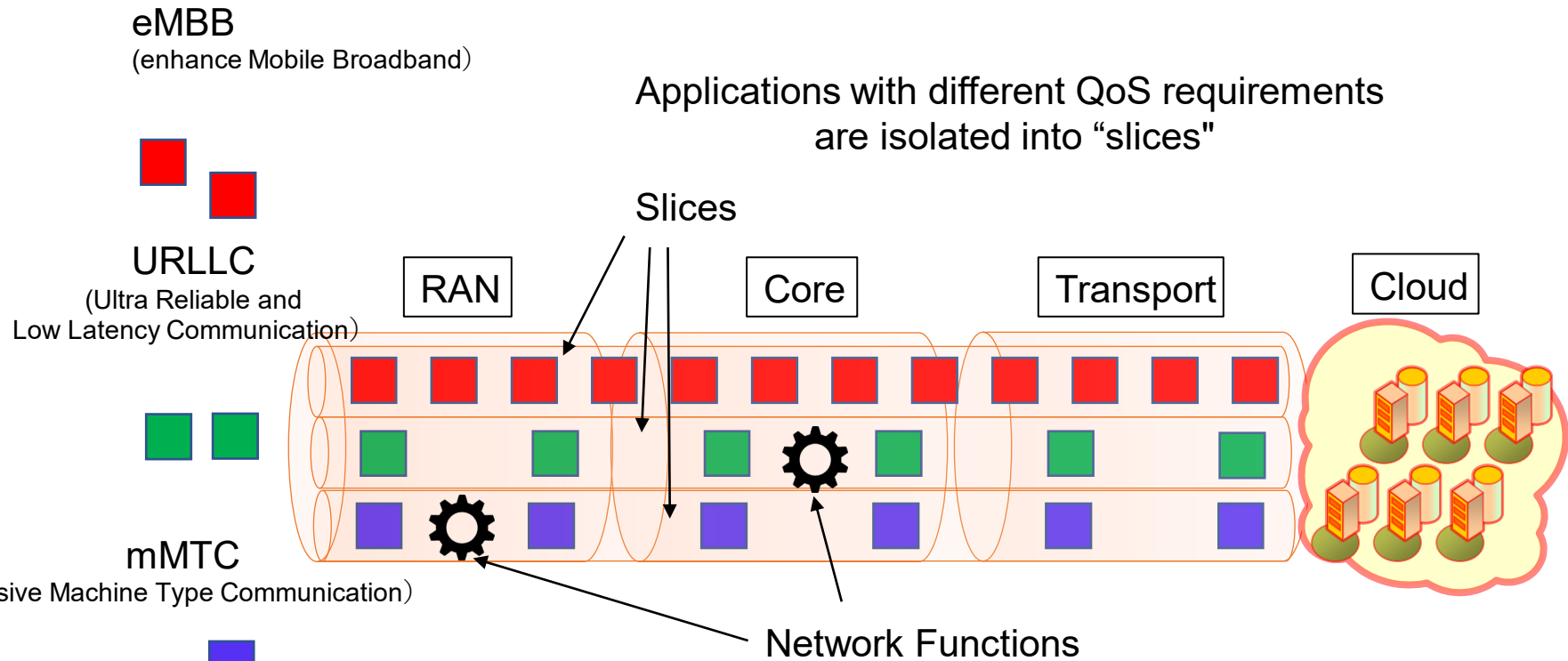
Underwater Drone
Video Streaming



Underwater Drone
Control



Underwater Drone
Sensors



Applications with different QoS requirements
are isolated into "slices"

Slices

RAN

Core

Transport

Cloud

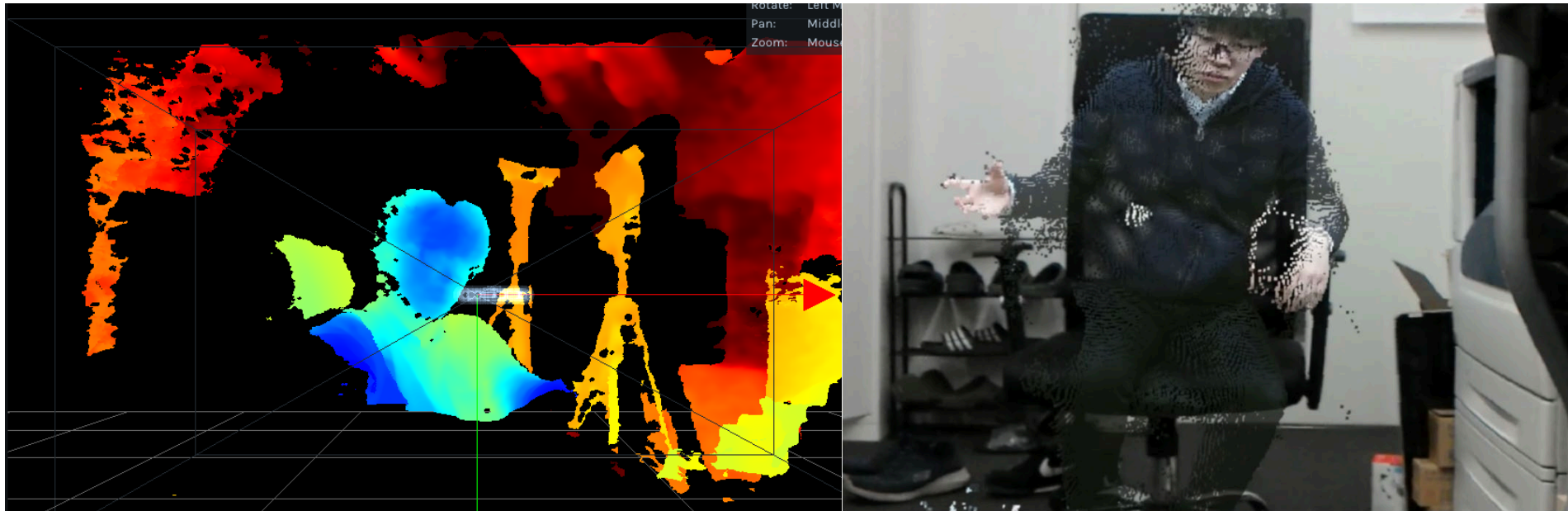
Network Functions

Communication Infrastructure is "softwarized"
Dynamic resource allocation is enabled
Network functions can be executed

Application of democratized telecommunication against COVID-19

- Under the risk of COVID-19 spread, **the biggest challenge is how to ensure continuity in our social activities, especially business, research and education under COVID-19.**
- We posit **that revolutionary progress in research and development and standardization in communication infrastructure be a necessity for the next decade**, as it should play a significant role in ensuring the continuity of our social activities.

Local5G Application of URLLC/eMBB: “Lively 3D VR-based Education”



- Capture social activities of human into 3D model.
- Compress the 3D model and reconstruct the model remotely
- Give an illusion that two remote parties physically coexisted in the same place
- Enhance 2D remote education into lively 3D VR-based education

Local 5G

The University of Tokyo
Nakao Lab

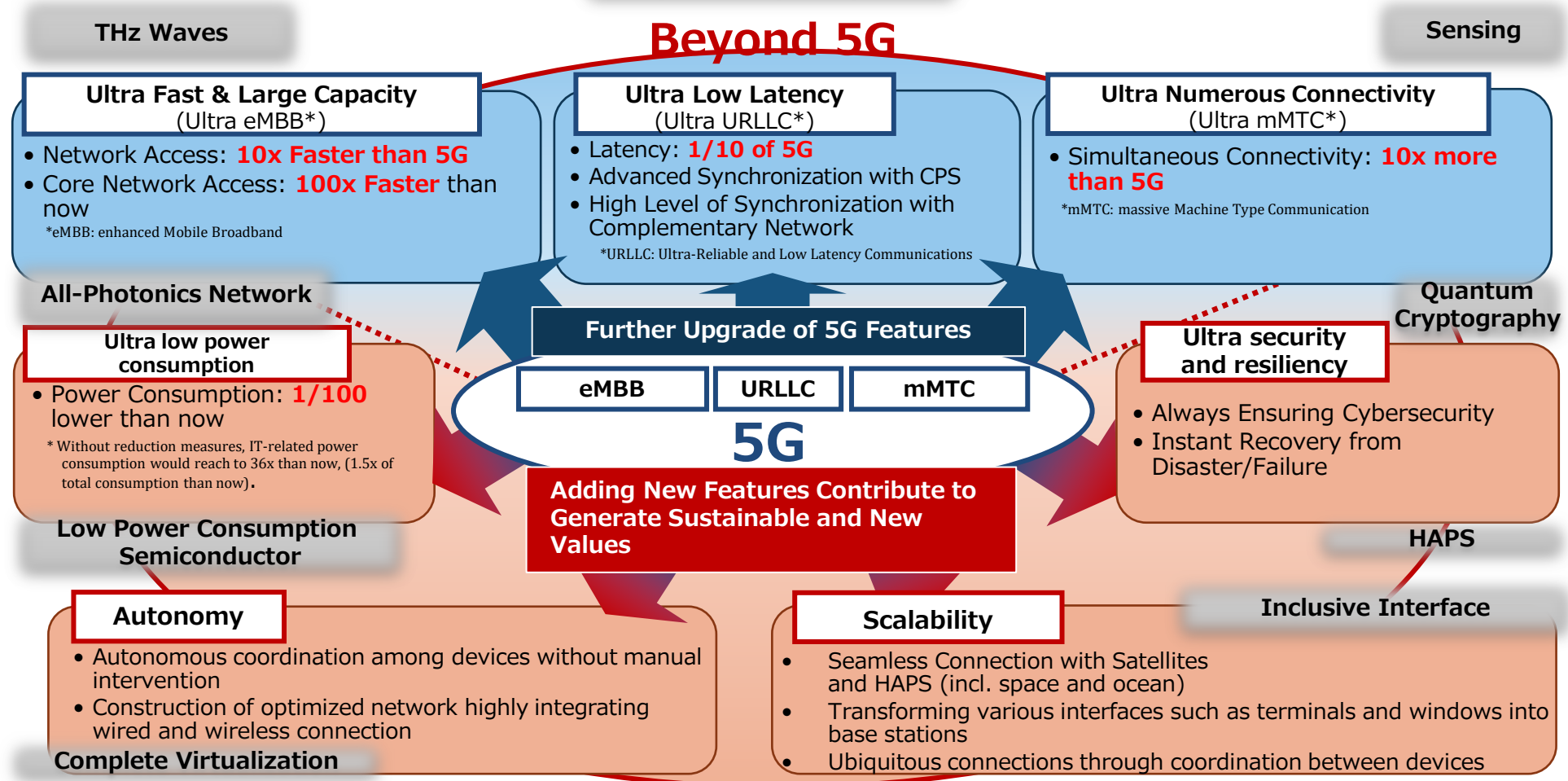
For the next decade: Beyond 5G / 6G to be realized in 2030

- Commercial 5G service has been globally deployed and utilized all over the world.
- On the other hand, research and development strategies aiming at 6G are already in progress. In Japan, 5G service has started in the spring of 2020 and the discussion on 6G has initiated in January 2020.
- In June 2020, the strategic proposal for 6G R&D has been summarized by the "Beyond 5G Strategic Board" held by the Ministry of Internal Affairs and Communications.

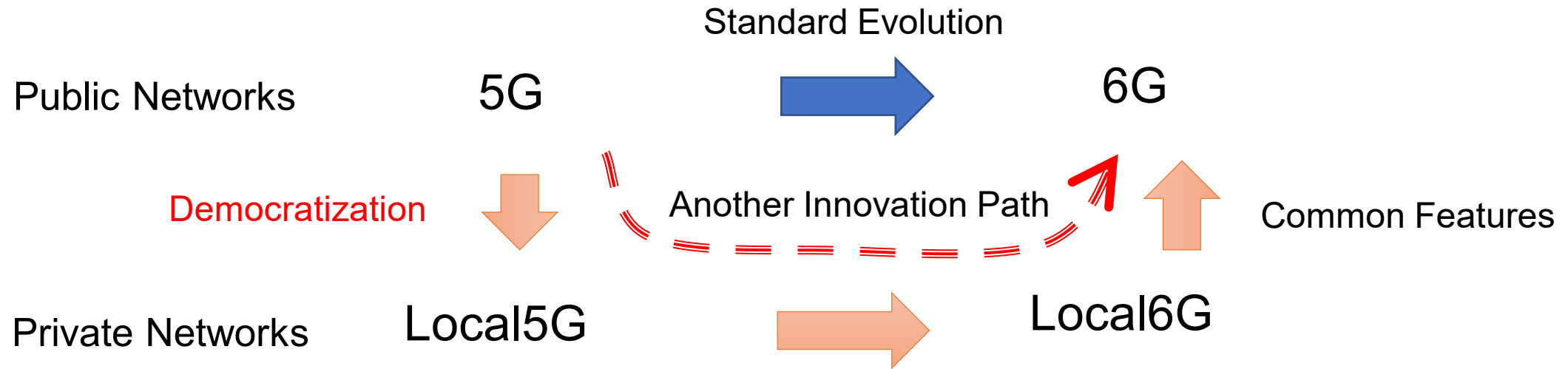
Key Features for Beyond 5G

Synchronization of Physical & Cyber Spaces

* **Green Words** are the examples of areas where Japan has advantages or is actively engaged in.



Another Evolution Path for Innovations Towards Beyond5G/6G



Innovations driven by **customizations for various stakeholders**
Diversity and Inclusiveness

Summary

- We believe that this “democratization” (making something accessible to anyone) will open a door to the innovations towards 6G.
- We observe that besides the regular migration path from 5G to 6G promoted by telecommunication operators and vendors, there is another evolution path possible, from private 5G to private 6G and then to public 6G because a lot more stakeholders may participate in the game of developing custom solutions tailored for their real use cases that may be eventually adopted as viable 6G technologies to be standardized. For instance, not only industries but also academia should be able to define new communication technologies for 6G in their developments and operations of private networks.
- We believe that in the course of developing 6G by “democratization of telecommunication” we may further develop new ways of utilizing telecommunications to ensure social life continuity, e.g., to live with COVID-19.

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Thank you!

