NICT's approach toward 5G and R&D status

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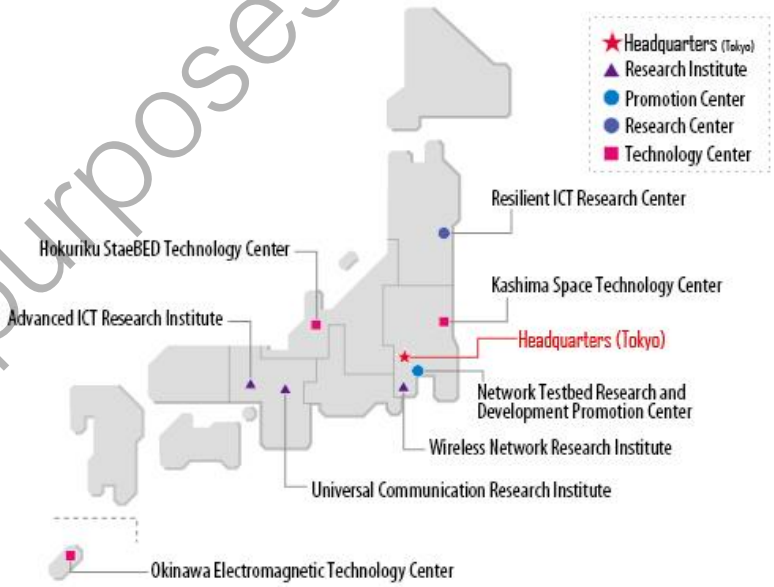
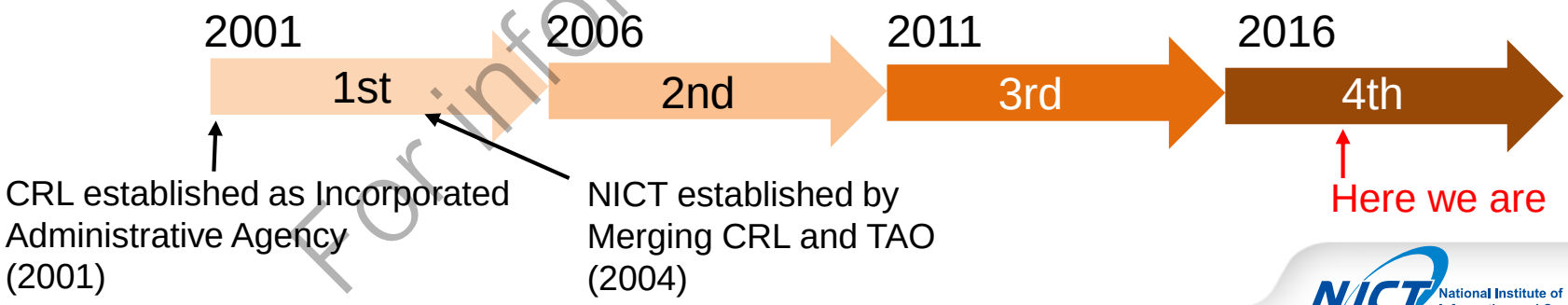
Introduction of NICT

- National Institute of Information and Communications Technology (NICT)
  - Japan's only national R&D agency of ICT.
- History
  - Radio Telegraph Research Division established as a part of Ministry of Communications (1896)
  - Radio Research Laboratory (RRL) established (1952)
  - Reorganized to Communications Research Laboratory (CRL) (1988)
  - NICT established (2004)



Note: The structure was changed on April 1st., 2016.

Mid-term Plan (5 years)



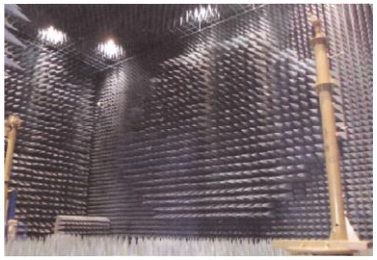
NICT's Wireless Networks Research Center

- Wireless Networks Research Center
  - **Wireless Systems Lab.**
  - Space Communications Lab.
  - Planning Office

- R&D on terrestrial wireless communications
- Over 40 staffs, most of the researchers are PhD holders
- Located in Yokosuka Research Park (YRP)

Yokosuka Research Park (YRP)


Good environment for wireless communications (e.g. poles and boxes with power supply and networks along with roads.


Anechoic chamber (big enough for cars)

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Future of Mobile Communication System

- Requirements for various performances of the 5th generation mobile communication system (5G)
  - Enhanced Mobile Broadband(eMBB)
  - massive Machine Type Communication (mMTC)
  - Ultra Reliable Low Latency Communication (URLLC)

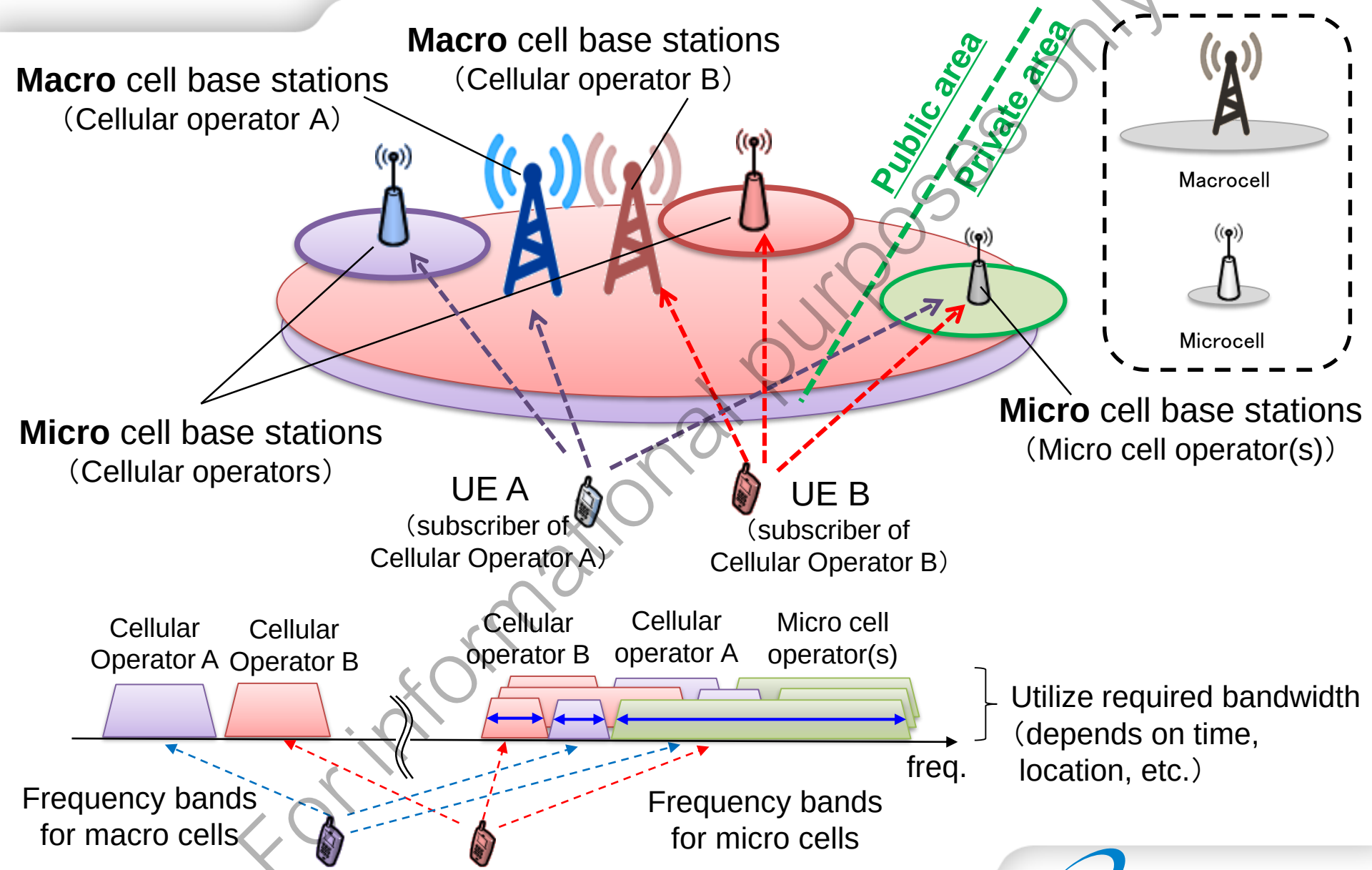
- Era of Internet of Things (IoT) is coming
  - Various specialized wireless systems will be deployed since a single system can not afford to satisfy all the requirements of variety of services
  - More cells with smaller access range

- Current cellular network architecture has come to its limitation

- Future wireless communication system including 5G should have a new way of functional improvement
  - A way to flexible deployment of micro cells (base stations)

Ref.: 5GMF White Paper "5G Mobile Communications Systems for 2020 and beyond" Ver.1.1(September 29, 2017)

Accessibility of UEs and spectrum sharing

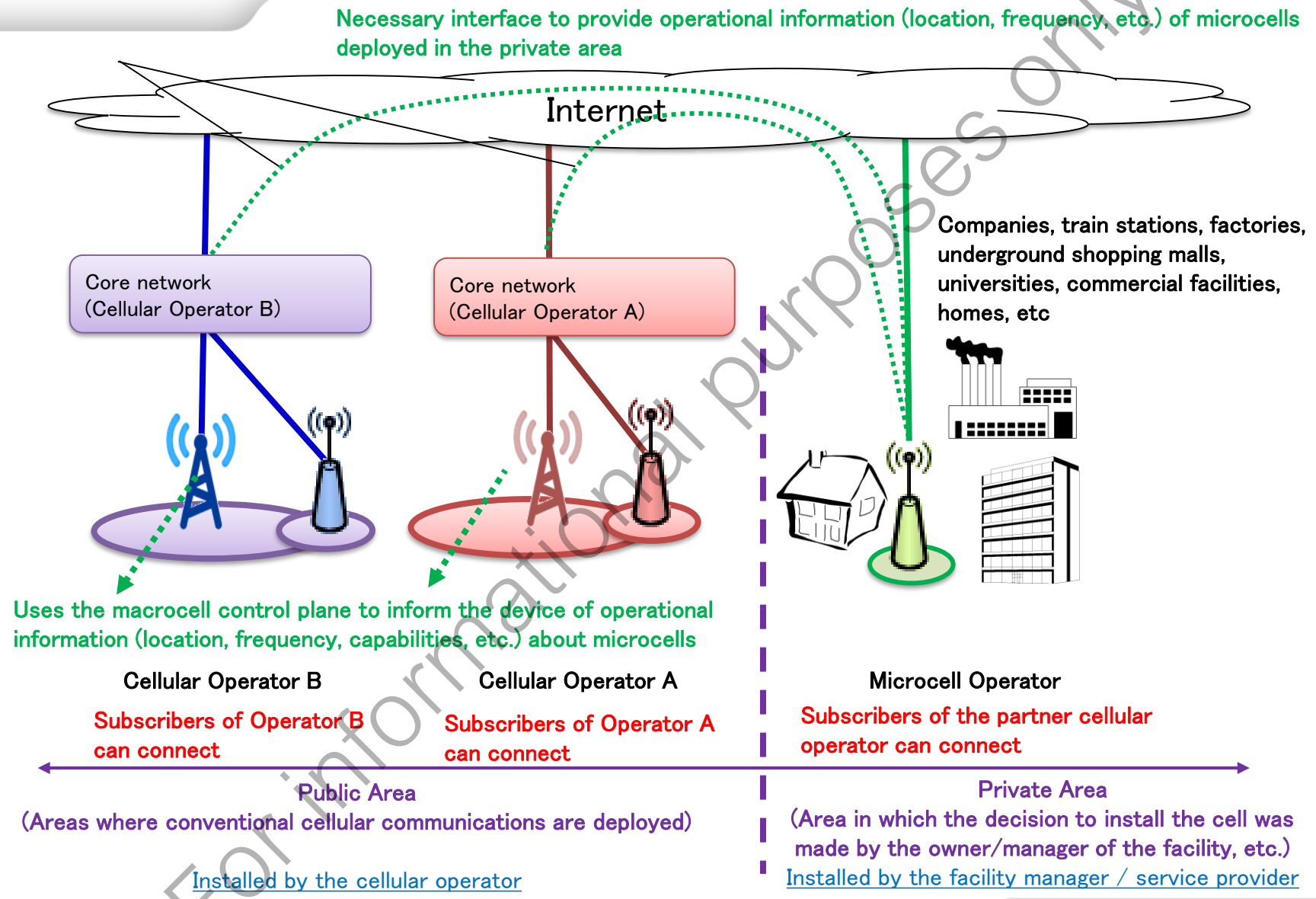


Introduction of “private area”

- To accommodate massive number of devices with different requirements
  - Classify operational area of micro cells
    - **Public area**:
      Area where cellular operators are operating
    - **Private area**:
      Area where specific individuals or organizations are operating (office, factory, university campus, shopping mall, etc.)

- Easy deployment, but mobility and guaranteed QoS
  - Some interfaces to the cellular system
  - Operation as an integrated mobile wireless system

Cooperation of “public area” and “private area”



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Discussion on Architecture in 3GPP

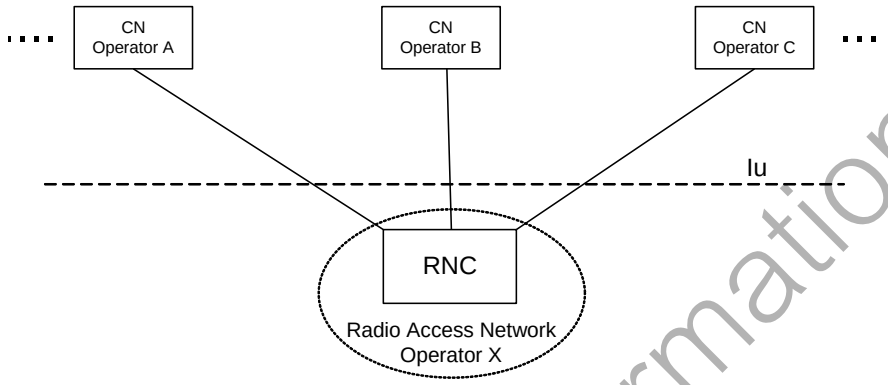
- Following features are discussed in 3GPP SA2 as 5G system architecture
  - Service based architecture with service-based interfaces and network function services
  - E2E network slicing
  - Data storage architecture with compute and storage separation
  - Common N1 and N2 interfaces for 3GPP and non-3GPP access
  - Support for edge computing
  - Application influence on traffic routing
  - Network sharing

Concept of Network Sharing

- 3GPP TS 23.251 mentions two approaches of “network sharing”
- NICT is proposing the concept jointly with vendors etc.

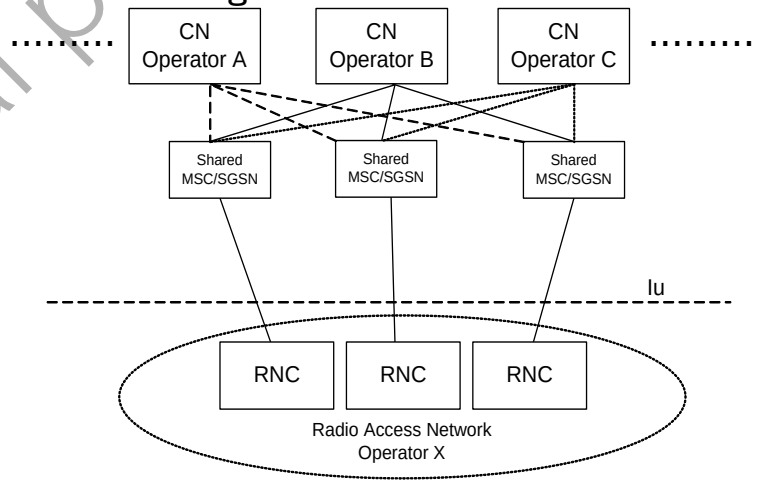
(1) MOCN: Multi-Operator Core Network

- Independent from core network
- A eNB is directly accommodated by multiple operators
- eNB is shared by the operators



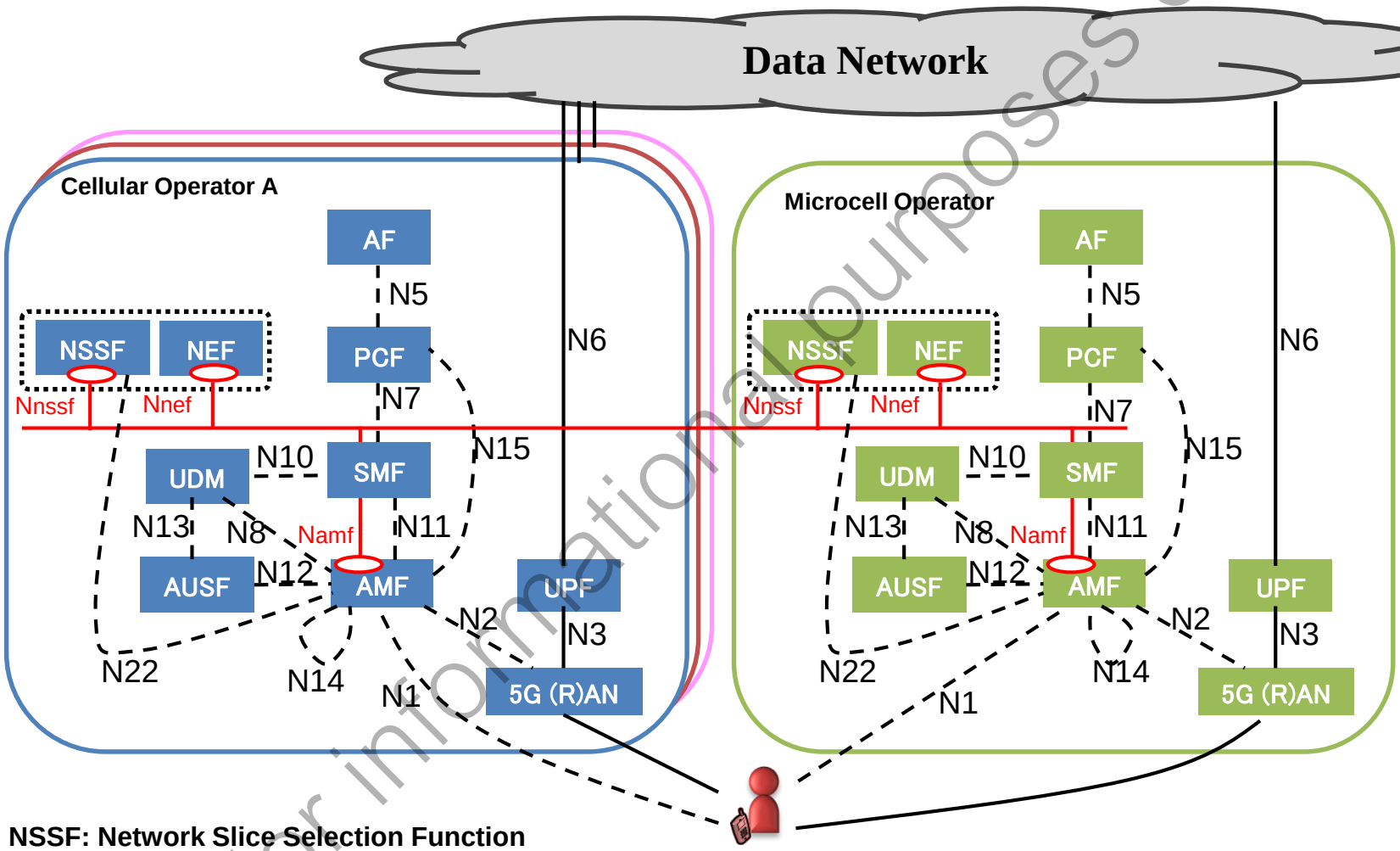
(2) GWCN: Gateway Core Network

- A part of core network is used in shared network
- Sessions in the same eNB are managed in shared network



Both the approaches should be discussed as acceptable approach would be different from operators to operators

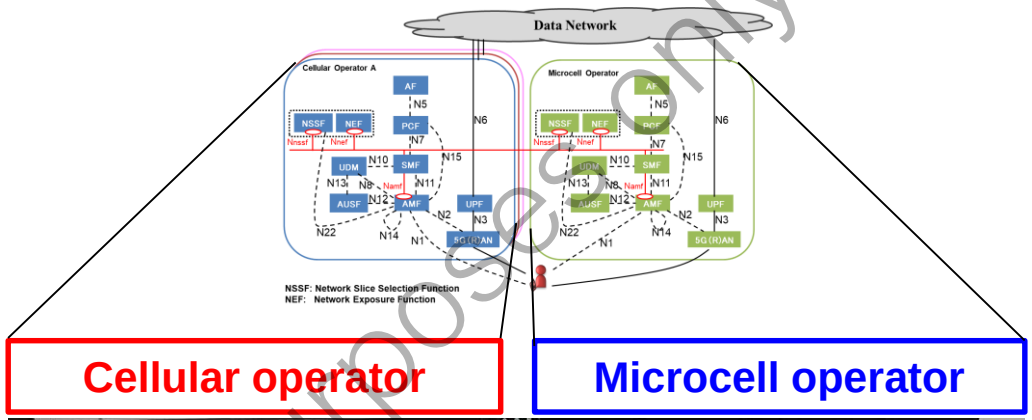
Proposed Architecture for 5G Core



NSSF: Network Slice Selection Function
NEF: Network Exposure Function

Proof of Concept Experiments using Prototype

(1) UE connects to cell (cellular)
(2) Cell (cellular) provide operational information of cell (microcell)
(3) UE connects to cell (microcell)
→ On disconnection from cell (microcell), UE reconnects to cell (cellular).



Devices (UEs)

Cellular operator

Microcell operator

Module for cellular operator

Module for microcell operator

Commercial LTE Modules connected to a PC with USB I/F

(1) Connection

(2) Operational information

(3) Connection

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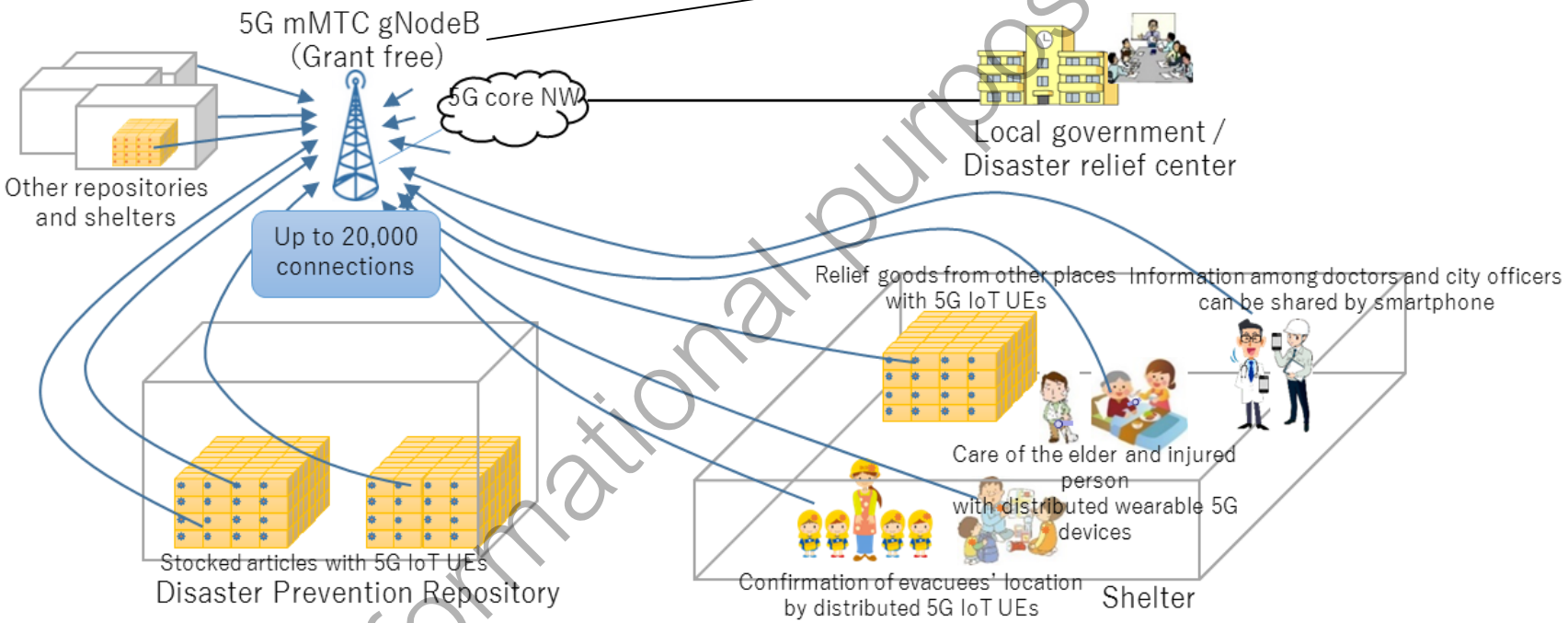
Trial of 5G Application - Disaster Prevention Repository –

- Target: massive Machine Type Communication (mMTC)
- Accommodate up to 20k devices by 5G New Radio (NR) with “Grant Free” feature

Large access area accommodating a massive number of UEs as **“private area”**



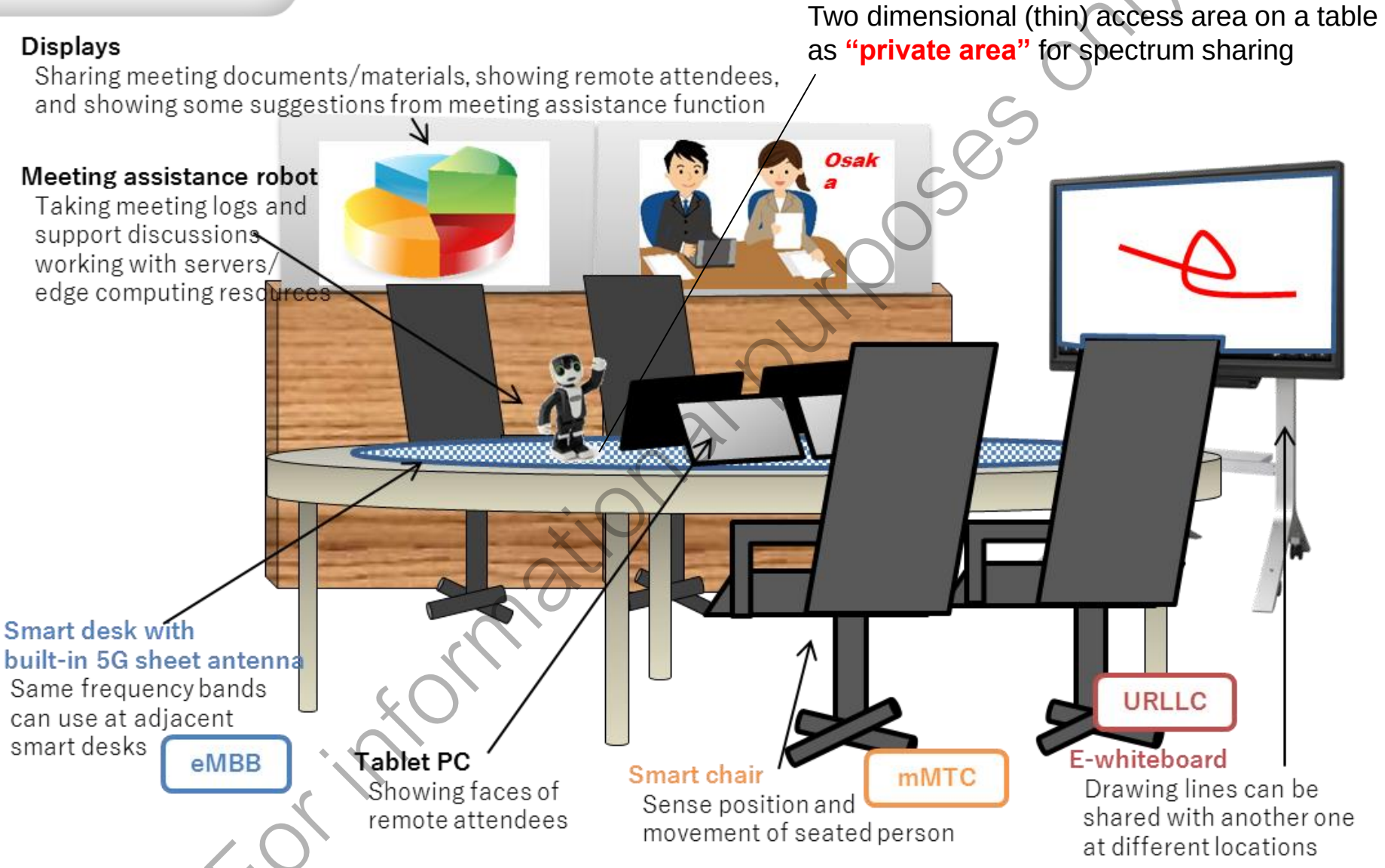
【Evaluation plan of massive MTC】

- Verify the performance of simultaneous massive connectivity to a 5G gNodeB (up to 20,000 UEs) , comparing with 4G
- Demonstrate the capability under a large-scale disaster scenario

【Use scenario】

- Manage the locations of articles and persons around shelters (doctors, volunteers, evacuees (with distinction of children / old people, male / female), etc.)
- Using 5G IoT devices and smartphone, integrated information can be provided to doctors, city officers and volunteers

Trial of 5G Application – Smart Office –



Conclusions

- 5G will play an important role
  - As an infrastructure for IoT
  - Concept of self-deployed micro cells and flexible integration into the mobile system is one of the keys

- **Prototypes and Collaboration** with variety of entities
  - 5G/IoT technologies are business/service oriented