R&D status on micro cell operator and spectrum sharing toward 5G and beyond

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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
  - 5G is the key technology for the infrastructure of IoT
  - Various specialized wireless access systems will be deployed since a single system can not afford to satisfy requirements of variety of services

- Current cellular network architecture has come to its limitation

- Future wireless communication system including 5G should have a new way of functional improvement, not just an extension of 4G
  - Aggressive micro cells deployment

Ref.: Final report from Radio Policy Vision Council of Japan (Dec. 2014)
Cooperation of “public area” and “private area”

Minimum necessary interface for providing operational information (location, frequency, etc.) about microcells deployed in the managed area.

- **Core network (Cellular Operator B)**
- **Core network (Cellular Operator A)**
- **Internet**
- **Companies, train stations, factories, underground shopping malls, universities, commercial facilities, homes, etc.**

- **Public Area** (Areas where conventional cellular communications are deployed) - Installed by the cellular operator
- **Private Area** (Area in which the decision to install the cell was made by the owner/manager of the facility, etc.) - Installed by the facility manager/service provider

- **Cellular Operator B**
  - Subscribers of Operator B can connect

- **Cellular Operator A**
  - Subscribers of Operator A can connect

- **Microcell Operator**
  - Subscribers of the partner cellular operator can connect

Uses the macrocell control plane to inform the device of operational information (location, frequency, capabilities, etc.) about microcells.
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 like the wireless LAN, but also **QoS guaranteed** like 3GPP
  - Minimum interfaces to the cellular system
Accessibility of UEs and spectrum sharing

**Macro** cell base stations
(Cellular operator A)

**Micro** cell base stations
(Cellular operators)

UE A
(subscriber of Cellular Operator A)

UE B
(subscriber of Cellular Operator B)

Utilize required bandwidth
(depends on time, location, etc.)

Frequency bands for macro cells

Frequency bands for micro cells

Macro cell base stations
(Cellular operator B)

Micro cell base stations
(Micro cell operator(s))

Freq.  

Macrocell  
Microcell
**Business Opportunity**

- **Micro cell operators**
  - Difficult for cellular operators to meet requirements of individual performance specific to each facility
  - Different business model required for a massive number of micro cells

- From cellular operators…
  - Area extension with various aspects of wireless communications without their own investment
  - Income for mobility management

- From micro cell operators…
  - Small investment to satisfy performance requirement customized for each use cases
  - Integrate with the cellular system, not just a independent small system

- 5G as infrastructure of various IoT services will have drastically wide business, so there should be mutually profitable model for both the operators.
Cell Broadcast Service (CBS) to distribute the operational information of microcells

Operational information (location, cell ID, frequency, bandwidth, cell selection criteria, etc.)

CBE: Cell Broadcast Enabler
CBC: Cell Broadcast Controller
MOM: Mobile Operator Manager

Defined in 3GPP
Original function

Transmission of operational information
Device connection
Proposed System Architecture (based on 3GPP Spec.)

- CBE: Cell Broadcast Entity
- CBC: Cell Broadcast Centre
- MOM: Microcell Operator Manager

Diagram details:
- Internet
- CBE
- CBC
- MME
- SGW
- eNodeB
- HSS
- PGW
- S1-MME
- S1-U
- S6a
- S11
- S5 GTP
- MOM
- SGi
- S1-MME
- S1-U
- S6a
- S5 GTP
- UE
- LTE-Uu
- Cellular Operators
- Microcell Operator
(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 (macrocell), UE reconnects to cell (cellular).

A device

Module for cellular operator

Module for microcell operator

Commercial LTE Modules connected to a PC by USB I/F
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
Displays
Sharing meeting documents/materials, showing remote attendees, and showing some suggestions from meeting assistance function.

Meeting assistance robot
Taking meeting logs and support discussions, working with servers/edge computing resources.

Smart desk with built-in 5G sheet antenna
Same frequency bands can use at adjacent smart desks.

Tablet PC
Showing faces of remote attendees.

Smart chair
Sense position and movement of seated person.

E-whiteboard
Drawing lines can be shared with another one at different locations.

Two dimensional (thin) access area on a table as “private area” for spectrum sharing.
Conclusion

- 5G will play an important role
  - As an infrastructure for IoT
  - Concept of self-deployed micro cells in private area and spectrum sharing could be one of the keys

- Collaboration with variety of entities
  - Necessary for 5G R&D, not like until 4G
  - IoT/5G technologies are more business/service oriented