

6G Radio Technology Project Advanced MIMO WG — WG Activities and White Paper —

September 30, 2025

Advanced MIMO Working Group

Introduction of Advanced MIMO Working Group

- **Advanced MIMO Working Group (A-MIMO WG)**

- Chair: Kazushi Muraoka (NEC)
- Vice chairs: Daisei Uchida (NTT), Shunsuke Kamiwatari (KDDI Research)
- 40 Members (As of 2025/09)
 - Industry: KDDI, NTT, NTT DOCOMO, Softbank, NEC, Sharp, Ericsson Japan, Panasonic, KYOCERA, Sony, Huawei Japan, NICT, Keysight, DNP,
 - Academia: Hokkaido Univ., Univ. of Electro-Communications, Tokyo Univ. of Science, Tohoku Univ., Fukuoka Univ., Tokyo Univ., Science Tokyo

- **Objectives of WG**

- Engage in discussions regarding domestic and international technological trends, standardization activities related to Advanced MIMO technologies as well as use cases and scenarios of practical application
- Propose directions for the Advanced MIMO technologies.

- **Recent Activities**

- Monthly meeting including discussion on Advanced MIMO related topics
- White Paper

Features of A-MIMO WG

- **A forum dedicated to discussions on MIMO technology**
 - Discussing MIMO technology from various perspectives, including future MIMO technology, MIMO technology for mobile communications, and uniquely Japanese MIMO technology.
 - Engaging in discussions on MIMO from the viewpoints of universities, vendors, and carriers
- **A platform for human networking that is not found in other consortia.**
 - Combining industry and academia.
 - Composed of members different from those in academic societies.
 - ※ With a focus on online meetings, participation is easy and timely.
- **External appeal (Promoting as Japanese MIMO researchers and engineers)**
 - White Paper Release: Overview will be presented Today
 - Submitting to international conferences for special sessions as a working group.
 - Showcasing Activities at Exhibitions and Other Events

Introduction of White Paper



- Preface
- Section I:
Evolution and Challenges of Advanced MIMO
Towards 6G
- Section II:
Recent Activities of Advanced MIMO Technologies
in Japan

Section I

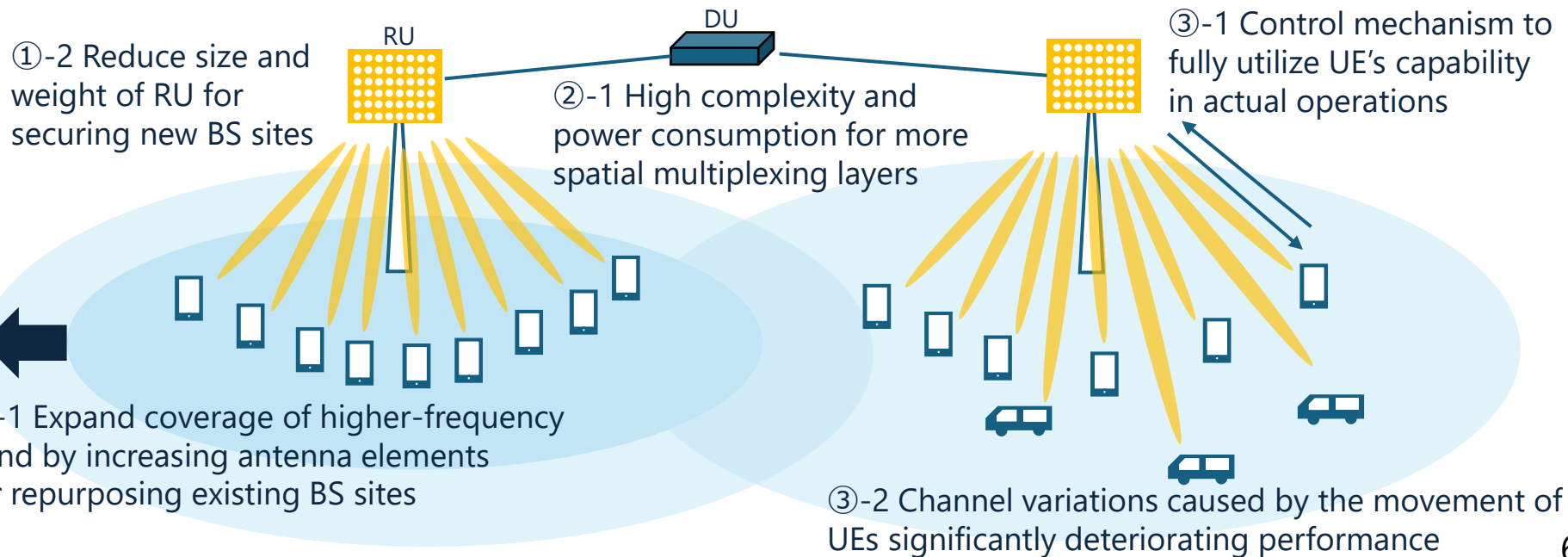
Evolution and Challenges of Advanced MIMO Towards 6G

I. Evolution and Challenges of Advanced MIMO Towards 6G

I-1. Current Status and Challenges of Massive MIMO

Challenges toward Advanced Massive MIMO

- ① Challenges related to BS deployment and frequency
- ② Challenges concerning equipment for BSs and Ues
- ③ Challenges in transmission methods



I. Evolution and Challenges of Advanced MIMO Towards 6G

I-1. Current Status and Challenges of Massive MIMO

Challenges of Distributed MIMO

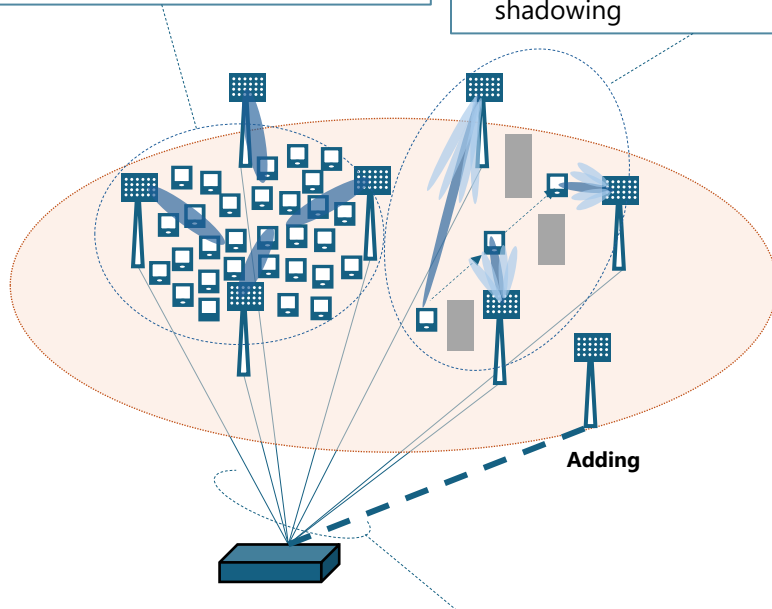
The number of spatial resource increase :

- Schedulers become more complex.
- Reference signals needs flexibility to increase.

Using high-frequency band:

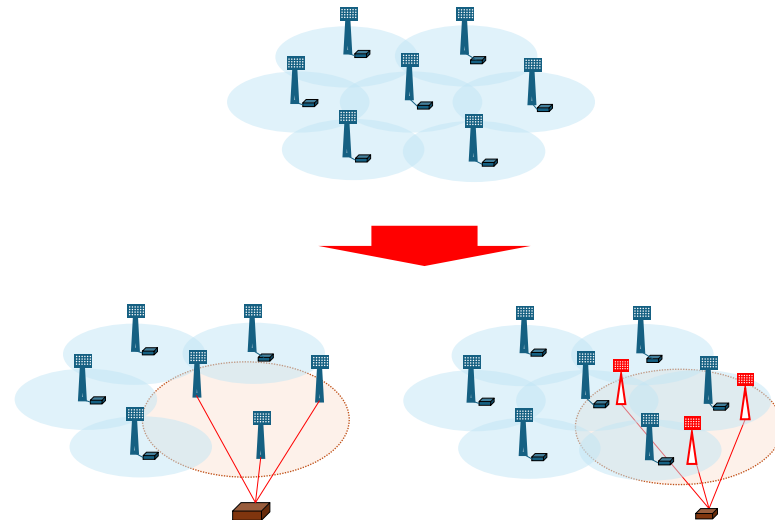
- Optimum selection for combination of TRP/beam
- Proactive selection of TRP under shadowing

How do we evolve from a cellular configuration to a distributed MIMO configuration?



Adding TRP:

- Deployment TRP cost need to be lower
- Fronthaul capacity need to be flexibly expanded



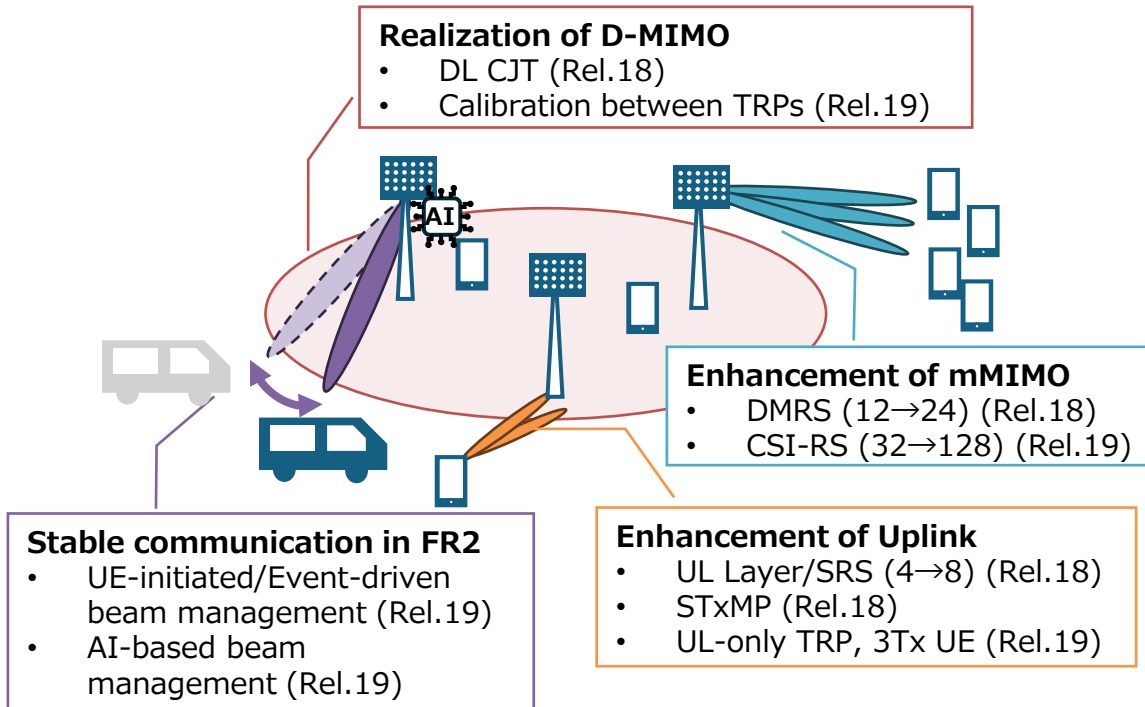
Configuring distributed MIMO with existence TRP

Configuring distributed MIMO with new TRP

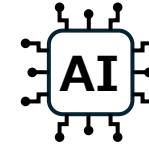
I. Evolution and Challenges of Advanced MIMO Towards 6G

I-3. Recent Activities related Advanced MIMO in 3GPP

A-MIMO in 5G-Advanced



Towards 6G



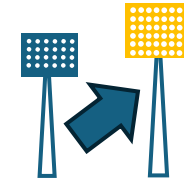
AI/ML-native NW

- AI-based function
- RS enhancement



Energy friendly NW

- Network Energy Saving
- Energy efficient MIMO



Further evolution of MIMO

- More massive antennas
- Practical D-MIMO
- Side systems (RIS, etc.)



New spectrum

- Frequency Range 3 (FR3)
- Efficient use of FR1-FR3

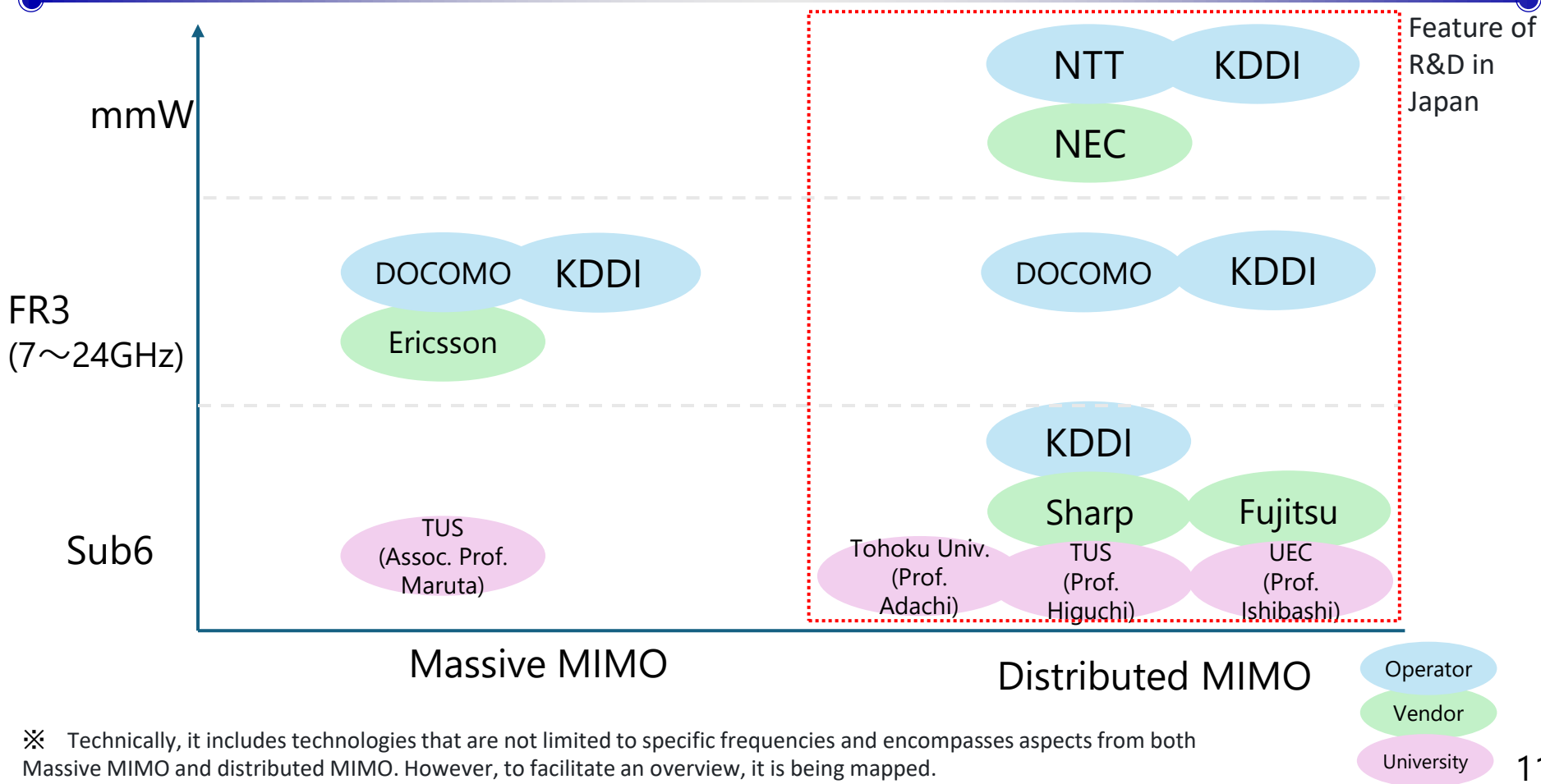
Section II

Recent Activities of Advanced MIMO Technologies in Japan

Section II Contributions

Contributors (1 st)	Title
KDDI Research, Inc.	Research Activities for MIMO Evolution in Each Frequency Range towards 6G
NTT DOCOMO, INC.	Performance Evaluation of FR3 Distributed MIMO Using 6G Simulator
NTT DOCOMO, INC.	Performance Evaluation of FR3 Massive MIMO in Real Urban Areas through Link-Level Simulation
NTT	High-frequency Band Distributed Antenna System
NEC Corporation	Distributed MIMO Technology for Efficient Utilization of Millimeter-Wave Bands
Fujitsu Limited	Distributed Antenna Technology (High-density Distributed Antenna System and Transmission Point Sharing Control)
SHARP Corporation	6G views on Coherent Joint Transmission and Multi-User MIMO
Ericsson Research Japan	A Study on Advanced MIMO Large Arrays in the 7–15 GHz Spectrum for 6G
Tohoku University	User Cluster-centric Approach for Cell-free Massive MIMO Systems
Tokyo University of Science	Low-Complexity User-Centric TRP Clustering Method in Downlink Cell-Free MIMO with Regularized ZF-Based Beamforming
Tokyo University of Science	Robust Massive MIMO Transmission Technology in Mobile Environments
The University of Electro-Communications	Recent R&D Activities of Distributed MIMO (D-MIMO) Technologies in Japan

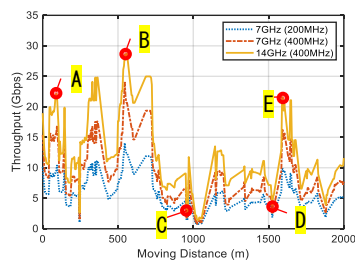
Main Target of Each Contribution



Massive MIMO (Sub6, FR3)

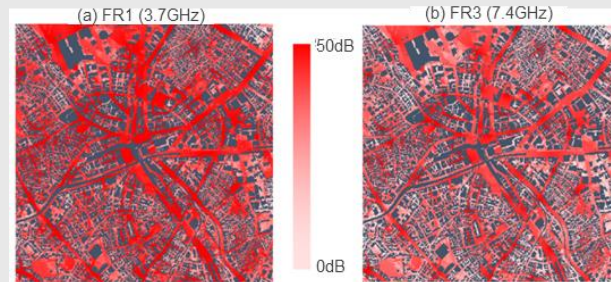
NTT DOCOMO

Evaluated the characteristics of FR3 Massive MIMO in a propagation environment using color imaging techniques.



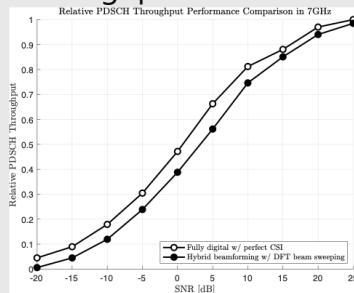
KDDI Research

Evaluated the characteristics of FR3 Massive MIMO and Sub6 Massive MIMO.



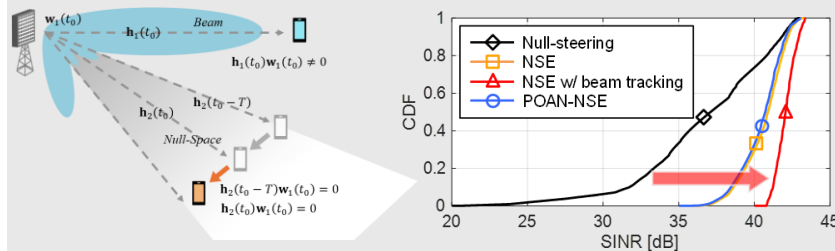
Ericsson Japan

Simulation shows that the hybrid BF of FR3 Massive MIMO approaches the throughput characteristics of full digital BF.



TUS (Assoc. Prof. Maruta)

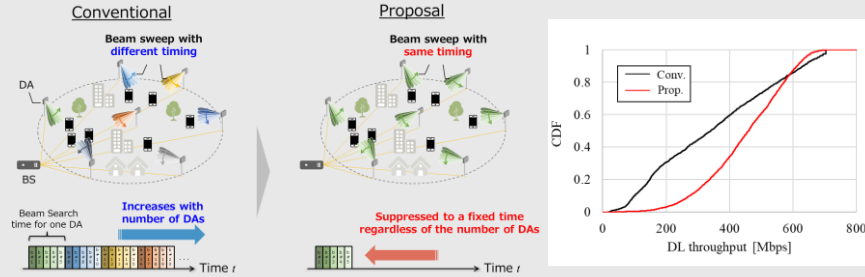
By using BF with null space expansion, robustness to channel time variations in multi-user MIMO is improved.



Distributed MIMO (mmW, FR3)

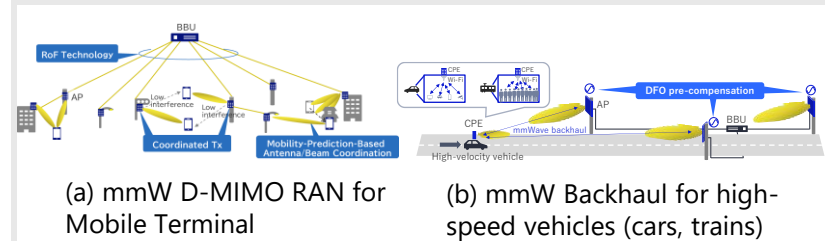
NTT

Evaluate simultaneous beam search sweeps across distributed antennas for mmW D-MIMO.



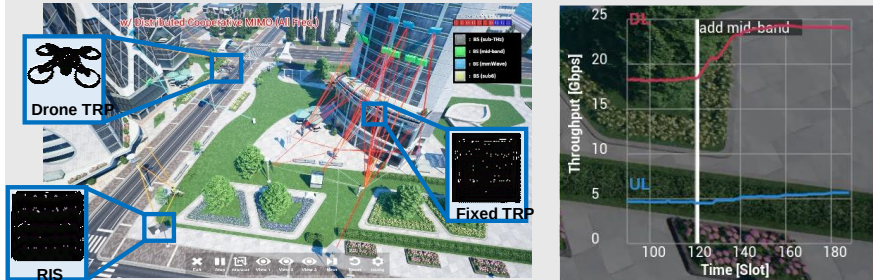
NEC

Enabling technologies for mmW D-MIMO in two use cases: for mobile terminals and high-speed vehicles.



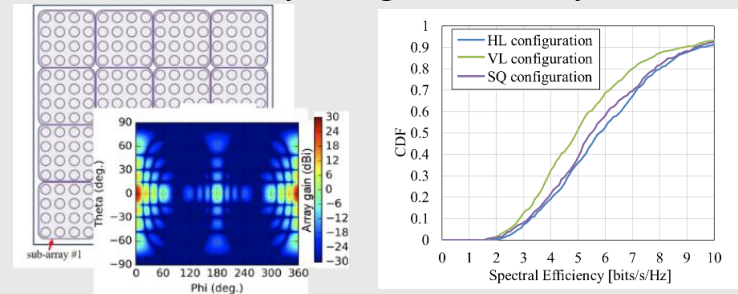
NTT DOCOMO

Evaluate the performance of FR3 distributed MIMO using a 6G simulator that emulates urban environments.



KDDI Research

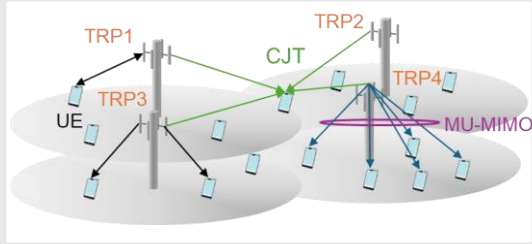
Evaluated performances of FR3 Cell-free mMIMO based on different subarray configurations of hybrid BF



Distributed MIMO (Sub6)

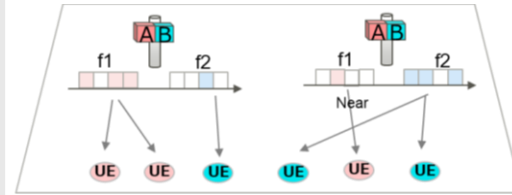
Sharp

Combine CJT with MU-MIMO in a multi-TRP environment.



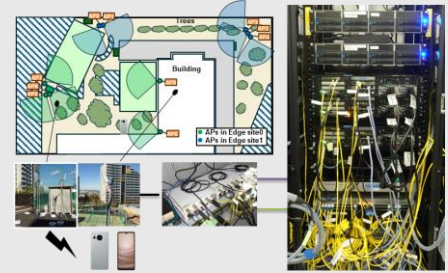
Fujitsu

Introduce shared RUs between MNOs for transmission from the optimal RU for each UE



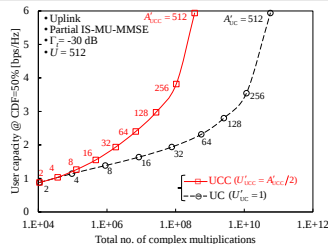
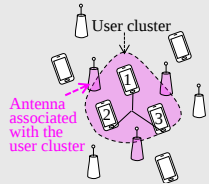
KDDI Research

Field trial of CF-mMIMO with 10 BS in 4.8 GHz with a 100 MHz BW



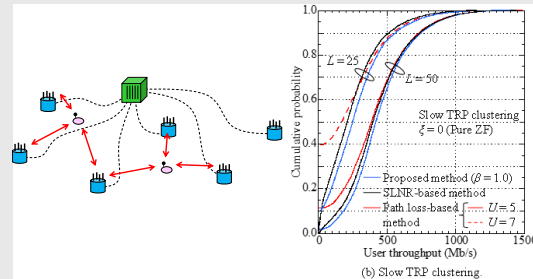
Tohoku Univ. (Prof. Adachi)

Improved computational efficiency-to-capacity by user cluster-centric CF-mMIMO.



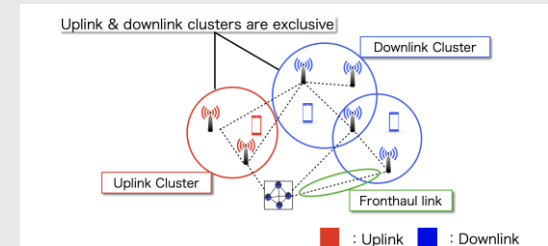
TUS (Prof. Higuchi)

Proposed low-complexity TRP clustering suitable for Regularized ZF



UEC (Prof. Ishibashi)

Duplex technology for D-MIMO and receiver design under FH constraints



Summary

- Introduction of Advanced MIMO (A-MIMO) WG
 - Many institutions from the industry and universities are participating
- A brief introduction to the summary of the white paper on Advanced MIMO Technology.
 - Massive MIMO and Distributed MIMO
 - A wide range of frequency bands, including Sub-6, FR3, and mmWave.

- **For those interested in the technical details, please refer to the white paper.**
- **If you are interested in discussions or gathering information about Advanced MIMO, please consider joining this WG.**