Beyond 5G International Conference

NEC's Vision and Activities for Beyond 5G

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Telecom Services Business Unit

NEC Corporation

NEC 2030VISION

Life

Bringing people together and filling each day with inspiration

Society

Nurturing prosperous cities with inclusive and harmonious societies

Creating sustainable societies by shaping new industries and workstyles

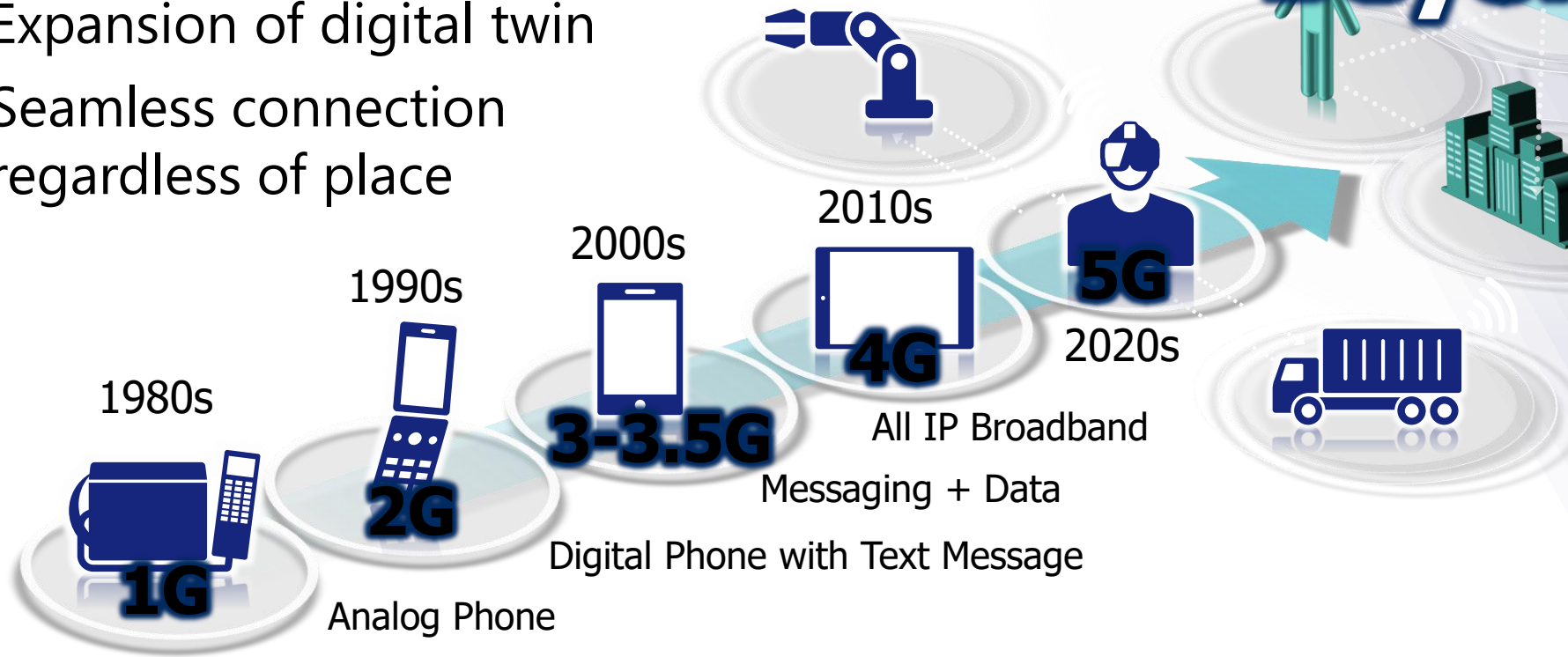**Sharing hopes that transcend time, space, and generational boundaries**

Environment

Living harmoniously with the earth to secure the future

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What is Beyond 5G/6G？

The world in 2030

- Hyperreal communications transcending time and space
- Expansion of digital twin
- Seamless connection regardless of place

Beyond 5G/6G

1980s
1G
Analog Phone

1990s
2G
Digital Phone with Text Message

2000s
3-3.5G
Messaging + Data

2010s
4G
All IP Broadband

2020s
5G

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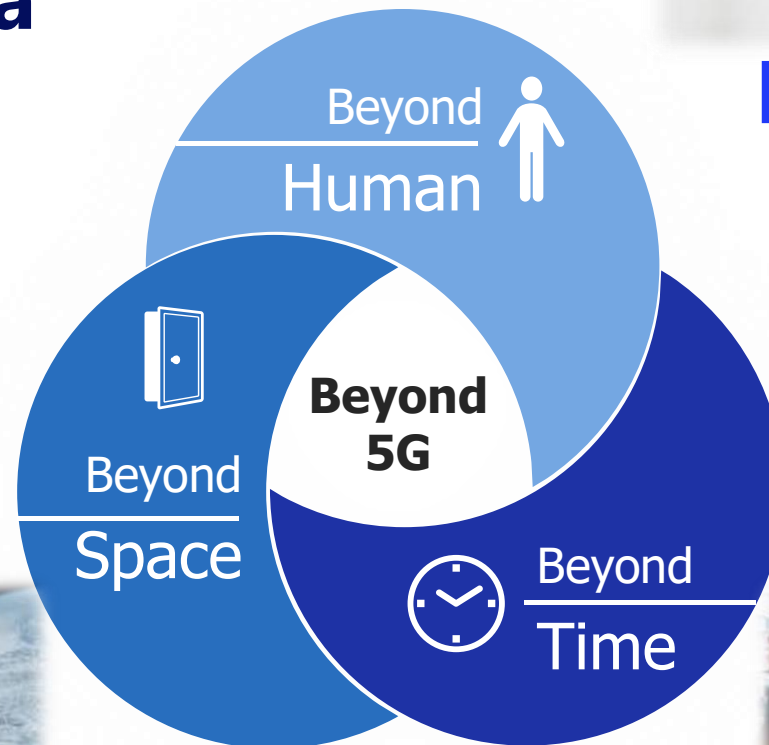**The world of new communication in Beyond 5G/6G era**

「Beyond Human」
Unleashing human potential over the limitation

「Beyond Space」
From sea to space
Beyond real and virtual

「Beyond Time」
Grasp the future and trace back the past

Beyond Human

Beyond 5G

Beyond Space

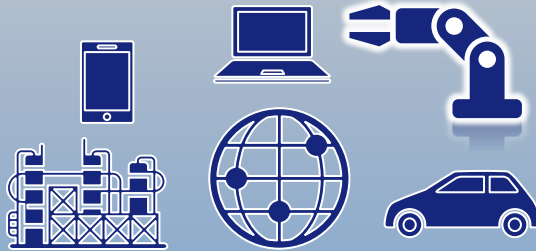Beyond Time

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Changes of market value in the Beyond 5G world

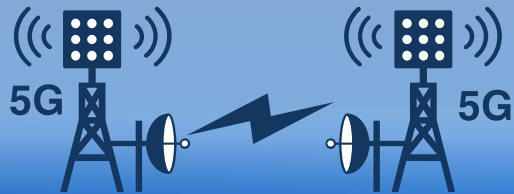
5G era

Mainly for industrial expansion

Digital transformation(DX)
Corporate activities and
urban issues resolved

High speed
connection of
people/ things

**Network connection with
high speed/ low latency/ massive connectivity**

5G   5G

Beyond 5G/6G era

Further evolution of human and society

New-normal/ workstyles
Sustainable society where
everyone has the chance to
reach their full potential

AI

Seamless
connection of
People/ things/
experience

Virtual

Digital twin

Real

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Social Design through Beyond 5G collaboration

NEC aims to solve social problems for realizing Society 5.0 by Social design approach through from collaborative R&D, PoC to social implementation with broad range of stakeholders.

R&D

2021 ~

Laboratories

University, Company

PoC, Test, Demonstration

2022~24

Living Lab.

Ecosystem Member

Social Implementation

2025 ~

Society

Citizen, Town, Industries

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Direction of wireless technology evolution

5G/5G Advanced → **Beyond 5G/6G**

Coverage band (Sub6,FR3) — Wide coverage by Sub6 Massive MIMO

Massive MIMO enhancement (e.g. AI based beam management)

Capacity band (mmW,SubTHz) — Fixed Wireless Access

mmW deployment (e.g. Distributed MIMO for Hot Spot/Zone)

DA
RoF
CU/DU/RU

AI native and Integrated Wireless Access

FR3 Micro
Sub6GHz Macro
mmW Pico/Spot

- Sub6GHz Access Link w/Beamforming
- FR3 Access Link w/Beamforming
- mmW Access Link w/Beamforming
- FR3 Front/Backhaul w/Beamforming
- mmW Front/Backhaul w/Beamforming
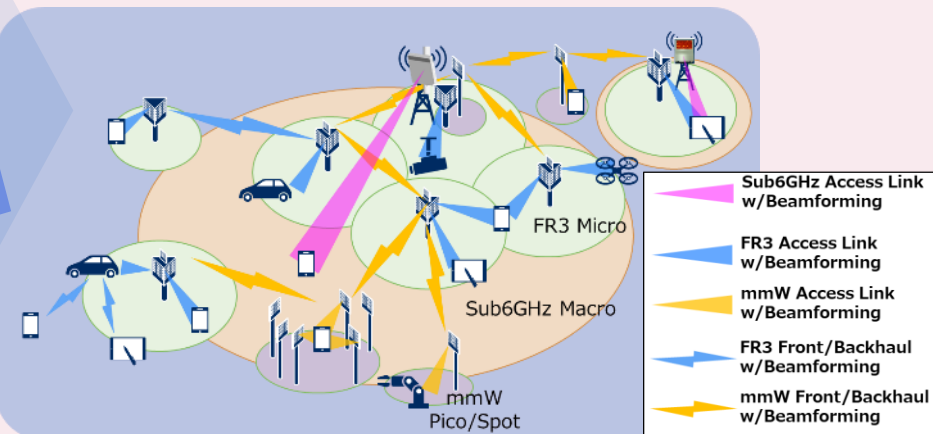
Sub6/FR3/mmW Heterogeneous NW achieving both Coverage and Capacity

+

SubTHz deployment for some specific use cases (e.g. Sensing and Communication)

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# 40GHz band distributed MIMO experiment by NTT, NTT DOCOMO and NEC

Technology 1: Multi-user transmission technology utilizing narrow beam
→Maintains the interference suppression effect under moving and multiuser condition

Technology 2: Antenna-beam selection technology based on terminal mobility prediction
→Possible to avoid disconnection by obstacles under moving condition

◆ **Realizes a stable, high-speed, high-capacity communication in the high-frequency band**
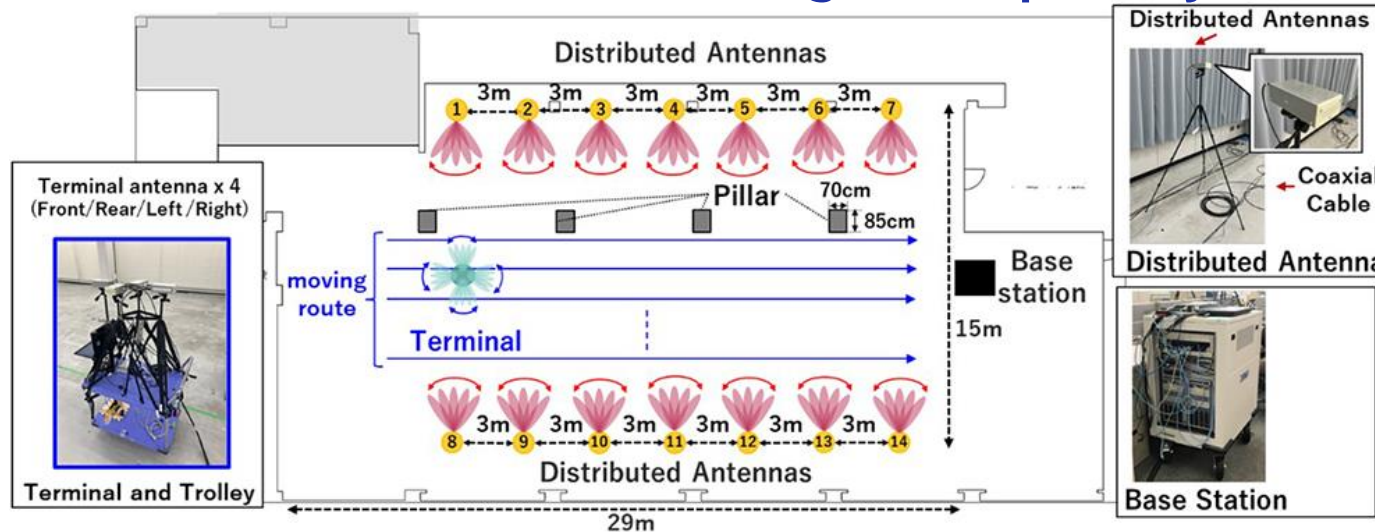
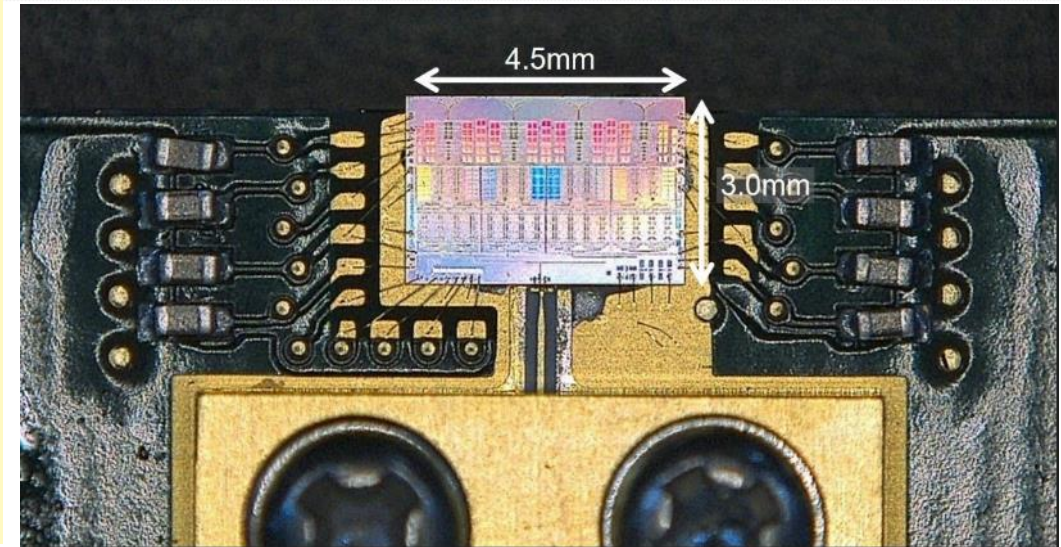https://www.nec.com/en/press/202310/global_20231031_01.html

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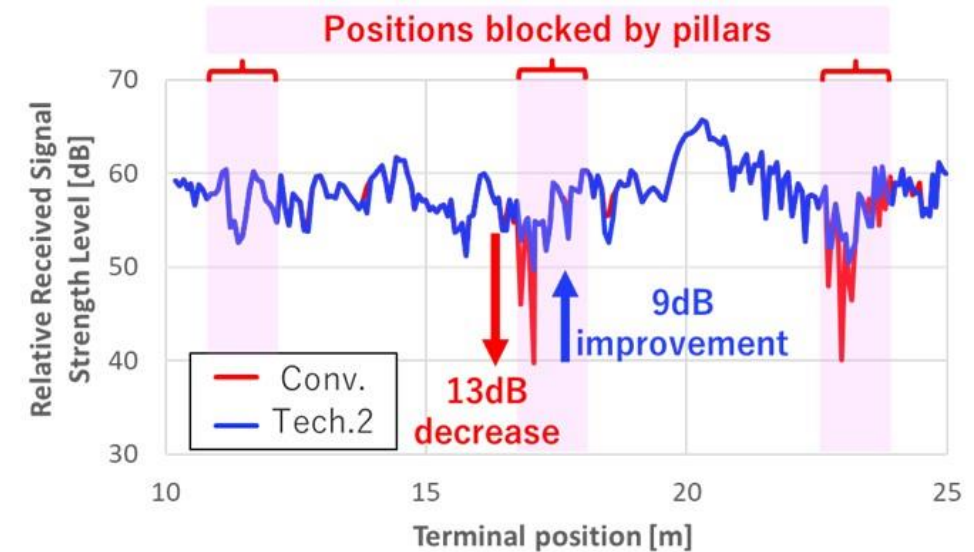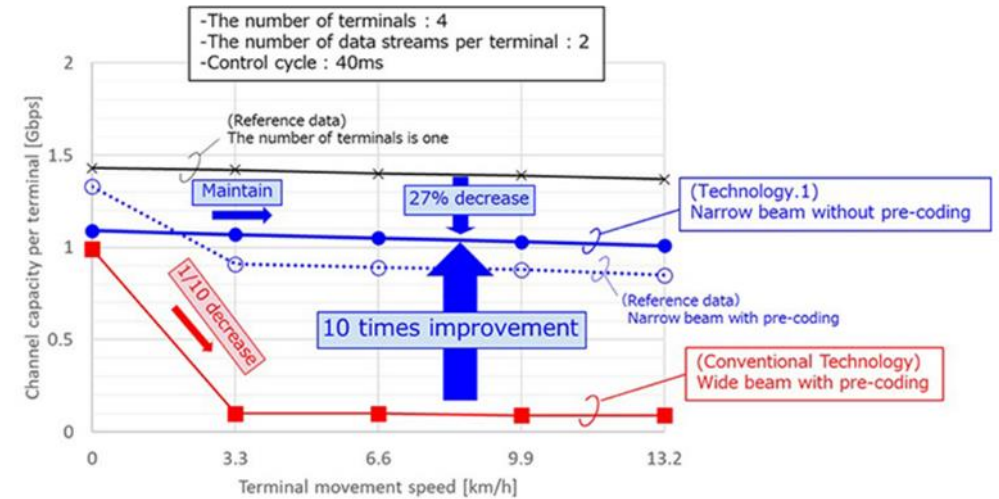
150 GHz Antenna-on-Chip transmitter IC for Beyond 5G/6G

150 GHz phased array antenna elements
+
**Phase shifters**
+
Transmission amplifiers

⬇

Single Chip
Antenna-on-Chip(AOC)

◆ **Minimizes the inter connection losses in the radio equipment**
◆ **Provides a solution to realize highly directional, high-gain antenna technology and its beam steering technology**

This research is supported by the Ministry of Internal Affairs and Communications in Japan (JPJ000254).

https://www.nec.com/en/press/202310/global_20231012_01.html
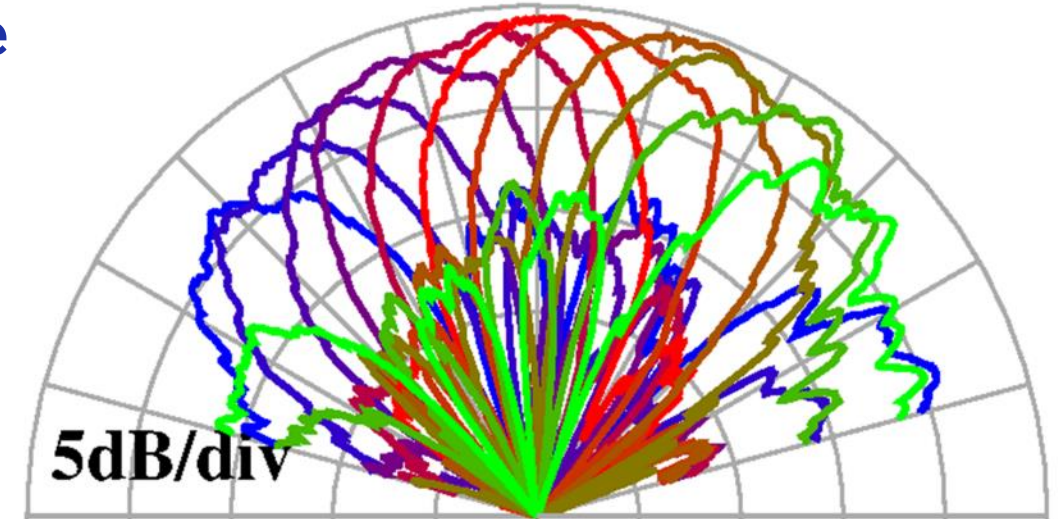
Measured beam steering performance of the AOC

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Towards social implementation of the next generation network

Our activity = More harmony with society
as the network to become a social infrastructure

**Vison based
back cast thinking**

Starting from scratch
Thinking from how we should be in long term

**Realizing a sustainable society
having goodness of Japan**

**Consumer perspective
With various players**

**Verification of social acceptance
using living space**

Starting from scratch
Participation of various citizens and companies

Starting from scratch
Both from virtual and real life

Harmony with local nature

Environment
Live with the minimum energy needed

**Living Lab with 6G / IOWN
to create new things from scratch**

**Sustainable
town system**

Society
Technology getting closer
and kind to the people

**Live as you
want to be**

Life
Connected whenever wherever

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Image of "Living Lab"

◆ Establish a **special ward**, which is a realistic social and living space that serve **as microcosms of society**, supported by cutting-edge digital infrastructure.

◆ Aiming **to verify and create new use cases** freely and flexibly using this ward.

Drone inspection
3D coverage
(Mobile Carrier/Satellite communication)

Mountainous area
Communications outside carrier network coverage
(NTN/Satellite communication)

Stadium
Ultra high-speed communications
(mmWave/THzWave)

Living space
Use case optimized communications
(Network slicing)

Remote control
Ultra low latency communications
(IOWN)

Logistics warehouse
Ultra Reliable communications
(Private 5G/QoE Control)

Key points of this Living Lab concept
✓ **Implement technology by taking regional characteristics (nature, culture, history, etc.) into account**
✓ **Set up a sustainable system which allows people to keep living by utilizing local resources.**
✓ **Transform the infrastructure for living toward the realization of ideal.**

ON AIR

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"NEC Beyond 5G Research Alliance Laboratories," established by Osaka University and NEC

NEC established a "Living Lab" for the Social Implementation of "Probabilistic Digital Twins"
- First demonstration at the elderly care facility in Osaka

Osaka University※

- Creation of ideal caregiving concepts
- Study of methods for collecting and analyzing data in daily life
- Examination of methods for predicting the emotional status of individuals

※Graduate School of Information Science & Technology,
Graduate School of Engineering,
Cybermedia Center

NEC

- Study of Digital Twins for the Beyond 5G era
- Study and verification of methods for collecting and analyzing data using Digital Twins
- Examining how to use Probabilistic Digital Twins to predict future outcomes

Analyzing the relationship between environmental changes and comfort, effective adjustments will be made in the real world.

Collaborate to "extend" digital technology to enrich people's heart

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# Beyond 5G Value Co-creative Social Collaboration Course with the University of Tokyo

"Only now, Only here, and Only for you" communications according to conditions, locations, and needs

Realizes by taking the advantage of the nature of high frequency bands, and provides a detailed, dynamic and robust communication environment to ensure the quality of service

mmWave   sub-THz Wave
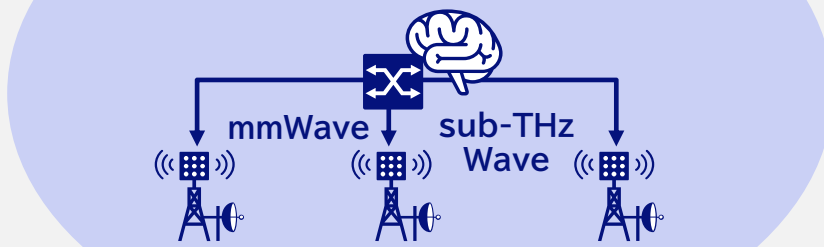
"Safety and Security"
where only specific users can access

AR/VR

Content viewing

Remote operation

Self-driving

Aiming to achieve through research and development of
"Dynamic Space-Time Slicing" and "End-to-End QoE Control Technology."

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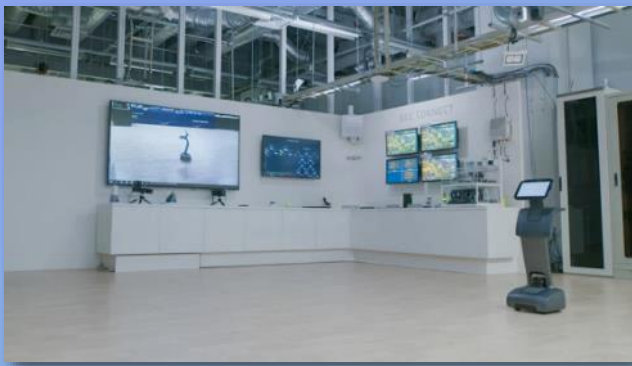# "NEC CONNECT": Open Co-creation lab using network technology

Invite partners from a wide range of industries and sectors to verify the technology and social acceptance, and steadily promote its social implementation

NEC CONNECT

Connecting the Present and the Future

Connecting people

Connecting concept and implementation

NEC CONNECT 5G Lab

NEC CONNECT Lab with IOWN

NEC CONNECT Living Lab

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URL : https://www.nec.com/en/global/techrep/journal/g23/n01/g2301pa.html

\<Theme\>
Special Issue on Open Network Technologies — Network Technologies and Advanced Solutions at the Heart of an Open and Green Society

\<Contents\>
- Open RAN and Supporting Virtualization Technologies
- Wireless Technologies for 5G/Beyond 5G
- Initiatives in Open APN (Open Optical/All Optical)
- Initiatives in Core & Value Networks
- Enhancing Network Services through Initiatives in Network Automation and Security
- Network Utilization Solutions and Supporting Technologies
- Global 5G xHaul Transport Solutions
- Toward Beyond 5G/6G

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NEC will keep challenging to realize
"the sustainable society where everyone has
the chance to reach their full potential"
with the power of innovation in the era of 5G and beyond

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