eMBB, URLLC, and mMTC
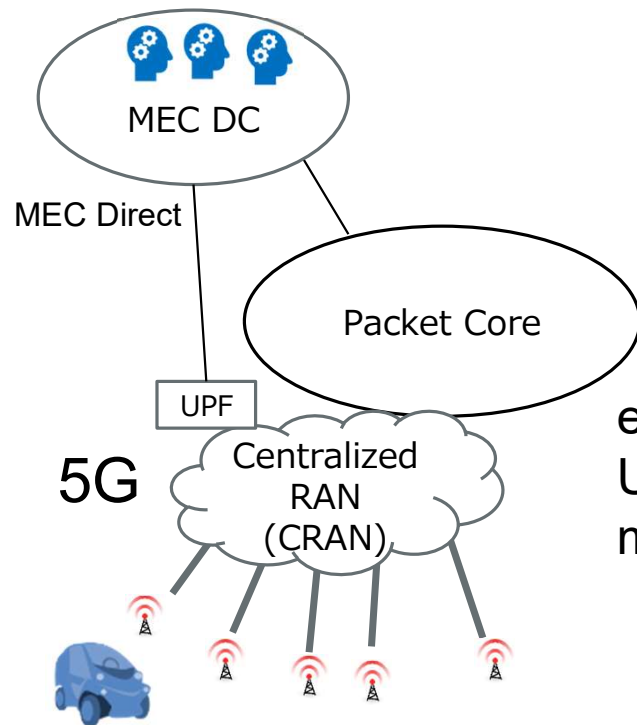# with
Cloud Agility, Elasticity, and Resiliency

December 2022

Masahisa Kawashima

IOWN Development Office, R&D Planning, NTT

Where we are
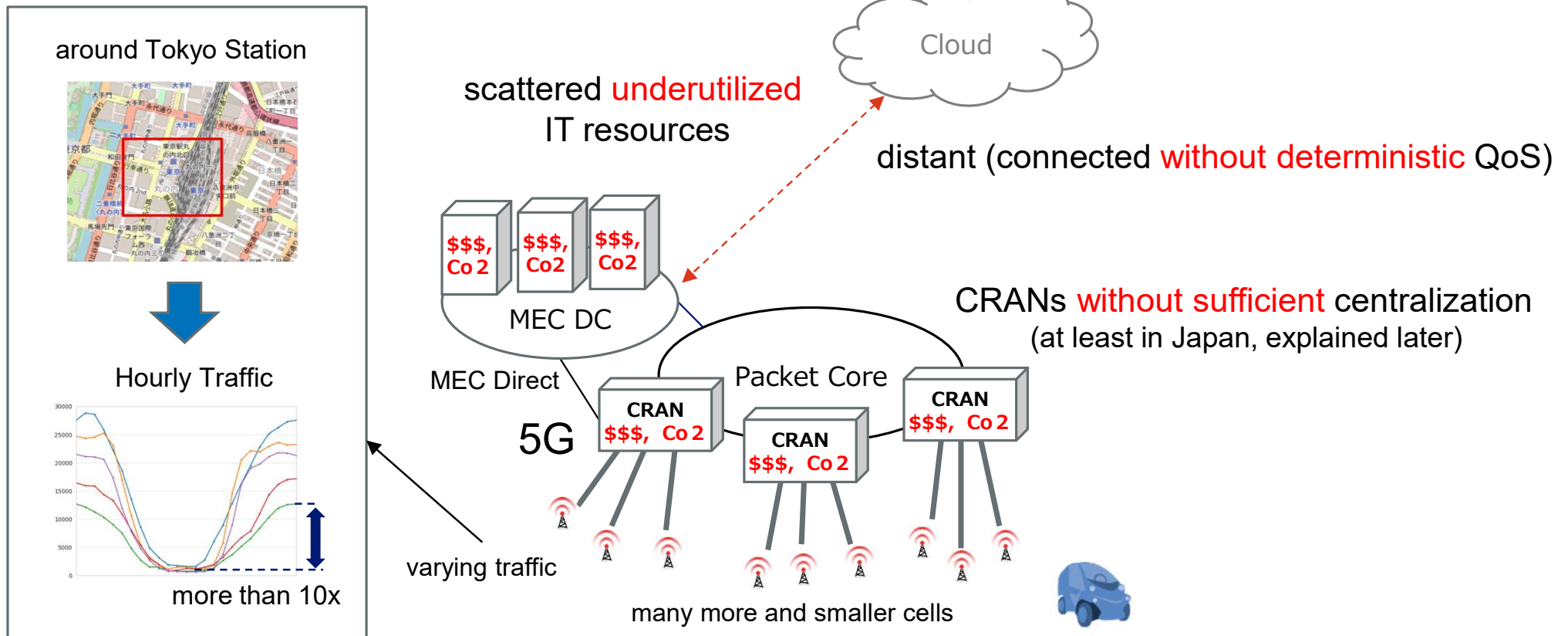
We've already got really great radio access systems.

cyber-physical applications

enhanced Mobile Broadband (eMBB)
Ultra-Reliable Low-Latency Communications (URLLC)
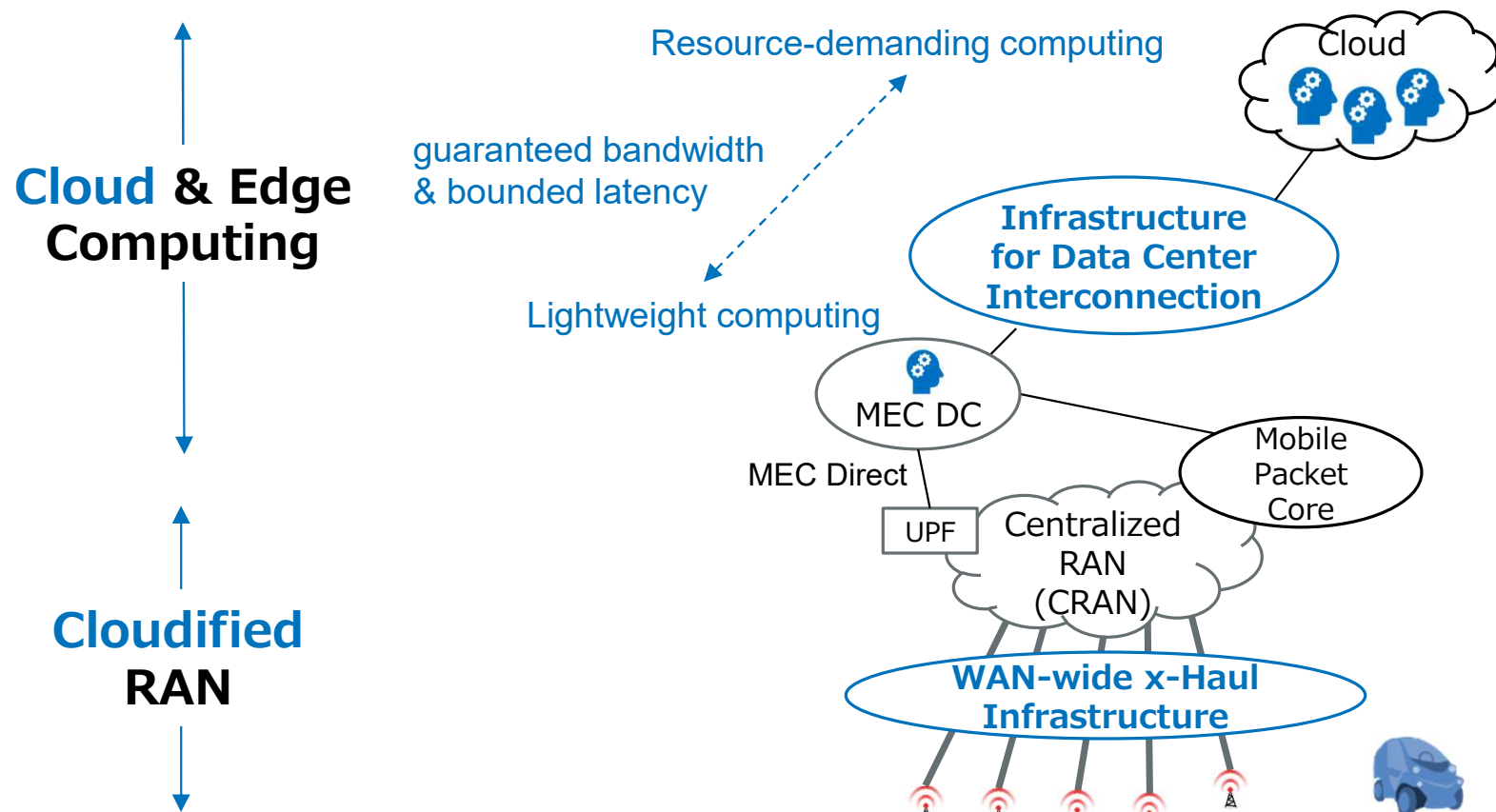massive Machine Type Communication (mMTC)

Issues

NTT

But 5G & MEC alone would not be able to
sustainably support cyber-physical applications

around Tokyo Station

Hourly Traffic

varying traffic

more than 10x

Cloud

scattered underutilized
IT resources

distant (connected without deterministic QoS)

$$$,
Co2

$$$,
Co2

$$$,
Co2

MEC DC

CRANs without sufficient centralization
(at least in Japan, explained later)

MEC Direct

Packet Core

5G

CRAN
$$$, Co2

CRAN
$$$, Co2

CRAN
$$$, Co2

many more and smaller cells

Where we should go : B5G Vision (Proposal)

NTT

eMBB, URLLC, and mMTC with **Cloud Agility, Elasticity, and Resiliency**

Resource-demanding computing

Cloud

Cloud & Edge Computing

guaranteed bandwidth & bounded latency

Infrastructure for Data Center Interconnection

Lightweight computing

MEC DC

MEC Direct

UPF

Centralized RAN (CRAN)

Mobile Packet Core

Cloudified RAN

WAN-wide x-Haul Infrastructure

3

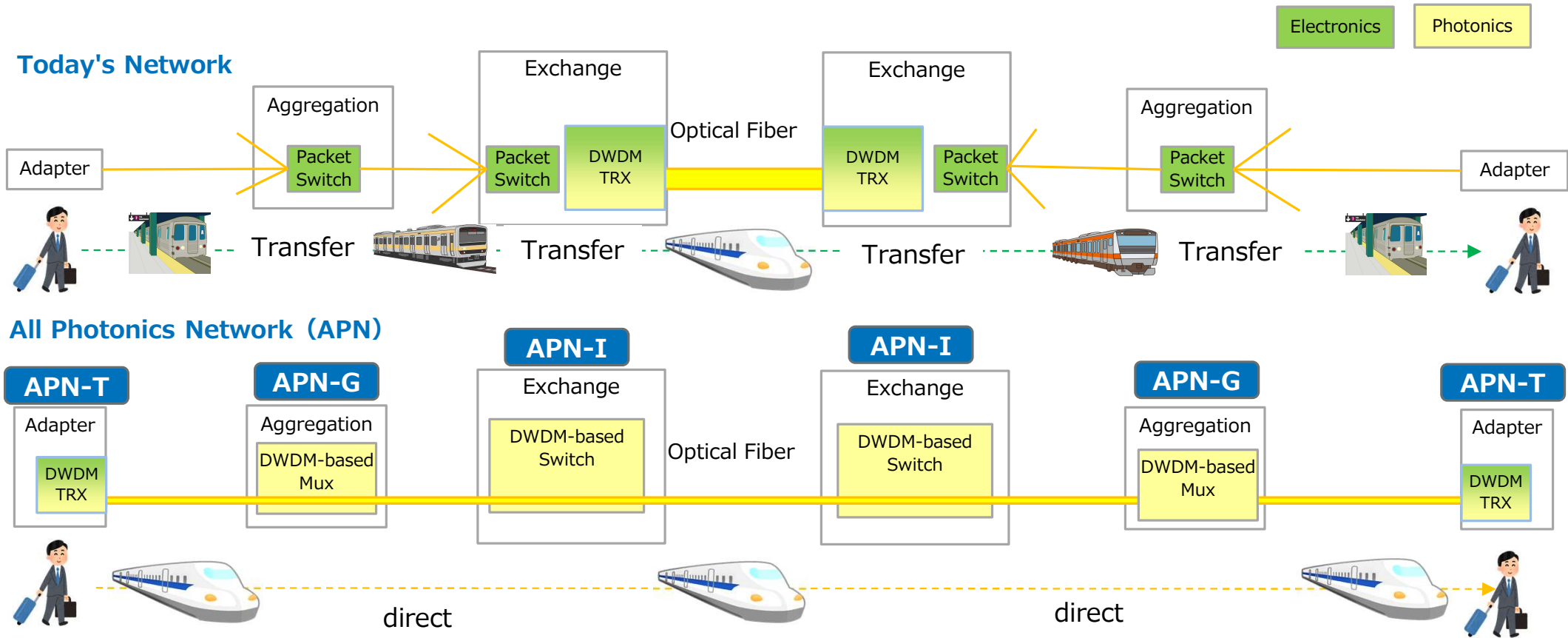# How could we achieve this vision?

NTT

Marriage between radio and optical networks

with IOWN All Photonics Network (APN)

IOWN : Innovative Optical and Wireless Networks

IOWN All Photonics Networks (APN)

Direct optical connections achieving guaranteed bandwidth and bounded latency

Electronics | Photonics

Today's Network

Adapter — Aggregation (Packet Switch) — Exchange (Packet Switch, DWDM TRX) — Optical Fiber — Exchange (DWDM TRX, Packet Switch) — Aggregation (Packet Switch) — Adapter

Transfer — Transfer — Transfer — Transfer

All Photonics Network（APN）

APN-T Adapter (DWDM TRX) — **APN-G** Aggregation (DWDM-based Mux) — **APN-I** Exchange (DWDM-based Switch) — Optical Fiber — **APN-I** Exchange (DWDM-based Switch) — **APN-G** Aggregation (DWDM-based Mux) — **APN-T** Adapter (DWDM TRX)
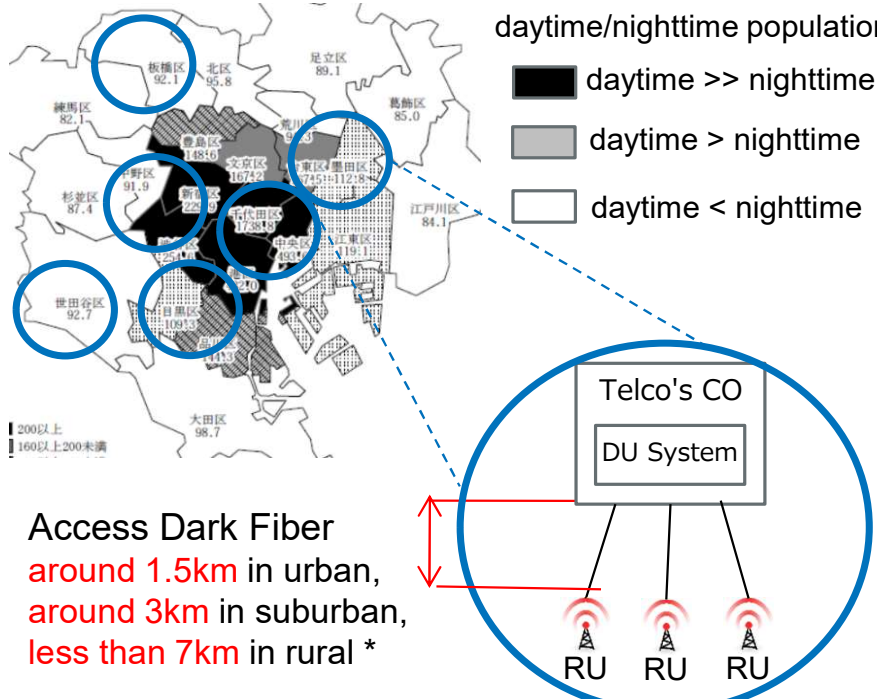
direct — direct

abc defined by IOWN Global Forum Open APN

RAN Infrastructure with Cloud Agility, Elasticity, and Resiliency

CRANs cannot be sufficiently centralized with dark fibers.

CRAN with Dark Fibers (TODAY)

CRANs are constrained by the span of access dark fibers

daytime/nighttime population
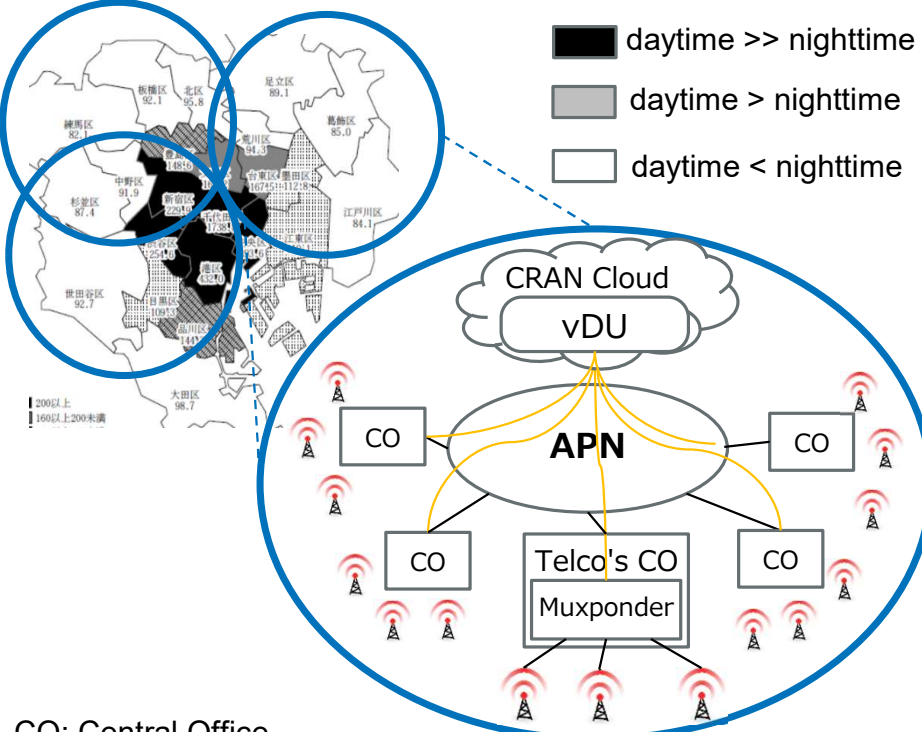- ■ daytime >> nighttime
- ▨ daytime > nighttime
- □ daytime < nighttime

Telco's CO
DU System
RU RU RU

Access Dark Fiber
around 1.5km in urban,
around 3km in suburban,
less than 7km in rural *

* based on the design of PSTN subscriber loops,
in other words, due to **historical reasons**

CO: Central Office

CRAN with APN

CRAN zones can cover both office and residential areas.
Reference: IOWN GF, Mobile Fronthaul over APN PoC

daytime/nighttime population
- ■ daytime >> nighttime
- ▨ daytime > nighttime
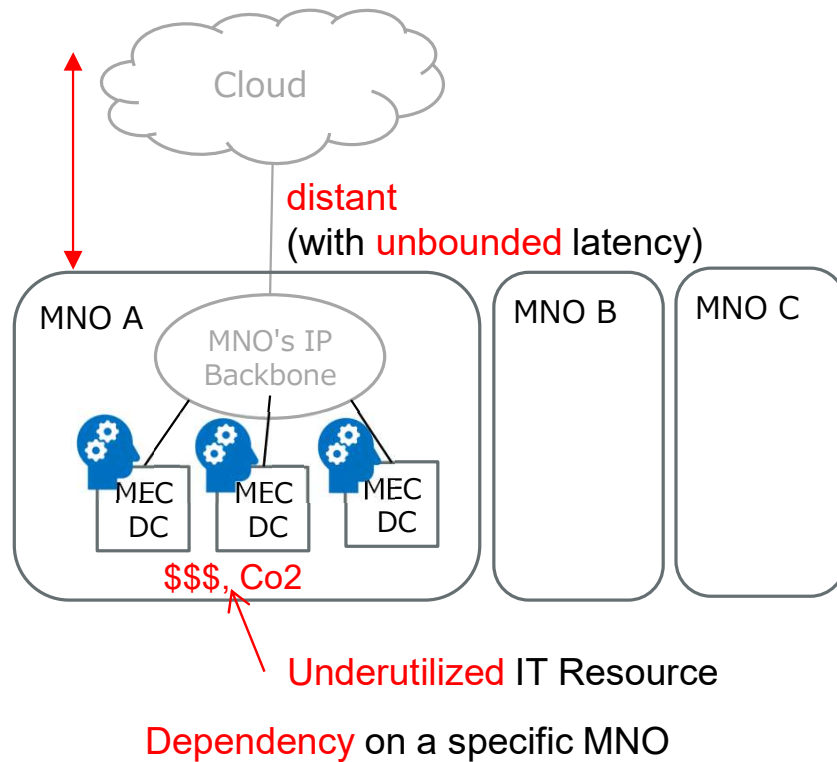- □ daytime < nighttime

CRAN Cloud
vDU
CO
APN
CO
CO
Telco's CO
Muxponder
CO

CO: Central Office

Cloud-and-Edge Computing

O NTT

Edge-Heavy Architecture (TODAY)

Cloud

distant
(with unbounded latency)

MNO A

MNO's IP Backbone

MNO B

MNO C

MEC DC

MEC DC

MEC DC

$$$, Co2

Underutilized IT Resource

Dependency on a specific MNO

Cloud-and-Edge Computing with APN

Carrier-Agnostic Low-Latency Computing
with a Large IT Resource Pool

Resource-demanding computing

Cloud*

IOWN GF DCI*

guaranteed bandwidth & bounded latency

MEC DC (MNO A)

MEC DC (MNO B)

MEC DC (MNO C)

APN

MEC DC (MNO C)

MEC DC (MNO B)

MEC DC (MNO A)

MEC DC (MNO A)

MEC DC (MNO B)

MEC DC (MNO C)

Lightweight computing
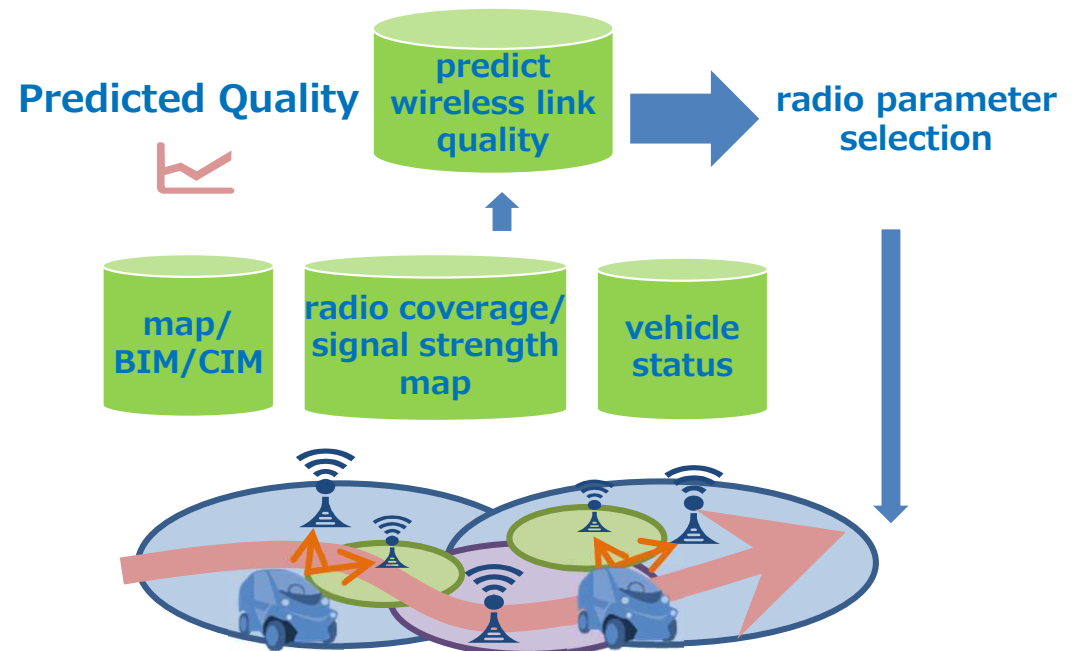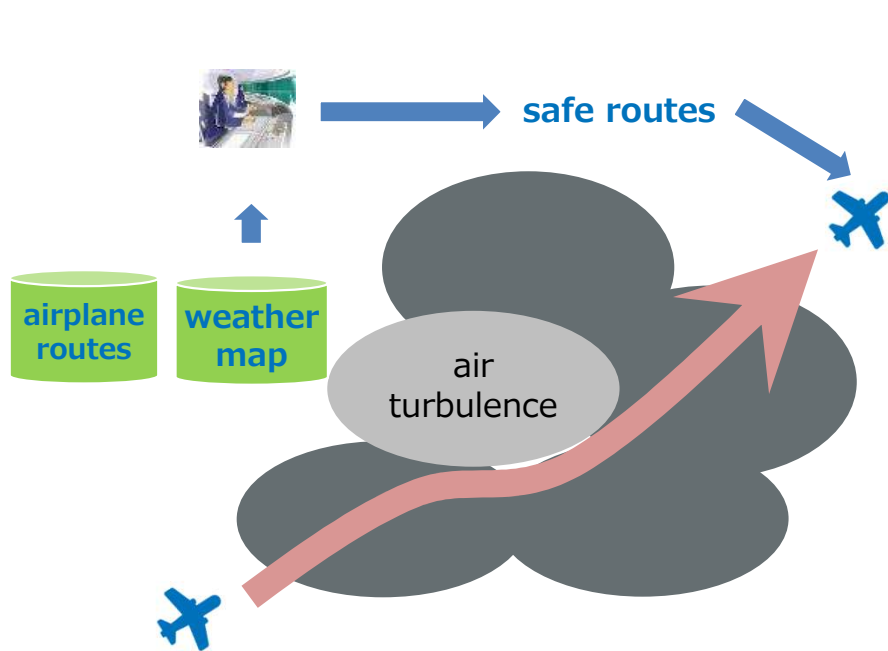
*DCI: Data Centric Infrastructure

7
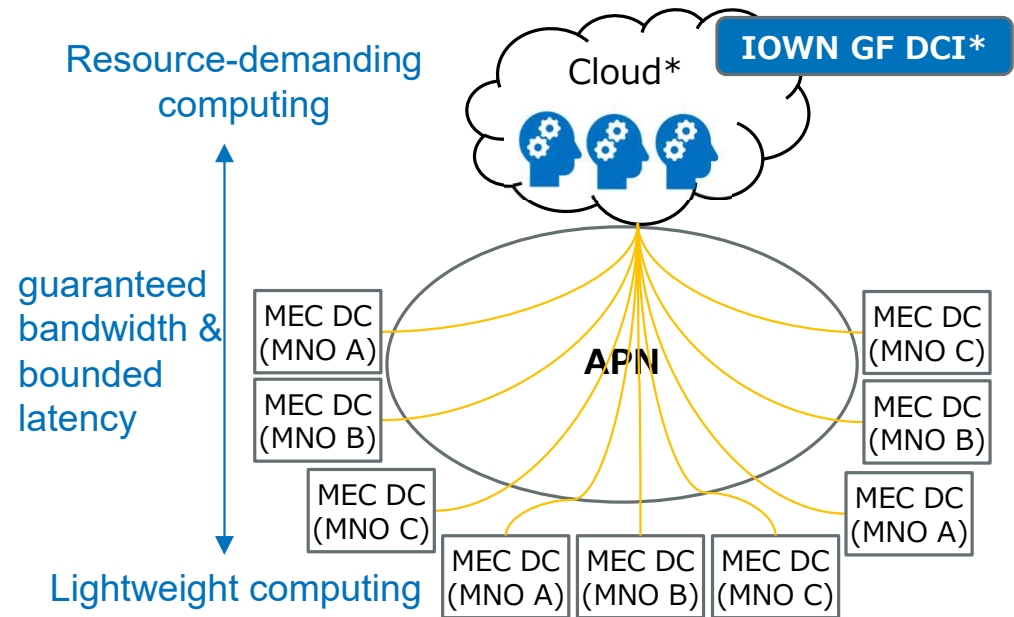
Dependable Radio under Pre-defined Mobility

NTT

Network operations like airplane flight operations

Airplanes can fly safely because
- They fly along pre-selected routes
- The weather condition of the routes is forecasted.
- The routes and schedules are updated based on the forecast

IOWN Global Forum

No one cannot achieve this vision alone.

- ✓ **In January 2020, NTT, Intel and Sony established Innovative Optical and Wireless Network (IOWN) Global Forum for the future communication**

- ✓ **Global non-profit organization for developing the next generation communication and computing infrastructure with new technologies, frameworks, specifications and reference architectures**
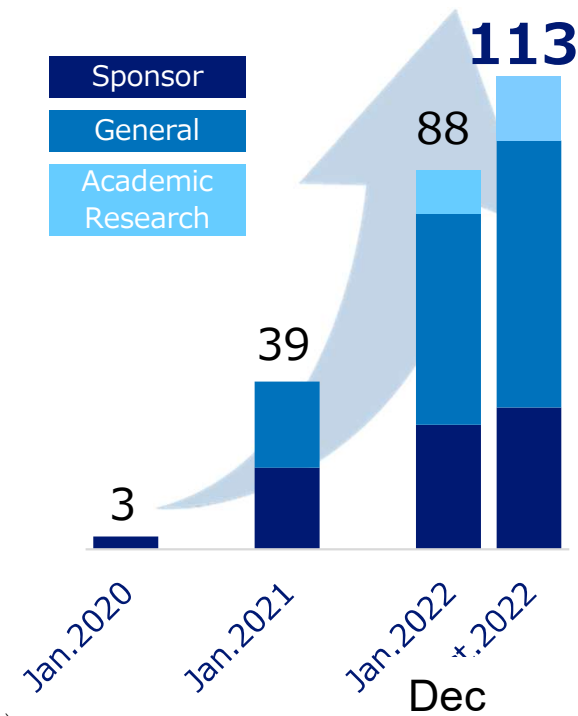
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	Hiroshima University

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General
Academic Research

113
88
39
3

Jan.2020 Jan.2021 Jan.2022 Dec. 2022

As of December 2022

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Executive Vice President, Head of Research and Development Planning, NTT Corporation

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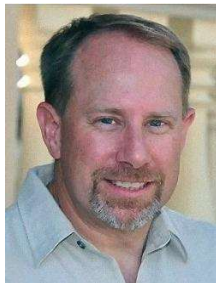**Dr. Masayuki Hattori**
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Vice President, Telecommunication Laboratories, Chunghwa Telecom

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IOWN Evolution Journey

2022 and beyond

Technology Documents

PoC Reference

- Data-Centric-infrastructure-as-a-service PoC Reference
- RDMA over Open APN PoC Reference
- Mobile Fronthaul over APN PoC Reference
- Open APN Fiber Sensing PoC Reference
- IOWN Data Hub PoC Reference
- Open APN PoC Reference
- PoC Reference：Reference Implementation Model for the Area Management Security Use Case

PoC activities
by each PoC team

Technical Feature **PoC**

Find next Work items / Study items
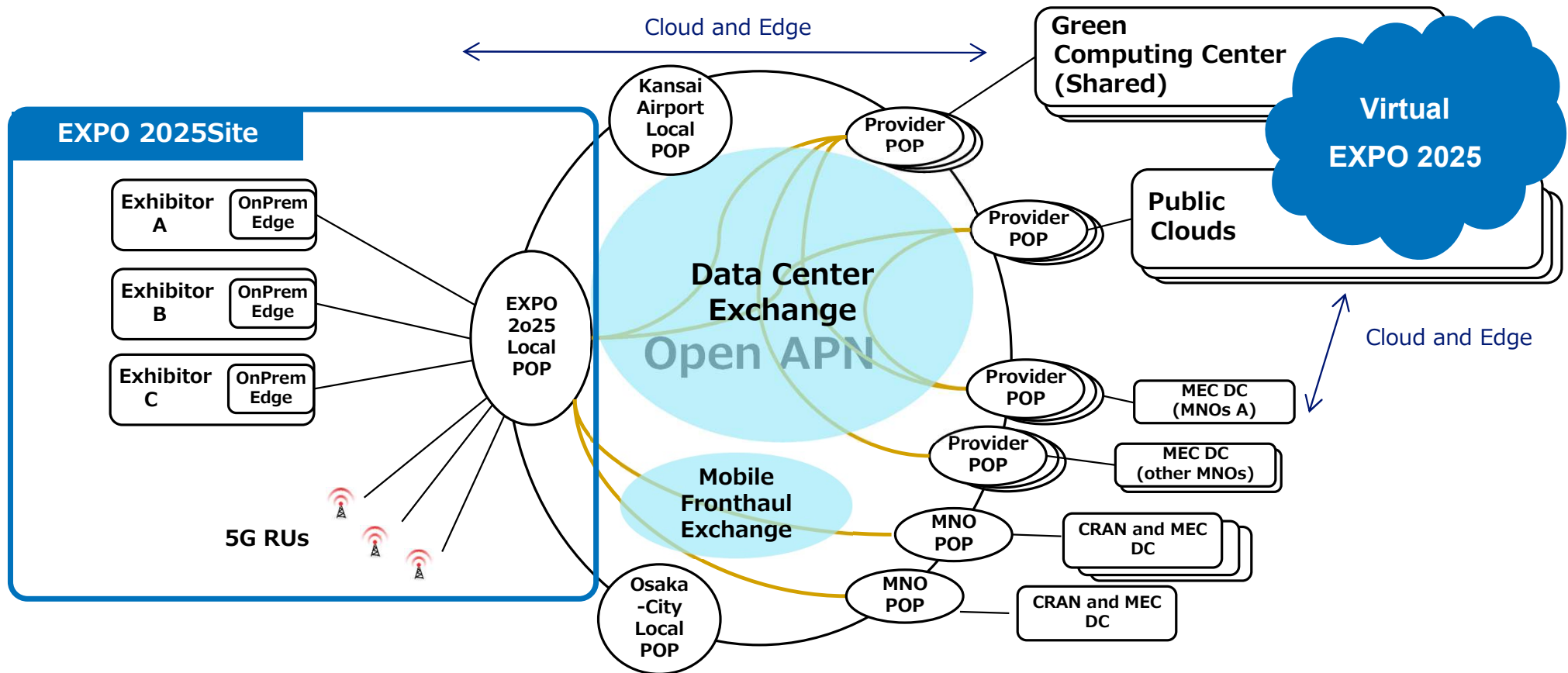
PoC
for Specific Use Cases

Demonstrate values

Continuous technology updates
through PoC activities

PoC : Proof of Concept
RDMA : Remote Direct Memory Access

IOWN APN for EXPO 2025, Osaka, Kansai (Under Study)

Cloud-and-Edge Computing for EXPO 2025

Disclaimer: Still Under Internal Study

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Conclusion

- eMBB, URLLC, mMTC with Cloud Agility, Elasticity, and Resiliency

- Marriage between Radio and Optical with IOWN APN
  - Cloudified RAN with IOWN APN
  - Cloud-and-Edge Computing with IOWN APN

- Dependable Radio
  - Network operations like airplane flight operations
  - under pre-defined mobility

- IOWN APN for EXPO 2025, Osaka, Kansai (under study)
  - Cloud-and-Edge Infrastructure for EXPO 2025

Beyond 5G推進コンソーシアム 国際委員会へのご登壇の件 (12/19（月） 13:00-15:00)

川島室長には
　　「**IOWNのユースケース（遠隔合奏の実証実験等）と現状，**
　　万博へのご展望などの内容」
を期待

【背景等】

・東大中尾教授が委員長の国際委員会の会合でのご登壇

・川島室長と尾上さんをピンポイントでご指名

・形式はオンライン

・発表は日本語でOK，資料は英語が望ましいが日本語でもOK

・講演は通訳システムの関係上，**Zoom**となる.

・**登壇者は尾上さんと川島さんのみ**を想定している．それ以外は技術分科会の進捗共有等がある.

・尾上さんは会の冒頭，川島さんはそのあとのご講演を想定している.

・お二方のご講演時間（長さ）は制限ないが，**長くてもそれぞれ20分程度**を想定している.

・ご講演後（質疑応答含む），退席してもしなくても構わない.