ECOC 2023 MOPA Workshop

Optical networking for future RAN

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Outline

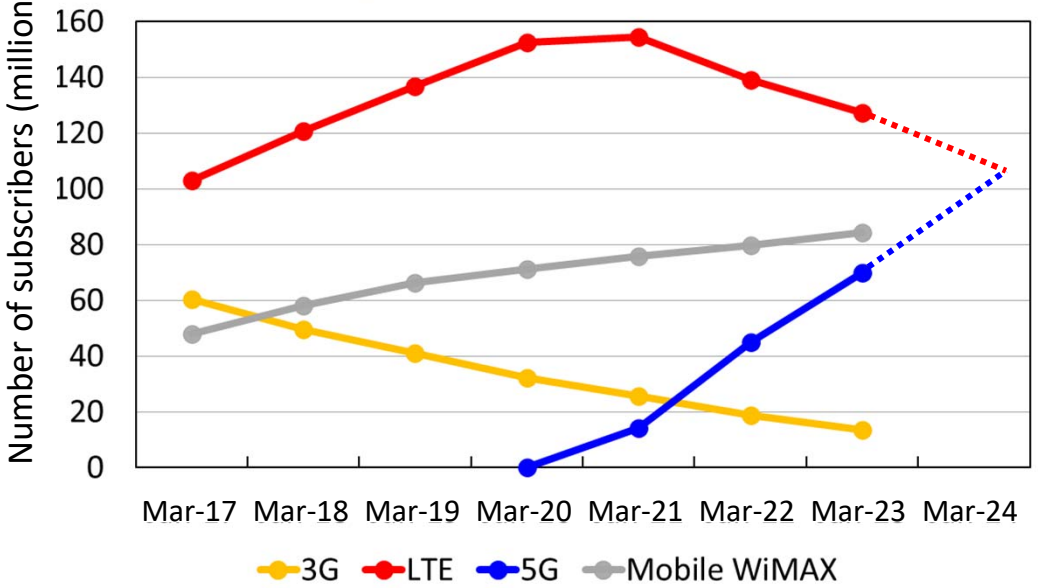
- Introduction
  - Trends of mobile broadband services in Japan
  - 5G Radio Access Network (5G RAN)
- Next-generation RAN and Transport Network
  - Bandwidth requirement
  - Virtualized RAN (vRAN)
  - Transport Network (TN): evolution path and industry trends
- Summary – direction of optical technologies for the next-gen RAN

Trends of mobile broadband services in Japan

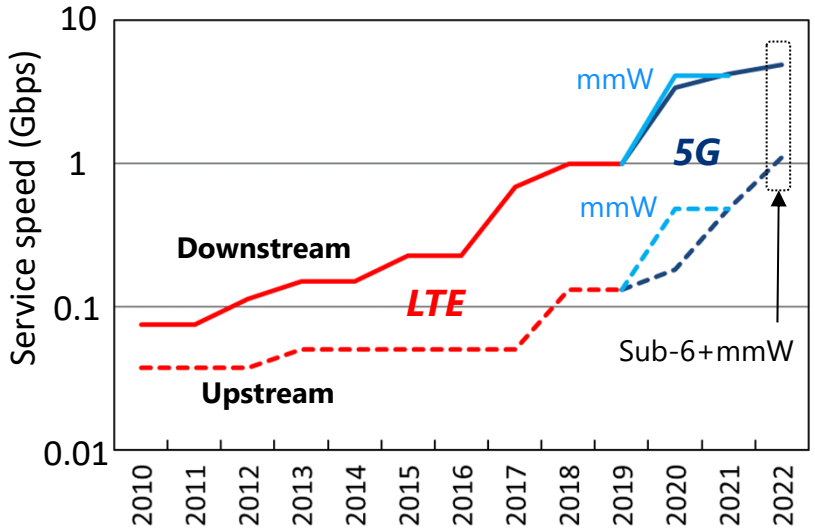
- 5G is growing, and likely to exceed LTE soon.
- Maximum speed is 4.9 Gbps for downstream and 1.1 Gbps for upstream.
  - This is realized by the combination of Sub-6 (3.7 GHz & 4.5 GHz*) and mmW (28 GHz*).

** in the case of NTT docomo*

Number of mobile broadband subscribers in Japan



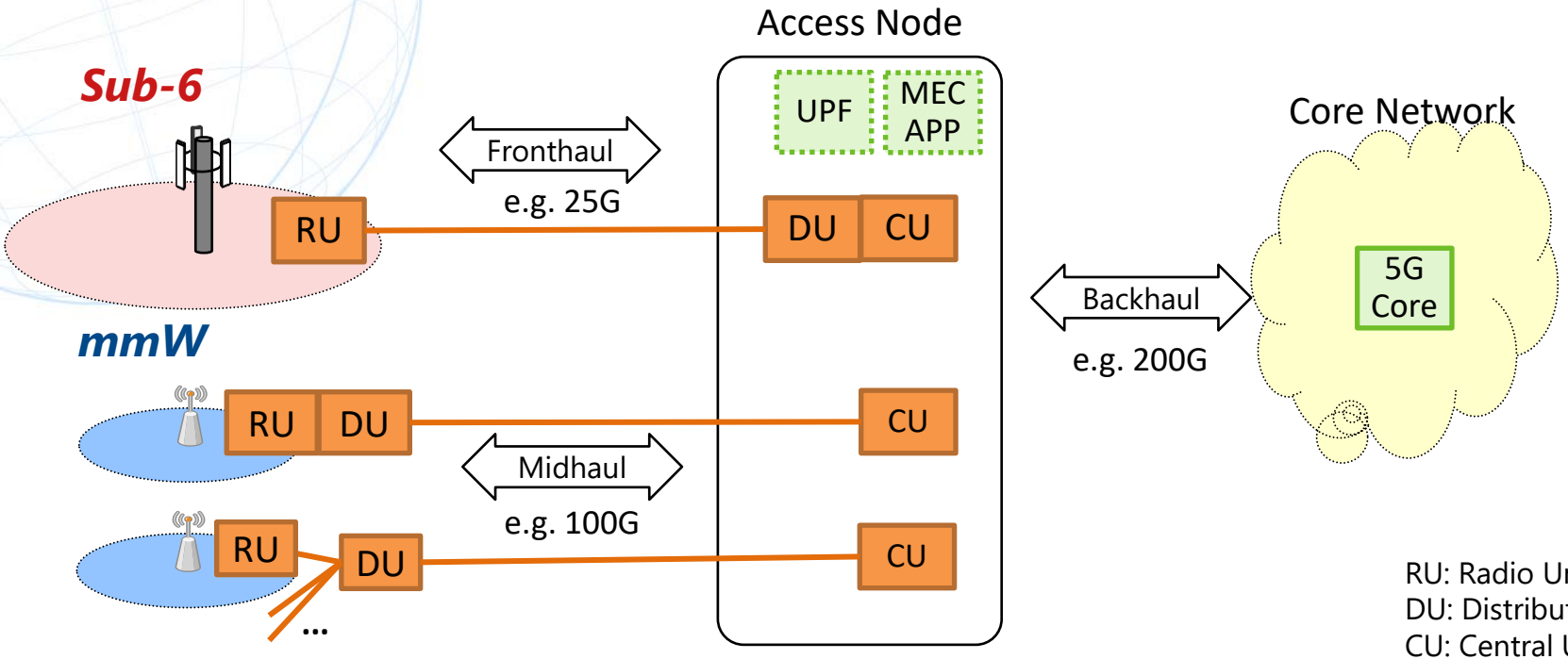
History of service-speed increase



Ref: White Paper on Information and Communications 2023, Ministry of Ministry of Internal Affairs and Communications, Japan (https://www.soumu.go.jp/johotsusintokei/whitepaper/r05.html)

Sub-6: Frequency bands under 6 GHz,
mmW: Millimeter wave.

5G Radio Access Network (5G RAN) – example



RU: Radio Unit,
DU: Distributed Unit,
CU: Central Unit.

How much bandwidth will we need in the next generation?

- 6G aims to realize peak data rate of 100 Gbps or over.

E.g. See NTT Docomo White Paper “5G Evolution and 6G”.

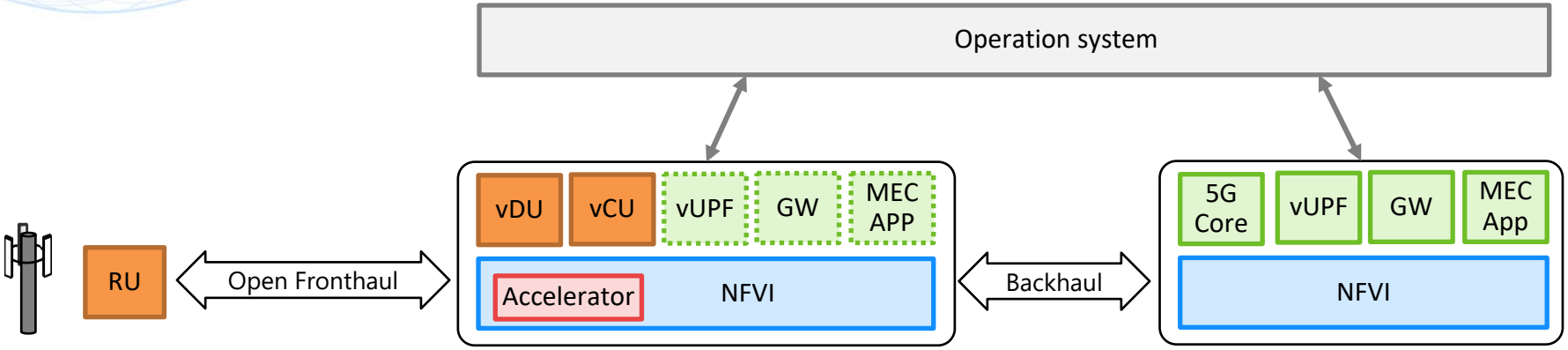
- It seems 25-Gbps to 400-Gbps optical modules can adequately support the next-gen RAN.
- For discussing whether these module are grey or colored, as well as IM-DD or digital coherent, we need to think how the transport network to support RAN will evolve.

IM-DD: Intensity Modulation – Direct Detection.

Virtualized RAN (vRAN)

- Expected benefits
  1. Optimal combination of RAN solutions by decoupling hardware and software
  2. Simple and intelligent RAN operation and maintenance through virtualization and automation
  3. Infrastructure sharing and unified operations from the edge to core network

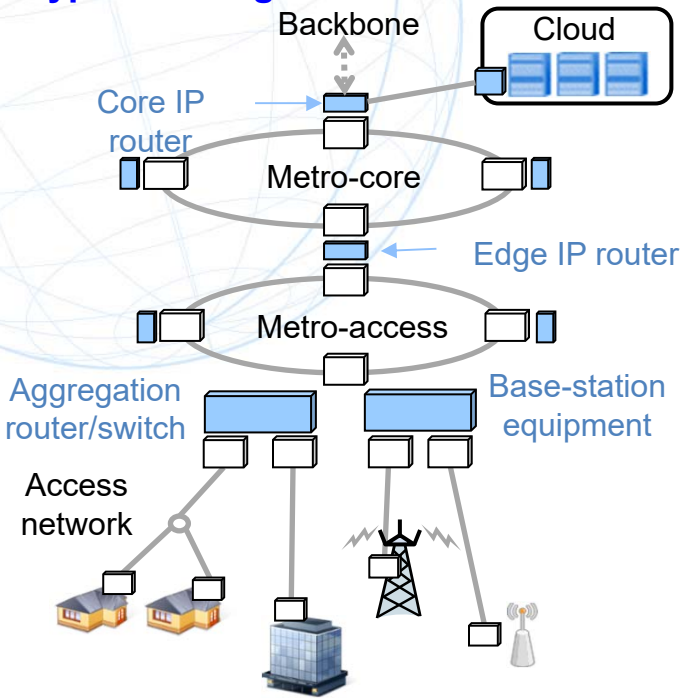
Ref: S. Mizuta, A. Umesh, Y. Nakajima, Y. Kuno, “Initiatives toward Virtualized RAN,” NTT Technical Review, Vol. 20, No. 11, pp. 52–63, Nov. 2022. https://doi.org/10.53829/ntr202211fa7



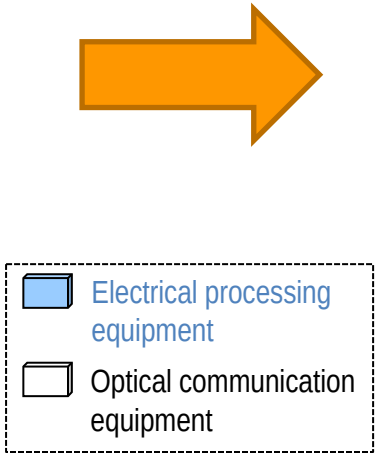
UPF: User Plane Function, GW: Gateway, MEC: Mobile Edge Computing.

Evolution path of Transport Network (TN)

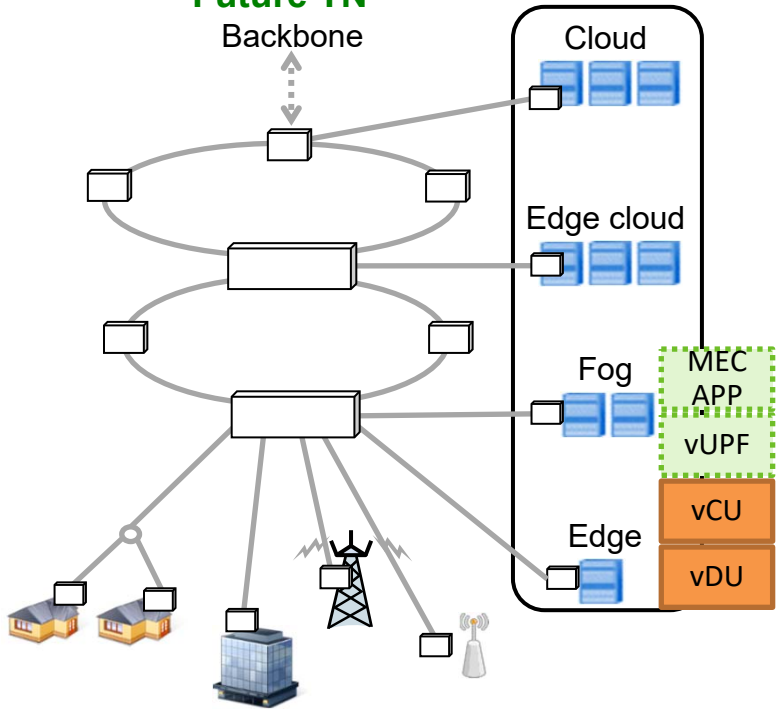
Typical configuration of current TN



Optimized to smooth access to Cloud, but has fundamental limitation to further increase bandwidth and reduce latency



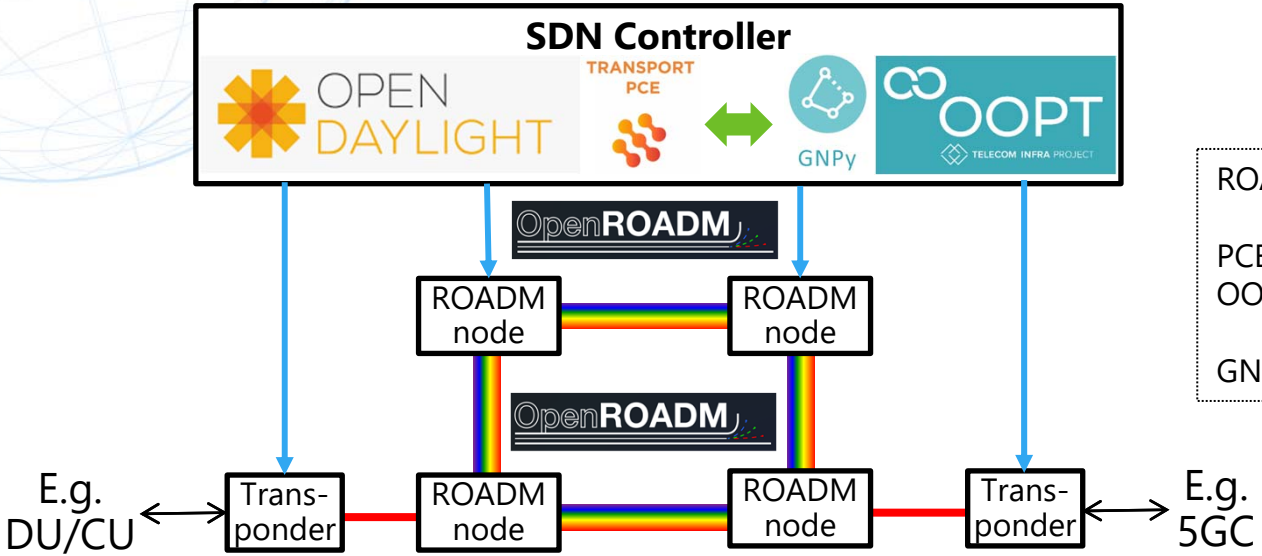
Future TN



- Flatter network
- Dynamic optical networking across access and metro

Open ROADM towards dynamic optical networking

- While the current RODAM networks are operated mostly with a static or semi-static wavelength-resource allocation, the following industry efforts are on-going towards dynamic networking.
  - Open ROADM MSA works on optical specifications and open APIs for ROADM nodes
  - Linux foundation works on Transport PCE as a module of Open Daylight.
  - OOPT project in TIP works on GNPy, a transmission quality simulator for on-the-fly route planning.

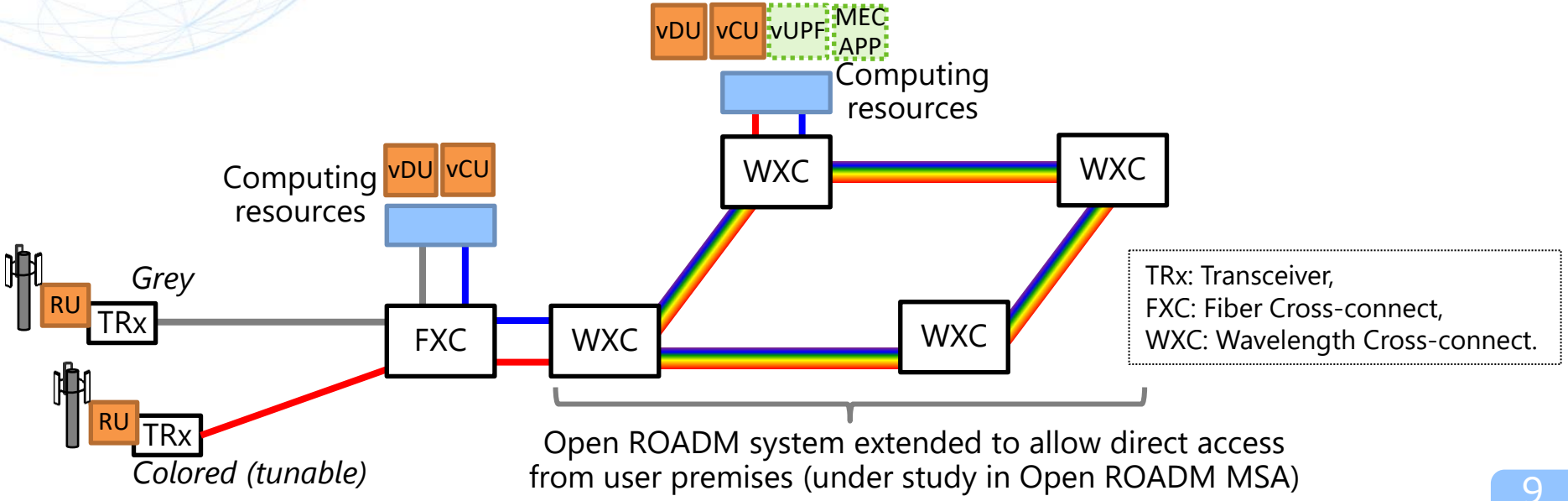


ROADM: Reconfigurable Optical Add/Drop Multiplexer,
PCE: Path Computation Engine,
OOPT: Open Optical & Packet Transport,
GNPy: Gaussian Noise in Python.

- Digital-coherent transceivers … Speed of wavelength tuning must be improved!

IOWN Open APN – updated architecture

- IOWN Global Forum is studying Open All Photonic Network (Open APN) to realize end-to-end optical networking to cover metro and access.
  - IOWN: Innovative Optical and Wireless Network
- IOWN Global Forum has just approved Open APN Functional Architecture Release 2.
  - The updated architecture accommodates short-reach and non-DWDM optical signals; this will allow a flexible support of the next-generation RAN as illustrated below.



Summary – direction of optical technologies for the next-generation RAN

- Optical modules for the next-gen RAN
  - 25-Gbps to 400-Gbps optical modules seem to support the next-gen RAN adequately.
- Evolution path of Transport Network
  - Metro and access networks will evolve to become flatter, so that distributed computing resources are flexibly connected.
  - The current industry efforts will realize dynamic optical networking to support this.
  - As for digital-coherent transceivers, speed of wavelength tuning must be improved.
- Fronthaul
  - Both of non-DWDM and DWDM optics will be applied according to the needs on the top of the new IOWN APN architecture.