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Update on the Innovative Optical and Wireless Network (IOWN) Initiative For Fixed Networks

September 18, 2022

Junichi Kani

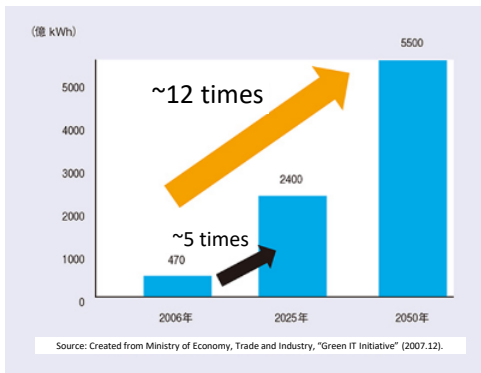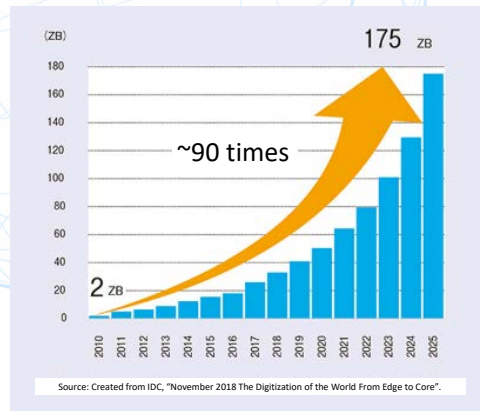**NTT Access Network Service Systems Laboratories, NTT Corporation**

Outline

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- **IOWN and IOWN Global Forum (IGF)**
  - Organization
  - Overall Architecture

- **Open All Photonic Network (APN)**
  - Open APN Architecture and Building Blocks
  - Deployment image
  - Relationship with Reconfigurable Add/Drop Multiplexer (ROADM) and Open ROADM MSA
  - Optical interfaces
  - Technical Issues under study

- Summary

IOWN and IGF

- IOWN (Innovative Optical and Wireless Network) is a concept of a new communication platform to realize a smarter world where data, activities and people in different industries will be brought together at around 2030.
- IGF was founded in 2019 to propel technologies to realize it.

(ZB) ... 175 ZB

~90 times

2 ZB

Source: Created from IDC, "November 2018 The Digitization of the World From Edge to Core".

(億 kWh)

5500

~12 times

2400

~5 times

470

2006年   2025年   2050年

Source: Created from Ministry of Economy, Trade and Industry, "Green IT Initiative" (2007.12).

IOWN Global Forum (IGF)

Key challenges

Lower power consumption by **100x**

Higher transmission capacity by **125x**

Lower end-to-end latency by **200x**

Founding Members

intel.   ⊚ NTT   SONY

Sponsor Members
31 Organizations (Chunghwa Telecom, Orange, Rakuten Mobile, SK Telecom, Ciena, Cisco, Dell Technologies, Ericsson, Fujitsu, Microsoft, NEC, Nokia, etc)

General Members
57 Organizations

Academic and Research Members
10 Organizations

Organization structure and use-case studies

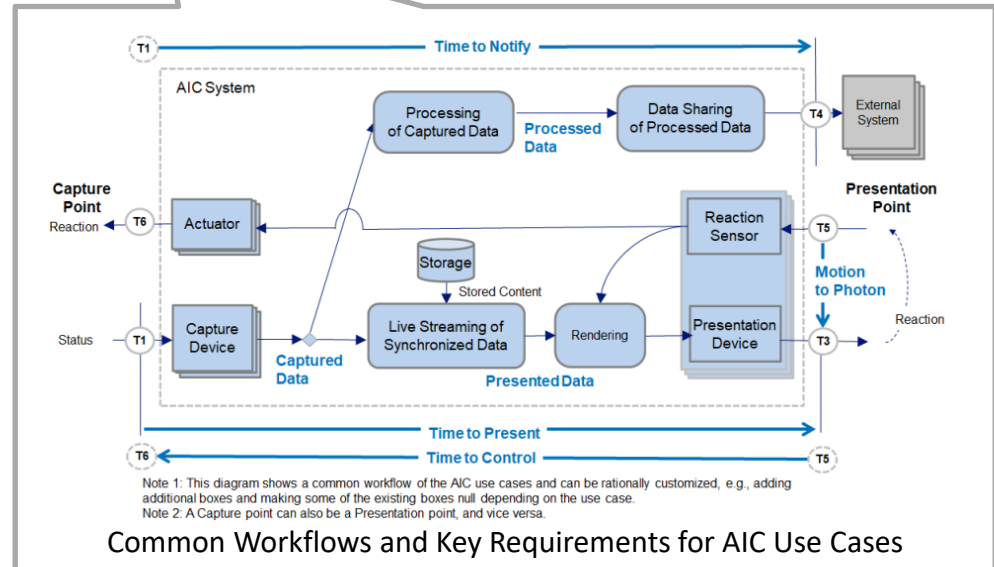## IGF organization structure

- *Working Groups*
  - Use Case Working Group
  - Technology Working Group
  - Liaison Working Group
- *Committees*
  - Technology Steering Committee
  - Vision Steering Committee
  - Marketing Steering Committee

AI-Integrated Communication (AIC) Use Cases

Entertainment, Remote Operation, Navigation, Human Augmentation

Cyber-Physical Systems (CPS) Use Cases

Area, Mobility, Industry, Network Infrastructure, Health Care, Smart Grid, Society Management

Note 1: This diagram shows a common workflow of the AIC use cases and can be rationally customized, e.g., adding additional boxes and making some of the existing boxes null depending on the use case.
Note 2: A Capture point can also be a Presentation point, and vice versa.

Common Workflows and Key Requirements for AIC Use Cases

https://iowngf.org/use-cases/

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IOWN overall architecture

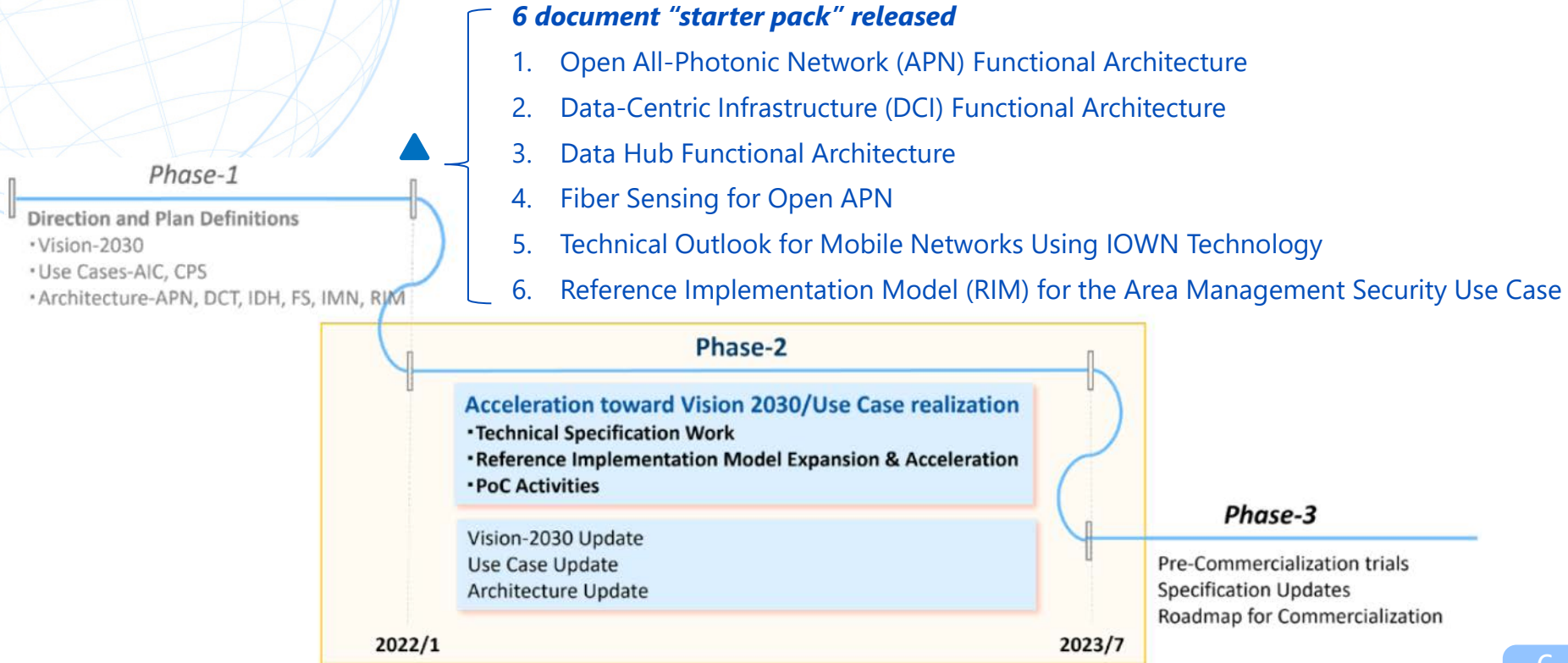- IOWN Global Forum published "System and Technology Outlook Report" in March 2021, in which the overall architecture comprises **Data-Centric Infrastructure (DCI)** and **Open All-Photonic Network (APN)**.

- Open APN is expected to provide **end-to-end optical connections** through **dynamic control**.
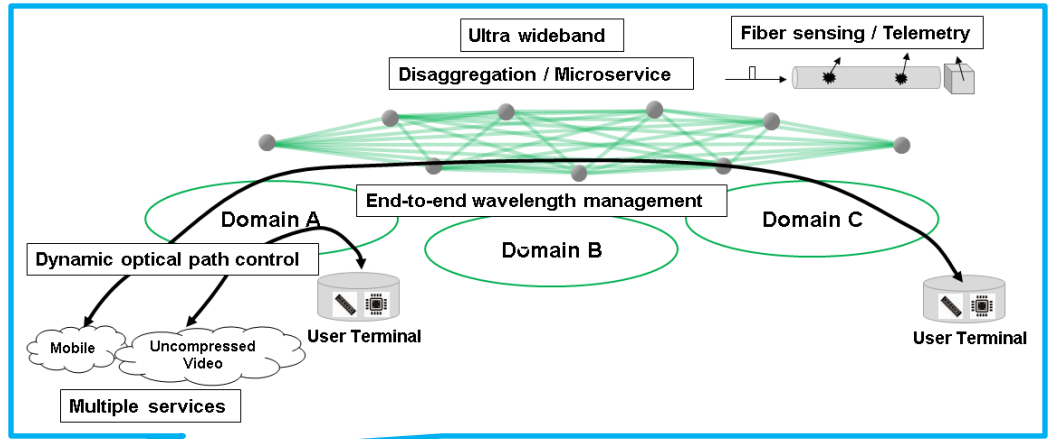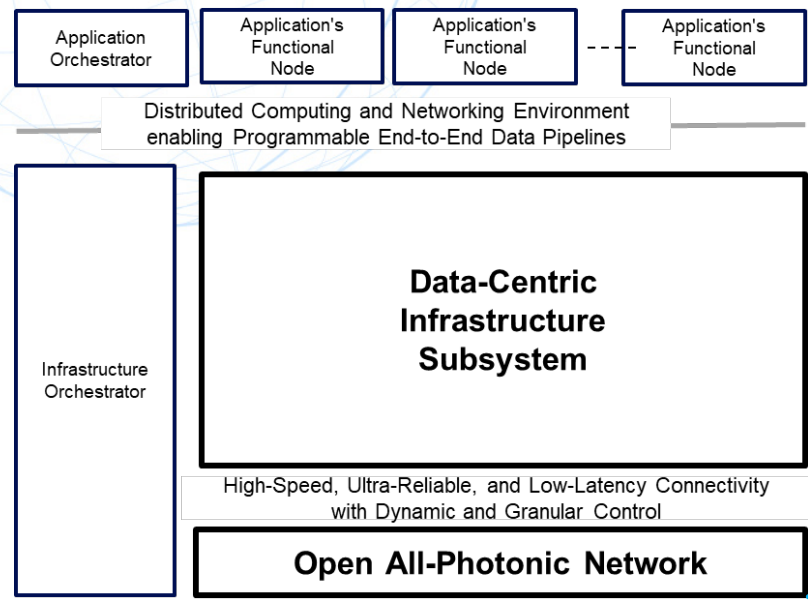
https://iowngf.org/wp-content/uploads/formidable/21/IOWN-GF-RD-System_and_Technology_Outlook_1.0.pdf

Current state

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- In January 2022, IGF released a six reference document "starter pack" for creating an intelligent, energy-efficient all-photonics data and communications architecture, and moved to Phase 2.

6 document "starter pack" released

1. Open All-Photonic Network (APN) Functional Architecture
2. Data-Centric Infrastructure (DCI) Functional Architecture
3. Data Hub Functional Architecture
4. Fiber Sensing for Open APN
5. Technical Outlook for Mobile Networks Using IOWN Technology
6. Reference Implementation Model (RIM) for the Area Management Security Use Case

Phase-1

Direction and Plan Definitions
- Vision-2030
- Use Cases-AIC, CPS
- Architecture-APN, DCT, IDH, FS, IMN, RIM

Phase-2

Acceleration toward Vision 2030/Use Case realization
- Technical Specification Work
- Reference Implementation Model Expansion & Acceleration
- PoC Activities

Vision-2030 Update
Use Case Update
Architecture Update

Phase-3

Pre-Commercialization trials
Specification Updates
Roadmap for Commercialization

2022/1   2023/7

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Open APN High-level Reference Architecture

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- Open APN comprises Open APN Transceivers (APN-T), Open APN Gateways (APN-G), and Open APN Interchanges (APN-I).
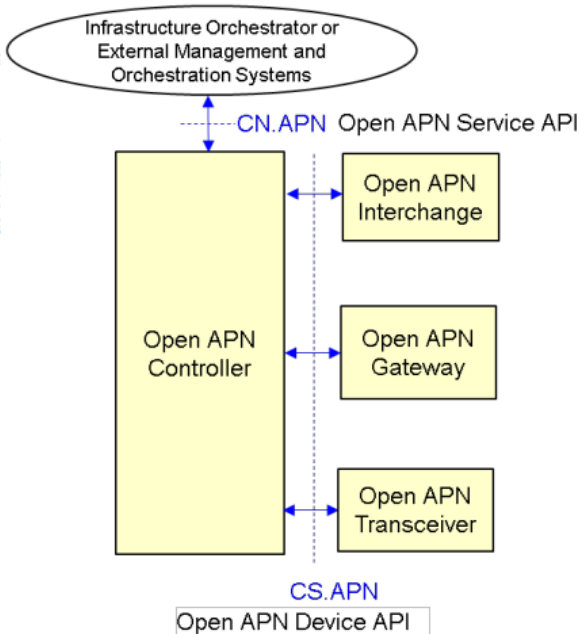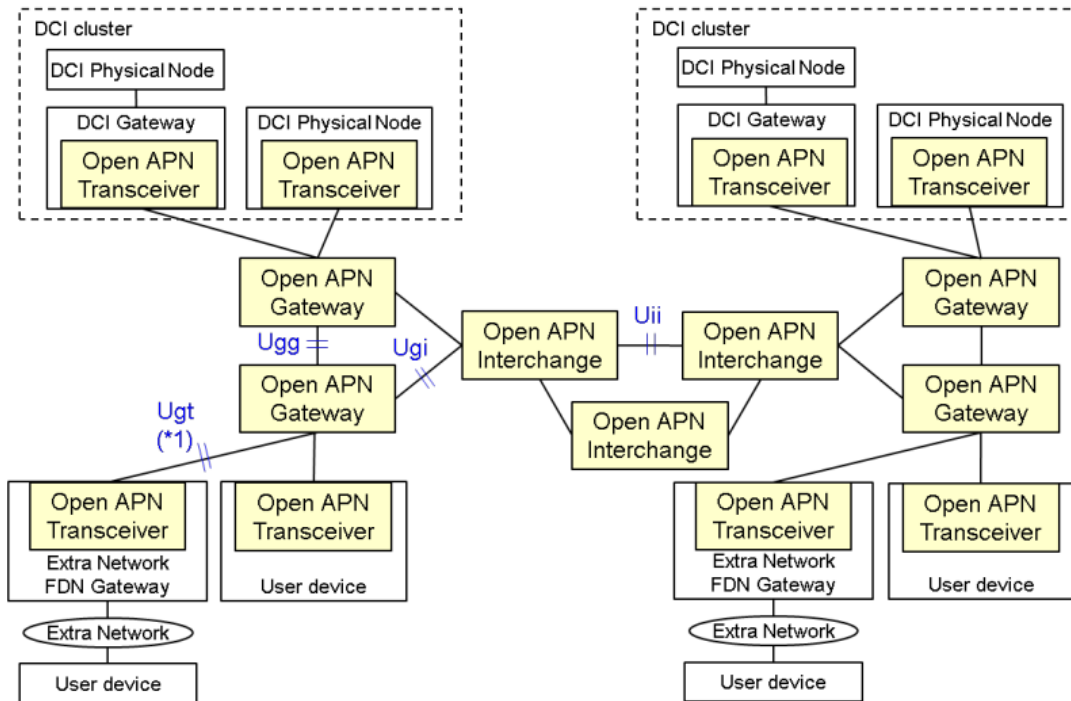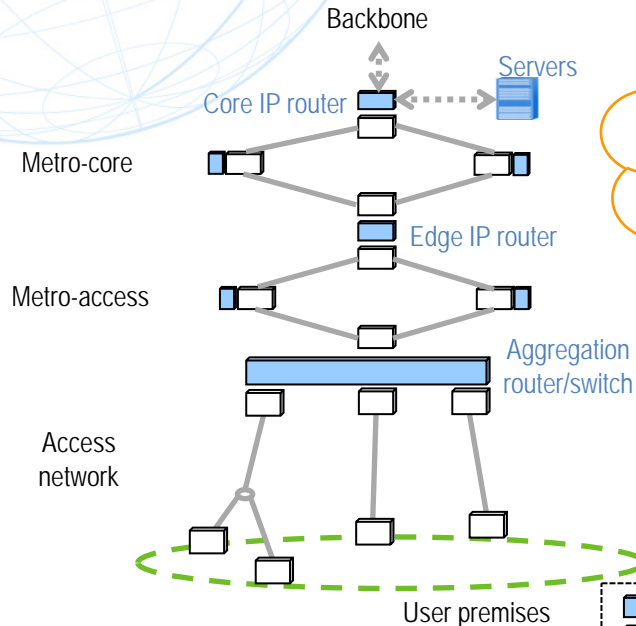

*1: Ugt can be a multiple wavelength interface.

Deployment image

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- Electrical processing functions (e.g. packet switching, electrical multiplexing) are not necessarily eliminated, but placed in DCI instead of being uniformly placed between segments, and are accessed only when needed.

- While this is similar to providing optical bypasses in each router/switch in terms of providing optical paths across segments, the electrical processing functions can be more converged with computing resources by putting them in DCI.

Current network configuration (typical)

Backbone

Servers

Core IP router

Metro-core

Edge IP router

Metro-access

Aggregation router/switch
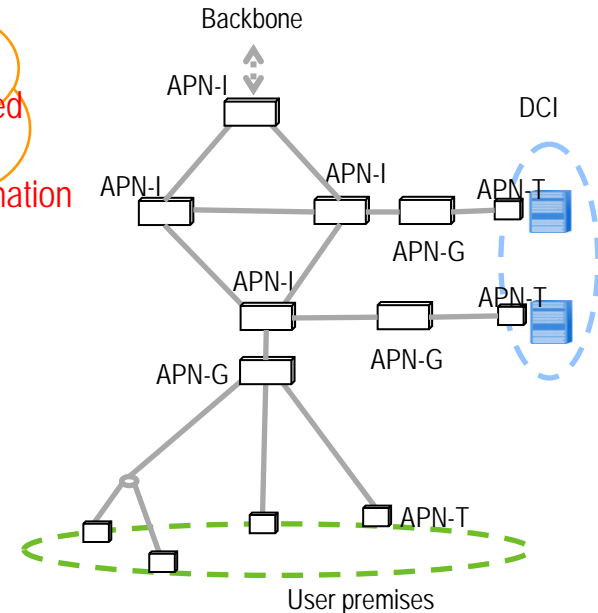
Access network

User premises

Technology evolutions
- Disaggregation
- Adaptive modulation for varied distances
- On-the-fly performance estimation for path computation

IOWN configuration (example)

Backbone

APN-I

DCI

APN-I

APN-I

APN-T

APN-G

APN-I

APN-T

APN-G

APN-G

APN-T

User premises

Electrical processing equipment
Optical communication equipment

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Extending ROADM technologies

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- Reconfigurable Optical Add/Drop Multiplexer (ROADM) technologies can be considered as the base of APN; Wavelength Cross-Connect (WXC), Add/Drop, and Transceiver (TRx) will be evolved to APN-I, APN-G, and APN-T, respectively.
- IGF has identified that the following extensions are needed for ROADM to realize end-to-end optical connections, and has started the discussion with Open ROADM MSA.
  1. Provision of control and management channels for TRx
  2. Provision of turn-back connections between TRxs under the same Add/Drop
  3. Support of typical access loss (e.g. 15 to 30 dB) and its variation
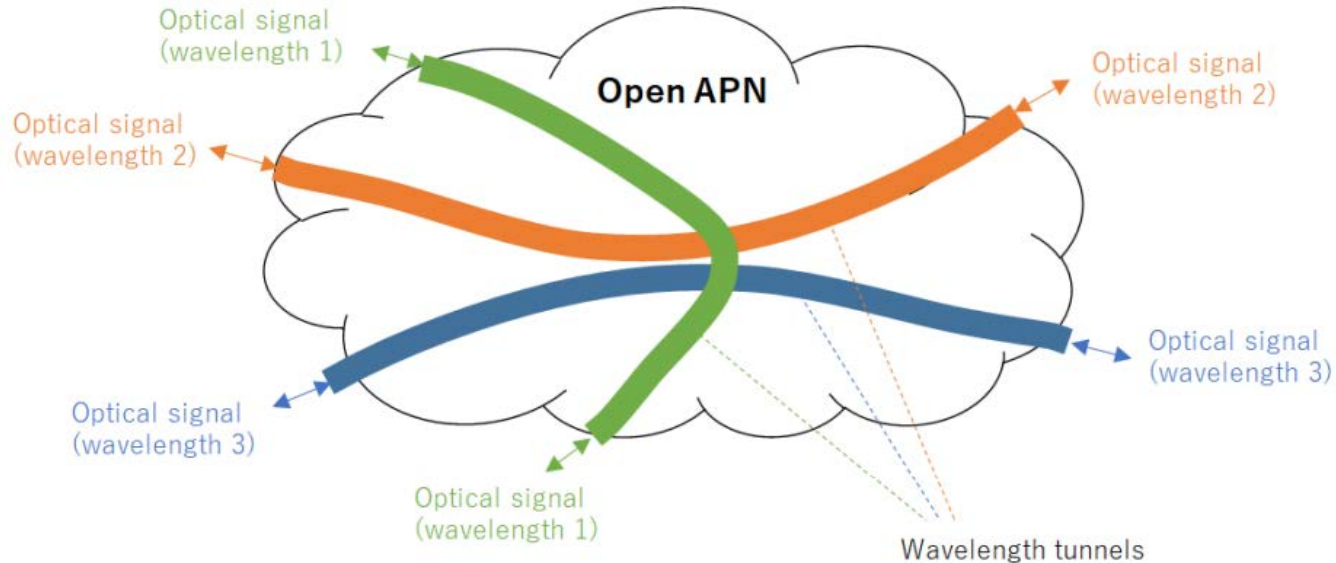
ROADM-based optical network

Open APN

Placing TRxs at user premises

Provision of control and management channels for TRx

Provision of turn-back connections
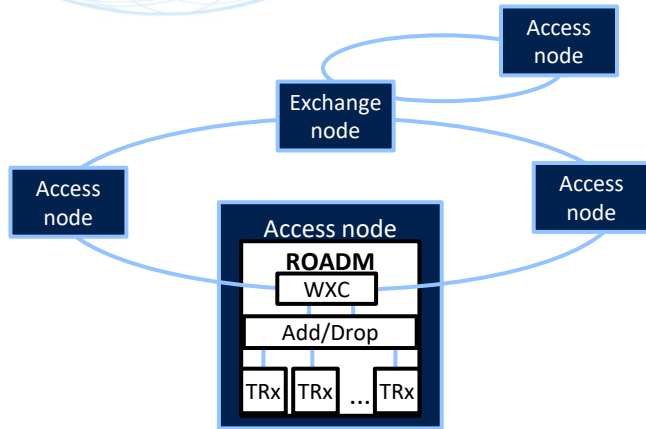
Support of typical access loss (e.g. 15 to 30 dB) and its variation

Optical interfaces

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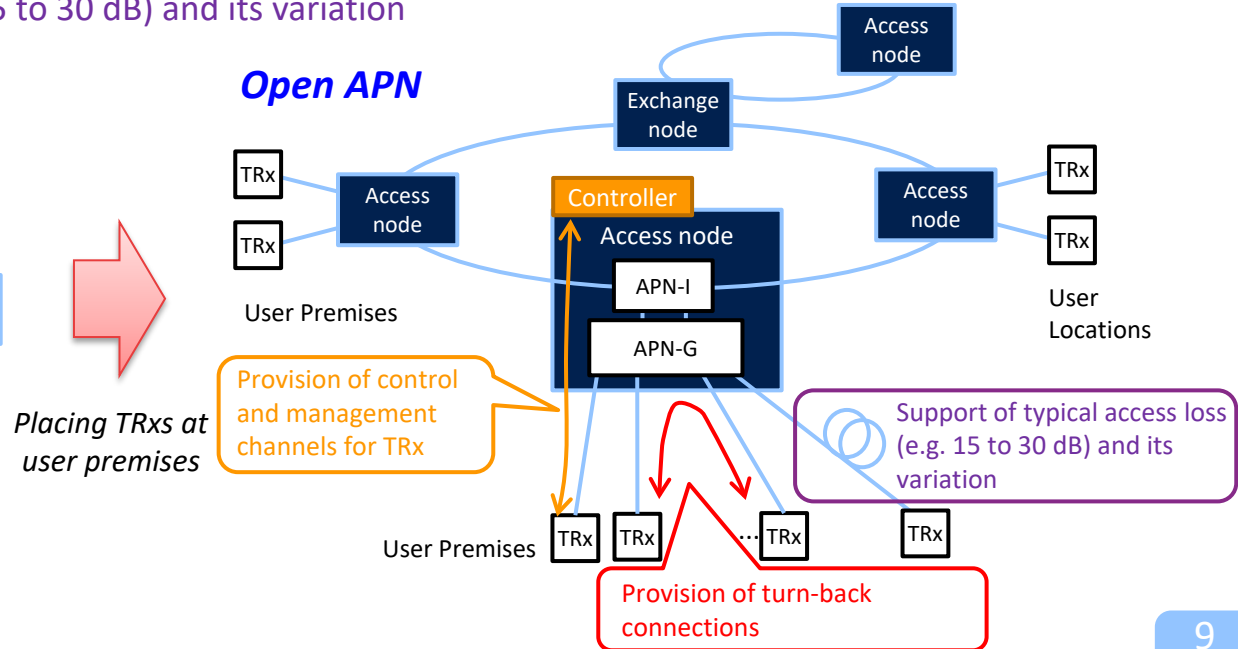
- Optical interfaces for the Open APN are defined as the combination of the optical signal specification and the wavelength tunnel specification.
- The optical signal specification must cover the following four options at least.
    1. W 100-200G 31.6 Gbaud of Open ROADM MSA Optical Specification Version 5.0
    2. W 200-400G 63.1 Gbaud of Open ROADM MSA Optical Specification Version 5.0
    3. NRZ 10G (N, W) of ITU-T G.698.2
    4. NRZ 2.5G (N, W) of ITU-T G.698.2

Optical signal (wavelength 1)

Optical signal (wavelength 2)

Open APN

Optical signal (wavelength 2)

Optical signal (wavelength 3)

Optical signal (wavelength 3)

Optical signal (wavelength 1)

Wavelength tunnels

Summary

- IOWN overall architecture comprises Data-Centric Infrastructure (DCI) and Open All-Photonic Network (Open APN).
  - Electrical processing functions (e.g. packet switching, electrical multiplexing) are not necessarily eliminated, but placed in DCI instead of being uniformly placed between segments, and are accessed only when needed.
- Initial Open APN will be realized based on ROADM technologies with some extensions to allow the placement of Transceivers at user premises.
- IGF's studies have entered Phase 2.
  - It includes technical specification works and considerations to conduct PoC.