NEC's Approach to APN Realization — Towards the Creation of Open Optical Networks

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Abstract

Communication networks such as the Internet have been widely used in recent decades in various fields such as business, education, and entertainment, and the challenge is to meet a diversity of needs and to solve social issues. To meet these challenges, the Open APN (All Photonic Network) is expected to be used to solve these issues from the viewpoints of high security, robustness, and power saving in addition to high capacity, low latency, and multi-connectivity. Now NEC is considering the photonic cloud as an example of participation in community activities, product development, and use cases. This paper introduces the trends in relevant community activities and NEC's commitment to Open APNs.

Keywords

IOWN Global Forum, Open APN (All Photonic Network), disaggregation, Open ROADM, photonic cloud

1. Introduction

Recent advancements in 5G, Internet of Things (IoT), and digitization have led to the creation of new products and services that are completely different from previous ones. Network transformation is now required to apply communication infrastructure to these new products and services.

In these new networks, high performance is essential in addition to advanced security and robustness as well as high capacity, low latency, and multi-connectivity depending on the service. Also, reducing power consumption for the entire network has also become essential to address global environmental issues.

Against this background, there is a need to realize the All Photonic Network in which all communications from the terminal to the core network are built using optical-based technologies. In the All Photonics Network, it is important to separate (disaggregate) functions and to design their specifications and interfaces based on open architecture. Efforts to address these issues are actively underway and are centered around organizations such as the IOWN Global Forum[1)], the Telecom Infra Project[2)], and the Open ROADM initiative and Multi-Source Agreement (MSA)[3)]. Also as the first step to strengthen our business in this field, we at NEC are accelerating our commitment to create an open optical transport market, including the release of the SpectralWave WX Series of open optical transport products[4)].

In this paper, we introduce NEC's initiatives for open architecture of optical transport equipment, use cases in APNs, and efforts towards market creation.

2. Commitment to Community Activities for Optical Transport

Major community activities related to optical transport and NEC's initiatives are introduced hereinafter.

2.1 IOWN Global Forum

The IOWN Global Forum is an international forum founded by NTT, Intel, and Sony in 2020. It promotes the establishment of a new communication infrastructure consisting of All Photonic Networks, edge computing, and wireless distributed computing. As of the end of January 2023, more than 100 companies and organiza-

tions have joined the forum.

The IOWN Global Forum published the first reference document for Open APN architecture in January 2022[5]. In this document, functional blocks of the Open APN Transceiver (APN-T), the Open APN Gateway (APN-G), and the Open APN Interchange (APN-I) are defined as follows.

(1) APN-T
An endpoint of an optical path; equipped with functions to send and receive optical signals.

(2) APN-G
A gateway for an optical path; equipped with functions such as multiplexing/demultiplexing of the optical paths and loopback connections of optical paths without converting optical signals into electrical signal.

(3) APN-I
The section that acts as a relay or interchange for an optical path; equipped with functions such as wavelength cross-connect and adaptation between interfaces.

In addition to participating in the Open APN Architecture Task Force of the IOWN Global Forum, we at NEC offer a product lineup that complies with the following document: Open All-Photonic Network Functional Architecture (Version 1.0). To achieve the Open APN, we regard the following issues as important: a) moving away from vertically integrated systems; and b) ensuring the scalability of optical networks. We are conducting investigations and research into these.

a) Moving away from vertically integrated systems
Adoption of horizontal disaggregation in open architecture to build an ecosystem will enable a wide variety of software, hardware, and device combinations. This would enable users to adopt the latest and most user-friendly technologies in a timely manner.

b) Ensuring the scalability of optical networks
To increase the number of lines accommodated in APNs, efforts are being made in increasing the types of wavelengths that can be used by methods such as multibanding and spatial multiplexing and in wavelength control to make effective use of wavelengths by methods such as wavelength conversion and remote control of wavelengths.

2.2 Telecom Infra Project

The Telecom Infra Project (TIP) is a global community of companies and organizations founded in 2016 and led by Meta with the aim of promoting cooperation and innovation to accelerate the deployment of open, disaggregated technologies in telecommunications networks. The TIP's Project Groups are divided into three strategic network areas: Access, Transport, and Core & Services. The Open Optical & Packet Transport project group (OOPT) is making a technical investigation of performance, scalability, and efficiency of communication networks.

We are participating in a project to develop an OOPT-supported transponder called Phoenix, which aims to open up the optical transmission domain. The Phoenix is a 400 Gbps transponder for high-capacity, dense wavelength-division multiplexing (DWDM) networks that are open and disaggregated into hardware and software. For deploying the network operating system on the Phoenix that runs on Wistron's Galileo Flex-T hardware (WX-T), NEC was the first in the world to be awarded two TIP Requirements Compliant Bronze Badges.

2.3 Open ROADM MSA

The Open ROADM Multi-Source Agreement (MSA), led by AT&T, was established in 2015. It defines specifications for improving the interconnectivity of optical transport systems, enabling SDN software control, and abstracting interfaces. The MSA divides the control standards into three layers — the Device Model, the Network Model, and the Service Model — to make control parameters open to any third party. Meanwhile in regards to optical standards, communication methods and optical conditions are specified for each transmission speed to improve inter-vendor interoperability. The participating members of the Open ROADM MSA are mainly composed of network operators and equipment/device vendors. As of January 2023, more than 30 companies are members. The MSA is periodically updated with input from each company, and the latest version is version 12.

We joined the Open ROADM MSA as a member in 2021 and are actively adopting the specifications to promote open architecture and improve interoperability.

Our optical transport system incorporates device models that conform to the Open ROADM MSA and make it possible to automate device management and control using the NETCONF open interface.

3. Utilization of Open APN

In this section, we take a look at the photonic cloud as an example of the value provided by Open APN and as a solution for the services it has to offer.

3.1 Value provided by Open APN

Open APN addresses a diversity of needs and social

issues by opening up and converting networks into APN through ecosystem formation (**Table**).

3.2 Photonic cloud

Spurred by the prospect of the proliferation of 5G, 6G, and IoT as well as the increasing traffic and increasing demands on the networks from services, moving application installation sites out of the cloud to sites closer to the users (edge data centers) and seamlessly connecting these edge DCs is under consideration.

At NEC, we are investigating a photonic cloud that uses optical transmission to connect services. In this solution, edge data centers and user locations are directly connected by optical paths using Open APN. This ensures connectivity with improved security by integrating multiple services in an optical closed network while achieving high capacity, energy efficiency, and low latency in the network (**Fig. 1**). This enables the provision of regionally closed services (regional medical care, factory management) and services with a sense of presence such as with a high image quality in real time (live streaming, virtual offices, and remote control).

Table Values provided by Open APN.

	Value provided	Description
Openness	Investment optimization	Elimination of vendor lock-in and appropriate functional separation
	Improved resilience	Reduced supply-chain risks through diversification of equipment procurement
	Accelerated innovation	Enabling various companies to enter and collaborate in areas where they can demonstrate their strengths
	Faster provision of services	Reforming operational tasks in multi-vendor environments
APN conversion	Ultra real-time communication	Improving high-capacity, high-speed communication and reducing latency and fluctuations
	Improving efficiency and energy savings	Achieving higher capacity and reducing power consumption through wavelength division multiplexing by shifting from electrical to optical transmission

4. NEC CONNECT Lab with IOWN for Achievement of Social Implementation and Construction of Co-creation Environment

With a view to implementing the innovative optical and wireless network in society, we established the NEC CONNECT Lab with IOWN in March 2023 at NEC Abiko Plant to provide a venue to verify open technology. The lab aims to co-create businesses and solutions with partners that can lead to a future we can share by utilizing networks (**Fig. 2**). In this lab, we will conduct technical verification of APN, including multi-vendor connections, with a focus on IOWN APN as well as verification of use cases in the IOWN era. In addition to verification by user companies bringing in their own equipment, this environment is also connected to external networks such as the one for the NTT Group, enabling feasibility verification in an environment close to actual use cases by connecting physically distant sites.

As an example of the use of this environment, in February 2023, NTT ArtTechnology and Tokyu Bunkamura held an event called "Future Concert that Echoes Across Distances II" or "Future Concert II."[6] This event verified the feasibility of remote concerts in real time by connecting the NEC Abiko Plant with multiple locations in Tokyo, Osaka, and Kanagawa.

5. Conclusion

In this paper, we introduced NEC's efforts towards the realization of APN. We have already released APN-compliant products and become involved in community activities such as the IOWN Global Forum and co-cre-

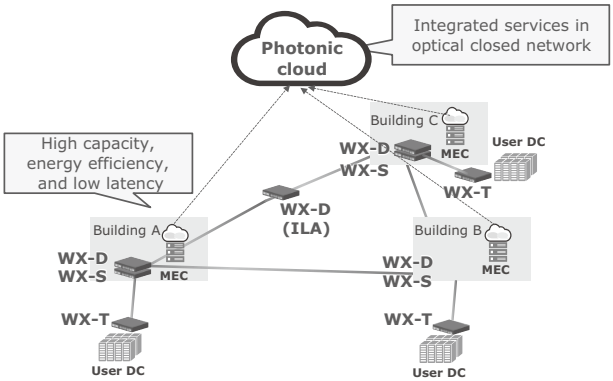

Fig. 1 Photonic cloud.

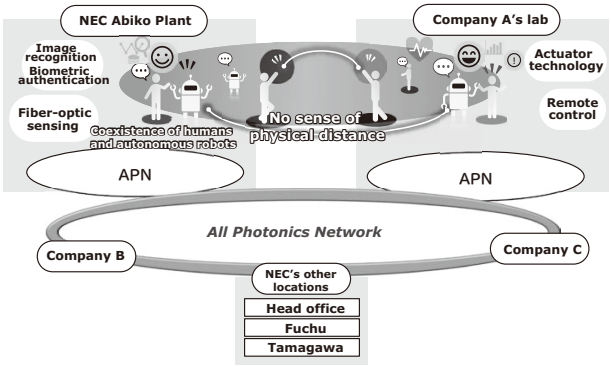

Fig. 2 NEC CONNECT Lab.

ation activities in the NEC CONNECT Lab with IOWN. We are now entering a stage of accelerating our efforts to achieve practical operation.

At NEC, we will continue to contribute to solving social issues through our optical transport business.

References

1) IOWN Global Forum
https://iowngf.org/
2) Telecom Infra Project
https://telecominfraproject.com/
3) Open ROADM MSA
http://openroadm.org/
4) NEC Press Release:NEC Drives Expansion of All Optical Networks, September 2022
https://www.nec.com/en/press/202209/global_20220915_01.html
5) IOWN Global Forum:Open All-Photonic Network Functional Architecture (Version 1.0), January 2022
https://iowngf.org/wp-content/uploads/formidable/21/IOWN-GF-RD-Open-APN-Functional-Architecture-1.0-1.pdf
6) NTT East Press Release: Future Concert II — A Real-Time, Remote Concert With IOWN All Photonic Network Connecting Tokyo, Osaka, Kanagawa, and Chiba (Japanese)
https://www.ntt-east.co.jp/release/detail/20221222_01.html

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