NEC's Approach to APN Realization — Features of APN Devices (WX Series)

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Abstract

NEC is accelerating its efforts to realize All Photonics Networks (APN), in which all communication infrastructure from the networks to terminals are built upon optical-based technologies. This paper discusses disaggregation (functional separation) and the open architecture of optical networks — which are crucial for APN — and introduces NEC's SpectralWave WX series, a family of NEC's first open specifications-compliant, open optical transport products.

Keywords

IOWN Global Forum, Open APN (All Photonics Network), disaggregation, Open ROADM, open architecture, TIP (Telecom Infra Project)

1. Introduction

At NEC, we are accelerating our efforts to realize an All Photonics Network (APN), in which all communication infrastructure from the network to terminals are built upon optical-based technologies.

The world today is undergoing a transformation with the rapid development of digital technologies, including the Internet of Things (IoT) that connects people and things, artificial intelligence (AI) that extends the intelligence of humans, and systems that highly integrate cyberspace and physical space in the real world.

To accelerate such transformation, it is essential that networks evolve so that the networks can be safely and securely used by anyone, at anytime and anywhere. Networks need to be modularized for ease of use, with necessary components readily available when needed. For this reason, it has become an important issue in APN to separate (disaggregate) functions and publish their specifications and interfaces. In order to address these issues, we have launched the SpectralWave WX Series[1] of NEC's optical transport product family and the world's first open optical transport products that are compliant with open specifications such as Open ROADM[2], the Telecom Infra Project's (TIP)[3] Phoenix solution and Mandatory Use Case Requirements for SDN for Transport (MUST), as well as Innovative Optical and Wireless Network (IOWN) APN[4]. Through the provision of the product family, NEC is contributing to the realization of All Photonics Networks and deployment of highly flexible networks with high security, robustness, and low power consumption in addition to high capacity, low latency, and multiple connectivity.

2. Functional Separation and Openness of Networks

While optical transport products have traditionally been provided in a vertically integrated and all-in-one fashion, NEC is committed to accelerating open innovation and leading an open ecosystem under NEC's concept of "Truly Open, Truly Trusted." The SpectralWave WX Series is a family of products that brings innovation to optical networks by supporting disaggregation and openness through the separation of functions that compose an optical network (**Fig. 1**). This makes it possible to select necessary functions and integrate them to sat-

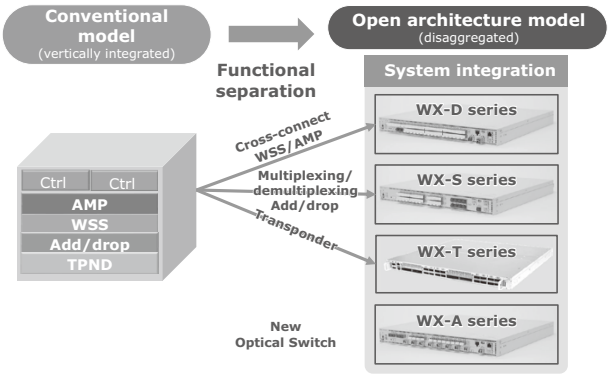


Fig. 1 Open architecture model.

isfy those requirements, thereby optimizing the system configuration over the long term while keeping costs low. Furthermore, by leveraging open ecosystems, it is possible to create new value such as prompt service provisioning for revenue generation, high reliability for less maintenance costs, optimized resource allocation, and the network virtualization through linkage with mobile networks, computing, and AI.

3. Overview of the SpectralWave WX Series

3.1 Support for multi-vendor configuration

Optical transmission products until now traditionally used a vertically integrated system that prioritized communication performance, and each network was commonly built with equipment all from the single vendor. The products in the SpectralWave WX series, however, differ from those traditional ones and achieve disaggregation (functional separation) by dividing by function. This makes it possible for customers to procure the required products or devices from multiple vendors and combine them to compose the entire network. In this way, the system configuration can be optimized to suit the customer's real needs.

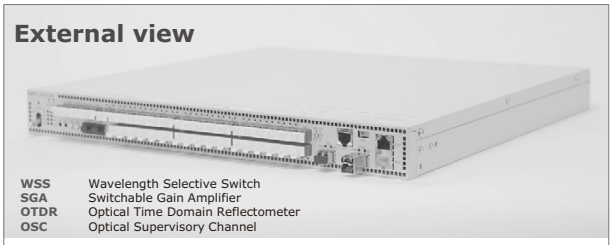
3.2 Flexible network construction

By conforming to open specifications, the products in the NEC SpectralWave WX series enable the latest configurations that connect to the function blocks of the Open APN Transceiver (APN-T), the Open APN Gateway (APN-G), and the Open APN Interchange (APN-I) as defined in the document about Open APN architecture published by the IOWN Global Forum. The NEC SpectralWave WX products also enable the ROADM configuration used in conventional optical transmission networks. These configurations can be achieved by changing the layout of the products. For instance, when turning back optical signals, it is usually necessary to connect all products for each of the APN-T, APN-G, and APN-I function blocks, but the SpectralWave WX products can change the direction of light and turn it back by connecting only two — the APN-T (the WX-T series) and the APN-G (the WX-S) — in accordance with the customer's needs. This makes it possible to build flexible and economical networks.

4. Product Overview

4.1 The WX-D series with multipath variable-gain amplifier

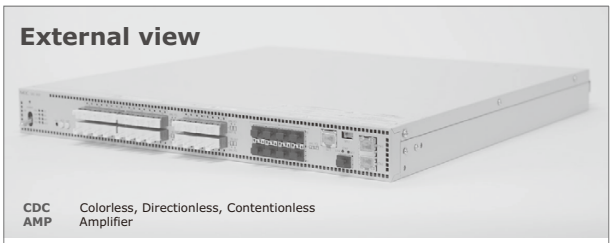
The products in the WX-D series are inserted between transmission segments and perform optical amplification in accordance with the transmission distance. Combining multiple units from the WX-D series makes it possible to



Open ROADM-compliant multipath and high-performance-degree models

- 1x33 WSS for optical cross-connect
- Variable-gain amplification (SGA: 0 to 35 dB) for optical amplification
- Optical surveillance control (OSC) function
- Optical channel monitoring (OCM) and port-specific power monitoring functions

Fig. 2 WX-D series with multipath variable-gain amplifier.



Open ROADM-compliant, CDC-compatible, high-performance SRG (shared-risk-group) model

- Support for CDC-ROADM optical systems
- 16 degree×8 transponder ports provided with add/drop function
- Support for optical turn-back function (unconditional support)
- Pluggable AMP that can be mounted in accordance with the number of connections required
- Equipped with port-specific power monitoring function

Fig. 3 WX-S series for add/drop and multiplexer/demultiplexer requirements.

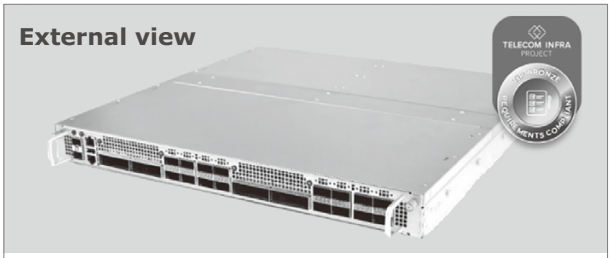
switch to multiple paths and to support various topologies such as mesh, ring, or linear (**Fig. 2**). The features of the WX-D correspond to those of the APN-I function block.

4.2 WX-S series for add/drop and multiplexer/demultiplexer requirements

The products in the WX-S series enable multiple wavelengths to be multiplexed when transmitting signals and also extract individual wavelengths when receiving. If there is branching at the endpoint, it is still possible to extract the wavelength. Also, this device is equipped with an add/drop function (to add or extract wavelengths) that corresponds to the colorless, directionless, contentionless (CDC) function, which enables flexible network design (**Fig. 3**). The features of the WX-S correspond to those of the APN-G function block.

4.3 WX-T series of white box transponders

The products in the WX-T series convert client signals received from an externally connected device into wavelength-division multiplexing (WDM) signals. Conversely, when sending signals to externally connected devices, this transponder converts WDM signals into client signals. During conversion, it can convert the signals to the appropriate signal format, signal level, and signal optical wavelength for wavelength multiplexing. The WX-T products are built by integrating open-specification white box hardware (assembled from commercially available parts), open source software, and commercially available optical transceivers. It is the world's first product that is compliant with TIP's Phoenix solution and MUST and that also has hardware and software separation, multi-vendor and multi-generation transceiver support (**Fig. 4**). The features of the WX-T correspond to those of the APN-T function block.



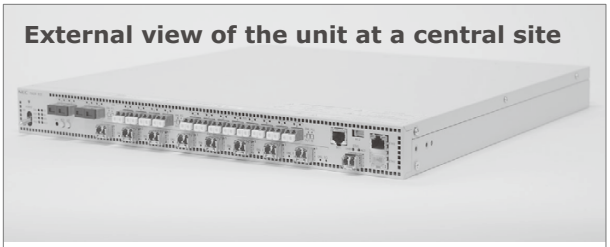
White box transponder compliant with the TIP Phoenix and MUST

Line interface	4 x 400G CFP2-DCO -100/200G QPSK -200/300G 8QAM -200/400G 16QAM
Client interface	16 x 100G QSFP28 4×QSFP-DD (Planned)

Fig. 4 WX-T series of white box transponders.

4.4 WX-A series of remote control and optical switches

The products in the WX-A series perform the conversion between electrical signals and optical signals in the same manner as the WX-T white box transponder and also perform optical switching. The WX-A products are also capable of converting the wavelength of optical signals remotely from the unit in a central site (**Fig. 5**) to the unit in a remote site (**Fig. 6**) using the remote control function.

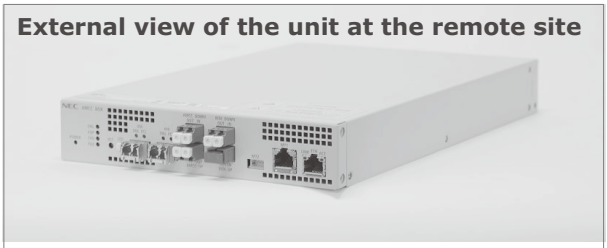


Gateway in the central site for optical switching and optical remote control

Optical switch (size: 1U) for 19-inch racks with an AMCC-compatible transceiver and modulation/demodulation unit, enabling communication between remote devices and AMCC

Path selection to an arbitrary port by optical switching (metro/core connection or access loopback)

Fig. 5 WX-A series of remote control and optical switches (central site).



O/E converter with half-rack mount equipped with an AMCC modulator/demodulator (modem), enabling communication with the unit at the central site

AMCC modulation applied to the transmitted optical signal from the SFP device on this unit or the optical transceiver under the control of this unit

Fig. 6 WX-A series of remote control and optical switches (remote site).

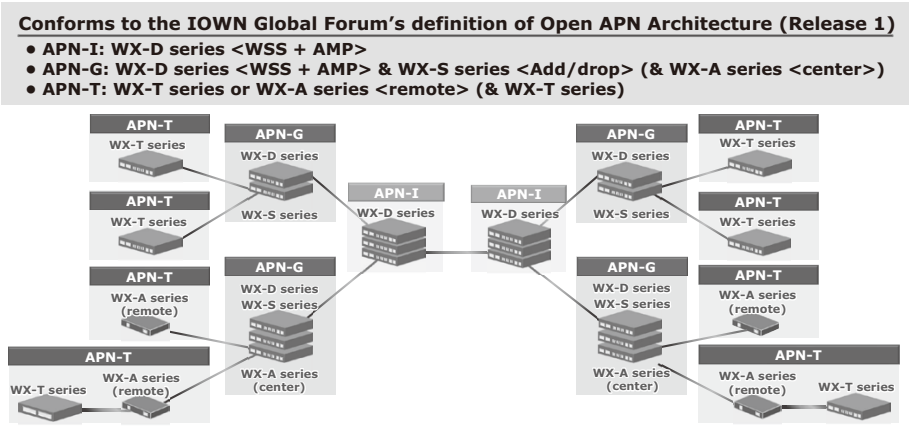


Fig. 7 IOWN Global Forum Open APN Architecture.

Fig. 8 Partially open architecture.

5. Applicable Networks

5.1 IOWN Global Forum models

The WX series conforms to the Open APN Architecture (Release 1) defined by the Open APN Architecture Task Force of the IOWN Global Forum. By combining these products as shown in **Fig. 7**, it is possible to achieve an Open APN as defined by the IOWN Global Forum.

5.2 Partially open architecture

Among the functions of optical transmission equipment, the transponder section is undergoing rapid technological innovation. There are many growing needs, especially among data center operators, to use the latest transponder functions to expand capacity. Until now, frequent replacement of equipment has been difficult and costly with vertically integrated, all-in-one equipment. By adopting products that are separated by function, however, it is now possible to switch only the transponder function to the latest model. By connecting the WX-T series to an existing WDM network, the customer can easily take advantage of the benefits of open architecture (**Fig. 8**).

6. Conclusion

In this paper, we introduce the SpectralWave WX series that can help build an APN. We at NEC continue to expand our business in the optical transport market by leveraging our expertise, experiences and know-hows accumulated in our long history of delivering a variety of optical transmission solutions for large-scale carrier networks worldwide. And through these efforts, we create innovation and contribute to solving social issues.

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