Orchestrating a brighter world

Open Optical Transport

NEC Corporation

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Introduction

NEC is working together to design new social systems by deepening "open co-creation relationships" with many stakeholders to find solutions to global issues such as population decline, regional development, and SDGs, which many nations are working together to address.

This white paper focuses on the field of optical networks and describes the future of networks, the progress and challenges of openness in the field and the value that NEC provides.

The Future of Networks

In the world today, digital technologies such as IoT, which connects people and things, AI, which extends intelligence, and systems that highly integrate cyberspace and the real world are rapidly developing. As a result, a transformation is underway to penetrate the technology into society, accelerate the creation of innovation, and solve social issues such as SDGs. For example, in Society 5.0, which aims to create a new society, all people and things will be connected by IoT, and a vast amount of information from sensors in the real world will be accumulated in cyberspace. In cyberspace, AI analyzes this accumulated big data and feeds back the analysis results to people in the real world in various ways to bring new value to industry and society that has never existed before.

The evolution of networks will play a key role in accelerating this transformation. Networks that connect cyberspace and the real world must be available to anyone, anytime, anywhere, safely and securely. Therefore, networks need to be modularized for ease of use and have everything readily available when needed.

For example, when you have an idea for a business and want to make it a reality, if you can get the necessary computer resources and networks as soon as you need them, you will be able to immediately give shape to your idea and improve your business through trial and error. However, if it takes several months to provide a network, the business is sometimes forced to give up.

The network required will vary in form depending on what is being connected. The scope of networks continues to expand to include sensor networks, local 5G, and inter-data center networks, with varying durations of need, such as only for events. It is difficult to meet this demand with a network with a single specification. Providing a network whose specifications can be changed and provided on demand according to a wide variety of user requirements will enable optimal services to be provided for each application.

Furthermore, if we can dynamically change the shape of the network in conjunction with the applications we use, i. e., if we can dynamically change the network according to the usage of computer resources, we will be able to optimize resources and save power. The rapid availability of networks whenever and wherever they are needed is the foundation of an innovative society.

On the other hand, in the computing world, virtualization and cloud computing have already progressed, creating flexible systems that can quickly provide the right resources when they are needed. Users benefit from the availability of computing resources as a service when they need them, and this is the foundation for an innovative society where new services are constantly being created. The driving force behind this has been the disaggregation of functions and the openness of defining and releasing the specifications and interfaces. The ability to build systems using any combination of products and vendors, rather than only those developed by a particular vendor, accelerated the introduction of new technologies, such as virtualization, deployment on cloud platforms, integration with other systems, and overall orchestrating, leading to the evolution of a flexible system that can quickly provide the right resources when needed.

Openness of Optical Networks

In networks, as in computing, separating functions, defining and exposing specifications and interfaces, and moving to an open architecture based on a multi-vendor ecosystem will be the keys to accelerating evolution and transforming the system into a flexible one that can quickly provide the right resources when they are needed.

Until now, networks have evolved to meet the demands of transporting large volumes of traffic, which are ever increasing. In the past, networks were realized with general-purpose devices, but by developing dedicated devices and systems, we have been able to support higher speeds and wider bandwidths. As a result, networks are provided separately as vertically integrated systems and are closed systems. They are provided separately for each network application, area, and layer, and carriers operate each of them separately to provide the services demanded by users. Therefore, when providing end-to-end services to users, each individual operation needs to be tweaked, service opening and changes are time-consuming, and the maintenance and operation costs are enormous.

To break from this situation, and to make operations common across applications and layers, and to control them from advanced applications created by various vendors, we need to move to an open architecture where specifications and interfaces are made public. In the mobile network space, discussions on network openness for Beyond 5G are already in full swing. In the realm of optical networks, the functions required of networks are changing, as shown below, and openness needs to be accelerated in the same way.

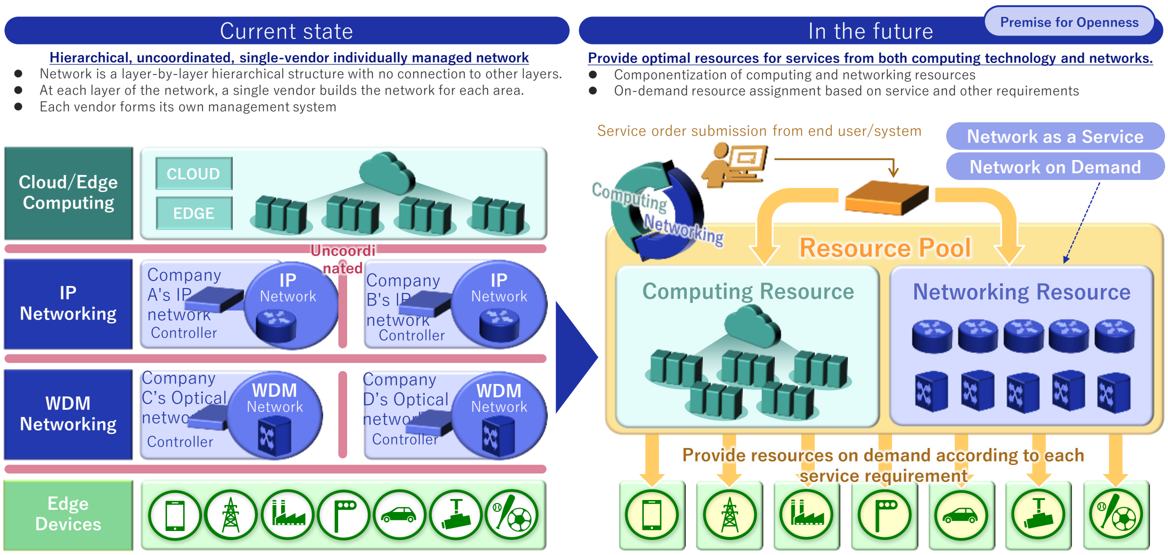

Figure 1 the future of networks

Until now, optical networks, especially systems such as WDM, have been mainly applied to the core areas of networks because they are good at transmitting large amounts of traffic. The traffic transmitted in core areas is the sum of the traffic of many users, and since the bandwidth per user is small, the variation of the sum is not large, and the bandwidth required has been predictable. As a result, optical networks were built in a planned and fixed manner, and the requirement for flexible changes was not high.

However, as more and more computing moves to the cloud, the traffic between data centers to run cloud applications is increasing, and the bandwidth required per transaction is increasing. The required communication is becoming highly variable to the usage of the data center, and as a result, the required bandwidth is dynamically changing even in the core area. To cope with this, even broadband optical networks are required to dynamically and even independently change their transmission/reception bandwidth according to demand.

For example, if we can change the configuration of the network between daytime and nighttime, or dynamically change the network depending on the usage of computer resources, we will be able to make more effective use of those resources. It could significantly improve the utilization rate of computer resources, which is currently said to be in the tens of percent range.

Furthermore, optical networks are expanding not only to the core region but also to the edge region. To collect huge amounts of data from the real world, analyze it in server space in real time, and feed the results back to the real world in various ways, edge computing, which processes data closer to its source, is gaining momentum. As computer resources are distributed, the application area of optical networks to connect them is expanding. Therefore, even in the edge domain, there is a growing demand to dynamically change the distributed processing of data and optical networks as one.

To meet these demands, it is necessary to link optical networks with cloud services, the Internet, and mobile devices that use them, and to continuously incorporate the latest technologies. To do this, it is necessary to change to an open architecture. By building optical networks with an open architecture based on a multi-vendor ecosystem, it will be possible to link them with various applications, mobile networks, etc. without depending on the vendor. This will enable end-to-end orchestrating of the entire service, as well as rapid incorporation of the latest technologies.

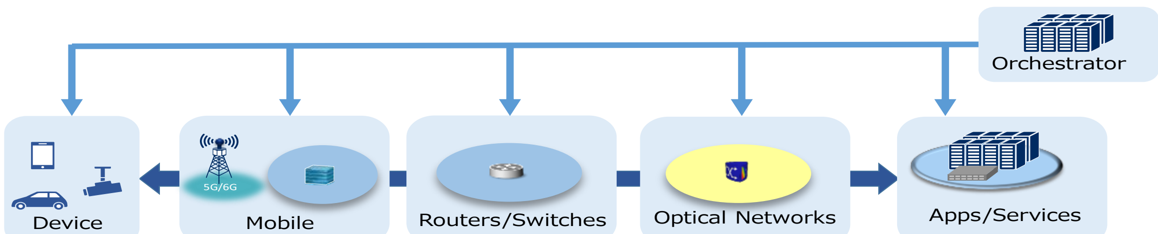

Figure 2 End-End orchestrating

Furthermore, openness can evolve optical networks to be sustainable. Firstly, it allows networks to be more resilient to disaster and procurement risks. By using multi-vendor network equipment, services can be continued by procuring alternative equipment even if the equipment cannot be procured due to a disaster or unilateral circumstances of the vendor.

Also, operation and maintenance tasks can be transformed into sustainable ones. While the operation and maintenance of optical networks, including WDM, requires a high level of skill, the skills required differed depending on the vendor of the equipment used. Securing maintenance staff and building business processes for each vendor is one of the factors that drive up maintenance and operation costs. Additionally, it is becoming increasingly difficult to secure maintenance staff due to population aging and other factors. Opening up optical networks and using standardized open interfaces to build business processes can help standardize operations. In addition, operations and maintenance can be transformed into a sustainable business by integrating with AI to enhance operations and maintenance, and by integrating with applications to automate operations.

Furthermore, it can contribute to energy reduction towards carbon neutrality. In addition to selecting power-saving devices, open specifications can be realized using general-purpose CPUs and devices instead of dedicated devices, allowing the components of the device to be shared with devices used in computers. This allows for a reduction in the energy required for manufacturing compared to network equipment previously built with dedicated modules.

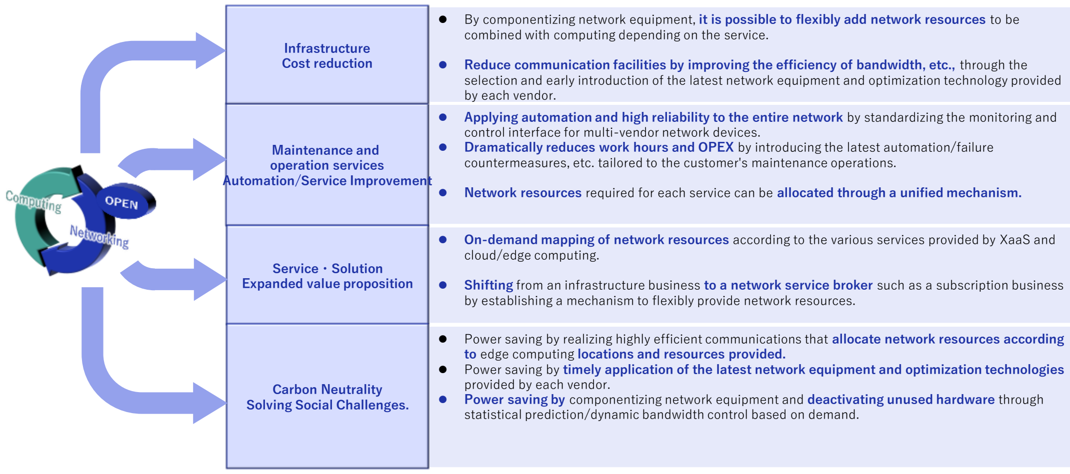

Figure 3 Advantage of open optical transport

Challenges and solutions for openness

To promote the openness of optical networks, it is necessary to transform the tools for this purpose, the business processes that use them, and the integration that combines the tools.

Standardization of operation and maintenance interfaces

Until now, interfaces for operating and maintaining optical networks have been provided by different systems and vendors. It is necessary to make this independent of the vendor, so that any network can be controlled, operated, and maintained using a common interface. To achieve this, it is necessary to define the functions of the components that make up the optical network, such as optical transmitters and transponders, and standardize the control interfaces for each as open ones for implementation in the system. Various organizations such as OIF, ONF, TIP, and OpenROADM are working on standardization, and many vendors are developing products with standardized interfaces. NEC is actively participating in these activities, working with operators and vendors to promote standardization and implementation in systems.

Advancement of operator maintenance and operation processes

To take advantage of the newly defined open interfaces, the process of mastering them will also need to change. Operators need to break away from operations that have been carried out at each layer, each area, and each function (e.g., line maintenance, network design, operation, etc.), where management data is uncoordinated, and where operations have been carried out in an impersonal, stove-piped manner. Each operator's operations have been refined over the years in each area, and each is highly complete, so the transformation to a new structure that integrates them may not be straightforward. NEC supports the transformation of operators based on its expertise in openness and operational reform, which is leading the way in the mobile domain.

Systems Integration

Until now, in vertically integrated systems, communication equipment vendors have designed and evaluated each module, assembled it, and guaranteed its operation as a system. On the other hand, in creating a system by freely combining open components, there is a new need for the role of the integrator, who is responsible for selecting equipment and software based on the operator's requirements, verifying operation, building an operation system, and managing bugs and vulnerabilities. NEC provides integration to build carrier-grade optical networks by combining open components based on its knowledge and experience of building products and highly reliable networks for telecommunication carriers over many years. We also partner with various open product companies to promote the creation of ecosystems.

The value NEC provides

A broad ecosystem with an open architecture

NEC provides a wide range of equipment and software, from networks to IT solutions, as well as system construction and operation. By linking optical networks with AI, cloud technology and mobile technology, we build a broad ecosystem with open architecture and integrate services.

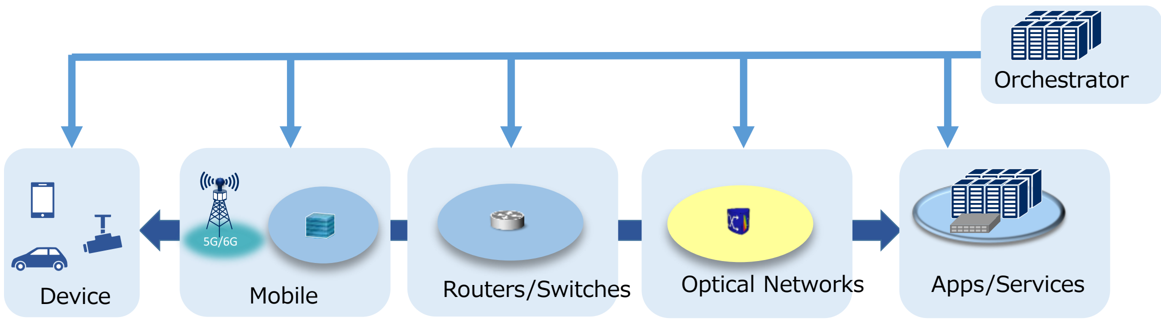

Figure 4 A broad ecosystem

It provides carrier-grade integration to build innovative networks such as network virtualization, cloud computing, and operational sophistication by combining the right open components in the right places to support end-to-end optimization across layers and areas, and rapid adoption of the latest technologies, which have been difficult to achieve with traditional closed networks.

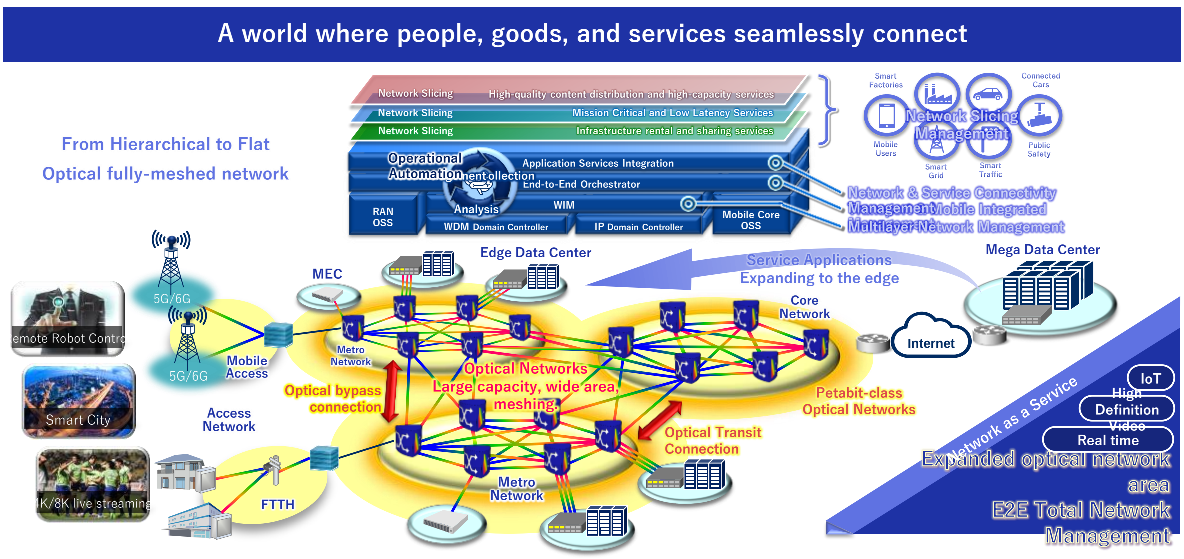

Figure 5 the future of optical network

Operational sophistication

Operating an optical network requires a complex process of design, construction, and maintenance. Automation of operations and the use of AI are essential to ensure the stability of this process and to provide customized services that meet the requirements of users in a timely manner. NEC realizes operational sophistication by combining it with AI and big data analysis applications that utilize open interfaces.

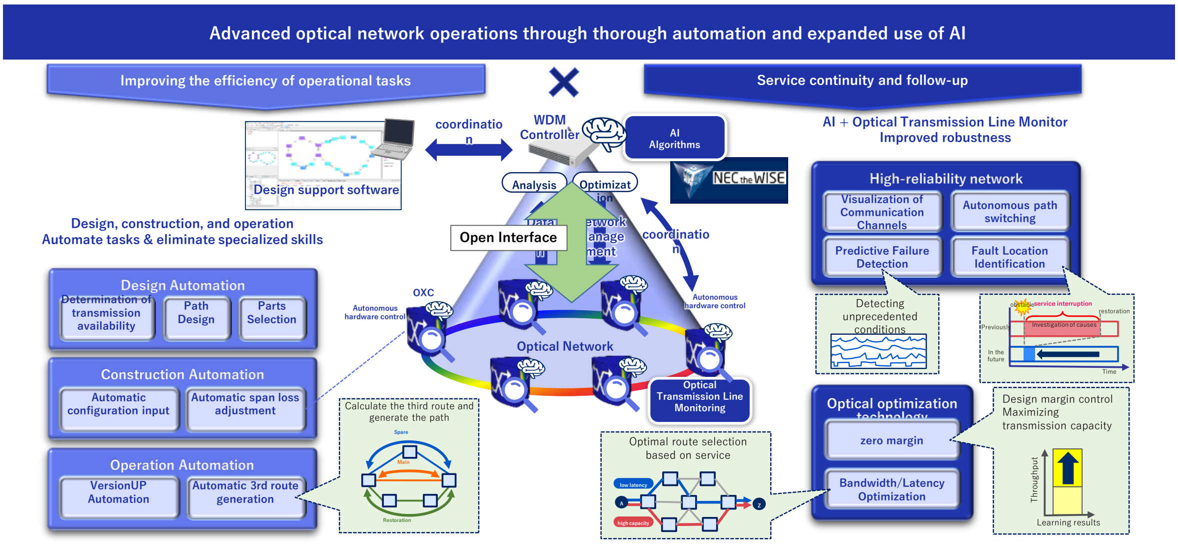

Figure 6 Operational sophistication

AI analysis of optical networks

One of the most important aspects of network operation is fault handling. To maintain a stable network, it is necessary to quickly identify the cause of a failure and restore the service when it cannot be provided. Furthermore, failure prevention is also very effective, as it detects degradation and other abnormalities before a failure occurs, and proactively replaces equipment and switches routes. NEC uses AI technology to analyze optical physical layer monitoring data to identify network conditions, including abnormalities, with a high degree of accuracy, and to automate and improve the efficiency of fault identification and condition diagnosis, which until now has been based on human experience.

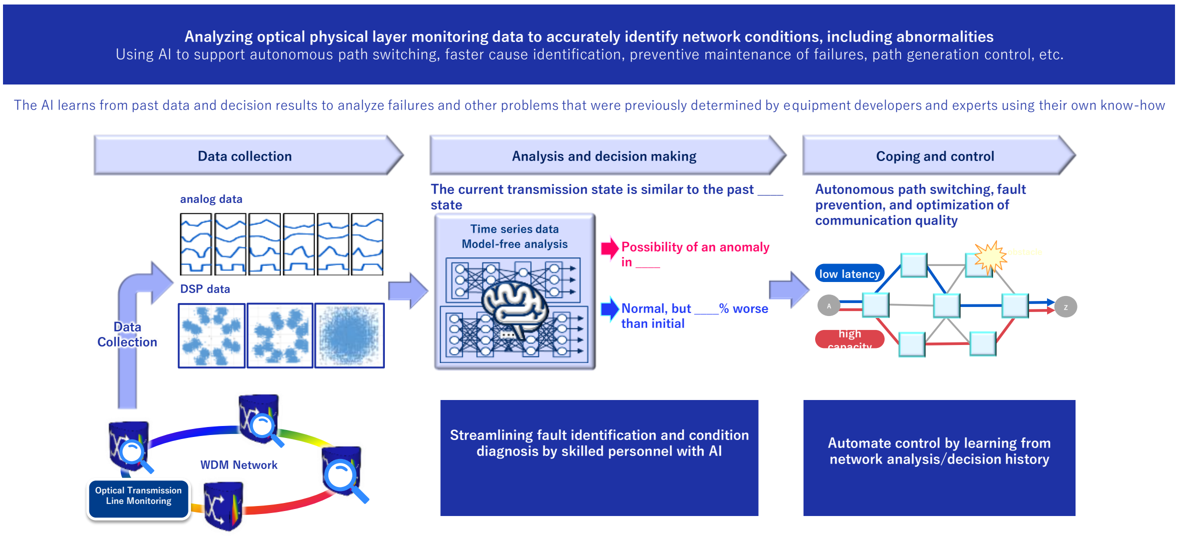

Figure 7 AI analysis of optical networks

Multi-layer management

Seamless integration with other systems is essential to provide customized services according to user requirements in a short time on an end-to-end basis. NEC links the optical wavelength path from the IP route with mobile OSS and end-to-end orchestrators to allow integrated management of multi-layer networks.

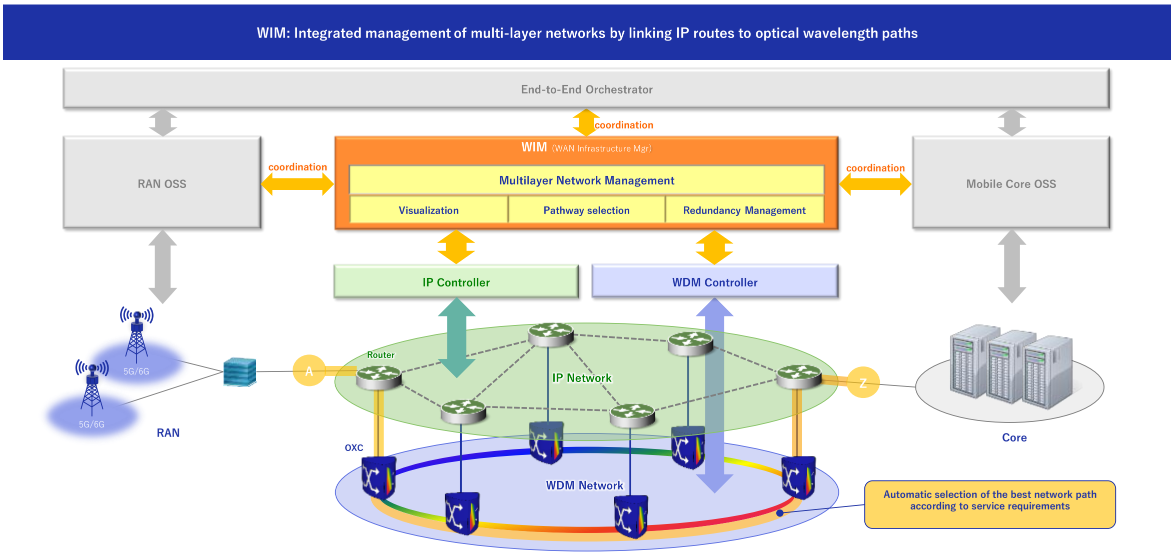

Figure 8 Multi-layer management

Open Optical Networks

To advance the operational sophistication, AI analysis, multi-layer management, and integration with computing and mobile as described so far, as well as to rapidly incorporate the latest technologies, it will be necessary to build an open optical network. NEC provides integration services that separate (disaggregate) the functions of optical transmission systems previously integrated in the traditional vertical integration model and combine open components to build carrier-grade optical networks.

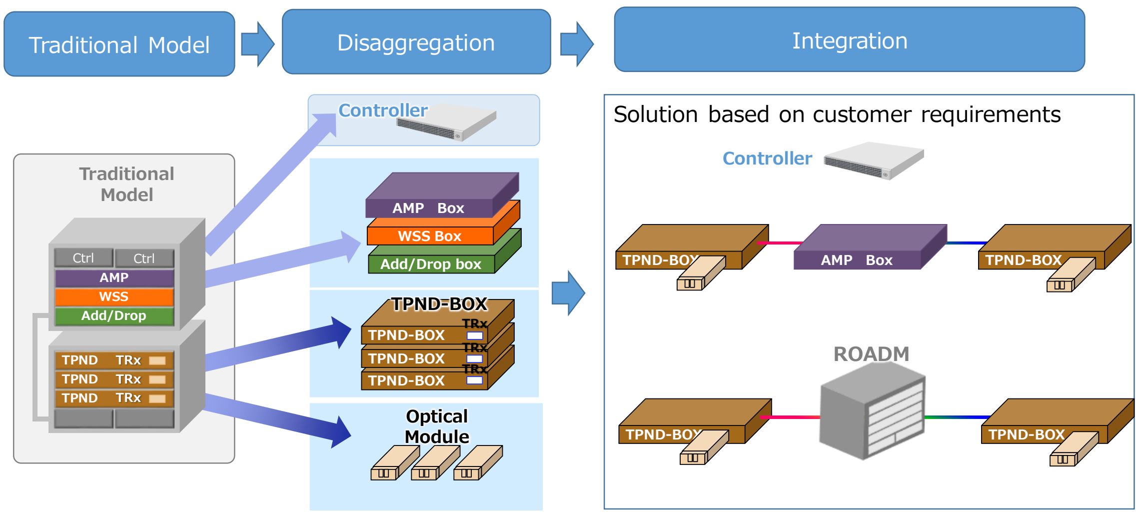

Figure 9 Open optical transport network

Compared to the conventional closed network with a single vendor, the multi-vendor environment presents challenges in terms of selecting and combining products that meet requirements, ensuring interconnection, quality and performance, managing vulnerabilities and bugs in each product, and maintenance. NEC provides optimal integration services based on its many years of experience in product development and network construction for telecommunications carriers.

High Performance Optical Devices

One of the key technologies that support increasingly open optical networks is optical devices that convert electrical signals into optical signals. NEC has been developing and applying its own optical transceivers for optical networks since the dawn of optical communications. In the future, the further expansion of the open network will require higher speed and capacity, as well as improved connectivity and a communication format that can be adapted to various network configurations.

NEC is vertically integrated in the development of optical devices using silicon photonics technology, the development of optical subassembly technology, and the development of optical transceiver technology combined with high-speed electronic circuits. This enables us to provide a variety of optical transceiver products in a timely manner to meet the needs of the growing open market.

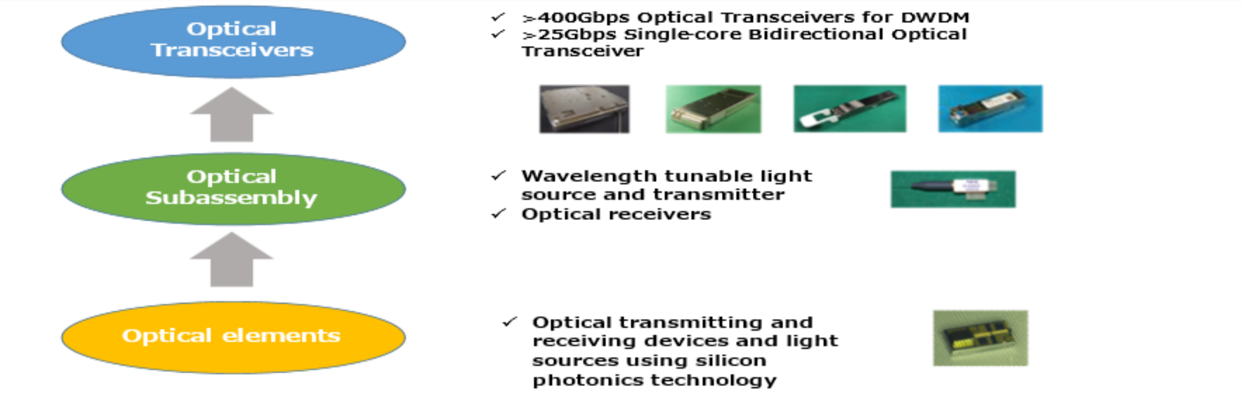

Figure 10 Optical Devices

NEC is focusing on the development of WDM optical transceivers with transmission speeds of 400 Gbps or higher using digital coherent technology in response to the recent openness of WDM optical networks. In this optical transceiver, a high-speed signal processing (DSP) LSI that performs digital coherent modulation and demodulation is important along with optical elements and optical subassemblies. In its development, NEC has participated in a state sponsored project to develop a DSP-LSI using state-of-the-art CMOS technology in cooperation with NTT and several other Japanese companies. This DSP-LSI has superior optical transmission characteristics to those of competitors, and also achieves connectivity with other companies in various communication standards, which is an essential condition for openness. NEC will continue this development activity to progress from the current transmission speed of 400Gbps to 800Gbps~1Tbps.

NEC's Goals

Our goal at NEC is to innovate through openness. The world is full of different ideas, innovations, and fascinating products. NEC aims to break away from the closed architecture of a single vendor, and partner with vendors to promote network innovation through open architecture through collaboration and integration. Furthermore, we will promote the creation of rules and systems to use open architecture, deepen "open co-creation relationships" with many stakeholders, and work to solve social issues including the SDGs.