Transport SDN Solution for Telecom Carriers

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Abstract

The introduction of Software Defined Networking (SDN) that targets the facilitation and advancement of network operation control began in the data center (DC) domain. However, it is expected that in future it will be deployed in the transport domain of the telecom carriers. In addition to layer 2/3 packet communication equipment, a large assortment of diversified multilayer communication systems are used in the transport domain. These include the layer 0/1 communication equipment, such as WDM optical transmission as well as microwave radio transmission systems. The SDN that is designed to match the characteristics of these types of communication equipment is called the Transport SDN.
This paper introduces the transport SDN solutions of NEC that enable: "advanced automation of operational control", "quick service provision and continuation" and the "provision of high added value for the network services based on transport control linked with the cloud services". This advance is achieved by implementing the comprehensive network operations and control job flows with software.

Keywords
SDN, transport SDN, multilayer integrated control, NFV, orchestrator, migration

1. Introduction

Mobile access from smartphones, Internet access such as the fiver to the home (FTTH) and the data transfer services such as the corporate-oriented virtual private network (VPN) services still result in a traffic increase at an annual rate of more than 50%[1]. However the fees paid by the users remain approximately at the same level. The profits of telecom carriers are therefore declining because of the facilities required for the secure transfer and the increasing traffic and also the expenditure required for operations of these facilities. As a result, it has become an urgent task for the telecom carriers to improve greater profitability. In order to achieve this, the telecom carriers are expected to expand the sales by improving the added values of the services, reducing the operation costs by increasing the equipment capacity and reduce the service operation costs by improving the efficiency and ease of operation.

Under such circumstances, SDN solutions are attracting attention because of their capability of "facilitating the network operations", "increasing the service provision speed" and "improving added value by the simultaneous provision of networking and services"[2) 3)].

At NEC, we have proposed the "carrier SDN/NFV solutions" and are advancing R&D by focusing on the following four domains as shown in **Fig. 1**.

1) Data center SDN
2) Network Functions Virtualization (NFV)
3) Transport SDN
4) Operation & orchestration

In this paper, we focus on the "transport SDN". This is an SDN that matches the characteristics of the transport domain and is oriented towards the telecom carriers.

2. Transport SDN Solution

2.1 What is NEC's Transport SDN Solution?

As shown in Fig. 1, the transport SDN targets facilitating and advancing operational control in the Core, Metro and Access domains of the telecom carriers. NEC's transport SDN is an extension of the SDNs that have already been introduced in the data center (DC) domain, in accordance with the required transport network characteristics of the telecom carriers. The transport SDN

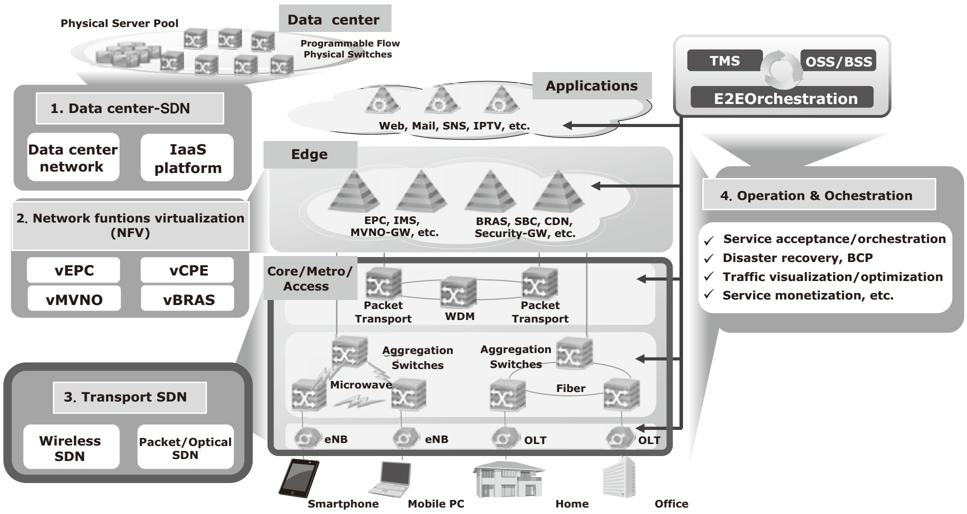

Fig. 1 NEC's carrier SDN/NFV solution.

extension consists of the following:

(1) Increased compatibility with various types of diversified multilayer communication systems

The transport network is composed not only of packet communication equipment such as the IP routers, Ethernet switches and Multi-Protocol Label Switching – Transport (MPLS-TP), but also of various types of diversified multilayer communications equipment such as: the long-distance optical transmission systems, optical cross-connect systems, Optical Transport Network (OTN) and Synchronous Digital Hierarchy (SDH) as shown in **Fig. 2**. As a result, the transport SDN is required to be compatible with various types of communication equipment as mentioned above as well as with the packet communication equipment.

(2) Extension of compatibility with legacy communication equipment

With regard to the traditional transport networks, different communication equipment was employed for each specific service. In such cases, the equipment was used continually for long periods of 5 to 10 years, once a service had been started. As a result, it was difficult to replace the communication equipment in a short period, whereas the generation change should optimally take a long time. This means that it is not desirable to introduce a transport SDN solution that necessitates the renewal of communication equipment. To deal with this issue, NEC has planned a smooth migration from the existing transport network to the SDN-compatible transport network of the future (**Fig. 3**).

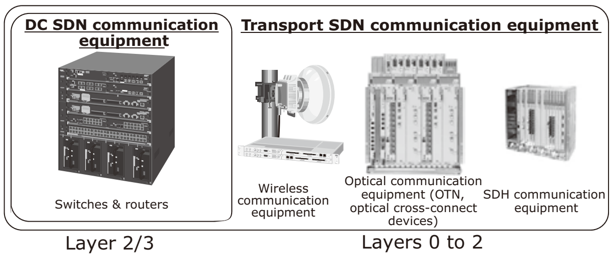

Fig. 2 Examples of communication equipment accommodated by transport SDNs.

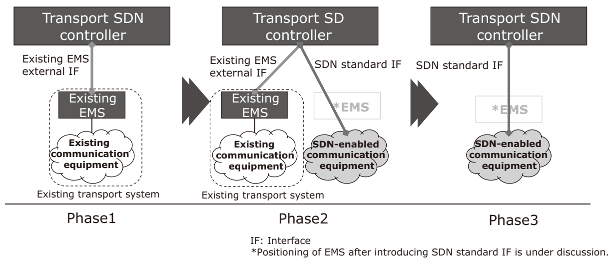

Fig. 3 Migration to transport SDN.

2.2 NEC's Transport SDN Solution

A target of NEC's transport SDN solution is to control and to dramatically facilitate operations of a transport network composed of multilayer and various communication tools of multivendor. In order to achieve it, we implement the comprehensive operation manuals and business flows with software. Consequently, it enables the following items.

1) Automation of operation management/control of

multivendor, multi-domain, multivendor transport network (elimination of human errors)
2) Quick and continual service provision
3) One Stop on Demand provision of network & cloud services based on linkage with DC-SDN/NFV

2.3 Architecture and Technological Outline of the NEC Transport SDN

Fig. 4 shows the NEC transport SDN architecture. The transport SDN is composed of the transport network that transfers data and the transport SDN controller that controls the network. The transport network is composed of various types of diversified communication equipment in multiple layers, from layers 0 to 3. With the layers 0 to 2 of the communication equipment, the Element Management System (EMS) specific to each piece of equipment is introduced. The EMS is also handled as being included in the transport network.

The transport SDN controller sets the path of each service and controls the operation status monitoring according to service orders from the higher-level system such as the service orchestrator and also according to the operation resource information from the transport network.

The main function modules of the transport SDN controller are the network driver, abstraction module, virtualization module and operation/control application module.

The "network driver" is the software for exchanging information between the inside of the transport SDN controller and the transport network (EMS and communication equipment). It performs conversion between the external interface of the connected EMS or communication equipment and the interface used inside the transport SDN controller. It is the network driver that enables the introduction of the transport SDN on an existing transport network.

The "abstraction module" is the function module for the simplified notation of the network configuration and for the facilitation of operations by expressing the diversified communication equipment uniformly as nodes, links and ports regardless of the layers and models. It is this function module that allows the operator to control the network easily without awareness of the complicated layers, domains and communication equipment.

The "virtualization module" divides the abstracted network logically per service and provides virtual networks. A typical example of a virtual network is the enterprise VPN.

The "operation/control application module" includes the operation and control applications deployed in the virtual networks. It mounts the applications required for the operation flow in each virtual network in order to automate and facilitate the operations. Typical examples of operation/control applications include the multilayer path calculation, multilayer provisioning and multilayer restoration applications.

As described in the above, with NEC's transport SDN, introduction of the network driver has made possible its application in an existing transport network, the abstraction integrates the control of multi-domain/multilayer communication equipment and the operation and control applications automate and facilitate the operation flow.

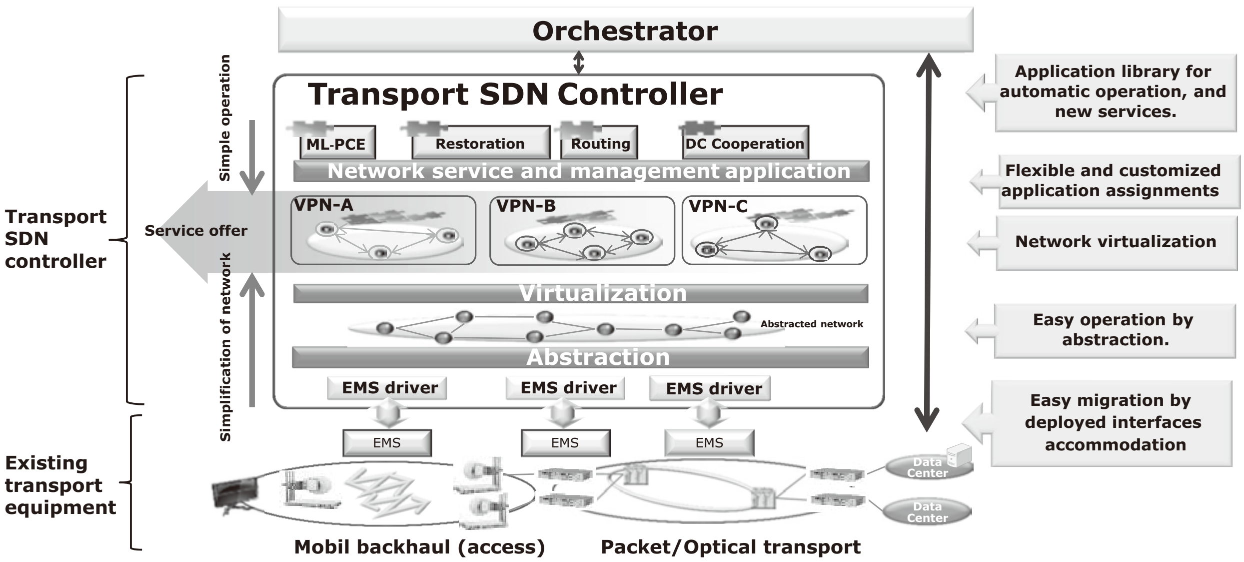

Fig. 4 Architecture of NEC's transport SDN.

3. An Actual Example of an NEC Transport SDN System

This section introduces the NEC transport SDN solution by taking a multilayer transport network using NEC-made communication equipment as an example (**Fig. 5**). The transport network in Fig. 5 is composed of the wireless domain using radio communication equipment iPASOLINK200, the packet domain using packet communication equipment DW7000 P-OTS and the optical domain using the DW7000 ROADM. These items of communication equipment are existing equipment and this example does not include a standard SDN interface such as OpenFlow.

Each item of communication equipment has an EMS for the equipment management, and the transport SDN controller controls and collects information from the communication equipment by utilizing the external interface of the EMS. **Fig. 6** shows an example of a graphical user interface (GUI) of the transport SDN controller. Using the abstraction module of the transport SDN controller, the communication equipment on the GUI is expressed as nodes, links and ports regardless of the type. Transport paths can be set on the abstracted transports using the operation/control applications.

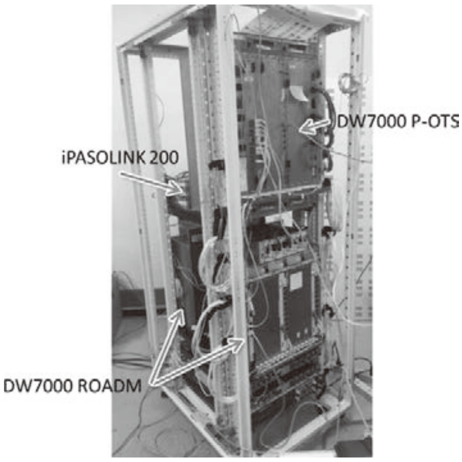

Fig. 5 Transport SDN communication equipment.

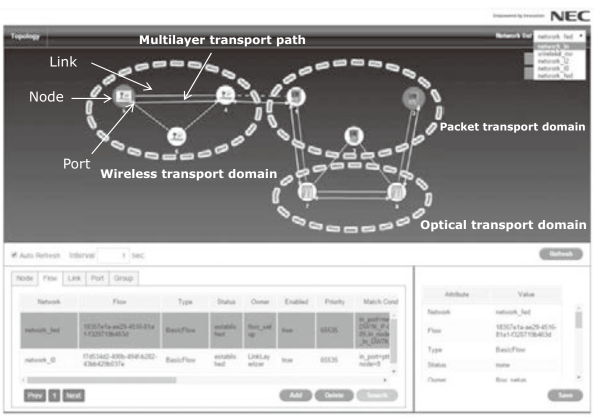

Fig. 6 GUI of the transport SDN controller.

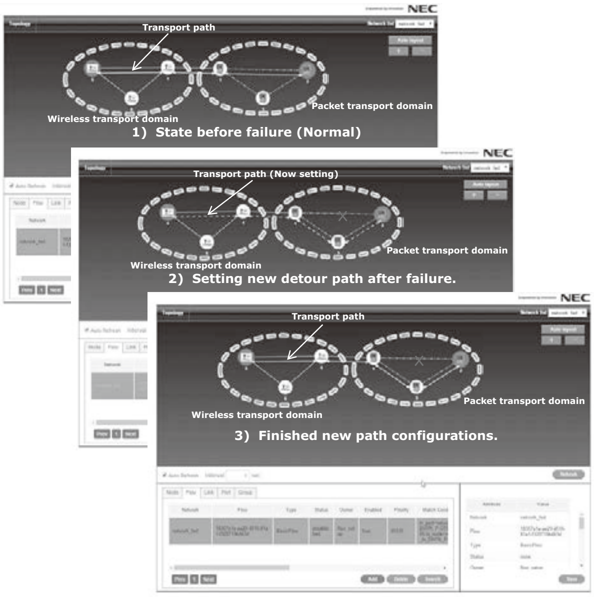

Fig. 7 Example of visualization of restoration process.

Fig. 7 shows an example of a display on a transport SDN controller during auto recovery (restoration) from a fault. When a fault occurs, the transport SDN controller is notified of the fault information by the transport network. The transport SDN controller displays the fault location and starts the restoration job flow that is described as software. The restoration job flow computes the routing path from the new transport topology, eliminating the faulty link using the Multi-Layer Path Computation Element (ML-PCE) function and sets the path to the transport network.

In this way, the routes and faults of the transport paths can be visualized regardless of the type of communication equipment and the frames of the layers so that the operational efficiency can be improved dramatically.

It is also possible to build a network & cloud (DC-SDN/NEV) service platform in linkage with the service orchestrator, which is the higher-level system to the transport SDN. The one-stop service of the network and cloud service enables more advanced service provisions featuring elimination of user troubles. This is achieved by integrating the service reception, rapid provision of end-to-end cloud services covering the network and easy identification/measures that deal with the effects of faults on the cloud service.

4. Conclusion

In this paper, we introduced NEC's transport SDN solution that enables "thorough automation of operation control", "quick service provision and continuance" and "provision of high added value for transport linked with the DC-SDN/NEV". This solution implements the transport operation and controls the flow with software.

NEC's transport SDN solution features applicability to existing transport networks that lack SDN compatibility. "Change without Change" that can change operations without a change in assets is the target at which NEC's transport SDN solution is aimed.

* Ethernet is a registered trademark of Fuji Xerox Co., Ltd.
* OpenFlow is a trademark or registered trademark of Open Networking Foundation.

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