# SDN/Automation for Beyond 5G

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**Abstract**

5G and Beyond 5G networks require software-defined networking (SDN) and automation support for efficient use of wireless transport networks. Standardization bodies such as the ONF, IETF, and ETSI are promoting the standardization of device monitoring and control interfaces using the Network Configuration Protocol (NETCONF) and data models. By complying with these standards and cooperating with SDN orchestrators, NEC's PASOLINK wireless transport devices and unified network management system (UNMS) provide automated solutions for the operation of wireless transport networks.

Keywords

wireless transport, network management, SDN, automation, NETCONF, PASOLINK

## 1. Introduction

5G and Beyond 5G networks are complex network systems that combine a variety of networks and that require end-to-end integrated operations management as well as optimization of network resource utilization to provide network services and applications. Also, more efficient network management is required for the domain of wireless transport that conventionally uses vendor-specific control and data models. To meet these needs, the introduction of software-defined networking (SDN) and the automation of operations are being considered.

In this paper, we discuss the standardization trends of SDN and automation in wireless transport and introduce NEC's response to these trends and NEC policies on relevant devices and network management products.

## 2. Standardization Trends of SDN and Automation in the Wireless Transport Domain

NEC has been involved with several standardization bodies in activities focused on the standardization of SDN and automation from the early stages and has contributed to the standardization activities of SDN through participation in the proof of concept (PoC)[1].

### 2.1 SDN architecture

The two main types of SDN architecture are described here. In one method, the SDN orchestrator directly monitors and controls the devices of multiple vendors (**Fig. 1**). In the other method, the controller of each

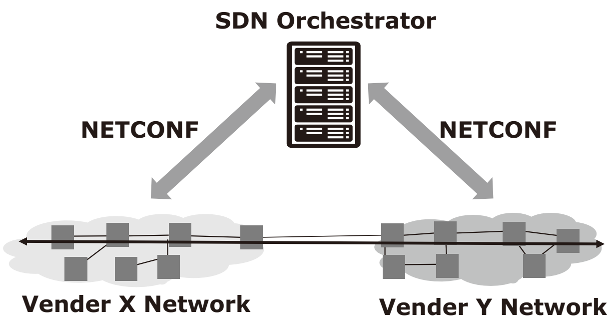


Fig. 1 Monitoring and control of devices using NETCONF.

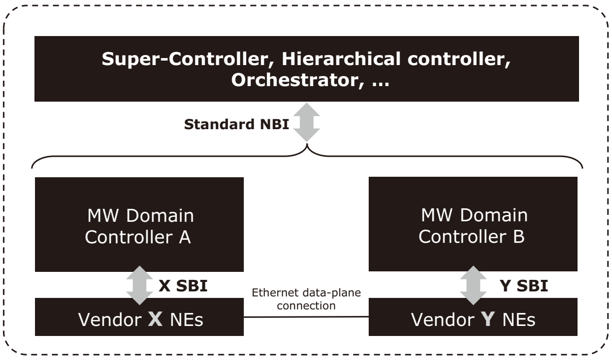


Fig. 2 Monitoring and control using domain controllers.

vendor (domain controller) monitors and controls their own devices, and the SDN orchestrator indirectly monitors and controls the devices via the vendor's controllers (**Fig. 2**)[2]. When each device conforms to a standardized SDN interface and data model, the first method of direct monitoring and control can be used. When adopting existing legacy devices, domain-specific technology, or vendor-specific functions, the second method using domain controllers for indirect monitoring and control is used.

The Network Configuration Protocol (NETCONF)[3] has been introduced as an SDN interface for device control in wireless transport. The NETCONF is a protocol that is gaining popularity as a monitoring and control interface that can replace the Simple Network Management Protocol (SNMP). It has more advanced features than the SNMP, and these features include good readability with XML-based text format, SSH (Secure Shell)-based security, and rollback functions.

The Open Networking Foundation (ONF) has defined the Transport API (TAPI)[4] as an interface protocol between SDN orchestrators and domain controllers, whereas the Internet Engineering Task Force (IETF) has defined Representational State Transfer Configuration Protocol (RESTCONF)[5] as its chosen interface protocol. TAPI is an interface that is used to manage VLAN (virtual local area network) services that span multiple devices and control them on a service-by-service basis, whereas RESTCONF is an interface that is used to control each device individually.

### 2.2 Standardization of data models

The standardization of management models is currently underway with the aim of achieving vendor-agnostic device management.

The OTCC (Open Transport Configuration & Control) project of the Open Networking Foundation (ONF) is developing a management model for radio transport equipment within the 5G xHaul team (Microwave Information Model TR-532)[6]. Proof of concept (PoC) and real-world testing are also underway. In a project led by Telefónica Germany in 2021, SDN controllers implementing the TR-532 Microwave Information Model were used to monitor and control 40,000 devices[7]. Meanwhile, the Common Control and Measurement Plane (CCAMP) working group of the Internet Engineering Task Force (IETF) is also developing a management model for wireless transport equipment and has published their proposed standard as the RFC8561 document[8]. As there is no compatibility between the two models, it remains to be seen which model will become the de facto standard, so we will have to closely monitor the situation.

### 2.3 Automation use cases

In the Industry Specification Group on millimetre Wave Transmission (ISG mWT) of the European Telecommunications Standards Institute (ETSI), research and validation of SDN and automation use cases are being conducted. The group issued documents that outline the SDN and automation use cases in wireless transport, including VLAN service control, optimization of power consumption, and optimal frequency allocation[9][10]. In addition, for validation of the use cases, the group conducted a plugtest in February 2023 based on the RFC8561[11]. In this plugtest, multi-vendor devices were controlled by using the NETCONF interface protocol to obtain network information and control VLANs.

## 3. Addressing SDN and Automation in NEC's Wireless Transport Domain

NEC offers PASOLINK wireless transport devices and the NEC Unified Network Management System (UNMS) as an advanced network management platform for those devices. In this section, we take a look at NEC's efforts to realize SDN and automation in the NEC PASOLINK and UNMS.

### 3.1 Monitoring and control interfaces

The UNMS acts as a domain controller for the wireless transport domain in the SDN architecture and provides efficient network management by controlling wireless transport devices in conjunction with the SDN orchestrator. Both TAPI and RESTCONF are implemented in the UNMS as upstream interfaces, enabling connection and coordination with a variety of SDN orchestrators. UNMS also supports the NETCONF protocol as a device control interface. Therefore, it can be connected not only to NEC devices but also to wireless transport devices from other manufacturers that are compatible with NETCONF and ONF's technical recommendation TR-532 to manage multi-vendor networks.

Because the PASOLINK supports the NETCONF protocol, direct monitoring and control from an SDN orchestrator is possible. The PASOLINK is also compatible with the two SDN architectures described in section 2.

### 3.2 Dealing with automation use cases

UNMS supports the six automation use cases specified in the ETSI GR mWT 025 group report[10)]. These six use cases comprehensively cover the challenges of network management in wireless transport. Automation in these use cases will contribute to the improved operational efficiency of communication service providers (CSPs).

#### 3.2.1 Automatic detection of networks and services

To manage the configuration of a complex network in an integrated manner, it is necessary to understand the topology of that network. After obtaining the configuration information, adjacency information, and VLAN configuration information from devices, the UNMS analyzes and manages the configurations for both the network and VLAN service. The UNMS then provides them to SDN orchestrators using a standardized SDN interface (**Fig. 3**). This enables the SDN orchestrators to manage multi-domain, end-to-end network topologies.

#### 3.2.2 Service provisioning

To efficiently utilize network resources and provide network services, it is necessary to design systems across networks be they IP or wireless transport. UNMS receives requests from an SDN orchestrator and performs optimal

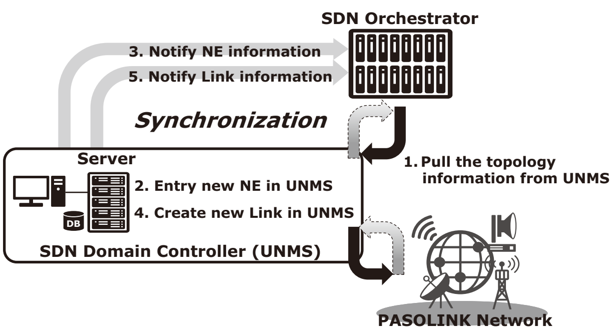


Fig. 3 Network/service discovery and synchronization.

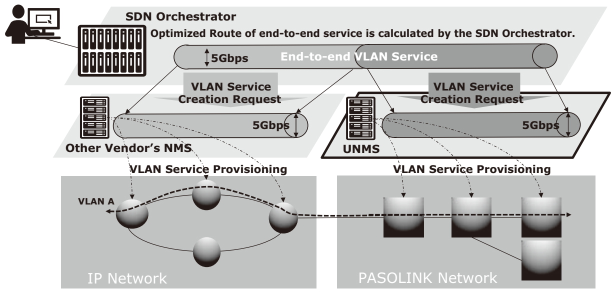


Fig. 4 End-to-end service provisioning.

path design and device configuration in the wireless transport domain. This enables end-to-end service provisioning of VLAN services in the SDN orchestrator (**Fig. 4**).

#### 3.2.3 Improving the efficiency of network resources

To efficiently utilize network resources, it is necessary to optimize the network configuration in accordance with the traffic information. The UNMS collects traffic information from devices and generates meaningful reports regarding the results of the analysis of wireless network operation performance. Also, there is a demand for the real-time display of traffic information and traffic prediction by AI and machine learning. And plans to implement these features in the UNMS are underway.

#### 3.2.4 Failure analysis and prediction

To reduce operating expenses (OPEX), increase network availability, and improve the quality of service to end users, advanced failure analysis and failure prediction are required. The UNMS has a standard SDN interface so it can notify SDN orchestrators of alarms from equipment and it has the ability to analyze failures in the wireless transport domain and provide alarm information affecting services to SDN orchestrators. This enables the SDN orchestrators to perform advanced multi-domain failure analysis and prediction.

#### 3.2.5 Power consumption efficiency

Reducing power consumption of the entire network, including in the wireless transport domain, has become an important issue for CSPs. The NEC UNMS can reduce power consumption on lines that use the Radio Traffic Aggregation (RTA) function, which performs packet transfers of multiple wireless channels by handling them virtually as one physical layer, by suspending some radio channels on the RTA line only during times when traffic volume is sufficiently low. Here, traffic volumes are analyzed to detect which radio channels are to be switched off, and the device settings are automatically changed.

#### 3.2.6 Automatic frequency allocation

With the advent of the 5G era and the increasing density of networks, we expect that mutual frequency interference will be more likely to occur between wireless links, resulting in an increasing need for automatic frequency allocation. To meet this need, we are exploring ways to make the UNMS visualize frequency usage conditions, perform phasing detection from traffic information analysis, and provide information to SDN orchestrators.

## 4. Conclusion

In this paper, we introduce the standardization trends of SDN and automation in wireless transport networks and NEC's efforts to deal with those trends. At NEC, we are actively committed to the standardization of SDN and automation in the wireless transport domain as well as providing our customers with the PASOLINK wireless transport devices and UNMS network management platform — both of which comply with the standardization efforts. What is more, we are also promoting the automation of the UNMS to improve operational efficiency in the wireless transport domain, regardless of whether an SDN orchestrator is introduced or not. Looking ahead to the Beyond 5G era, we will continue to endeavor to contribute to the development of telecommunications networks and the provision of network services by achieving the optimization and advancement of network operations.

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