NEC SDN Solutions Accelerate New Service Implementations for Railway Stations

MATSUMOTO Katsushi, NISHIYAMA Tomotaka, MATSUMOTO Yoshiyuki, NAGAI Hideki, YOKOYAMA Takumi

Abstract

The complicated network layouts around stations may impose delays on the timely implementation of planned new services. East Japan Railway Company (JR-EAST) has been facing such an issue that has been resolved by using the "common station network" (JR-STnet) that employs an SDN solution. This strategy enables the timely updating or upgrading of a network without physically necessitating the construction of another network. This paper discusses NEC SDN Solutions introduced to the "common station network" at Tokyo station.

Keywords

SDN, OpenFlow, IP network, Virtual Tenant Network (VTN), network management, UNIVERGE PF series

1. Introduction

A railway station is equipped with a large number of networks. For example, Tokyo Station of East Japan Railway Company (hereafter referred to as JR-EAST) is equipped with several dozen types of networks: for providing train service information, controlling cameras used for managing the operating status of escalators and various other types of equipment, monitoring digital signage and vending machines and managing the business systems of all the onsite tenant shops, etc.

Originally these networks have been built separately when the need arose. This practice resulted in extensively jumbled wiring in the backyard, which created an extremely complex situation for the network. In such a situation, building new service networks that had to be incorporated in the current already complex networks imposed delays on the timely implementation of planned new services.

In this paper, we introduce the case study of a "common station network" (JR-STnet) that employs an SDN solution as prepared for Tokyo Station. This approach enables the timely updating or upgrading of a network without physically necessitating the construction of another network.

2. Network Issues Uniquely Found at Railway Stations

Network construction and its management at railway stations possess unique issues that are explained below.

Issue 1: Rapid deployment of new services in order to enhance the quality of service availability at stations

It was essential to implement the rapid deployment of new services in order to enhance the quality of the current services at stations in order to suit a variety of passengers; especially for those visiting from outside Tokyo, and even from outside Japan.

Issue 2: Network configuration changes are necessary each time that improvement construction works are undertaken

A railway station undergoes frequent improvement construction work. However, the existing network configuration may require that network equipment is relocated or removed, and such modifications require a rearrangement of the network topology.

Issue 3: Three hours between the last train at night and the first train in the morning is the time window for any network modification work

The construction work inside the station has to be conducted without interfering with train schedules. This means that the available time window for the work is for only three hours after the last train at night has left and the starting of the first train in the morning. When allowing time for a fallback operation, the actual time that remains for the relevant network modification work is only one hour or less per night.

Issue 4: A reassignment of IP addresses is necessary when integrating network systems

Various systems are adopted to configure physically independent networks at stations. The same IP addresses therefore often coexist. In such situations, the IP addresses must be reassigned and revised when integrating network systems.

3. Resolving Issues by Employing SDN

In order to solve issues found in network configuration and management that are station-specific, NEC inaugurated the common station network for Tokyo Station in March, 2014. This network employs NEC's "UNIVERGE PF Series" (**Photo**) that enables implementation of Software-Defined Networking (SDN).

The common station network makes it possible to create a logically independent network by using the virtual tenant network (VTN) functions provided via the UNIVERGE PF Series.

The common station network not only makes it possible to significantly reduce the time required to construct additional networks, but also to enable the rapid deployment of new services. For examples, JR-EAST has developed a "Smart Device" environment by constructing a "Wireless LAN" backbone, and also has started the "*Suica* locker availability" information service inside Tokyo Station. The "*Suica* locker availability" service is receiving much approval from train passengers because it allows them to find vacant lockers easily when they install a "JR-EAST Application" in their smartphones, even in the enormous Tokyo Station.

Flow switches based on OpenFlow protocol are connected to a mesh network, so that reviewing the network topology is no longer necessary when adding and removing switches due to station remodeling work, etc. This solved the issue of reconstructing networks that was referred to in Issue 2.

Moreover, it became possible to change networks simply by operating the flow controller that enables software-based control of entire network systems. This improvement has achieved time reduction for the network construction work hours and resolved issues referred to in Issue 3.

Photo UNIVERGE PF Series.

The VTN function also allowed us to construct a physical network without being constrained by IP address duplication with other network systems. This has resolved the issues referred to in Issue 4.

4. Range of Processes from Designing a Network to Managing a Network System

4.1 Network Design

(1) Data network and control network

A Network system using OpenFlow protocol employs a flow controller to control the flow switches via a SecureChannel. This means that disconnection from a SecureChannel must be avoided while constructing additional networks.

The common station network was designed to be compatible with such a situation. It isolates the data network and the control network; the former is for user data transmission and the latter is for SecureChannel data flow (**Fig. 1**). The data flow system offers two choices when building a control network: the outbound system and the inbound system.

The outbound system employs a configuration that physically isolates the data and control networks and it features a simple design. However, besides the optical cable core for the data network, another one is required for the control networks connecting the wiring rooms in the station.

The inbound system can share the same optical cable core for both the data and control networks. This is done by building a VLAN on the data network for connecting the networks. Although this strategy is advantageous, the inbound system still has some issues. A control network has to be designed with the logical and loop free configuration instead of employing a loop prevention function. Also, a priority control function has to be installed, because data transmissions of both data and control are coexistent. Therefore, the inbound system is expected to require more effort to be used in the network design and management, especially for the larger scale network systems.

By considering the above issues, JR-EAST decided finally to employ the outbound system, because the configuration is rather simple and it is more suitable for configuration expansion and maintenance.

(2) Numbers of flows

The number of resources needed to handle flow entries is limited per flow switch. Therefore, a common station net-

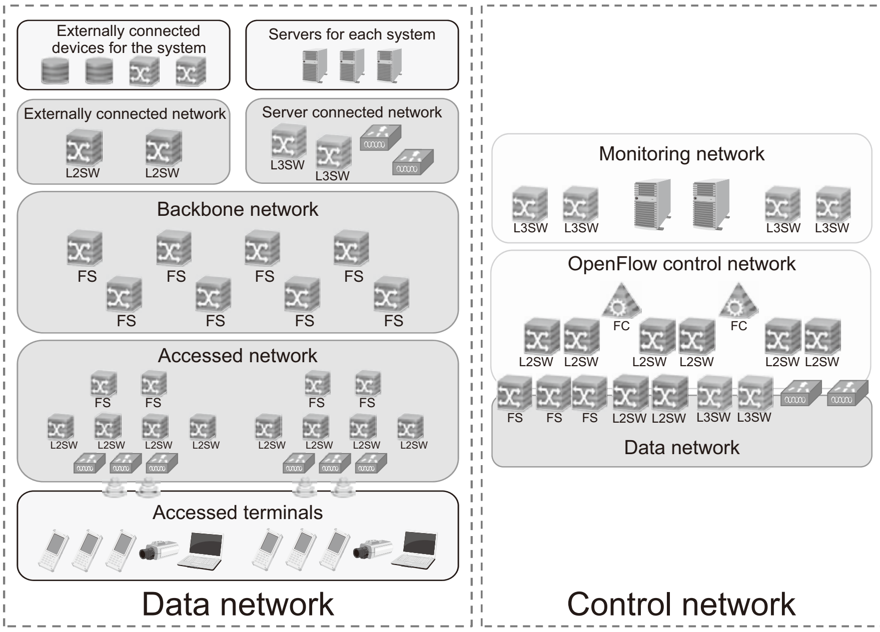

Fig. 1 Data network and control network.

work was designed by considering the numbers of flows of each system to be housed in the network.

4.2 Testing before Shipping

Tests to check unicast/broadcast transmissions are generally performed before shipping a product. However, networks based on the OpenFlow protocol employ a different packet transmission mechanism to the one employed by the conventional networks. Therefore, we conducted additional tests to check whether Packet-In, Packet-Out and Flow-Mod messages are transmitted appropriately. Load tests were also provided, and we have conducted a resources test in order to confirm the number of flow entries per flow switch, as well as a bench mark test that is compliant with RF2544 standard.

4.3 Network Construction

By employing OpenFlow protocol we were able to reduce the network construction time compared to that for the conventional TCP/IP network.

Station improvement work has to be carried out in the short time interval between the last train at night and first train in the morning. Such conditions also apply to the construction of the common station network. Conventional networks have hitherto required a work load proportional to the number of devices. This was because it was necessary to check the performance status and the data transmission status of every single device every time that networks were modified or newly built.

On the other hand, the network based on OpenFlow protocol enables the flow switch status to be checked via the flow controller once the SecureChannel connection is established between the flow controller and the flow switch. Consequently, configuration of more devices requiring limited work hours and human labor was now possible and a shortening of the expected work schedules could be achieved. Moreover, the easier configuration work allowed JR-EAST to build a network for a certain area in Tokyo Station within a time frame between the last and first trains.

4.4 Network Management

Adding the network configurations required when deploying new services may be now carried out with greater ease compared to the conventional TCP/IP network.

When adding a new network to an existing one, it is necessary to add and modify all of the relevant devices. However, the common station network only requires the additional setting of a flow controller.

Moreover, the VTN function provided via a flow controller can cope with a request that the network constructed for new services will be isolated from the existing networks and will not be in communication with each other. The VTN function allows us to add network configurations just by conducting the relevant settings on the flow controller, and without conducting additional settings to a large number of flow switches. Moreover, the logical network configured via the VTN function allows users to check the network status with GUI so that high performance network management is achieved, even for a large scale network system (**Fig. 2**).

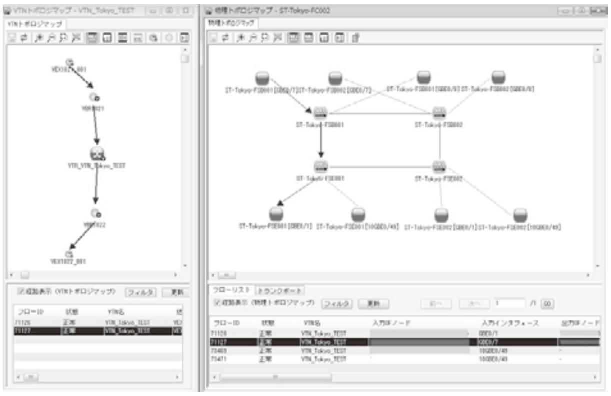

Fig. 2 Screen with GUI display.

5. Issues and Approaches of the Common Station Network

A network system similar to the one constructed at Tokyo Station is now being prepared for Shinjuku Station and other hub stations. Employing SDN to service broader networks than just for stations is also under consideration.

Employing SDN for broader network area, however, still requires several issues to be resolved. A significant issue can be seen especially in the example of isolating a data network from a control network. A large number of optical cable cores are needed to connect network devices. We consider that this issue is one of the main issues to be solved in the immediate future.

6. Conclusion

The common station network is now one of NEC's leading case studies that has provided proof of how SDN can enable the easy setting and management of railway station networks and can also support the rapid deployment of a new service. It has therefore excited the interest of many other railway companies.

For railway companies, which have the responsibility of maintaining a social infrastructure, safe and reliable transportation is of the utmost importance. Besides this, improved services are also demanded. By understanding the functions and performances that railway companies are looking for, NEC is aiming to provide innovative support in order to establish a network system that will satisfy the needs of our clients.

Authors' Profiles

MATSUMOTO Katsushi
Project Manager
Ubiquitous Network Systems Division
NEC Solution Innovators, Ltd.

NISHIYAMA Tomotaka
Assistant Manager
Transportation and City Infrastructure Division

MATSUMOTO Yoshiyuki
Manager
Transportation and City Infrastructure Division

NAGAI Hideki
Assistant Manager
Transportation and City Infrastructure Division

YOKOYAMA Takumi
Transportation and City Infrastructure Division

Information about the NEC Technical Journal

Thank you for reading the paper.
If you are interested in the NEC Technical Journal, you can also read other papers on our website.

Link to NEC Technical Journal website

Japanese | English

Vol.9 No.1 Special Issue on Solutions for Society - Creating a Safer and More Secure Society

Vol.9 No.1

January, 2015

Special Issue TOP

NEC Information