Integrated Group Network Using SDN Case Study: Toyo Seikan Group Holdings

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Abstract

As the Toyo Seikan Group's network grew, the cost and complexity of network connections between the Group companies increased, while the lead time required to incorporate new companies or change network settings grew longer. To solve these problems, the Toyo Seikan Group turned to NEC to help build an integrated, cost-effective WAN. Using SDN, NEC was able to successfully integrate the Group's WANs, as well as its firewalls. This paper introduces NEC's SDN solutions by examining the case of the Toyo Seikan Group WAN.

Keywords

SDN, OpenFlow, IP network, VTN, network administration, UNIVERGE PF Series

1. Introduction

Taking the opportunity provided by its transition to a holding company system, Toyo Seikan Group Holdings set out to build a network of shared systems and optimize its resources.

Originally, in order to allow each Group company to control access according to its own policies, firewalls were installed at the contact points between the Group companies and only approved network traffic was passed through the firewalls.

However, as the number of Group companies connected to the network increased, problems began to emerge. These included the increasing cost of introducing, maintaining, and operating equipment as more and more equipment was added, the increasing difficulty of making changes to system configurations as the complexity of these configurations increased, and the corresponding increase in lead time that these problems created.

To solve these problems, Toyo Seikan Group Holdings chose NEC, basing their decision on our extensive experience in developing network solutions and technology. To effectively integrate the Group's network, eliminate the connection problems between Group companies, and reduce cost and complexity, we used NEC's Software-Defined Networking (SDN) solutions.

2. Problems in the Network

Toyo Seikan Group Holdings uses a network data center and a main data center that are shared by all the Group companies.

The group's shared systems and the individual firewalls belonging to each company are installed in the network data center. To maintain each company's security, the network data center is configured to ensure that network connections between the companies are always made via the firewalls in the network data center.

The main data center functions as the co-location site for backbone and operation servers belonging to each company. Prior to the introduction of NEC's SDN solution, Toyo Seikan Group's network (**Fig. 1**) had three major problems.

- **Problem 1**
  Firewalls individually configured for different companies and applications had to be installed in the network data center. As a result, whenever a new company was added to the network, additional equipment had to be installed and connected to the shared system. Whenever a device was added or exchanged, the network settings had to be changed. Installing new equipment, maintaining a wide range of devices, and resetting individual devices as re-

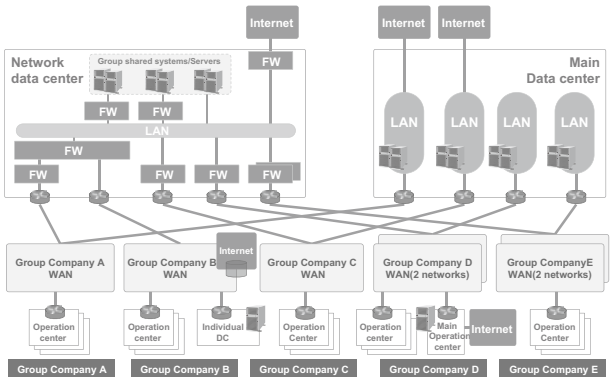

Fig. 1 Network configuration prior to the introduction of SDN.

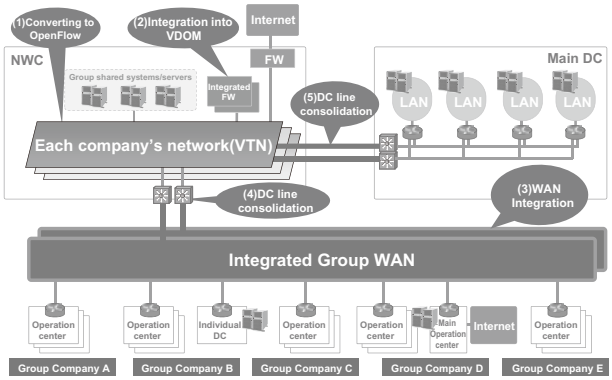

Fig. 2 Toyo Seikan Group WAN configuration.

quired had a significant impact on costs.

- **Problem 2**
  With more and more devices being added to the system, the complexity of overall system configurations - multistage firewall configuration, for instance - increased dramatically. This in turn made it more difficult to add new Group companies and reconfigure the system. Quick response and rapid turnover was impossible; instead, lead times grew longer and longer as advance confirmation of configuration and operational adjustment by dedicated engineers became necessary.
- **Problem 3**
  Because the Group companies configured their WANs separately, overall optimization was not achieved. Each Group company had to install its own WAN lines in the network data center and in the main data center, resulting in high wiring costs.

3. Solving Toyo Seikan Group's Network Problems Using SDN

Having been commissioned by the Toyo Seikan Group to solve these problems, NEC built a WAN in the Group's network data center in August 2014 (**Fig. 2**). The new system was built around NEC's SDN-compatible UNIVERGE PF Series.

3.1 Logical Independence of Each Group Company Facilitated Using SDN

Using the OpenFlow Virtual Tenant Network (VTN) function implemented in the UNIVERGE PF series, the Toyo Seikan Group WAN provides each Group company with the same level of security available using conventional security system level on a single physical network (Fig. 2 (1)).

3.2 Firewall Integration Using SDN and Virtual Firewall Functionality

For the Group's integrated firewall, we adopted the Fortinet FortiGate Series. Using FortiGate's virtual domain firewall (VDOM) functionality, it was possible to build firewalls for multiple Group companies using just the two FortiGate 1100C firewalls (Fig. 2 (2)).

Using the VTN and VDOM in combination, we were able to build all of the routers and firewalls to handle network traffic for each of the Group's companies using a total of just four devices - two FortiGate 1100C physical firewalls and two PF5240 ProgrammableFlow Switches (PFSs).

As of June 2015, ten Group companies have been integrated into the system (equivalent to 10 firewalls and 10 routers). This allowed us to significantly reduce the number of devices required and eliminate the need to add more equipment in the future, this effectively solved Problem 1.

Turning the WAN into SDN and VDOM-based system has simplified not only the physical configuration but also the logical configuration, making it possible to add networks and change firewall settings using software only. This significantly reduced the complexity and difficulty of integrating new companies into the network and adjusting settings, thereby solving Problem 2.

3.3 Integration of the WAN Using SDN

We positioned the WAN lines (main and backup networks) which Toyo Seikan Group Holdings was subscribing to as the matrix of the Toyo Seikan Group WAN and built a configuration that integrated the WAN lines of the Group companies (Fig. 2 (3)).

By adopting the wide-area Ethernet (WAE) L2 service for the WAN lines and using virtual LAN (VLAN) functions, we were able to ensure that each company's network traffic was physically separated. Also by allocating WAN lines using SDN at the points where each company's traffic entered and exited the system and by logically dividing them using the VLAN, we enabled the Group companies to share the bandwidths of the lines (Fig. 2 (4)).

This measure has eliminated the need for each Group com-

pany to have its own WAN lines connecting it to the network data center and helped optimize Group-wide WAN costs, thereby solving Problem 3.

Moreover, the lines between Toyo Seikan Group's main data center and its network data center have been consolidated into low-cost, low-delay lines that use point-to-point (P2P) Ethernet, which doesn't use WAE. This creates an environment in which the connection between the network data center and main data center operates as if they were hooked into a LAN. This eliminated the need for each company to run its own WAN lines into the main data center, further enhancing network optimization and increasing cost savings (Fig. 2 (5)).

4. Network Design

4.1 VTN Design

For the nodes used by each company's VTNs. We created vExternals and integrated firewalls, as well as virtual routers (vRouters) and virtual bridges (vBridges). By allocating VLAN IDs to the Group companies and by setting them in the vExternals, this design provides entrance and exit points for the WAN lines and VDOMs used by the Group companies (**Fig. 3**).

4.2 Redundancy Design

The PFSs are compatible with multi-chassis link aggregation (MCLAG), so we adopted a system that uses the MCLAG function to create a redundant connection between the PFSs and the WAN L3 switch which stores the WAN line, as well as between the PFSs and the integrated firewall.

Redundancy of the WAN line was achieved using the network monitor function of the UNIVERGE PF Series.

4.3 Flow Entry Design

The link aggregation (LAG) function of the WAN L3 switch which stores each WAN line is configured so that flow entries are distributed to two PFSs. Because it's easier to fix the addresses of the devices such as servers on the data center side, the flow entries can be distributed to the two PFSs by using the LAG function's traffic distribution capability according to the sender's MAC address (device on the operation center side).

PFSs also have memory resources divided into a certain size of units. Because each unit is associated with a physical port, load distribution needs to be taken into consideration. Since the PF5240 has two units, it is designed to allocate the physical port in a way that keeps the unit that connects to the integrated firewall separated (**Fig. 4**).

5. Transition and Switching Method to the New Network

As the first step towards shortening the time needed to switch from the existing firewalls to the integrated firewall, we decided to store the existing firewalls in the VTN.

This allowed us to switch the route from the existing firewalls to the integrated firewall simply by modifying the vRouter's routing settings using the software in the ProgrammableFlow controller. In so doing, we were able to reduce both the transition time and switch-back time. The adoption of this method enabled us to complete the switching operation for each company with a communication interruption time of 5 minutes or less.

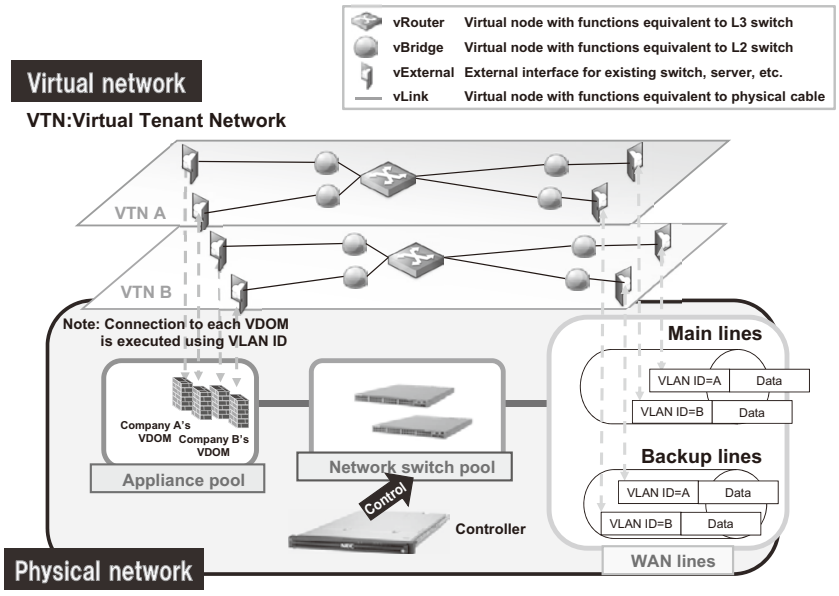

Fig. 3 VTN configuration.

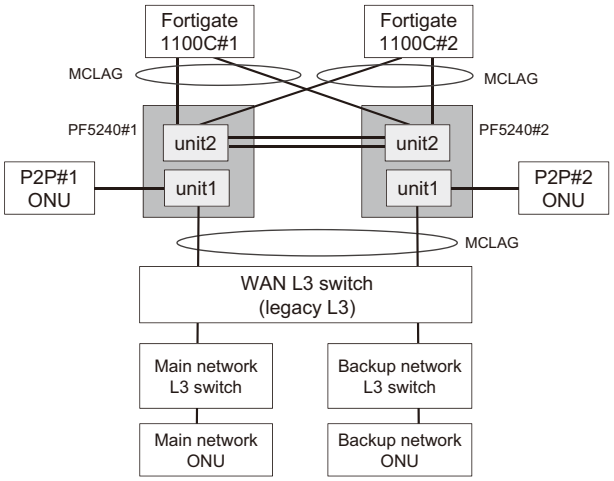

Fig. 4 Flow entry configuration.

6. Future Prospects

Thanks to NEC's SDN solution, the Toyo Seikan network is much more scalable, making it easier and less expensive to integrated additional companies into the network than with the previous TCP/IP network. With the previous system, separate firewalls, routers, and lines had to be installed for each company that was going to be added to the network. But with SDN, adding new company to the network is a simple matter of using the system software to create a new VTN and VDOM. The result was a big reduction in initial costs, as well as a significant shortening of delivery time.

As for the future, we are currently looking into usage efficiency optimization of multiple WAN lines by using traffic flow control, LAN integration by converting the main data center and WAN operation center into a software defined network, and security measures and disaster measures by making good use of SDN. We will continue to offer SDN solutions that offer more value to customers.

* OpenFlow is a trademark or registered trademark of Open Networking Foundation.

* FortiGate is a registered trademark of Fortinet, Inc.

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