

Topics

Initiatives for Generic NW Equipment Sharing on Virtualization Platforms

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With the ongoing virtualization of mobile network communication systems at NTT DOCOMO, the company implemented for the first time the functions of generic network equipment (hereinafter referred to as generic NW equipment) such as Load Balancer (LB)^{*1}, FireWall (FW)^{*2}, Domain Name System (DNS)^{*3} on DOCOMO's virtualization platform systems [1], and begun its operation in April 2019. This enables DOCOMO to share generic NW equipment between multiple systems (hereinafter referred to as communication systems) on its mobile network, which holds promise for lower design and facility costs. This article describes the configuration design of generic NW equipment from the perspective of sharing between communication systems, and examples of application of generic NW equipment on the virtualization platform.

1) Approaches to Network Equipment Sharing

Sharing generic NW equipment between communication systems confers advantages in terms of facility costs. Generic NW equipment is also suited for sharing because the differences of individual

communication systems requirements for generic functions such as LB, FW and DNS are essentially small. However, with on-premises^{*4} generic NW equipment running on dedicated hardware, increases in communications traffic also entail increases in hardware, which makes rapid handling problematic. To address this issue, virtualized generic NW equipment enables flexible response without the need to increase physical resources, by adding Virtual Machines (VM)^{*5} to virtual resources (the resource pool^{*6}) shared on a virtualization platform (Figure 1).

2) Approaches to Application on Virtualization Platforms

In applying generic NW equipment to virtualization platforms, we aimed to:

- (1) Create generic configurations (to lower design and testing costs)
- (2) Make it easy to find out which function is in use (to improve maintenance operations)
- (3) Define and commonize maintenance work (to improve maintenance operations)

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^{*1} LB: Equipment to distribute communications traffic load.

^{*2} FW: Equipment to prevent unauthorized access of an internal network from an external network such as the Internet.

^{*3} DNS: A system that associates host names and IP addresses on IP networks.

^{*4} On-premises: Refers to an environment where HW that makes up a corporate system is possessed, operated and maintained by the company.

^{*5} VM: A computer (virtual machine) created in a virtual manner by software.

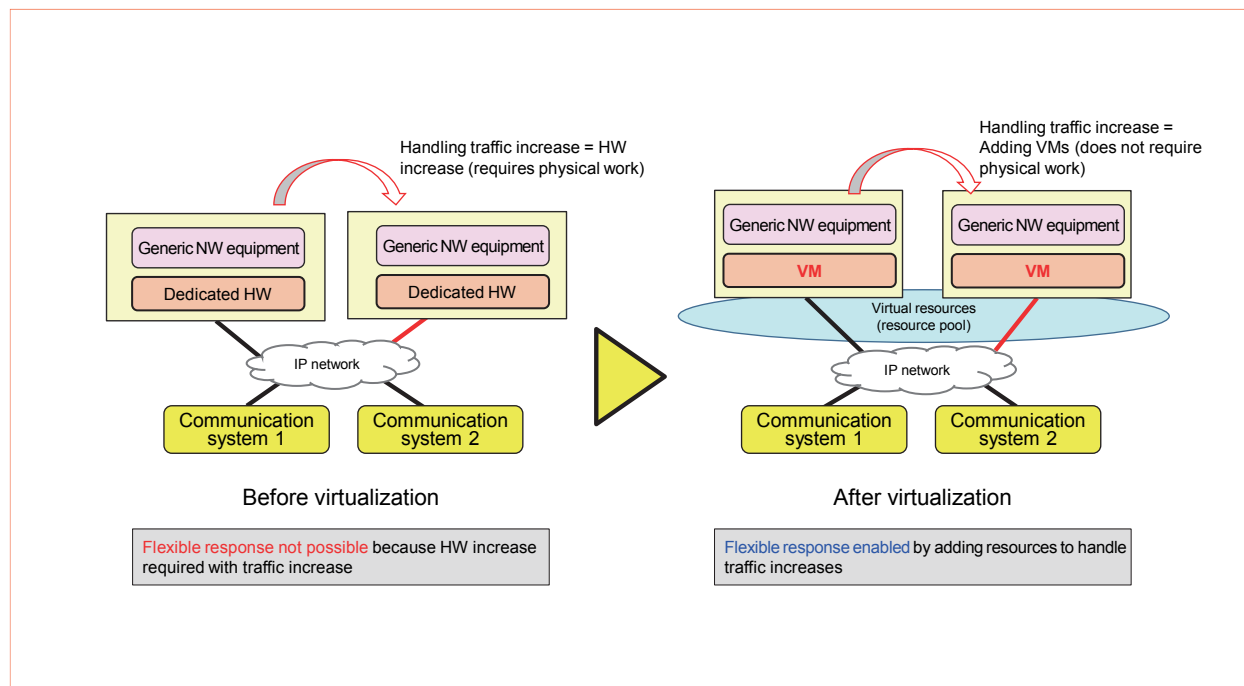


Figure 1 Image of shared generic network equipment

- (4) Make the communications bandwidths on the mobile network more efficient (to lower facility costs)

Below, we describe the aspects we studied to satisfy the above goals.

- (1) We defined a Virtual Network Function (VNF)^{*7} class called “generic NW equipment VNF” generalizing LB, FW and DNS functions, etc., and configured VNFs by adding VMs for each function. We also configure another VNF when adding each VM to cope with increases in communications traffic.

We commonized VNF functions and the VNF Descriptors (VNFD)^{*8} that define actions so that VNFDs are the same for all generic NW equipment. Below, the reasons for this are discussed in terms of design and testing costs.

- Defining individual VNFDs for each generic NW equipment function or addition of VM would require dedicated design and thus would contribute to increased

costs.

- Changing VNFDs defined for VNF functions and operations on a virtualization platform would require testing of generalized operations to manage VMs, which would contribute to increased costs.

The same VNFD enables lower design and testing costs for LB, FW and DNS functions or when adding VMs to respond to increased traffic, and enables flexibility.

- (2) In the definition of the VNF Records (VNFR)^{*9} that uniquely define each VNF, we newly defined LB, FW or DNS functions or added VMs and respectively distinguished these to make it possible to understand which VNFs

^{*6} Resource pool: A set of resources achieved by bundling together many units of hardware each possessing certain types of resources (CPU, memory, HDD, etc.). Various types of virtual machines can be created from a resource pool.

^{*7} VNF: Communication functions that run on virtual machines achieved by software implementations.

^{*8} VNFD: A template that defines the behavior of a VNF function.

^{*9} VNFR: A variable in the same VNF class.

are operating with which functions. This approach achieves improvements in maintainability by enabling confirmation of the details of those definitions on monitoring systems using Operation Support Systems (OSS)^{*10}, etc., and enabling understanding of which function is being monitored.

In light of (1) and (2) above, **Figures 2 and 3** show an example of generic NW equipment VNF configuration.

(3) In addition to general maintenance operations (instantiation^{*11}, healing^{*12}, etc.) for managing

^{*10} OSS: A system for discovering, controlling, and dealing with faults and congestion in a mobile communications network, or an operations support system for network operators. For a network operator, this means full or partial network or system fault management, configuration management, charging management, performance management, and security management for operating provided services.

^{*11} Instantiation: The process of launching communications software by preparing a virtual machine on generic hardware.

^{*12} Healing: A procedure for restoring communications software to a normal state in the event of a hardware or VM failure by moving the VM to (or recreating the VM on) hardware operating normally.

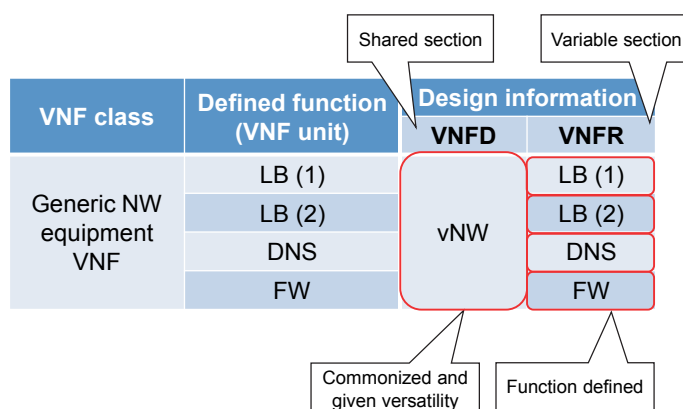


Figure 2 Generic NW equipment VNF configuration example (1)

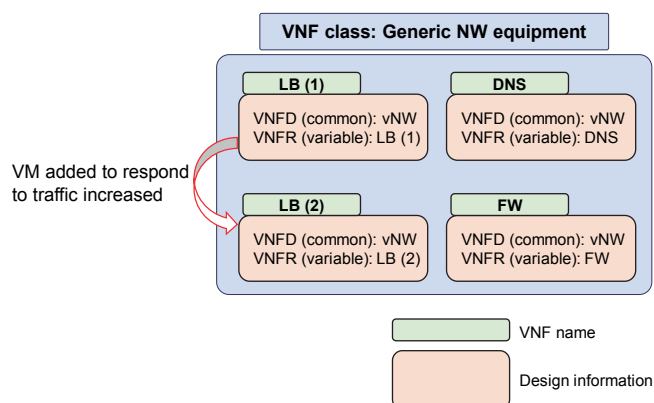


Figure 3 Generic NW equipment VNF configuration example (2)

VMs with Network Functions Virtualisation (NFV)^{*13}, we commonized works specific for generic NW equipment such as OS and firm-ware update work and server firmware and hypervisor[®]^{*14} update work by newly defining them as maintenance operations linked to the virtualization platform, and commonizing the work as generic NW equipment VNF maintenance operations. This achieves better maintainability by providing commonized maintenance operations regardless of the generic NW equipment VNF function.

- (4) Although communications between communication systems are done on an L3 connection via a switch (L3^{*15} switch) for connecting between different VNFs, more communications bandwidth efficiency is achieved by call back communications between communication systems and generic NW equipment with an L2 switch (L2^{*16} connection)

connecting servers instead of an L3 switch.

Figure 4 shows an example of generic NW equipment VNF application in light of the above considerations.

This article has described points considered and the results of those considerations, and examples of application in the configuration design of generic NW equipment VNF from the perspective of sharing between communication systems in the application of generic NW equipment on a virtualization platform. With the success of this implementation case,

^{*13} NFV: Achieving a communications carrier network on generic hardware using virtualization technologies.

^{*14} Hypervisor[®]: A virtual server technology that assigns and manages physical resources for applications to mount on virtual machines, and runs multiple virtual machines on physical resources. A registered trademark of IBM Corp.

^{*15} L3: The third layer of the OSI reference model (the network layer).

^{*16} L2: The second layer of the OSI reference model (the datalink layer).

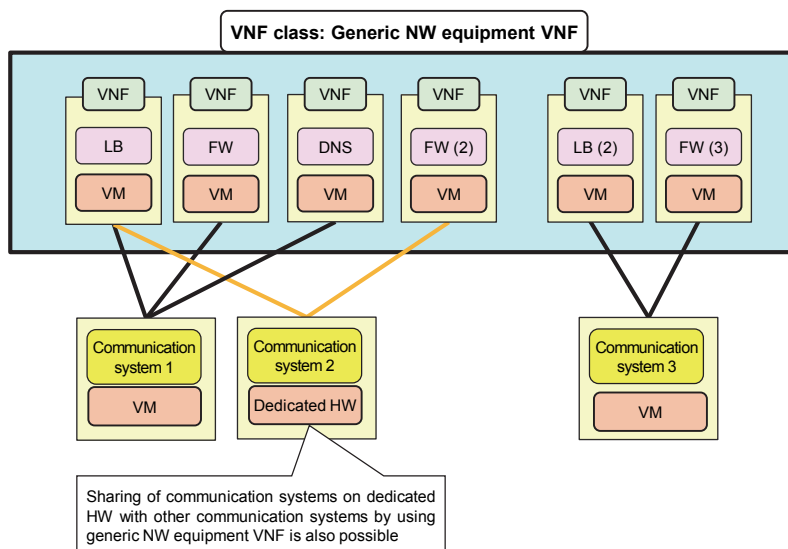


Figure 4 Generic NW equipment VNF application example

we anticipate further progress with conversion of on-premises generic NW equipment to virtualized generic NW equipment and sharing in DOCOMO's mobile network communication systems. Going forward, to share various communication systems like those in the application example in Fig. 4, we will formulate optimized VM layout design policy for sharing or adding VMs to systems based on the

characteristics of individual generic NW equipment functions and communications traffic.

REFERENCES

- [1] T. Kamata et al: "Practical Implementation of Virtualization Platform in NTT DOCOMO Network," NTT DOCOMO Technical Journal, Vol.18, No.1, pp.20-28, Jul. 2016.