UNIVERGE PF Series: Controlling Communication Flow with SDN Technology

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Abstract

Big data multiplies and changes every day, and the quantity of data and the required computing/processing capability vary between projects. To process big data efficiently, it is necessary to locate the required ICT resources dynamically and scalably in optimum placement. This paper describes the features and effectiveness of ProgrammableFlow that optimizes computer and network resources dynamically using OpenFlow/Software Defined Network (SDN) technology.

Keywords

OpenFlow, Software Defined Network, ProgrammableFlow, MapReduce, Hadoop

1. Introduction

OpenFlow and Software Defined Network (SDN) are attracting recent attention as next-generation network technologies which, in conjunction with ICT resources such as virtual servers, are capable of improving cloud data center operation efficiency. The SDN based on OpenFlow is composed of multiple switches, which transfer data for each flow by following instructions from a controller, and the controller, which performs centralized control of the switches. Centralized control of switches by a controller enables network virtualization and advanced route control. A flexible, highly extensible cloud system can also be implemented by integrating virtual servers and virtual storage devices into a virtual network linked to a cloud controller at a higher level (**Fig. 1**).

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OpenFlow/SDN can implement scalable network extension in conjunction with virtual server resources and advanced route and QoS (Quality of Service) control of priority traffic. Linking the network virtualization technology of OpenFlow/SDN with a big data operations management system makes it possible to build a cloud environment for the efficient processing of big data.

The OpenFlow protocol connecting the control plane and the data plane is a network protocol being standardized by the Open Networking Foundation (ONF). At NEC, we noticed OpenFlow technology and began supporting related activities from an early stage. In the spring of 2011, leading the world, we started shipment of the UNIVERGE PF Series (hereinafter referred to as “ProgrammableFlow”) based on OpenFlow technology.

ProgrammableFlow is composed of a ProgrammableFlow controller (PFC) and a ProgrammableFlow switch (PFS).

ProgrammableFlow was the first implementation of SDN architecture. In addition to implementing OpenFlow technology,

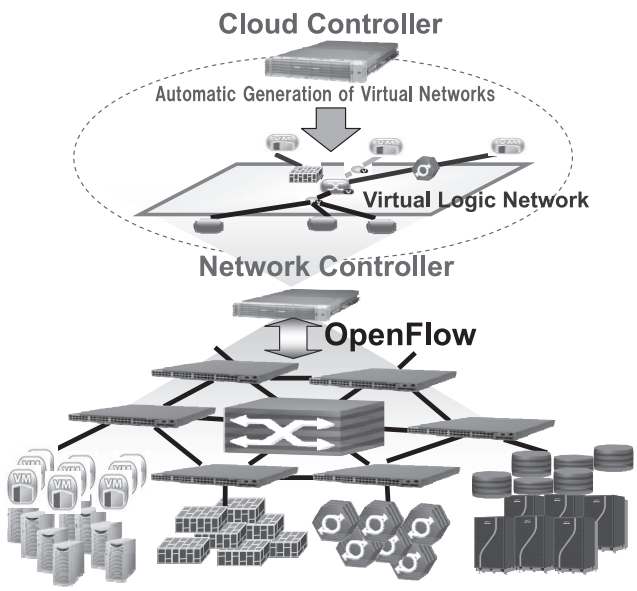

Fig. 1 SDN architecture.

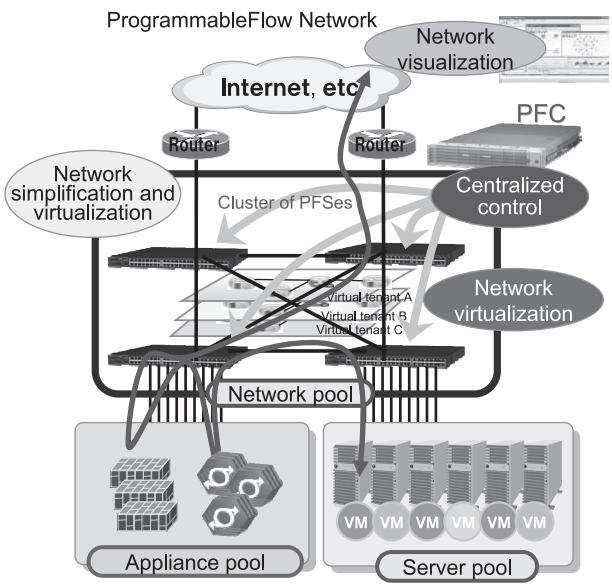

Fig. 2 Features of ProgrammableFlow.

it offers additional benefits including network simplification, network virtualization and network visualization (**Fig. 2**).

This paper introduces how big data can be processed using ProgrammableFlow, which performs dynamic optimization of computer and network resources.

2. Network Infrastructure for Big Data Utilization

"Big data" refers to collections of various types of data, including text, figures, images, movies and emails, which are increasing explosively today. The rise in attention to big data is backed by an expansion in the use of rich content following the dissemination of smartphone and tablet terminals, an increase in information gathering using various sensors and an increase in the conversion of information into data by humans.

The utilization of big data requires the processing of a large amount of data in a specified period of time. Since most of big data is unstructured, processes such as storage, search, sharing, analysis and visualization take time. However, the launch of high-speed parallel processing technology, as represented by MapReduce, has triggered the start of the effective utilization of big data.

MapReduce employs a computational model that successively executes functions such as input, map, shuffle and reduce

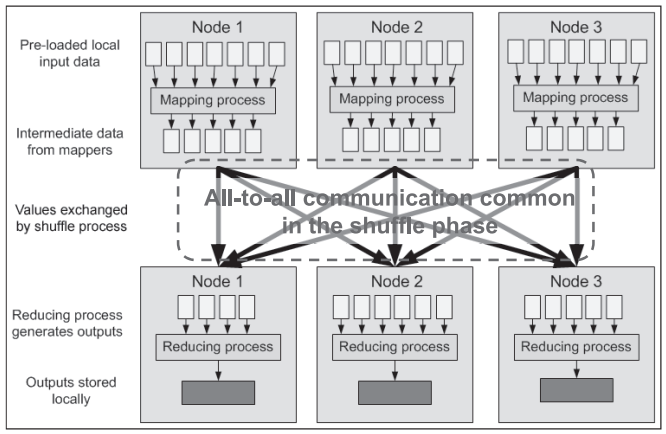

Fig. 3 Computational model of MapReduce.

(**Fig. 3**).

In order to execute processing operations efficiently and to manage operations and configuration flexibly, it is desirable for network infrastructure to be equipped with the following functions:

- **Virtual networking**
  Flexible ICT system configuration and resource assignment by project.
- **Network extension**
  Flexible network extensibility supporting system scaling according to the volume of processed data.
- **Network traffic engineering**
  Network traffic control for handling burst data.
- **Network monitoring**
  Identification of the network traffic situation to enable optimum placement of nodes and data by applying considerations of processing locality.

In the following section, we will introduce these functions as implemented by ProgrammableFlow.

3. Functions of ProgrammableFlow

3.1 Virtual Networking

Big data is utilized in various scenarios, from traffic management to logistics, healthcare, finance and energy.

ProgrammableFlow provides a virtual network called a VTN (Virtual Tenant Network) in a cloud environment. Even when there are several projects utilizing the same big data, a VTN is created for each project and ICT resources are assigned flexi-

bly and dynamically to each VTN (**Fig. 4**).

This feature improves the operational efficiency of the cloud data center because, even if the volume of processed data varies between projects or the necessary ICT resources vary within each project, ProgrammableFlow can easily assign ICT resources in the cloud environment to the projects in need of them or return redundant ICT resources from the projects to the cloud environment.

3.2 Network Extension

In order to process big data that is expanding every day, it is desirable for nodes to be flexibly variable. Consequently, the network should be flexibly extensible.

ProgrammableFlow allows network equipment to be expanded according to performance requirements. Network equipment expansion is possible without interrupting network operation. An expanded switch is extended into a virtual network so that the network equipment expansion is not noticed at the application level.

When network equipment is expanded, servers and storage devices can also be expanded (scaled out) accordingly (**Fig. 5**).

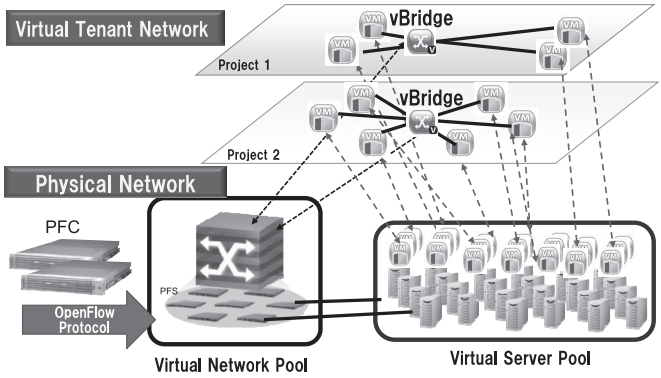

Fig. 4 Virtual network.

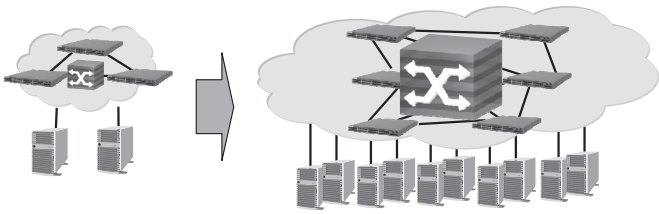

Fig. 5 Scaling out.

3.3 Network Traffic Engineering

The utilization of big data necessitates the processing of a large volume of data in a short period of time. Since data bursting is involved, temporary bursts should be accepted. What is important is the mechanism for controlling these bursts.

ProgrammableFlow can flexibly control network flow. It is capable of setting the flow so that important traffic is directed through paths with wider bandwidth and of applying QoS for priority flow processing. Such flow control for the prevention of data transfer delays enables high-speed processing of MapReduce applications.

Traffic Monitor can be used for bandwidth threshold monitoring. When a value exceeds or falls below the threshold, an SNMP (Simple Network Management Protocol) trap is generated. The SNMP trap becomes the trigger for actions such as letting a Hadoop management node manage the MapReduce application to avoid crowded network paths and switch to another route using the PFC API.

In addition, ProgrammableFlow supports multipath functionality based on ECMP (Equal-Cost MultiPath) to promote the effective utilization of network resources through the distribution of network loads.

3.4 Network Monitoring

A Hadoop management node obtains flow statistics information and network traffic information such as sFlow through the REST I/F of the PFC. Based on the obtained information, the Hadoop management node can optimize node configuration and data processing through optimum placement of the VMs (virtual machines) in which big data processing applications are installed.

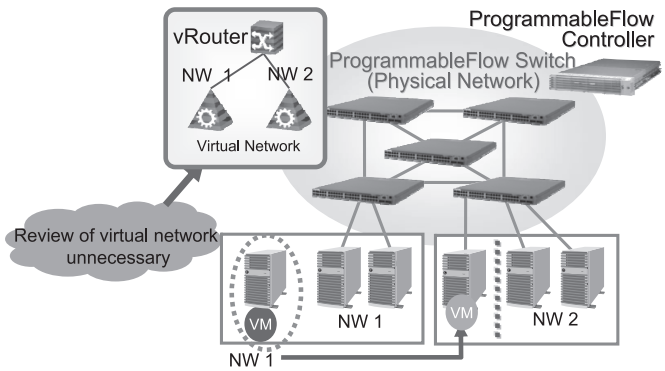

Fig. 6 VM migration.

In this process, ProgrammableFlow functions to absorb the effects of VM migrations. Even when a VM is migrated across subnets, it is no longer necessary to review the overall network setting as had been required with traditional L2/L3 networks (**Fig. 6**).

4. Conclusion

To handle big data that is expanding every day, MapReduce must be capable of optimum server resource placement and dynamic network control integrated with data processing applications.

ProgrammableFlow can handle networks with extreme flexibility. It provides a programmable network that makes applications network-aware and allows them to perform the necessary controls.

As shown in **Fig. 7** , the Hadoop management node that controls a Hadoop cluster can collect the network information in the Hadoop cluster linked to a PFC and execute the relevant network control through the PFC API.

The handling of big data is expected to be a very critical issue in the future. As part of this trend, we are determined to endeavor toward the implementation of programmable networks with higher flexibility and operability than before.

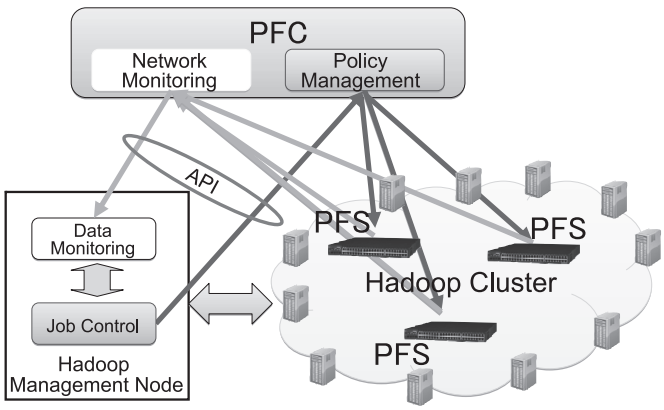

Fig. 7 Example of links between Hadoop and ProgrammableFlow.

*Hadoop is a registered trademark of the Apache Software Foundation.

*sFlow is a registered trademark or trademark of InMon Corp.

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