iPOP2014 Hot Lectures

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1. Overall

For the tenth iPOP (International Conference on IP + Optical Network), the iPOP program committee planned a program comprising keynote lectures, invited lectures, general lectures and poster presentations centered around the subject of software-defined networking (SDN) for communication carriers, where high reliability, monitoring and operability are the prime concerns (Table 1). There was a fairly even balance of Japanese and foreign presenters, with ten from Japan, seven from the United States, one from Italy, and one from South Korea. In this article, we first describe one of the keynote lectures and one of the invited lectures, focusing on the lectures about trends in large-scale network administration and control techniques for collaboration with data centers and collective administration of multiple domains in systems built around SDNs for the transport network. We also introduce the technical sessions relating to the application of SDNs in packet transport and optical networks, which are the central topic of iPOP each year, and two new trials that were performed at iPOP to mark its tenth anniversary — a joint session on network virtualization and network function virtualization (NFV) with the IEICE Technical Committee on Network Virtualization, and a discussion entitled "Current status and challenges of SDN and NFV toward future of transport network" with panelists invited from Japan and overseas.

2. Keynote speech

Yukio Ito of NTT Communications gave a keynote speech with the title "Next Steps in the SDN/OpenFlow Network Innovation". He started out by discussing how increases in traffic and equipment/operating costs can impact on revenue growth in communication service providers, and showed how a fast, high-capacity and instantly reconfigurable network can resolve this issue. He then described how a total line capacity of 8 Tbps (100 Gbps per wavelength × 80 wavelengths) is provided between Tokyo

Table 1: iPOP2014 technical program

Thursday 22, May 2014	
	iPOP Plenary Presider: iPOP Organizing Committee Co-Chair ***Opening Address*** - Naoaki Yamanaka, iPOP General Co-Chair, Keio University, Japan - Bijan Jabbari, iPOP General Co-Chair, Isocore, USA ***Keynote*** K-1 Yukio Ito, SVP Service Infrastructure NTT Communications, Japan K-2 Justin Dustzadeh, Ph.D. CTO & VP Technology Strategy Networks, Huawei, USA ***iPOP Exhibition introduction*** - iPOP Exhibition Co-Chair ***Local arrangement / Lab tour introduction*** - iPOP Local arrangement Co-Chair
Exhibition Showcase	***Technical Session 1: SDN for Optical Networks*** Chair: Motoyoshi Sekiya, Fujitsu Labs America, USA T1-1 Xiaoyuan Cao, KDDI R&D Labs., Japan T1-2 Takaya Miyazawa, NICT, Japan T1-3 Sota Yoshida, Mitsubishi Electric Co., Japan
	Business Session Chair: Akihiro Nakamura, TOYO Corporation, Japan B-1 Chris Liou, Infinera Corporation, USA B-2 Atsushi Iwata, O3 Project, Japan B-3 Alex Henthorn-Iwane, QualiSystems, USA B-4 Toshal Dudhwala, Ixia, USA B-5 Hiroaki Harai, NICT, Japan B-6 Hidenori Inouchi, Hitachi, Japan B-7 Allen Umeda, Spirent Communications, USA
	Poster Session / Exhibition P-1 Julien Thieffry, Keio University, Japan P-2 Sam K. Aldrin, Huawei Technologies, USA P-3 Masa Iwashita, A.I.Corporation, Japan P-4 Shaheedul Huq, Coriant, USA

Friday 23, May 2014	
	Technical Session 2: Software-Defined Networking and Network Virtualization Chair: Itaru Nishioka, NEC, Japan T2-1 Shinya Ishida, NEC, Japan T2-2 Shuji Ishii, NICT, Japan T2-3 Takumi Oishi, Hitachi, Japan
Exhibition Showcase	***Invited-talk Session:*** Chair: Kohei Shiomoto, NTT, Japan I-1 Young Lee, Huawei, USA I-2 Ming Xia, Ericsson Research, USA I-3 Jin Seek Choi, Hanyang University, Korea
	Technical Session 3: Traffic Engineering and Resource Optimization Chair: Shoichiro Seno, Tokushima Bunri University, Japan T3-1 Paparao Palacharla, Fujitsu Laboratory of America, USA T3-2 Asato Kotsugai, Keio University, Japan T3-3 Gianmarco Bruno, Ericsson Telecomunicazioni, Italy T3-4 Victor Yu Liu, Huawei Technologies, USA
	Joint session of IEICE Technical Committee of Network Virtualization and iPOP Chair: Katsuhiro Shimano, NTT, Japan J-1 Hirokazu Takahashi, NTT, Japan J-2 Michiaki Hayashi, KDDI R&D Laboratories Inc., Japan J-3 Akihiro Nakao, The University of Tokyo, Japan J-4 Yasunobu Chiba, NEC, Japan
	Closing Panel Session by iPOP Technical Program Committee "Current status and challenges of SDN and NFV toward future of transport network" **Panelists**: Akihiro Nakao (Univ. of Tokyo), Shuji Ishii (NICT), Shinya Ishida (NEC), Young Lee (Huawei), Meral Shirazipour (Ericsson), Katsuhiro Shimano (NTT), Xiaoyuan Cao (KDDI Labs) **Coordinator**: Kohei Shiomoto (NTT)
	Closing by iPOP Organizing Committee Co-Chair

and Osaka as a packet transport network (PTN) that provides a next-generation high-capacity network, and how a colorless, directionless, contentionless (CDC) reconfigurable optical add/drop multiplexer (ROADM) can switch traffic to another path even when two paths have failed, taking the experiences of the Great East Japan Earthquake as an example. He also showed how an economical network providing fully meshed packet paths at edge routers can be implemented by introducing packet transport, instead of the conventional method where packets are aggregated together with a core router in order to make the network more economical.

As a flexible network architecture, he described the efforts being made to implement SDN/NFV, which allows uniquely differentiated services to be provided very quickly. He described how NTT Communications provides cloud services from data centers spanning ten different countries around the world, and is able to use network controllers and OpenFlow switches to provide network resources rapidly within data centers and between data centers when there is a request from a customer. End-to-end communications are implemented using a virtual local area network (VLAN) and multi-protocol label switching (MPLS), with settings made automatically by the SDN controller to form a VPN.

He also described a concept whereby various services can be provided by using an SDN controller to control hardware such as OpenFlow switches, gateways and packet optical nodes, and providing NFV functions such as WAN access routers and firewalls at the edges, and a VOLT system that allows SDN networks to be designed and tested under the same conditions as their actual operating environment.

Finally, he introduced the Okinawa Open Laboratory for the promotion of SDN and cloud computing research, and the O3 Project, which aims to implement an SDN with multi-layer network integration functions that speed up the reflection of data between physical and virtual networks, and recommended promoting the spread of SDNs while contributing to the Open Networking Foundation (ONF).

3. Invited session

At the invited session, Young Lee (Huawei, USA) made a presentation on the subject of Abstraction and Control of Transport Network (ACTN), which is the theme of a new discussion started by the Internet Engineering Task Force (IETF) (Photo 1).

The aim of ACTN is to visualize a transport network consisting of vendor islands with (each with their own set of technologies) as a single entity, and to create a virtual environment for managing this network in order to achieve virtualized network operations.

The transport networks of communication carriers generally consist of multiple domains, with each domain forming a vendor island (a network domain configured from equipment made by the same vendor). The transport network is configured from multiple vendor islands in this way because different vendors use different

Photo 1: Invited talk on ACTN

technologies with different operating policies. The difficulty of operating between different vendor islands has for many years presented a challenge to communication providers that operate transport networks. When a new service is introduced, crossing between multiple vendor islands entails a great deal of design work and manual maintenance.

At ACTN, deliberations are under way with the aim of scaling up existing services by speeding up the deployment of network services and improving conventional network operations. ACTN defines the methods and capabilities that are used to operate transport network resources. Its provisions include a function for abstracting network resources on lower layers and showing them to applications and users on higher levels, a function for slicing infrastructure resources and connecting customers in order to satisfy the requests of specific applications and users, calculation methods for servicing diverse customers requesting connectivity or network resources via an information model, virtualized network controllers, and an open interface with virtualized topology.

Virtual network operation is a use case of ACTN, for which ACTN aims to establish a standard API and virtualization techniques. Another possible use case of ACTN is its application to a global data center. At the IETF, an ACTN BoF (Birds of a Feather) is being planned, and is expected to coordinate requests from diverse carriers.

4. Technical sessions

The application of SDN to optical networks is been studThe application of SDN to optical networks has been studied. The lectures on this subject, including a live ShowCase demonstration, are introduced below.

Xiaoyuan Cao (KDDI R&D Laboratories) discussed an optical packet switching application of SDN (for a technical overview, see the lecture presented by Takaya Miyazawa (NICT) in the same session), as a study into accommodating dynamically fluctuating traffic levels.

Sota Yoshida (Mitsubishi Electric) examined architectures where OTN is applied to SDN, and discussed methods for using a SDN adapter to utilize GMPLS signaling. The SDN adapter transfers the control frames of conventional network elements to a network management system. He also introduced three factors including signaling in each domain, which makes it easier to identify fault locations and allows optical paths to be set up faster and more easily.

There is a demand for uninterrupted transfer from IP/MPLS networks to SDN-based packet transmission networks. Shinya Ishida (NEC) discussed a technique for using stateful path computation elements (PCEs) to migrate from IP/MPLS networks to packet transmission networks. He introduced an IP-integrated transport network (ITN) as a solution for implementing a software-defined transport network.

Takumi Oishi (Hitachi) proposed a method for using network virtualization technology to migrate diverse existing networks such as IP networks, ATM networks, SDH networks and frame relay networks to a network with multiple integrated services.

Shuji Ishii (NICT) discussed the design and implementation of the RISE 3.0 OpenFlow/SDN test bed, which was started in 2011 as a public service on the JGN-X (Japan Gigabit Network eXtreme) network.

5. Joint sessions

The joint sessions were planned by the IEICE Technical Committee on Network Virtualization and the iPOP Program Committee with the aim of stimulating technical fields that cross over between the domains of cutting-edge network virtualization technology and optical IP network technology. This session comprised four lectures.

The lecture on Lagopus (Hirokazu Takahashi, NTT) introduced the design of a software-based OpenFlow switch called Lagopus (version 1.3), and a prototype implementation of the switch. The main target of Lagopus is providing the performance and functions needed when applied to wide-area networks. It was revealed that a Lagopus prototype with a flow processing performance of the order of 10 Gbps can be implemented on Intel x86 server equipment by using the latest multi-core CPU and a network input/output interface.

In the lecture on inter-domain virtualization (Michiaki Hayashi, KDDI R&D Laboratories), an inter-domain virtualization technique was introduced whereby SEP is introduced to establish connections between different virtualized domains. In an inter-domain architecture using SEP, it is possible to connect control planes and to convert between the data frames of different virtual domains by defining a common application interface (API) and slices.

The lecture on FLARE (Akihiro Nakao, University of Tokyo) introduced the FLARE architecture for making data planes programmable. FLARE uses a many-core processor instead of ASICs, thereby making the processing of packets programmable. The lecture reported on the FLARE design concept, which facilitates hierarchical resource management using general processors, many core processors and many types of processor, and on a prototype implementation and its performance.

The lecture on management and orchestration architecture for NFV (Yasunobu Chiba, NEC) discussed the issues of implementing NFV in practice, and the management and orchestration architecture needed to provide service level guarantees. Concentrated management and orchestration functions are needed to configure network services in NFV. It was reported that providing service level guarantees entails estimating the logical computing resources and controlling their allocation to physical resources.

Photo 2: Closing panel session

6. Panel sessions

Although packet-optical transport (the main theme of iPOP) is a transport network architecture of the future, communication providers have a choice of transport technologies. Candidate technologies for the packet transport include IP, MPLS(-TP) and Ethernet, and candidate technologies for the optical transport include OTN and WSON. With the availability of these choices, communication providers are looking closely into what sort of packet-optical transport to design, and how it should be operated.

SDN is a technology that has attracted attention in recent years, and it is believed that it will play an important role in the operation of transport networks by telecom operators in future transport networks. By using SDNs, communication carriers can separate the control frames from network equipment and implement their own independent operational policies.

NFV is another technology that has attracted interest in recent years. When network functions such as SGSN/GGSN (Serving General packet radio service Support Node/ Gateway General packet radio service Support Node), firewalls, NAT (Network Address Translation), CDNs (Content Delivery Networks), load balancers and DPI (Deep Packet Inspection) are virtualized and deployed on a transport network, these network functions can be selected and connected together to implement a wide range of network services. NFV allows communication providers to configure a wide variety of network services by implementing network functions in software, and commercial IT virtualization technology can be used to consolidate these services in a data center on the carrier cloud. In the carrier networks of the future, NFV and SDN are expected to be promising enablers of service orchestration. In other words, they enable the integrated management and control of multi-technology transport networks and network services.

This subject formed the background of the panel discussion. The facilitator of the panel discussion was Kohei Shiomoto (NTT), and the panelists were Akihiro Nakao (Univ. of Tokyo). Shuji Ishii (NICT), Katsuhiro Shimano (NTT), Xiaoyuan Cao (KDDI Labs), Shinya Ishida (NEC), Young Lee (Huawei) and Meral Shirazipour (Ericsson). The panel held lively and thought-provoking discussions on the following topics: (1) Do we have enough software development resources in the SDN/NFV era? (2) Standard-driven or Open-source-driven? (3) What do operators say about the real pain points? (4) Multi-domain issues? Vendor islands? Organization domains? Virtual network operation? (5) Is it easy to deploy and operate a nationwide SDN/NFV network? (6) Should IP be integrated into the transport network (O-PTN)? (7) Should optical nodes be controlled by a SDN? (8) What is the role of optics in the SDN/NFV era? (Photo 2)

Nakao argued that the success of SDN/NFV depends on the creation of talented programmers, and introduced the concept of toy blocks as an example of the foundations necessary for the construction of an ecosystem where this can happen. Shimano talked about open-sourcing the Lagopus high-performance SDN/OpenFlow software switch for wide-area networks. Ishii introduced the operation and current state of RISE (the national wide-area SDN/OpenFlow network), and discussed how troubleshooting in a wide-area integrated environment will become more refined. Cao introduced European projects such as STRAUSS, and discussed how a SDN can be very useful as a means of connecting between domains with diverse optical transport integration and domain interconnection. Shirazipour introduced some examples of the use of NFV in optical networks.

Cover Art

Meisho Edo Hyakkei Fukagawa Susaki Jumantsubo

(Jumantsubo Plain at Susaki in Fukagawa Province, from the series One Hundred Famous Views of Edo)

Utagawa Hiroshige (1797-1858)

Woodblock print:
Courtesy of Sakai Kokodo Gallery