APP Store Installed in ONOS-based Multi-layer and Multi-domain Transport SDN Platform with Novel TE Abstraction

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Abstract: An APP store is demonstrated over multi-layer and multi-domain transport software defined networks (T-SDN) platform, which is developed based on IETF ACTN standard. A novel traffic engineering (TE) abstraction method is used with different applications demonstrated.

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1. Overview

The transport networks today are facing great challenges with the emergence of various services requiring large bandwidth and dynamic provisioning in the cloud datacenter (DC) era. In order to face such challenges and facilitate business success in heterogeneous network scenarios, the multi-layer and multi-domain transport SDN solution is proposed. Our solution is based on open-source platform, i.e., ONOS and supports a transport APP store with various APPs via pre-standard transport APIs and models.

Abstraction and Control of TE Networks (ACTN) [1] proposes multi-layer and multi-domain transport SDN architectures shown in Fig.1. Different Physical Network Controllers (PNC) are developed for different physical networks, such as IP and optical networks. Multi-domain Service coordinator (MDSC) orchestrates all PNCs according to different services requests. CNCs are developed for various applications to construct the APP store. All the controllers are developed based on ONOS. In the above architecture, The CNC and MDSC interface (CMI) is implemented in REST or other text-based protocol. The MDSC and PNC interface (MPI) is implemented in PCEP and Restconf, and southbound interface (SBI) is implemented with PCEP and OSPF-TE. Workflow for virtual machine (VM) migration using this architecture is shown in Fig.2.

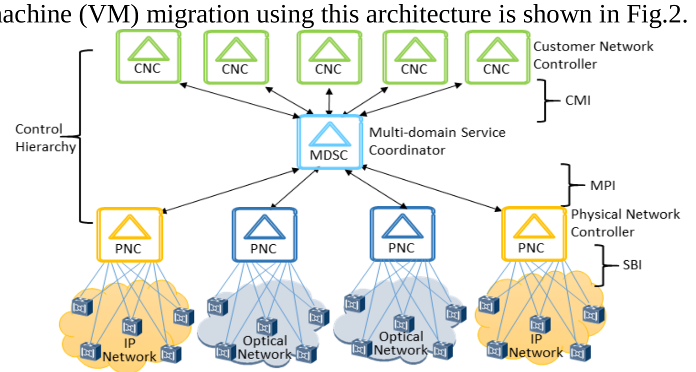

Fig. 1 Multi-layer and multi-domain transport SDN solution architecture

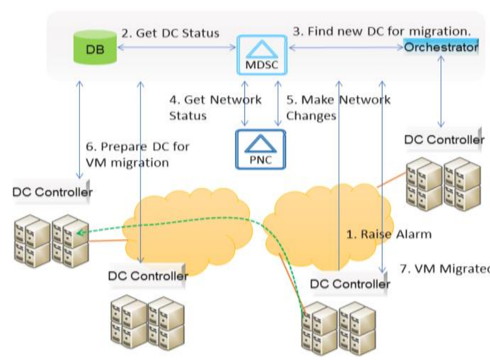

Fig. 2 Workflow for VM migration

Based on the above solution, an APP store is built and different transport applications will be demonstrated, two of which are introduced. For <u>*datacenter load balancing*</u>, a virtual network (VN) is created with two services 1 & 2 with 50Gbps & 50Gbps as shown in Fig.3. As DC3 needs to off-load to 10G and move the rest 40G to DC 2 due to VM overload, the application can update service 1 (50G->10G) and service 2 (50G->90G). For <u>*restoration application*</u>, primary tunnel is running (100G pipe) from DC1-DC3 as shown in Fig.4. When fiber cut takes place, a backup path is created based on failure notification and abstract data update from each domain reflecting fiber cut.

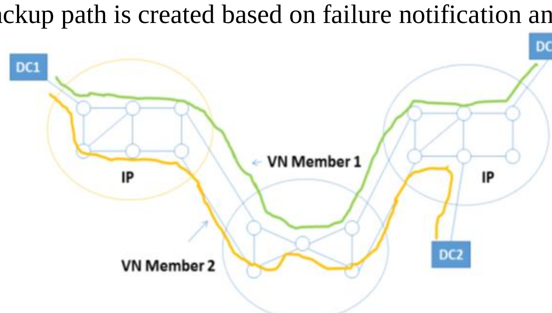

Fig. 3 Datacenter load balancing

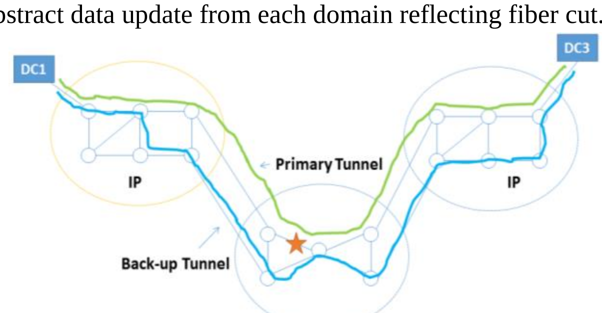

Fig. 4 Restoration

2. Innovation

In this demonstration, multi-layer and multi-domain SDN solution will be shown based on IETF ACTN standard work. An APP store is developed, from which the applications can be downloaded online. An important innovation is the abstraction method of multi-domain network topology. As shown in Fig.5, in multi-layer and multi-domain (such as IP + optical) environment, MDSC is required to compute an optimal end-to-end (E2E) lightpath based on abstract topology view of the underlying domain networks which is collected from each domain controller. Collaboration between MDSC and PNC is necessary for TE abstraction. Then how to abstract an optical network TE information in scalable manner and timely manner becomes an important issue.

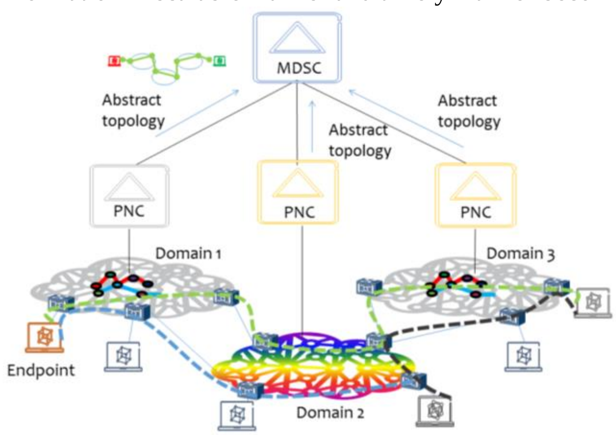

Fig. 5 IP + optical environment

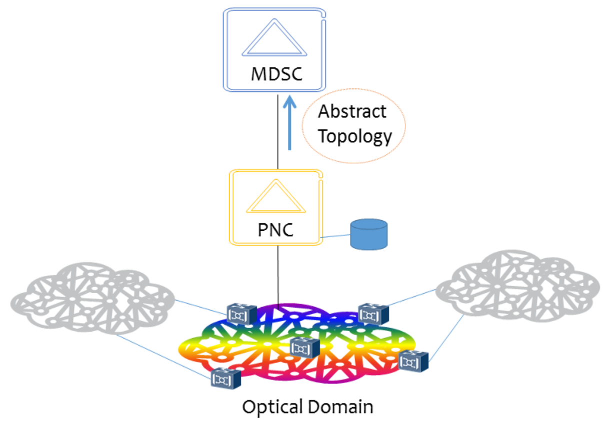

Fig. 6 Topology abstract

In this demonstration, a novel abstract method is presented about how to abstract optical TE topology based on actual TE topology in order to hide the details of the optical network. It also describes how to provide timely and scalable abstract topology for the optical network. As shown in Fig.6, GMPLS/PCEP creates/updates TED, then PNC runs the abstraction method based on the TED and sends the partial abstract topology to MDSC. In the abstraction methods conducted in PNC, the maximal flow among any gateway node pair in every lambda plane is calculated first following wavelength continuity. Then the max flow values across all lambda planes are added up, which is converted to the equal bandwidth, i.e., max bandwidth path. On the other hand, for every lambda plane, the shortest path between any gateway node pair can be calculated with delay as the link weight. Then for all the lambda planes where the shortest path computation is successful, the lightpath in which has the lowest path distance is chosen as the min latency path. Then the max bandwidth path with latency threshold can be selected. With this idea, an abstract optical TE topology can be created timely and scalable based on actual TE topology in order to hide the details of the optical network.

Based on the above multi-layer and multi-domain transport SDN platform, several valuable experiments can be conducted and demonstrated. For example, large-scale network performance can be evaluated on different scalabilities, such as node, link, and services. Also, the interface performance using different protocols can be compared, such as binary and text-based protocol for MPI. Different discovery mechanisms using OSPT-TE and PCEP can also be compared in terms of topology update and convergence time.

3. Relevance

Multi-layer and multi-domain network is a very important scenario for transport SDN deployment, which is the focus of OFC2017. There are a lot of practical issues to be dealt with, among which topology abstraction is foremost. This interesting idea will be presented in the demonstration through different transport services. Many other challenging issues in large-scale multi-layer and multi-domain transport SDN will be demonstrated accordingly, such as protocol performance analysis and discovery mechanisms comparison. These are all common interest for both academic research and the industry.

Acknowledgement
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References

[1] ACTN Framework, D, Ceccarelli and Y. Lee, et. al., draft-ietf-teas-actn-framework-01.txt, October 25, 2016.