Demonstration of SDN Based Optical Network Virtualization and Multidomain Service Orchestration

T. Szyrkowiec*†, A. Autenrieth*, J.-P. Elbers*, W. Kellerer†, P. Kaczmarek‡, V. López§, L. Contreras§, O. Gonzalez de Dios§, J. P. Fernández-Palacios§, R. Muñoz¶, R. Vilalta¶, R. Casellas¶, R. Martínez¶, A. Mayoral¶, M. Channegowda‖, S. Peng‖, R. Nejabati‖ and D. Simeonidou‖
*ADVA Optical Networking, Martinsried (Munich), Germany
†Technische Universität München, Munich, Germany
‡ADVA Optical Networking, Gdynia, Poland
§Telefónica I+D, Madrid, Spain
¶Centre Tecnològic de Telecom de Catalunya, Castelldefels (Barcelona), Spain
‖University of Bristol, Bristol, UK

***Abstract*—This paper describes a demonstration of SDN-based optical transport network virtualization and orchestration. Two scenarios are demonstrated: a dynamic setup of optical connectivity services inside a single domain as well as a multidomain service orchestration over a shared optical infrastructure using the architecture defined in the STRAUSS project.**

***Keywords*-SDN; Optical Network; OpenFlow; GMPLS; Control Plane; Multidomain Orchestration;**

I. Introduction

Software-defined networking (SDN) for optical transport networks (OTN) is gaining attention in research projects and standardization bodies. The Open Networking Foundation (ONF) recently published a solution brief on "OpenFlow-enabled Transport SDN" [1] which introduces the control virtual network interface (CVNI) for exchanging the virtualized view of transport network resources between client and provider. Similarly, the Application Based Network Operations (ABNO) architecture, defined in an IETF draft [2], is addressing network virtualization and orchestration of multiple network domains with different underlying networking technologies.

There are various challenges in orchestrating OTNs over multiple domains: heterogeneous control plane and transport technologies inside the domain as well as various communication interfaces§ and protocols for external access need to be considered. In this demonstration we will show both a single domain optical network virtualization using the ONF CVNI approach and an ABNO-based multidomain network orchestration.

II. Demonstration Setup

Our demonstration combines two parts: a single domain SDN-based optical network virtualization and a multidomain service orchestration running on top of three optical network domains – an ADVA OpenFlow & GMPLS enabled DWDM domain, an OpenFlow enabled flexi-grid DWDM domain at University of Bristol and a GMPLS-enabled flexi-grid DWDM domain at CTTC. The ADVA domain is shared between both scenarios utilizing multi-tenant capabilities. The client interfaces of both parts will be shown at the venue including network management tools via remote access. Figure1 gives an overview of the complete demonstration.

The demonstration of the SDN-based optical network virtualization illustrates a scheduling of media services (blue background in Figure1). The content delivery is triggered by the user initiating the setup of a lightpath between the server and the client in the background. The multidomain service orchestration highlights the control plane management by a single orchestrator independent of the underlying technologies and controller instances (orange background in Figure1). The optical infrastructure is shared between the use cases by assigning client ports to a specific client SDN controller.

A. Single Domain Optical Network Virtualization

The network virtualization is based on an optical network hypervisor (ONH) which is a software mediating between the network elements below and the controllers on top. It collects the configuration of the network elements as well as the state of the network in general. The ONH exposes an SDN interface towards the tenants controller. It can be used to create and tear down optical connectivity dynamically. In addition, the network is abstracted to hide the physical topology and the complexity of the underlying optical network with its implied constraints. An abstracted network slice can be exposed as a single node or a topology comprising abstract nodes and links. These abstractions are created and maintained for every tenant individually. The OpenDaylight (ODL) controller is used as a reference controller. ODL is an open source project with a modular and flexible SDN controller at its core. It is programmed in Java and can be deployed on all machines providing a Java Runtime Environment.

B. STRAUSS Multidomain Network Orchestration

The STRAUSS multidomain SDN network orchestration is based on the ABNO architecture. The orchestration controller is the main component of this architecture and is responsible for orchestrating and invoking the components in the right order. All end-to-end path requests across the network are handled by the path computation element (PCE) [3]. It calculates the label switched path

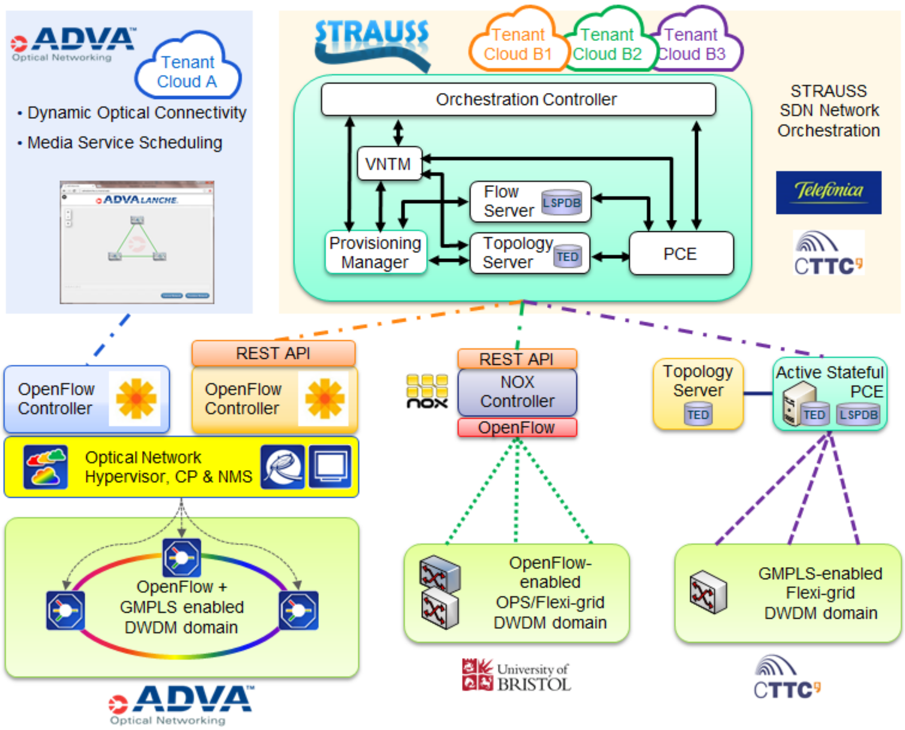

Figure 1. Demonstration Setup

(LSP) by using the traffic engineering database (TED). The PCE optimizes the optical spectrum consumption within the network with respect to the available bandwidth and network constraints. The TED is managed by the topology server which is responsible for storing and providing per-layer and inter-layer topology information. One main task is to maintain an up-to-date topology based on the available resources Another task is to share the collected information with other components as the provisioning manager, PCE or virtual network topology manager (VNTM). The VNTM maintains the topology of the upper layer and connections in the lower layer. The LSPs established in a layer 0 network are advertised to the layer 3 resources as virtual links to provide connectivity. This entity simplifies the upper-layer routing and traffic engineering decisions by hiding the optical connection setup. The VNTM can also respond to traffic demands, topology changes or network failures by releasing unused resources. The provisioning manager communicates with the domains and establishes LSPs. It either configures the resources through the data plane or triggers a set of actions in the control plane. There are several protocols that allow the configuration of network resources such as OpenFlow, NETCONF, CLI and PCEP.

The general workflow (not including all components) is as follows: the topology server collects the topology information from all domains. In the case of SDN controllers this is done using a REST-API. For domains with a PCE and an associated topology server, BGP-LS is used. Requests for end-to-end paths from the tenants are accepted by the orchestration controller. Based on the calculation result of the PCE, the orchestrator can decide if a path is available. In the case that resources are available an LSP setup is triggered through the provisioning manager. For SDN controllers again a REST API is used and for PCEs PCEP [4] is utilized.

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