XMPP as a scalable multi-tenants isolation solution for ONOS-based Software-Defined Cloud Networks

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***Abstract*— BGP/MPLS IP VPNs has emerged as a stable solution for L3 tunneling and inter-sites routing and connectivity system over a Wide Area Network (WAN). This solution can be extended via the Extensible Messaging and Presence Protocol (XMPP) to provide simple and scalable multi-tenants isolation technology for cloud networks with Software Defined Networking (SDN) scheme. Also, it provides interoperability between BGP-based WANs and internal SDN-based cloud networking, and avoids inter-subnet or north-south traffic to be routed via central network gateway acting as single point of failure. In this work, we overview this solution and introduce the structure of our implementation of the XMPP as a South-Bound Interface (SBI) framework for the Open Networking Operating System (ONOS); a popular SDN controller Our work allows the deployment of new use-cases based on ONOS.**

I. Introduction

Recently, a CISCO report [2] forecasted that the data traffic flow will exceed two Zeta Bytes by 2020. According to CISCO report [2], by 2020, 92 percent of Internet workloads will be processed by cloud data centers (DC). This means that network configuration, traffic forwarding and multi-tenants traffic isolation will be a complex task for network operators and service providers. In addition, to maintain a certain level of the quality of services (QoS) the operators should invest in new resources to handle the traffic volume and thus they should increase their capital expenses (CAPEX) and operating expenses (OPEX) [3]. However, with the arriving of the virtualization and later the Software-Defined Networking (SDN) the solution of the puzzle is changed. Network virtualization facilitates fast deployment of new network services with a flexible re-use of the same shared hardware resources and this permits to reduce the CAPEX. SDN provides new ways to design, build and operate the networks of operators, enterprises and service providers [4]. By separating the control plane from the data plane and centralization of the network configuration into a cluster of servers called controllers, SDN allows to decrease the OPEX. A SDN controller such as ONOS [5], OpenDayLight (ODL) [6] and OpenContrail [7] communicates with the network devices via a southbound interface (SBI), e.g., OpenFlow [8], Netconfig[9] and SNMP. A SBI is a key element of this big image and allows a SDN controller, on one hand, to collect topology events and information about the circulating traffic through the network. On the other hand, to automatically configure the devices according to the policies defined at the higher level by the network orchestration system such as Heat of OpenStack [10] and XOS [11]. This paper we address the implementation and validation of XMPP as SBI for ONOS.

The rest of this paper is organized as follows. In Section II, operational model for both the BGP IP VPN and XMPP for cloud networks is presented. The high level modular architecture of XMPP as SBI for ONOS is introduced in Section III. Section IV shows the virtual lab deployment of a Proof-Of-Concept PoC. In section V some related works are discussed. Last, Section VI concludes the work and gives some perspective.

II. System architecture

MPLS protocol is widely used in Wide Area Networks (WAN) for simplifying the routing in the core backbone of an Internet service provider (ISP) or an operator. It consists of provider edge routers (PE) that communicate with customer edge devices (CE) and central provider routers (P) that forward MPLS packets in the network. BGP is used to distribute routing information over the networks. One important service of using BGP/MPLS networks is the virtual private networks (VPN) that connects multiple customer network sites over a shared core network. The IETF draft [12] discusses how the control plane for BGP IP VPNs [13] can be used and extended via the XMPP protocol to provide a solution for large-scale data centers that meets some key requirements. OpenContrail SDN controller is the first project led by Juniper that implemented this solution illustrated by figure 1. In fact, a key element of OpenContrail is the virtual router (vRouter), which sits in the hypervisor of the compute nodes or servers [14].

A good detailed example on the use of vRouters and XMPP as SBI for interconnecting the VMs of the same tenants is explained through Fig. 11-5 in [14] with the complete XMPP exchanged messages (e.g., Subscribe request, Update notification, etc.). The Open Network Foundation (ONF) has adopted ONOS as the main SDN controller for its most successful and popular deployment project: CORD (Central Office Re-architected as a Datacenter) [15]. However, the ONOS controller does not support XMPP implementation as SBI yet, thus the usage of ONOS in the BGP VPN framework is not possible so far. This paper seeks to bridge

*This work is supported by the ONOS project of the Open Network Foundation ONF [1]

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this gap through the implementation of XMPP as a SBI for ONOS.

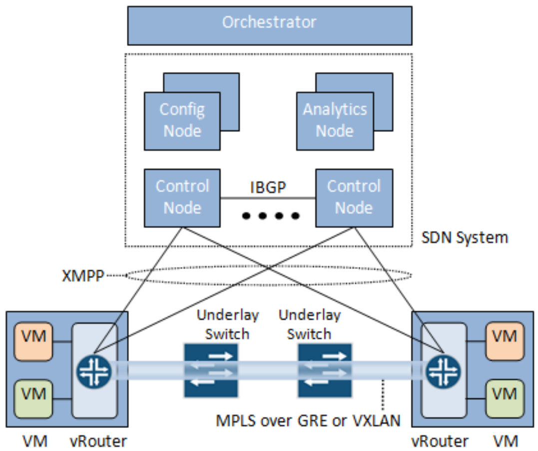

Fig. 1. Typical BGP/MPLS IP VPNs Architecture [7]

A. system components operational model

This section presents the general role of the system components and overviews the basic operational model of both the IP VPN and XMPP (with BGP payload) route signaling solution. As shown in Figure **??** the solution consists of several components at (i) the controller side and (ii) at the compute nodes or physical servers side (end system nodes). vRouter is a virtualized routing element implemented at the hypervisor level that handles localized control plane and forwarding plane traffic on the compute node (end system) [12]. The VPN forwarder is co-located with the virtual interface of the host or virtual machine (VM) and represents the traditional Provider Edge (PE) forwarding component in the standard BGP IP/VPN deployment. The virtual interface is created for a VM (a host) and plays the role of a traditional Customer Edge (CE) device.

The XMPP protocol is an extensible, XML-based message exchange protocol. The core of XMPP protocol has been defined in [16].

III. Framework structure

We have designed the implementation architecture to be in line with ONOS design principles.

Our implementation and design of XMPP functionality in the ONOS architecture is depicted in figure 2. The software architecture can be divided into three main parts: (i) XMPP protocol, (ii) XMPP Provider and (iii) Route Server application. The XMPP protocol handles the low-level operations such as session management. The XMPP Provider is the core module being responsible for abstracting XMPP devices and messages for SDN applications. The functionality of XMPP Provider includes serialization and de-serialization of XMPP stanzas and translation of XMPP concepts into high-level ONOS data model. The Route Server application makes use of XMPP Provider and also BGP Provider in order to realize the IP/VPN system.

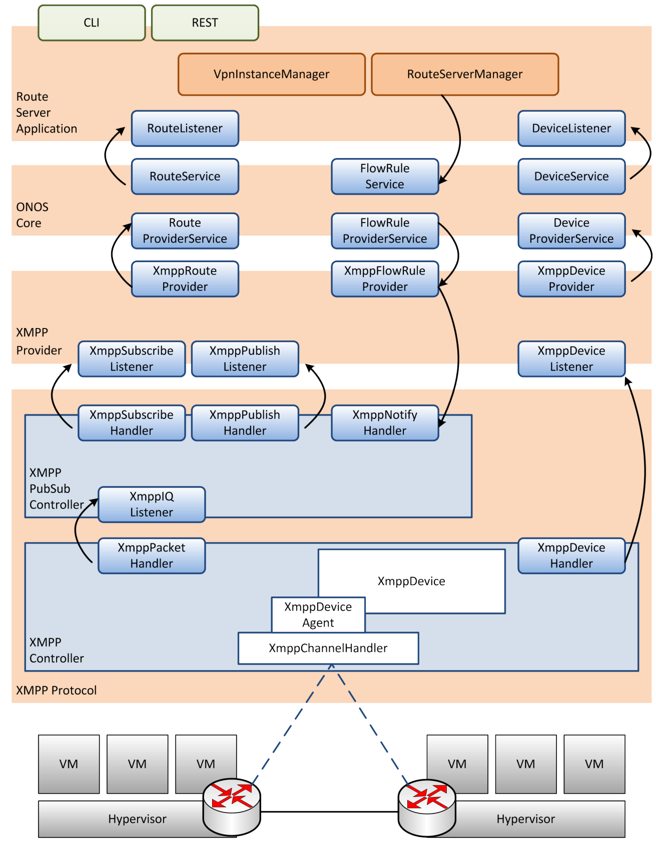

Fig. 2. XMPP-based IP/VPN subsystem in ONOS

IV. Proof of Concept

The Mininet software allows to effectively emulate OVS-based networks by using kernel virtualization. We have designed a lab deployment as the shown example in Figure 3 to exactly imitate desired BGP IP/VPNs architecture based on Mininet and Open vSwitch.

V. Related Works

The ONOS controller does not support XMPP so far, so the network innovators around ONOS project must rely on alternative protocols. The OpenFlow as a main SDN protocol is used in most of the applications such as traffic engineering, L2 switching or L3 routing. The OVSDB combined with OpenFlow is the basis for cloud networking solutions e.g. for ONOS SONA. The BGP protocol implements the east-west interface between peer SDN controllers. The ONOS controller supports also management protocols such as SNMP or NetConf. However, none of them is an ideal solution for the BGP-signaled L3VPN architecture.

Moreover, the usage of XMPP in other SDN solutions is very limited. The main competitor of ONOS, OpenDayLight [6], does not support XMPP protocol as SBI, even if it supports wider range of southbound protocols. Currently, the only SDN controller, which supports XMPP protocol is OpenContrail developed by Juniper [7]. It implements the XMPP Publish/Subscribe extension as well as the XEP-0248 extension introducing Collection Nodes functionality

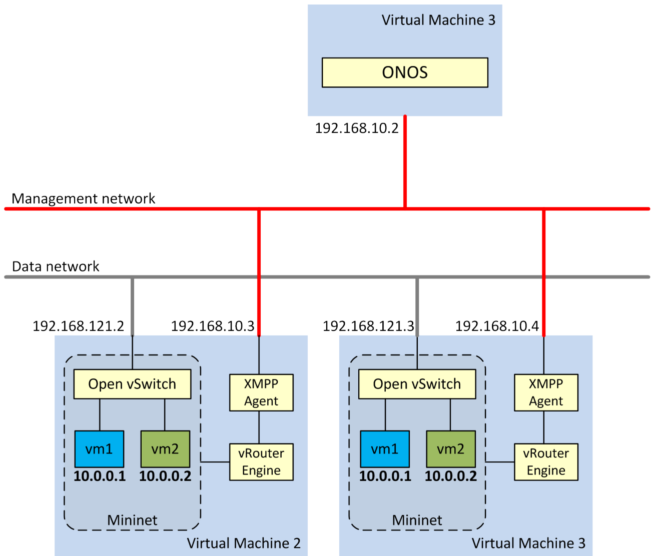

Fig. 3. Proof of concept - Lab deployment

for XMPP Publish/Subscribe. The XMPP is used in the framework of BGP-signaled L3VPN architecture to distribute routing information over the network. However, OpenContrail supports only one use case application as the XMPP and BGP protocols are the only southbound interfaces. Thus, OpenContrail cannot be used in a hybrid SDN deployments, while ONOS is used in wide area of applications. Moreover, the OpenContrail cannot be easily extended by new XMPP extensions, because it does not have a modular architecture. The one more drawback of OpenContrail is it implements the old version of [12], while the newest version has major improvements.

VI. Conclusion and Perspective

We have summarized in this work the BGP/MPLS IP VPNs solution for SD-cloud and have presented the modular BGP VPN solution design with the XMPP protocol. We have introduced the general structure of the framework implementation and the design principles. We have developed and set up a proof of concept virtual lab of the complete solution using Mininet [17] and Open vSwitch and provided externally published user guide.

As extension of this work, we are planning to add support to Extended VPN (EVPN) and to perform some experiments for evaluating the prototype performance. We open-source all the code of the framework and the vRouter engine simulator to be freely used by research centers or universities for academic purpose.

Acknowledgment

We thank the technical steering committee of ONF and in particular Andrea Campanella and Thomas Vachuska for their kind assistance and help for the general architecture design and code review. We thank also Emil Kowalczyk, Head of Advanced Networking Solutions Agency at Orange, Polska for his support.

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