An Approach to Multi-Vendor Orchestration in a Software Defined Ecosystem
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Abstract

Rapid advancements in cloud technology have been augmented by extensive usage of bandwidth-consuming 'always on' devices, and on-demand network, infrastructure, and virtualization needs. This has made it imperative for telcos to deploy orchestrated multi-vendor systems that enable on-demand services and fulfil infrastructural needs for better QoS and QoE.

The telco cloud network is evolving towards an orchestrated ecosystem of vendor agnostic hardware (bare metal), multi-vendor virtualized network functions (vendor specific or otherwise), and multi-vendor or open-source orchestration platforms. These are enabling accelerated scale-in and scale-out of network functions (such as software and infrastructure) based on network needs.

This paper evaluates one such use case for enabling multi-vendor orchestration in a Software Defined telco cloud ecosystem.
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<th>Acronym</th>
<th>Description</th>
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<tr>
<td>APIs</td>
<td>Application Program Interfaces</td>
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<tr>
<td>BGP</td>
<td>Border Gateway Protocol</td>
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<td>CRUD</td>
<td>Create-Read-Update-Delete</td>
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<td>DPI</td>
<td>Deep Packet Inspection</td>
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<td>EMS</td>
<td>Element Management System</td>
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<td>GMPLS</td>
<td>Generalized Multi-Protocol Label Switching</td>
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<td>GRE</td>
<td>Generic Routing Encapsulation</td>
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<td>MPLS</td>
<td>Multiprotocol Label Switching</td>
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<td>NETCONF</td>
<td>Network Configuration Protocol</td>
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<td>NFV</td>
<td>Network Function Virtualization</td>
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<td>NMS</td>
<td>Network Management System</td>
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<td>OVSDB</td>
<td>Open vSwitch Database</td>
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<td>QoE</td>
<td>Quality of Experience</td>
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<td>QoS</td>
<td>Quality of Service</td>
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<td>SDN</td>
<td>Software Defined Networking</td>
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<td>REST</td>
<td>Representational State Transfer</td>
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<td>XMPP</td>
<td>Extensible Messaging and Presence Protocol</td>
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<td>VXLAN</td>
<td>Virtual Extensible LAN</td>
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<td>VPN</td>
<td>Virtual Private Network</td>
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Introduction

In today’s mobile cloud era, business needs and monetization banks on better QoS and QoE. This requires telcos to roll out next-generation technologies such as cloud virtualization, converged infrastructure, NFV, software defined storage, networks, data centers, and predictive network management. The evolution of these technologies are critical in the transformation trajectory of the key stakeholders of the telco industry.

For telco cloud ecosystems, the co-existence of new technologies (virtualization, SDN, orchestration) and multi-vendor product suites will hold the key to effective transformation, with the modified infrastructure supporting and enabling inter-working with legacy systems.

This is driving the demand for a multi-vendor orchestration solution that provides simplicity, flexibility, agility, and speed, and addresses end-to-end needs while offering reduced cost, efficient scale-in or scale-out of network functions, and multi-vendor interoperability.

The Typical Telco Cloud Ecosystem

A telco cloud ecosystem includes both the managed and management environments, with these components:

- **The Orchestration Layer:** This includes various applications or orchestrators (for example, OpenStack, CloudStack, and other vendor specific orchestration engines) that manage the cloud infrastructure and workflow (including scale-in and scale-out)

- **The Control Plane:** This is provided via the SDN controllers (for example, OpenDaylight, Floodlight, OpenContrail, vendor specific SDN controllers) and legacy platforms (such as NMS or EMS), enabling centralized or distributed interworking of the orchestration and the SDN ecosystem

- **The Data Plane:** It includes the virtual (vRouter, OpenVswitches, vendor specific–virtualized network functions such as vCDN, vFirewall, and vLoadBalancer) and physical nodes (core routers, PE routers, route reflectors, transport nodes, and DPI probes)

- **The End-to-End Ecosystem:** This is managed by standardized protocols such as XMPP, BGP, OpenFlow, NETCONF, REST, APIs, and so on

The Multi-Vendor Telco Cloud Ecosystem: An Approach

Multi-vendor equipment (physical hardware) already exists in the telco ecosystem, providing services on a vendor dependent domain that inter-work as per agreed protocols or interfaces for extending day-to-day services.

The telco cloud brings in hardware that is vendor agnostic. However, the orchestration, control, and data plane is transformed into vendor customized solutions. While open-source solutions are evolving, there remain challenges with conforming to the carrier-grade specifications (such as reliability and high-availability) that are mandated by telcos.
The migration path from legacy systems to the telco cloud is therefore expected to be vendor specific, wherein each vendor upgrades or introduces their specific virtualized network functions that inter-work with customized control plane solutions. From the telco’s perspective, the master SDN controllers and service orchestration platform will be introduced to interface to these vendor dependent legacy and virtualization domains.

This paper considers a typical ecosystem containing a master service orchestration platform (OpenStack) with the base network consisting of multiple vendor networks. We consider OpenVswitch (open-source) and vendor specific virtualized network function (vRouter) formulating the data plane. At the control plane, we consider the master SDN controller, OpenDaylight (Helium release), for the orchestration–data plane interworking.

In such a deployment, OpenDaylight as a master SDN controller is envisioned to:

- Support and manage data planes from different vendors, including the latest innovations in the market as well as the legacy framework. Within the scope of this paper we consider a green-field deployment, consequently overriding legacy nodes or networks.
- Enable and support different SDN controllers to manage the end-to-end solutioning. For instance, for VPN provisioning in an ecosystem that includes technologies from Juniper Networks, Ericsson, and Nokia Networks, the equivalent of a plug-on recommendation would enable these vendor specific components to inter-work.
- Support service orchestration applicable for the complete network (including vendor dependent and agnostic networks).

The gap in this multi-vendor ecosystem approach is that the vendor specific vRouter can be managed only by the vendor’s SDN controller (in this case OpenContrail or Contrail) via the proprietary interface. Consequently, the deployment of the vendor specific vRouter in a multi-vendor network, as discussed earlier, is a hindrance to end-to-end orchestration for the telco.

The paper investigates a viable use case and proposes an approach that provides an OpenDaylight southbound plugin to enable inter-operability across orchestration (OpenStack), control plane (OpenDaylight), vendor specific control plane (OpenContrail or Contrail), and vRouter and OpenVswitch (data plane). This would enable orchestration in a multi-vendor or hybrid telco cloud ecosystem, as illustrated in Figure 1.
The Recommended Technical Approach

Within the scope of this paper, we consider the telco ecosystem of multi-vendor, multi-layer, and multi-generation networks, creating the need for a framework that can orchestrate this telco network.

Architecture Overview

The overall architecture of a viable deployment scenario in a multi-vendor telco cloud ecosystem consists of:

- In the hierarchical SDN architecture, the data plane comprises network nodes (legacy or virtualized network functions) from multiple vendors forming the L0-L1 and L2-L3 layers.

- These data plane elements are managed by best suited or vendor specific legacy NMS, EMS, or SDN controllers using standardized southbound protocols. Within the telco cloud, the information exchange among these vendor specific controllers can be achieved either via east-west interfaces (like SDNi) or the master SDN controller can be enhanced to support such information.

- The master SDN controller stays responsible for the multi-vendor network ecosystem to ensure centralized control and programmability via REST APIs (master controller–vendor specific controllers). These components (consisting of the master SDN controller and vendor specific controller) form the control plane that enables traffic engineering based on network parameters, QoS or QoE mandates, and service requests.

- Inter-VPN communication is established using techniques like MPLS, GMPLS, GRE, VXLAN, GRE Tunneling, and so on.

![Figure 2. Multi-layered architecture of the telco cloud (green field deployment) ecosystem](image-url)
In Figure 2, a sample green-field deployment (with no legacy nodes), the approach of a master SDN controller enables end-to-end service orchestration on a multi-vendor SDN network. The existing systems and the results of the deployment are depicted in Figure 3 and explained in Table 1.
Assumptions

This paper considers a few additional assumptions to enable the ecosystem to inter-operate OpenStack Orchestration with OpenDaylight-Helium and SDN Controllers in the following manner:

- ML2 Plugin in OpenStack is configured to direct neutron V2 API calls to OpenDaylight
- L3 plugin is configured to direct neutron calls for router and floating IP to OpenDaylight
- Agents are configured for managing advanced services such as load balancing, firewalling, and VPN alongside ML2 plugin

Interoperability across the Multi-vendor Telco Cloud

Considering the current network with OpenVswitch (open-source) and vendor specific virtualized network function (vRouter), the need is to enable a single platform for orchestration to ensure ease of operations in a multi-vendor telco cloud ecosystem.

Figure 4. An overview of the telco ecosystem enhancements

To facilitate multi-vendor support, the telco ecosystem needs to implement the following enhancements, which are also depicted in Figure 4:
Enable Nova drivers to plug and unplug network interfaces while supporting different combinations of machine virtualization and switching technologies without knowing the underlying network details. This includes:

- Integration of the OpenStack or devstack with OVSDB using the Nova VIF driver (to communicate with the OVS agent in OVSDB)
- Integration of the OpenStack or devstack with the OpenContrail controller using the Nova VIF driver (to communicate with vRouter agent in OpenContrail) and disabling of the neutron services of the OC controller
- Implementation of respective interfaces or south-bound plugins (leveraging north-bound APIs provided by the vendor specific SDN controller) to support various network functionalities
- Include CRUD operations support for network objects: subnet, port, router, floating IP, security groups, and security group rules

Conclusion

To conclude, SDN in a multi-vendor telco cloud will act as a catalyst, enabling radically changing ecosystems to achieve scalability based on network demands. While vendor-agnostic hardware will be used in the telco cloud leveraging the virtualization of network functions, the virtualization network functions themselves will be vendor specific.

Multi-vendor orchestration will play a key role in accelerating technology adoption, enabling multi-vendor interoperability in a Software Defined Network or telco cloud. The specific use case of enabling orchestration in a multi-vendor telco cloud ecosystem, consisting of open source and vendor specific virtualized network functions, reiterates the importance and advantage of the deployment.

We project an evolving roadmap that brings transformation that can neither be met by master SDN controllers (Super Controllers) nor by multi-vendor SDN inter-communication (Super APIs interface enabling south-bound, north-bound, or east-west). The next-generation telco world will depend on a promise theory based model that ensures independent agents (in overlays and underlays network) interact with each other to deliver a service.
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