Integration Challenges For The Evolving SDN/NFV Ecosystem

Subhas Chandra Mondal

Table of contents

Abstract

Software-defined networking (SDN) and Network Function Virtualization (NFV) have taken center stage in the telecommunications world. Well accepted in enterprise and data center networking, these concepts are now transforming the equipment market. The technologies are, however, at an early stage of development for carrier networks. Therefore, the deployment scenario in a communication service provider network will have to undergo transformation in several stages, in areas where traditional and new technologies will co-exist for many years. Furthermore, different layers of the network will evolve at a varying pace. While there is huge promise of SDN/NFV bringing simplicity, speed, agility and cost savings to the process of rolling out new network services, the integration of the diverse network of multi-layer, multi-vendor and multi-generation will be a key enabler in accelerating the technology's adoption. This paper presents a point of view on the role an integration framework plays in enabling the quick adoption of SDN/NFV.

Introduction

Software defined networking started with the concept of separating the control plane (CP) and data plane (DP) functions to bring programmability to the network (please refer to Figure 1). With a standard interface between CP and DP elements, it is now possible to have a common controller for DP elements from multiple vendors. However, equipment vendors designing and manufacturing transport, switching and routing equipment for decades have developed special purpose Application Specific Integrated Circuits (ASICs), Systems on a Chip (SOCs) and network processors to attain superior performance in an integrated design. While separation of the CP and DP by respective vendors has progressed significantly, attaining the same level of performance from a common controller is still being experimented. At this stage, there are several open source controller initiatives like OpenDayLight, Floodlight, OpenContrail and emerging Open Networking Operating Systems (ONOS) controllers which have gained prominence. There are also several other upcoming controllers like NOX, POX, Beacon, Trema, Ryu etc. Controllers play an important role in SDN as the real intelligence comes from them. Hence, there is a war among players to attain prominence in the controller segment.

Over the last few years, there has been a phenomenon of hyper competition in data plane virtualization substantiated by the rise of vendors like VMware, Cisco, Microsoft and Nicira with their own virtual switches (vSwitch). The primary usage segment for these vSwitches is data centers. Some of these vSwitches support a plugin into OpenStack or other cloud operating systems for cloud orchestration. The vSwitch can be controlled by a controller that supports a flow control protocol like OpenFlow or any proprietary interfaces.

There are also open source virtual switches like OVS that have been embedded in many other open source platforms like Citrix Xen, Linux KVM, and Oracle Virtual Box.

As SDN moves outside the data center in a carrier network scenario, the concept of virtualized switch layer as the DP element changes for core, edge and access layers. High-scale forwarding plays a vital role in ensuring node performance. Virtualized switches may not scale at the same pace as the rise in need for higher-scale forwarding in edge and core networks. This has given rise to another set of high-scale forwarding nodes called white boxes. The white boxes could be DP elements from traditional network element vendors or from a new set of players who realize higher-scale forwarding on general purpose merchant silicon.

The scale of forwarding will vary from layer 0 (L0) to layer 7 (L7) in a network hierarchy. An Optical Transport Network (OTN) switch at a photonic layer (L0) will need to provide an extremely high speed interface but the switch path is rather static. At layer (L1) the speed is again extremely high while the path is semi-static. The switch path at (L1) Optical Channel Data Unit (ODU) and Optical Channel Transport Unit (OUT) need not be changed frequently.

As we move up to Layer 2/3 (Ethernet, MPLS, IP etc.), increased rate of path change coupled with high scale forwarding will be a primary requirement. The open networking concept originated at this layer and has now spread to other layers (L1 to L7).

High-scale forwarding is achieved with purpose-built chipsets, programmable pipelines and also with fully programmable network processors. The current network processor technology needs to evolve to attain the same level of efficiency as a purpose-built chipset. Research indicates that this is expected to be a reality in the next few years. In essence, this will accelerate the commoditization of forwarding plane elements. This will give rise to new players who will come up with innovative data plane solutions that support open standards and, thus, a centralized controller constitute a network over time.

As the evolution of DP and CP elements takes place, with multiple players, traditional network elements will continue to co-exist with the evolved network architecture.

While there is a serious interest to embrace the technology, communication service providers (CSPs) face the dual challenge of choosing the right solution by putting different pieces together and making a network that will stand the test of time. Any new technology introduction is a long process from the hype cycle to the reality.

There are many questions to answer:

1. Will the network become open source?
2. What about security in an open environment?
3. Will it scale?
4. Will open networking eliminate vendor dependency?
5. Will they interoperate?
6. Will it really bring cost benefits?
7. Will it be reliable?

Let us take a look at the technical aspects that will help answer some of these questions.

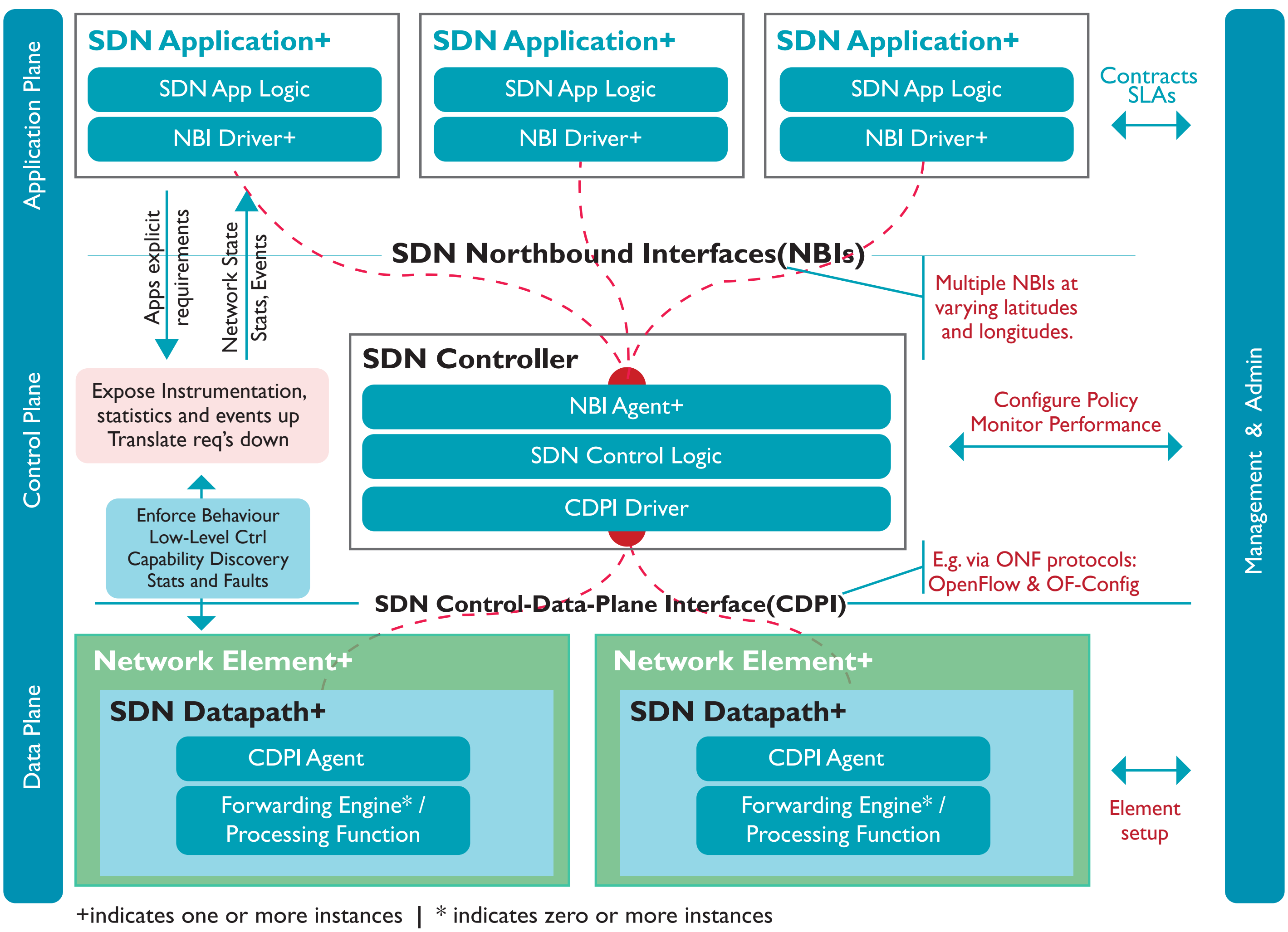

Figure 1: SDN reference architecture (source ONF)

Rise of Multi controller environment

As per a recent survey by Infonetics research[1], the top five drivers for Communication Service Providers (CSPs) to look at SDN are:

1. Speedy creation of new network services
2. Optimization network configurations in real time
3. Simplification of network provisioning
4. Quick Creation of new virtual networks
5. Creation virtual networks across multi-vendor equipment

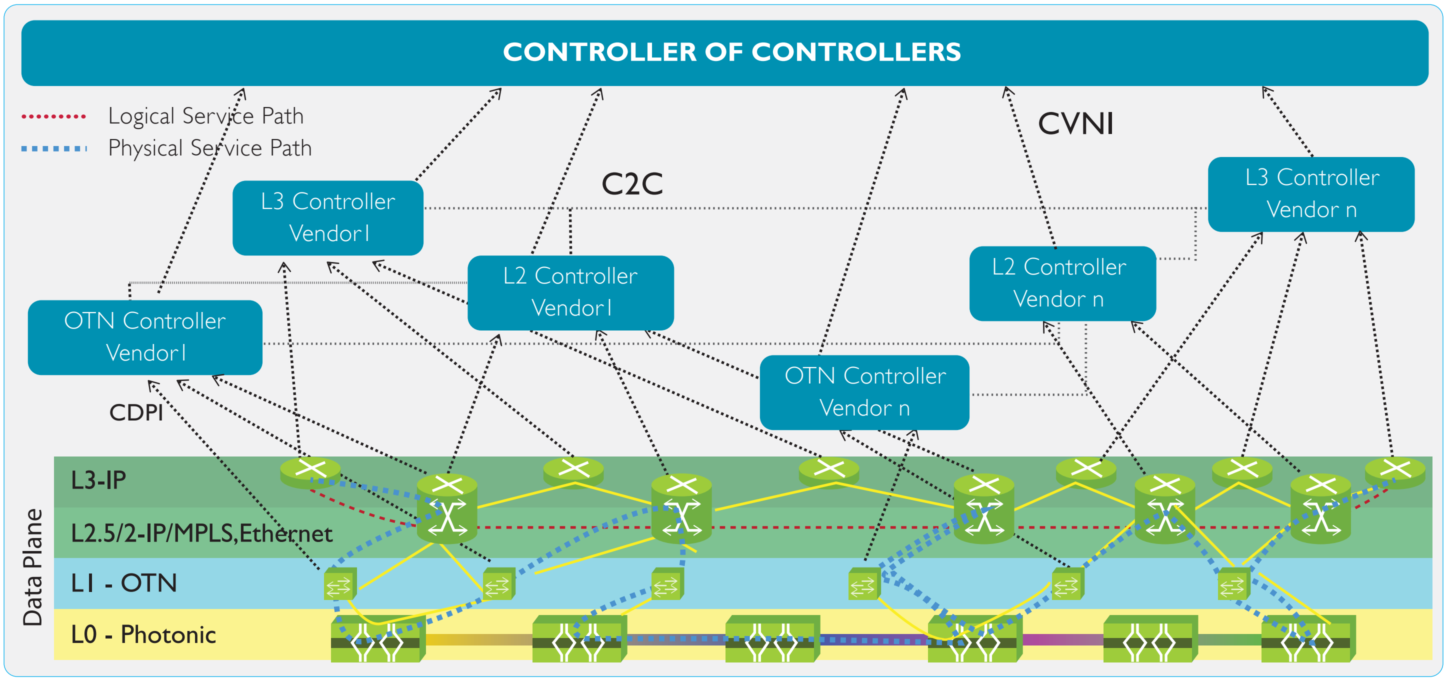

Figure 2: SDN controller ecosystem

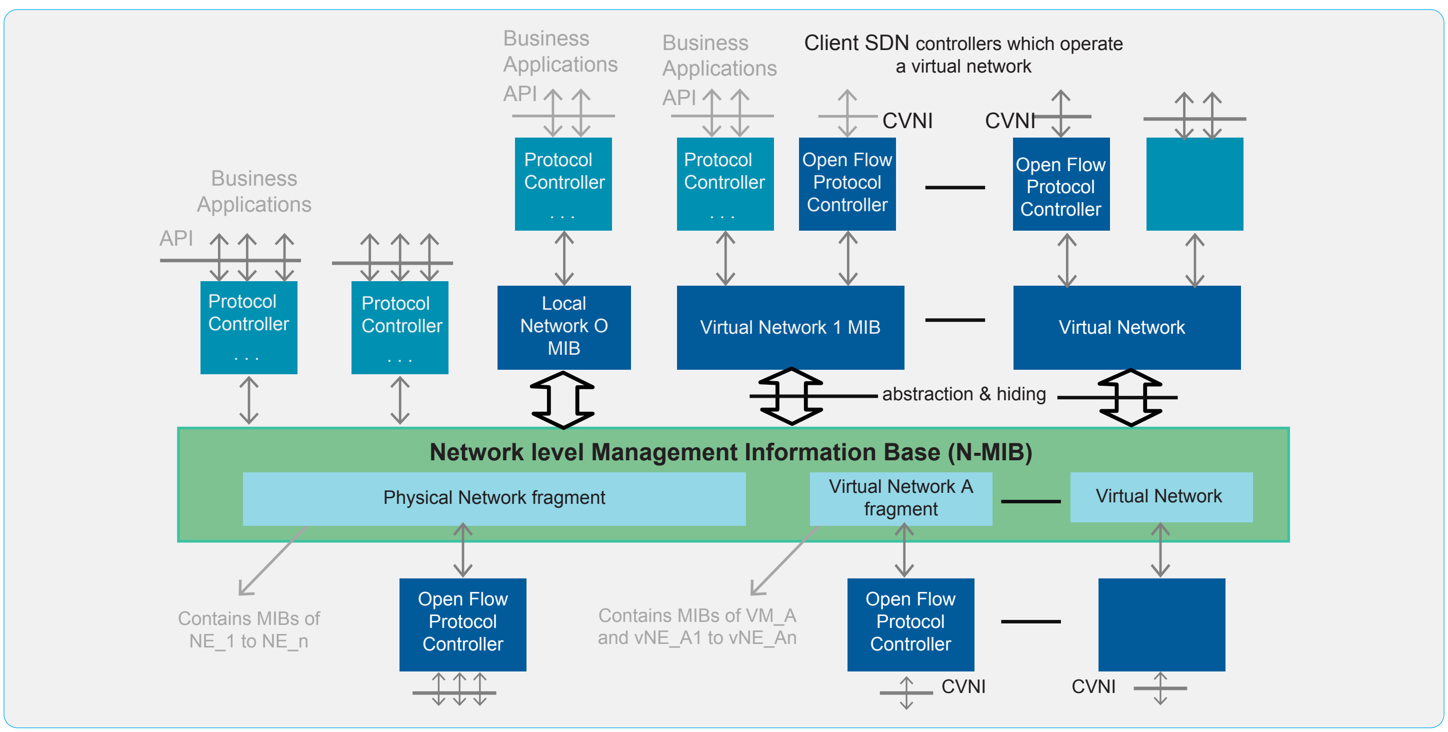

Figure 3: Network Data Model (Source ONF)

1http://www.infinera.com/pdfs/whitepapers/Infinera-WP-The_Multi-Layer_Transport_Network_Opportunity.pdf

While SDN and NFV technologies, have the potential to realize all of the above, there are technical challenges they need to address before realizing the full potential. Let's take a look at some of the challenges and what it takes to address them.

1. Existence of multiple controllers:

SDN standards are setting forth the concept of a logically centralized controller. In principle, this will allow the CSPs to define a network services schema quickly on an end-to-end basis. However, to realize the service, the flow across multiple network nodes needs to be aggregated. The nodes will be controlled by another controller best suited to meet the needs. This controller, in turn, may be controlled either by an upper layer controller or may work in tandem with another controller at the same hierarchical level. The standards are evolving to standardize inter-controller interfaces (also called CVNIs for control virtual network interfaces). The industry is looking forward to an open controller ecosystem so inter-operability is no longer an issue. While open controller initiatives are progressing, the leading vendors in this space continue to have their proprietary extensions to CP and DP nodes in order to provide a differentiated offering. As a result, open controllers as well as proprietary controllers will co-exist. In order to make these open controllers and performance differentiated proprietary controllers work together, there will be a need to adapt and harmonize the controller interfaces. The controller layer could be virtualized using NFV and it can, therefore, provide on-demand elastic capacity from a control layer capacity standpoint. The security aspect of the new ecosystem will require a fresh review.

2. Existence of multi-vendor data plane elements:

The existing appliance-based network elements will evolve to have data plane elements decoupled from the control plane. The leading vendors will continue to have integrated offerings where data plane will be controlled by a vendor provided controller with openness only at its northbound API. However, the leading vendors are also providing open standard compliance on their decoupled DP node so an open controller can regulate them. Also expected to arise are new DP vendors who will bring merchant silicon with open standard interfaces fully compliant with CDPI (Control Data Plane Interface) standards e.g. OpenFlow. In the long term, the DP nodes may run on a general purpose network processor that will match the performance level of DP nodes that are based on custom-built silicon. Integrating the multi-vendor data plane nodes with a uniform interface, performance benchmark and inter-operability is essential to adapt the new technology. Once the DP elements become commodity, elastic capacity creation with plug-and-play addition/deletion of DP elements in the infrastructure layer will be possible.

3. Existence of multiple data models:

In order to define the end-to-end network service, there is a need to have a uniform data model. ONF has chosen Yang as the modeling language. Model for network elements are being defined and over a period of time we expect that the model for all necessary elements in the network will be built. It is likely that the SDN ecosystem will have elements with compliant and non-compliant data models. There will also be traditional network elements. The data model for traditional nodes may need to be built from scratch and to make these work together it is essential to harmonize this model. ONF has defined a data model on the network services level as shown in Figure 3.

4. Existence of traditional network nodes:

Traditional network nodes need to be transformed in order to meet the priority expectations of CSPs. Since their replacement with SDN-based implementation will be carried out in a phased manner, there is a need to adapt these nodes to make sure all the benefits of SDN can be extended during this transition period. Hence, there is a need to model these nodes with a data model and enable adaptation of SDN-based configuration, along with provisioning and optimization mechanisms that simplify the network and service operations.

5. Existence of a traditional network management system:

Open standards-based implementation will bring an opportunity to simplify the element and network management systems that can simplify the provisioning, optimize the network configuration in real-time, create new virtual networks quickly, and embrace multi-vendor ecosystems to set up a virtual network topology. However, the existing Network Management Systems/Operations Support Systems and Business Support Systems (NMS/OSS/BSS) will co-exist during the evolution. Integrating the existing management system while embracing the new technology is essential to protect the investment, maintain service continuity and drive faster service roll-out.

While SDN and NFV technologies, have the potential to realize all of the above, there are technical challenges they need to address before realizing the full potential. Let's take a look at some of the challenges and what it takes to address them.

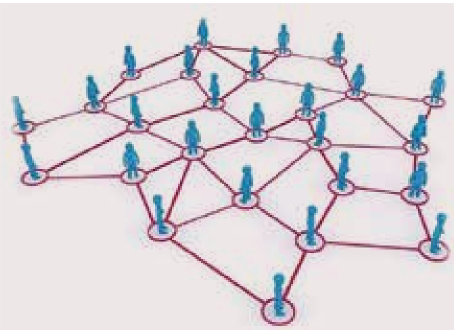

Figure 4 illustrates a WAN network topology with traditional appliance-based network nodes. The traffic from different access networks are aggregated in an edge network. The edge node will perform the transport and routing function. Typically, there would be optical equipment with DWDM/OTN functionality alongside a router. The edge traffic would be aggregated in a core network ring with long haul transport capability.

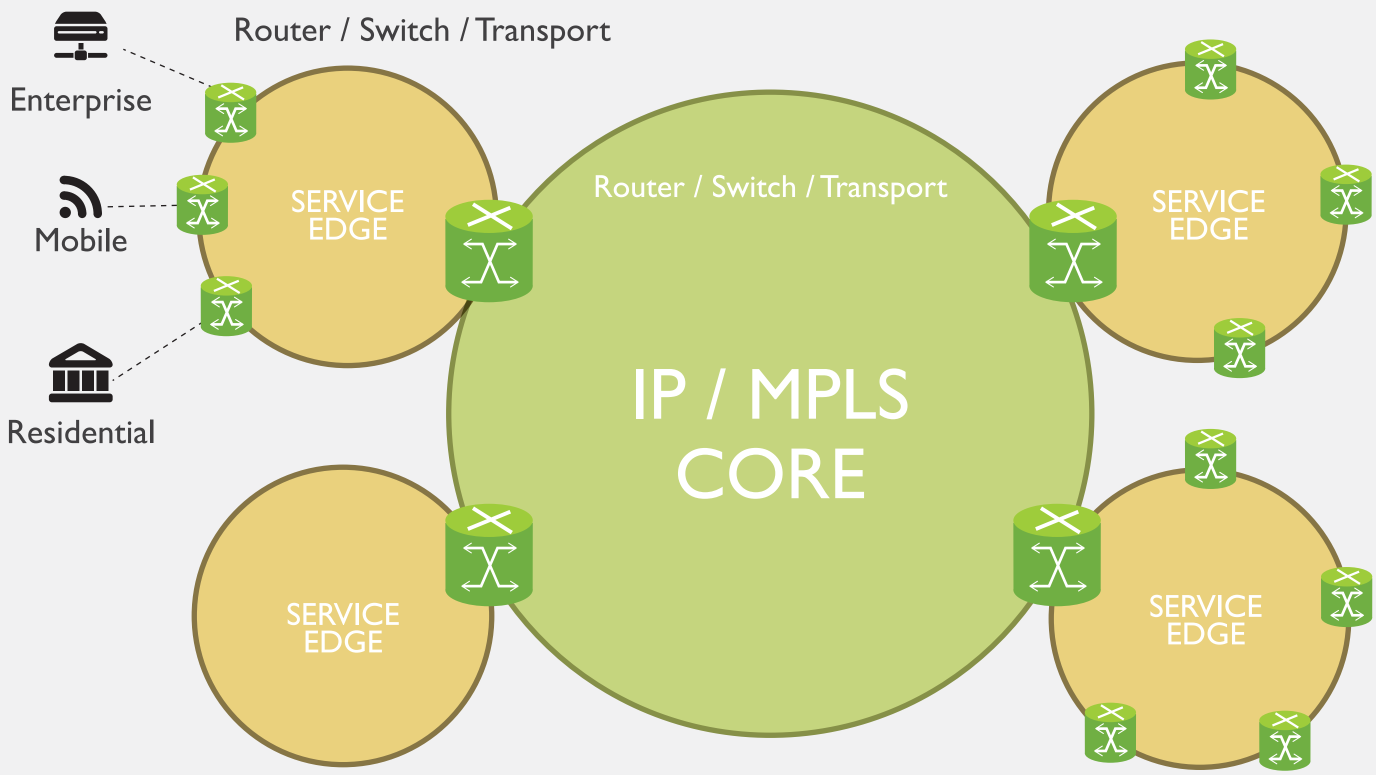

Fig:4 Current Network with Integrated Appliances

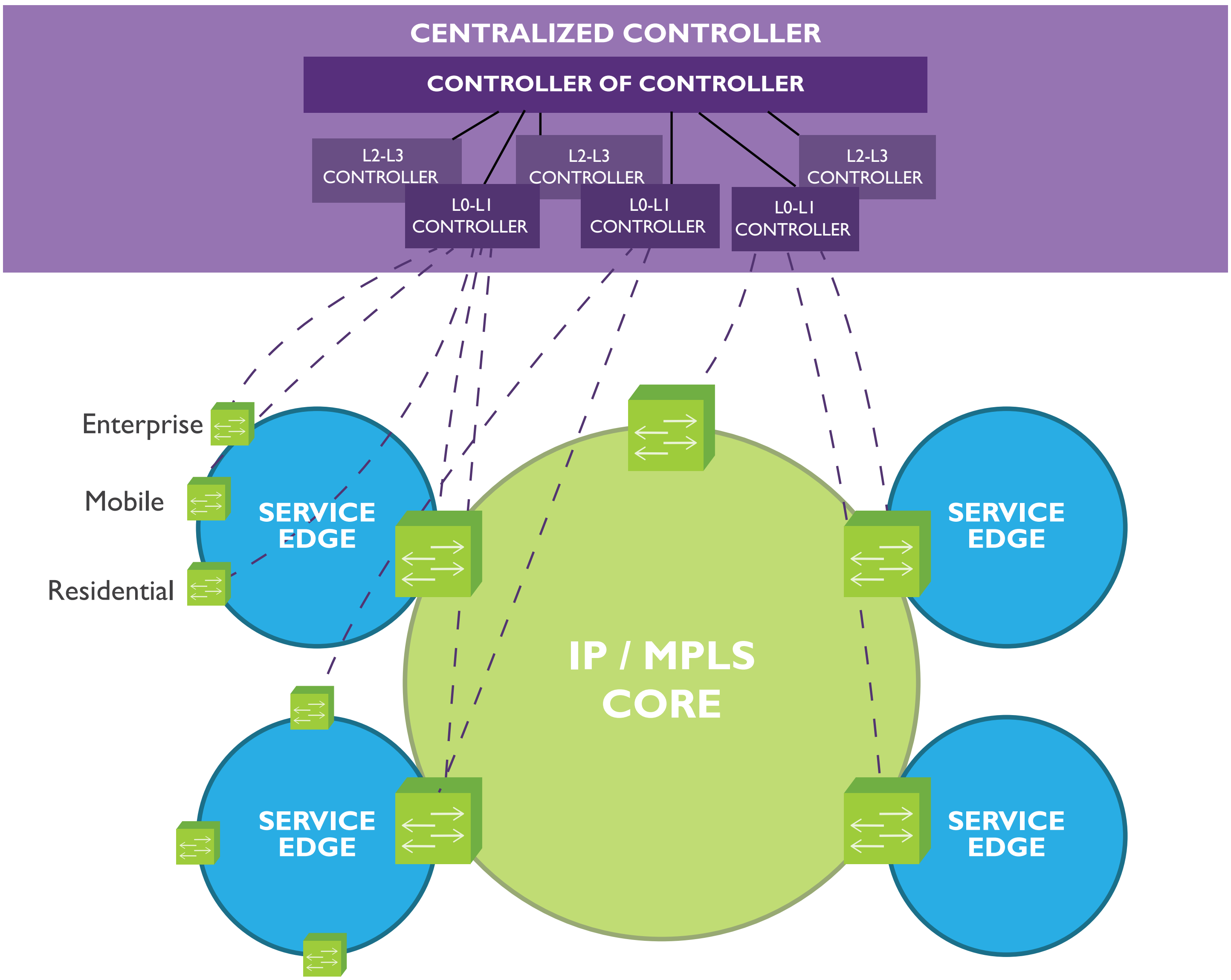

Fig 5: Decomplied Data and Control plane in WAN

Figure 5 shows how traditional WAN nodes will evolve with SDN and NFV technologies. The aggregation nodes will now only have data plane capabilities and control will be provided from a logically centralized controller. The complexity will be moved up to the controller and the data plane nodes will provide simple forwarding capability. The low scale forwarding requirement in the DP boxes can easily move into a general purpose computing platform with a virtualization engine capable of implementing a virtual switch. Once the DP boxes achieve virtualized switching capability, they can scale up as required and this process can be automated when the nodes are left with additional computing/storage/bandwidth capacity. Low scale forwarding will be an application in the access nodes. We believe that edge and core nodes will require higher scale forwarding. The higher scale forwarding can be realized either with specialized proprietary hardware or on a general purpose network processor. Applying the virtualization concept here will require the addition of physical DP capacity as opposed to a software instance, which is possible in case of low scale forwarding.

The controller layer is expected to be hierarchical. Each network layer will have its specialties and hence needs to be managed accordingly. As explained earlier in Figure 2, we expect multiple vendors and multiple controllers in L0-L1 and L2-L3 layers. These will be aggregated in a central controller. Adapting all the controllers together, applying a centralized traffic engineering and optimization will be key aspects. Some of the nodes will continue to be based on traditional implementation. While the decoupled architecture is likely to be driven with a uniform data model with minor variations, the traditional nodes will require modeling and adapting in this ecosystem. There will, therefore, be a need for an integration framework that can harmonize this diverse ecosystem of multi-vendor, multi-layer and multi-generation networks.

Conclusion

SDN and NFV technologies promise a great opportunity to innovate in the communications industry. As the technology evolves, the current challenges will be overcome. The ecosystem is coming together to embrace the change and standardization bodies are playing a key role. The ecosystem players are now redefining their role to adapt to this change. An integration framework that meets the evolving needs of the ecosystem will accelerate the technology adoption. At the end of the day, the telecom market is going to win in providing flexible, faster, cheaper and better networks that will delight customers. We believe that the SDN/NFV technology will transform the networking market.

About the Author

Subhas Chandra Mondal has over 22 years of Telecom experience spanning across Product R&D, Outsourced Software development, System Engineering, Solutions architecting, Technical presales. He currently heads the Wireline R&D practice that includes a portfolio of Optical, Ethernet and IP technologies. Subhas is a passionate technologist, always eager to learn new Technologies. SDN is a key interest area and he is developing SDN solutions that are relevant to Wipro customers.

Winning in a Digital World

Wipro's comprehensive suite of converged services and solutions addresses the entire digital value chain - from the network core to device applications. Our vertically aligned business model ensures that we understand the business and technology imperatives of specific industries, while our technology service lines allow us to architect integrated technology solutions. In an era of digital disruption, Wipro is uniquely positioned to partner with Telco-Media organizations to deliver the business and technology expertise that enables them to do business better.

About Wipro Technologies

Wipro Technologies, the global IT business of Wipro Limited (NYSE:WIT) is a leading Information Technology, Consulting and Outsourcing company, that delivers solutions to enable its clients do business better. Wipro Technologies delivers winning business outcomes through its deep industry experience and a 360 degree view of "Business through Technology"– helping clients create successful and adaptive businesses. A company recognized globally for its comprehensive portfolio of services, a practitioner's approach to delivering innovation and an organization wide commitment to sustainability, Wipro Technologies has over 140,000 employees and clients across 61countries.

For information visit www.wipro.com or mail info@wipro.com

WIPRO
Applying Thought

DO BUSINESS BETTER

WWW.WIPRO.COM

NYSE:WIT | OVER 150,000 EMPLOYEES | 61 COUNTRIES | CONSULTING | SYSTEM INTEGRATION | OUTSOURCING

WIPRO TECHNOLOGIES, DODDAKANNELLI, SARJAPUR ROAD, BANGALORE - 560 035. TEL: +91 (08) 2844 0011, FAX: +91 (08) 2844 0256, EMAIL: INFO@WIPRO.COM

North America South America Canada United Kingdom Germany France Switzerland Poland Austria Sweden Finland Benelux Portugal Romania Japan Philippines Singapore Malaysia Australia

IND/PRA/JAN2013-MAR2013