Carrier Ethernet and SDN

Part 1

An Industry Perspective

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1 Introduction and Overview

1.1 Abstract

This paper examines how Carrier Ethernet fits together with Software-Defined Networking (SDN). It describes SDN, then looks at how SDN can be applied as a vehicle for delivering Carrier Ethernet. The result is that SDN makes Carrier Ethernet more dynamic and agile. This more dynamic Carrier Ethernet is well-suited for on-demand cloud applications and interconnecting virtual network functions and their cloud computing infrastructure. Carrier Ethernet provides high performance, reliable and deterministic connectivity across the wide-area network. Carrier Ethernet is well-suited to dynamic environments with virtualized network functions and cloud based computing infrastructure. Carrier Ethernet is the glue that interconnects these new technologies and combined with SDN facilitates the on-going network transformation.

1.2 Document Purpose and Scope

In this paper, the working definitions of SDN and models for Carrier Ethernet (CE) and SDN are described. Evolving CE service deployments which provide the benefits of SDN based management and responsiveness are also discussed.

A companion paper "Carrier Ethernet and SDN Part 2: Practical Considerations" discusses the architectural models of CE and SDN and Operational Considerations of SDN and CE for OSS systems. The second paper also provides a number of use case examples covering CE and SDN services and management scenarios.

1.3 Executive Summary

The wide area network (WAN) is in the midst of a paradigm shift. Demand for bandwidth continues to grow with no apparent end in sight. Simultaneously, expectations are for bandwidth to be instantaneously available and changed on demand.

End users demand more Carrier Ethernet services and are consuming standardized, highly reliable, scalable, carrier-grade Ethernet services that support quality of service. The market for Carrier Ethernet services exceeded $40 billion in 2014 and is projected to exceed $60 billion in 2018[1].

In a competitive environment, Carriers need to rapidly introduce differentiated product offerings built around Carrier Ethernet Services and strive to turn-up service instances in minutes instead of weeks. End-users are looking for more control of their services including the ability to dynamically modify their service on-demand.

The proliferation of data centers, cloud computing, virtualization and anything-as-a-service (XaaS) is also creating a paradigm shift in the way we think about how services are delivered and consumed. Within the data center, XaaS can be temporal and dynamic. Unfortunately, while today's network services do provide high-performance connectivity across the WAN, the services are not agile and cannot match the dynamism often required by XaaS. The fulfillment of network services often involves numerous complex and manual processes, and service management often requires coordination of many different operations silos and/or software systems. Shortening turn-up cycles requires automation. Streamlining and enhancing operations requires new approaches to exploit new technologies while supporting

[1] Infonetics Research: Carrier Ethernet Equipment 2013 and Ethernet and IP MPLS VPN Services 2013

existing business processes. Thus, service providers today are looking for automation, service agility and end-to-end network control.

This white paper examines the synergies of SDN and Carrier Ethernet in the network and in the operational environment. The paper considers how Carrier Ethernet services are enhanced by SDN. Additionally, the paper discusses how Carrier Ethernet provides connectivity for and enriches software-defined networks and networking applications that depend on connectivity across the WAN.

2 Software-Defined Networking

2.1 SDN Drivers

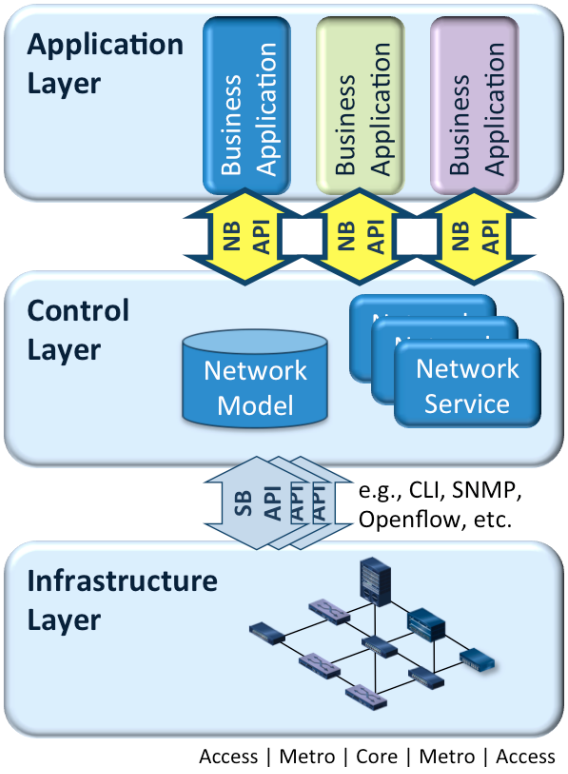
As carriers are challenged to meet the growing demand for bandwidth, while holding operational costs in check, they are looking at SDN as a means for transforming their networks and their businesses. Carriers will use SDN to simplify their networks and streamline operations by centralizing control and providing an end-to-end perspective on services. Leveraging service automation allows carriers to turn-up more services, more quickly, and with fewer errors. This translates directly into a shorter time to revenue. And by utilizing service centric information models and northbound APIs, carriers can introduce new services or alter existing services more easily. These are new services that represent new opportunities for revenue.

2.2 SDN Description

There is no single, industry-wide definition of SDN (some common definitions are listed in section 8). However, in order for the MEF to build service attributes, information models, and APIs to support SDN, it is essential to provide a working understanding to management, describing the commonly agreed principals so that CE services may evolve and support both traditional and SDN approaches. This section provides the MEF perspective on SDN as it is applied to CE services.

SDN is a new way of operating networks that leads to better end-to-end control, automation and service agility. SDN can be characterized by the following attributes.

An SDN enabled network is, by definition, programmable and must provide open, northbound application programming interfaces (APIs or NB APIs) allowing other software to programmatically control and monitor the network. Openness brings the possibility for potentially anyone: service provider, end user/customers, or other independent application developers, to interact with the network via APIs and programmatically control the network. In the case of a Carrier Ethernet SDN, an API would include the ability to create and delete Carrier Ethernet services as well as dynamically change Carrier Ethernet service attributes allowing the network to respond to changing application requirements or unpredictable high traffic periods. Some use case scenarios are shown in part two of this paper.



An SDN uses abstraction to expose important functionality while hiding non-essential details. For example, with Carrier Ethernet services, an abstracted representation of services would include the Carrier Ethernet service and service attributes – EPL/EVPL, VLAN IDs, port attributes, etc. Lower layer technology implementations, such as network topology, transport technologies or specific vendor's equipment, need not be exposed.

SDN separates the control plane from the data plane. The control plane is logically centralized providing a "single logical point" for network knowledge and control. Note: an actual SDN deployment may physically distribute the control plane functionality across one or more locations in order to meet availability requirements. With a Carrier Ethernet SDN, the control plane maintains a wider perspective and end-to-end visibility of services and infrastructure. The control plane would typically manage network resource allocation, enforce network policy and monitor key performance indicators.

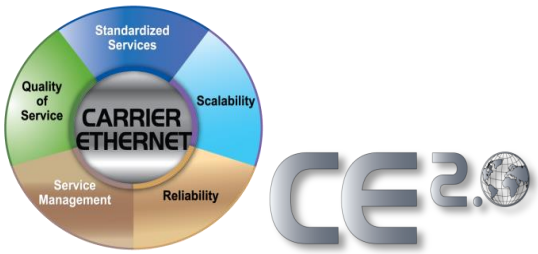
An SDN enabled network should support virtualization. Virtualization allows multiple users to "share" the same physical infrastructure in such a way that each user experience is as if they are using a private resource. Carrier Ethernet already supports virtualization of services with Ethernet Virtual Connection constructs and is compatible with these SDN concepts.

Finally, an SDN enabled network should embrace existing, in-place network infrastructure. Benefits achievable through SDN are needed today. Therefore migration must be carefully introduced.

3 Carrier Ethernet and SDN

3.1 Carrier Ethernet

The MEF is the industry's defining body for Carrier Ethernet. The global market for CE Services is expected to grow from $38B in 2014 to $56bn by 2017,[2] with the majority of the world's business services bandwidth delivered as Carrier Ethernet. Unlike Ethernet used in the LAN, Carrier Ethernet is differentiated by attributes required for WAN connectivity such as supporting multiple subscribers over a common network infrastructure and being able to troubleshoot network issues remotely.



The MEF further characterizes Carrier Ethernet as a Standardized set of services with Scalability Reliability, Service Management and Quality of Service

CE 2.0 added additional service types, interconnection standardized Classes of Services and manageability.

Carrier Ethernet services include connectivity between user-to-network interfaces and/or external-network-to-network interfaces.

Each CE service can have an associated bandwidth profile which specifies the committed and excess information rates (CIR and EIR). The CE service may also support one or more classes of service and measurable Quality of Service performance metrics, such as frame delay (latency), inter-frame delay variation, frame loss, etc., to accommodate various application performance requirements.

Wholesale services interface between network operators at an ENNI (External Network Network Interface) enables global interconnectivity. The MEF has defined these Ethernet services to be independent of the underlying transport network technology.

[2] Infonetics Research: Carrier Ethernet Equipment 2013 and Ethernet and IP MPLS VPN Services 2013

3.2 Carrier Ethernet and SDN

Carrier Ethernet services are standardized services. Customers know that they are getting high performance, highly reliable services with scalability, quality of service, and manageability. While this has helped accelerate the adoption and deployment of Carrier Ethernet, the challenge now is that essentially all carriers are offering the same generic Carrier Ethernet service. So, in many markets, Carrier Ethernet may be a commodity service. In this case, when combined with Carrier Ethernet, SDN can enable innovation and provide differentiated Carrier Ethernet services.

Here are a few examples. SDN provides **programmability** which enables services to be agile and meet the ever-changing, on-demand, dynamic service requirements of today. Specifically, agility can mean flexible services that are easy to turn up and easy to tear down – e.g., Carrier Ethernet services without long-term contracts. **Agility** can mean Carrier Ethernet services with dynamic attributes – e.g., Carrier Ethernet with bandwidth on-demand. Agility can be used to create new service offerings – e.g., other service or application offerings that include carrier-grade Carrier Ethernet connectivity.

SDN provides an **abstracted interface** to the network. The abstracted view is simpler and easier to use. Simplified control means more robust OSS integration and streamlined operations. Both lead to lower operational costs. Lower operating costs give the network operator flexibility to offer lower prices or operate at higher margin.

An SDN controller maintains the global, end-to-end perspective on the network. The SDN controller can collect real-time performance metrics, assure SLA conformance and run data analytics. This data can be used by the carrier, selectively shared with the end-customer, or coupled with analytics and monetized.

SDN supports **virtualization**. Virtualized services can be connected to highly dynamic applications like those running in the cloud today. This enables Carrier Ethernet to be a connectivity option for deployment of cloud and cloud services.

So, combining Carrier Ethernet with SDN leads to a richer networking environment – one that is dynamic, with faster turn-up, easier tear-down, lower operating costs, better analytics and more sophisticated applications with virtualization. A Carrier Ethernet network with SDN is more agile with services that are more innovative and is differentiated from other networks with conventional Carrier Ethernet offerings.

3.3 Cloud, Carrier Ethernet and SDN

The emergence of cloud computing is driving change throughout the network. Enterprises are migrating their applications and infrastructure into the cloud. This transformation forces more traffic into the network and makes performance, reliability and security of the traffic more critical. Carrier Ethernet is a natural fit for applications requiring carrier-grade performance. Carrier Ethernet provides standard, highly reliable, scalable Ethernet services, with quality of service and manageability. It serves a wide variety of mission critical applications including enterprise, government, healthcare, educational and financial applications. Thus, Carrier Ethernet is a natural fit for cloud.

However, cloud applications are often highly dynamic – being turned up on-demand, run for short durations and then torn down. This level of dynamism inside the data center is orchestrated by cloud management systems and hypervisors which are architected to coordinate the large number of virtualized environments. However, the wide-area network traditionally is not able to match the agility and dynamism required by cloud. Carrier Ethernet SDN services addresses this issue. SDN brings network programmability, software control and automation. These are key to enabling the Carrier Ethernet WAN to match the needs of those moving at cloud.

3.4 NFV, Cloud, Carrier Ethernet and SDN

Network Function Virtualization (NFV) aims to transform the way that network operators architect and operate, networks and network services, by evolving standard IT virtualization technology to consolidate

many network equipment types onto industry standard high volume servers, switches and storage (see ETSI NFV White Paper referenced section 8). Essentially, NFV is a new way to design, deploy and manage networking functionality. Every major carrier and many equipment vendors are talking about NFV. NFV's goal is to increase scalability and agility of networking functions while making them operationally easier to use with a lower cost to maintain. So, considering NFV, cloud, Carrier Ethernet and SDN. NFV represents virtualized networking functionality that can be instantiated essentially anywhere in the network. Cloud provides infrastructure, compute and scale to run these highly dynamic, virtualized network functions. SDN provides control. And, Carrier Ethernet provides high-performance network connectivity across the network and between networked functions. NFV, cloud, SDN and Carrier Ethernet all play critical roles in delivering an end-to-end service. The technologies are very much synergistic and will be subject of a future white paper.

3.5 SDN and OSS

Service agility, rapid integration, and reduced operational costs are challenges that traditionally have been the domain of OSSs. Now, with SDN providing a programmable, abstracted view of network and services, SDN addresses some of these issues. SDN leverages standard interfaces, well abstracted representations of the network and automated activation of network service instances. Thus, SDN facilitates service agility and simplifies operations from a networking perspective. Modern OSSs leverage catalog-driven behavior, strong information models, and top-down automation to address these challenges from an operational and business process perspective. These approaches complement each other, and when these information models used by both SDN and OSS are aligned on a common abstraction, such as that provided by Carrier Ethernet, overall operational efficiency is greatly increased.

4 Preview of Part 2 of the SDN Paper: Practical Considerations

Part 2 of this white paper discusses practical considerations of SDN from the perspective of network evolution, operations impacts and illustrative use cases. Part 2 addresses the following questions:

How does Carrier Ethernet fit with SDN?

Both SDN and Carrier Ethernet provide unique architectural perspectives and abstractions of the network. This section discusses the alignment of these perspectives and shows the benefits of leveraging their combination.

How does SDN for Carrier Ethernet fit with OSS?

The OSS is significantly impacted by the evolution of the network to SDN. This section discusses how the OSS remains relevant to SDN operations and shows that the combination of SDN, the Carrier Ethernet information model and a modern OSS can provide a consistent operations environment that can lead to greater operational efficiency.

Where will Carrier Ethernet and SDN be applied?

Part 2 of this paper also provides details on a number of use case scenarios covering

1. Enhancements from implementing SDN in a simple point to point service (the most common implementation seen by service providers)
2. Service Creation
3. Cloud Connectivity. The emerging use case enabled by dynamic/elastic service attributes under development by the MEF
4. Subscriber initiates service changes
5. Optimizing, monitoring and testing the network

Implementation with SDN requires access to the CE functions in network elements.

5 Summary and Conclusions

Carrier Ethernet is the standard bearer for high performance, scalable network services that include quality of service and manageability. SDN provides the opportunity to enhance basic Carrier Ethernet services. SDN provides agility and dynamism to enable service innovation. SDN provides end-to-end control which simplifies operations and lowers the total cost of ownership. And, SDN enables flexibility and speed of delivery which allows Carrier Ethernet to be delivered per the demands of cloud service delivery. Thus, SDN can be applied to Carrier Ethernet services to differentiate and make them more valuable.

As the network undergoes a transformation and moves forward with cloud, SDN and NFV, Carrier Ethernet provides the high performance, highly reliable, carrier-grade connectivity across the wide-area network. Thus, Carrier Ethernet is a key enabler and driver behind the network transformation.

6 About the MEF

The MEF is a global industry alliance comprising more than 225 organizations including telecommunications service providers, cable MSOs, network equipment/software manufacturers, semiconductors vendors and testing organizations. The MEF's mission is to accelerate the worldwide adoption of Carrier-class Ethernet networks and services. The MEF develops Carrier Ethernet technical specifications and implementation guidelines to promote interoperability and deployment of Carrier Ethernet worldwide. The MEF's Certification Program has resulted in more than 800 products and services from more than 160 companies and more than 2500 certified professionals. For more information about the Forum, including a complete listing of all current MEF members, please visit http://www.MetroEthernetForum.org.

7 Glossary and Terms

A glossary of terms used in this document can be found online at from the MEF public website http://www.metroethernetforum.org.

8 Definition References

Source	Link
Wikipedia	http://en.wikipedia.org/wiki/Software-defined_networking
ONF	https://www.opennetworking.org/sdn-resources/sdn-definition
Light Reading	www.lightreading.com/carrier-sdn/nfv-(network-functions-virtualization)/defining-sdn-and-nfv/a/d-id/707339
CE/SDN article	http://www.carrierethernetnews.com/articles/726110/take-5-with-caroline-chappell
ETSI NFV White Paper	http://portal.etsi.org/NFV/NFV_White_Paper2.pdf

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