Independent market research and competitive analysis of next-generation business and technology solutions for service providers and vendors

HEAVY READING WHITE PAPER

The Role of Automation in Network Migrations

A Heavy Reading white paper produced for Sedona Systems

sedona systems

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INTRODUCTION

Automation is not just a buzzword in telecom. Automation is a mandate for network operators, which must adapt to communications in the 21st century or face extinction. As such, automation affects all aspects of network operators' businesses across technologies, business lines and business functions, including the carrier wide-area network (WAN).

This white paper discusses the requirements and benefits of delivering automation in the carrier WAN, with a focus on the IP and optical layers and the value of software-based coordination between the two layers, using software-defined networking (SDN). The paper concludes with three specific use cases for multilayer automation that deliver near-term and long-term operator benefits.

AUTOMATION IN THE WAN

An automated WAN provides a programmable foundation that simplifies service providers' ability to transform and offer new virtualized, on-demand services. Automation in the WAN has both internal network use cases (such as improving network utilization) and external uses (such as bandwidth-on-demand services).

Heavy Reading has been researching WAN automation for the past seven years. Below we summarize the key benefits of WAN automation for a network operator perspective, based on a combination of operator surveys and one-on-one interviews.

- **Dynamic networks for cloud services delivery:** Automation enables on-demand changes and cuts network service setup times from months down to minutes. It also allows provisioning and assurance of services with tight latency and diversity constraints, which are key for cloud connectivity.

- **New/differentiated revenue streams:** Automation enables competitive differentiation via turn-up and provisioning speed. The programmability and software control used to implement automation is also a catalyst for innovation and the development of new services.

- **Reduced opex through automating network tasks:** Automation simplifies network operations, enabling one user, with one click, to fulfill and assure network services. Automating provisioning reduces technician truck rolls and is critical to boosting the profitability of business, consumer and wholesale services.

- **Reduced capex through greater network efficiency:** Automation is used to rapidly configure and reconfigure networks in ways not physically or economically possible with manual processes. As a result, networks can run "hotter," delaying/reducing overall capex.

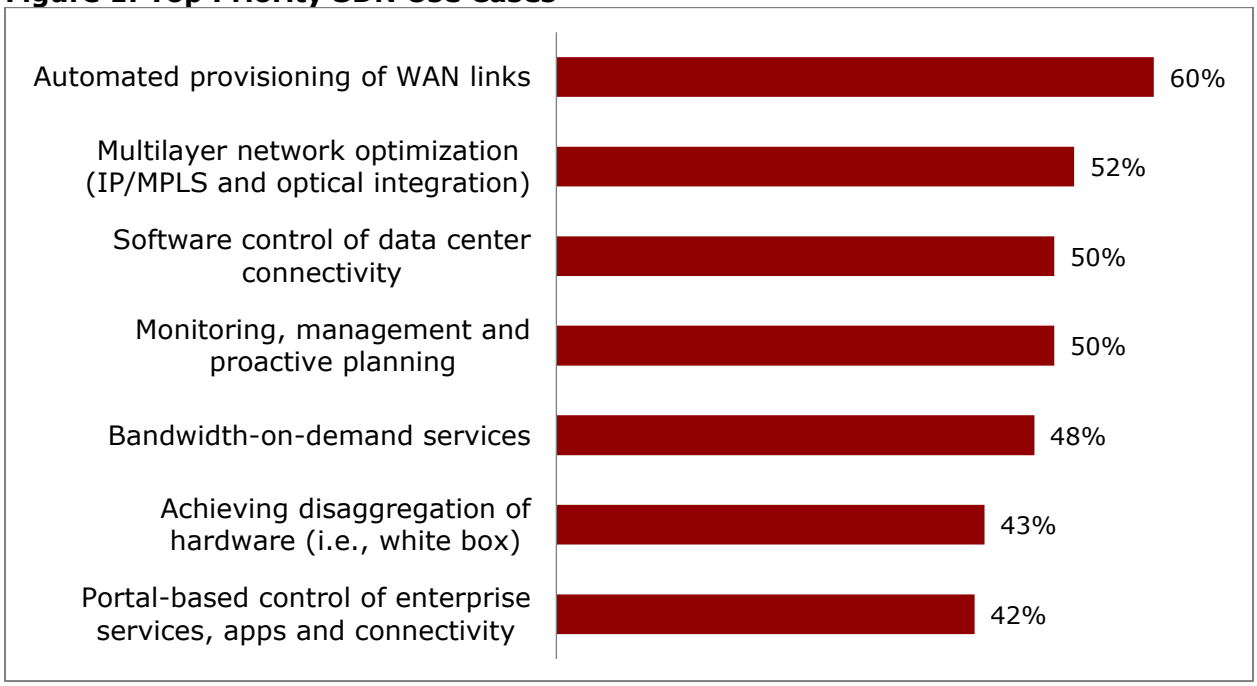
- **Improved reliability:** Automation also regulates and improves the accuracy with which services are turned up. Fewer errors translates into less troubleshooting, fewer process restarts and more streamlined operations. Additionally, automation improves the reliability of the IP layer itself, allowing it to withstand more simultaneous failures.

The Role of SDN in WAN Automation

SDN has emerged as key technology to address network operators' challenges in the cloud era, and as a key enabler for WAN automation. Heavy Reading global operator surveys consistently place the ability to create and deploy services more rapidly, along with network and service agility, as the top priorities for SDN/NFV.

For operators, the connection between SDN and WAN automation is also clear. In a 2017 survey, Heavy Reading asked network operators from around the world to identify their top SDN use case priorities (see **Figure 1**). Automated provisioning of WAN links ranked first on the priority list.

Figure 1: Top Priority SDN Use Cases



Source: Charting the Path to Network Automation and Disaggregation: Carrier SDN Survey Analysis, Feb. 2018; N=137

The early commercial focus has been on using SDN to automate functions across a single network layer, such as Ethernet services or optical wavelength connectivity. However, the greatest benefits will come from applying automation across domains, vendors and network layers – particularly across the IP and optical layers. Note that multilayer network optimization ranked second on the priority list in our operator survey.

In the next section, we discuss SDN-enabled multilayer integration in further detail.

THE PATH TO MULTILAYER INTEGRATION & AUTOMATION

To be clear, the new era of multilayer IP and optical integration is about software interactions and automation between layers, not the physical hardware combinations of the past. Operators can benefit from a phased approach to IP and optical integration that starts with

IP and optical layer coordination in "read-only" mode and evolves to full SDN-based integration over time.

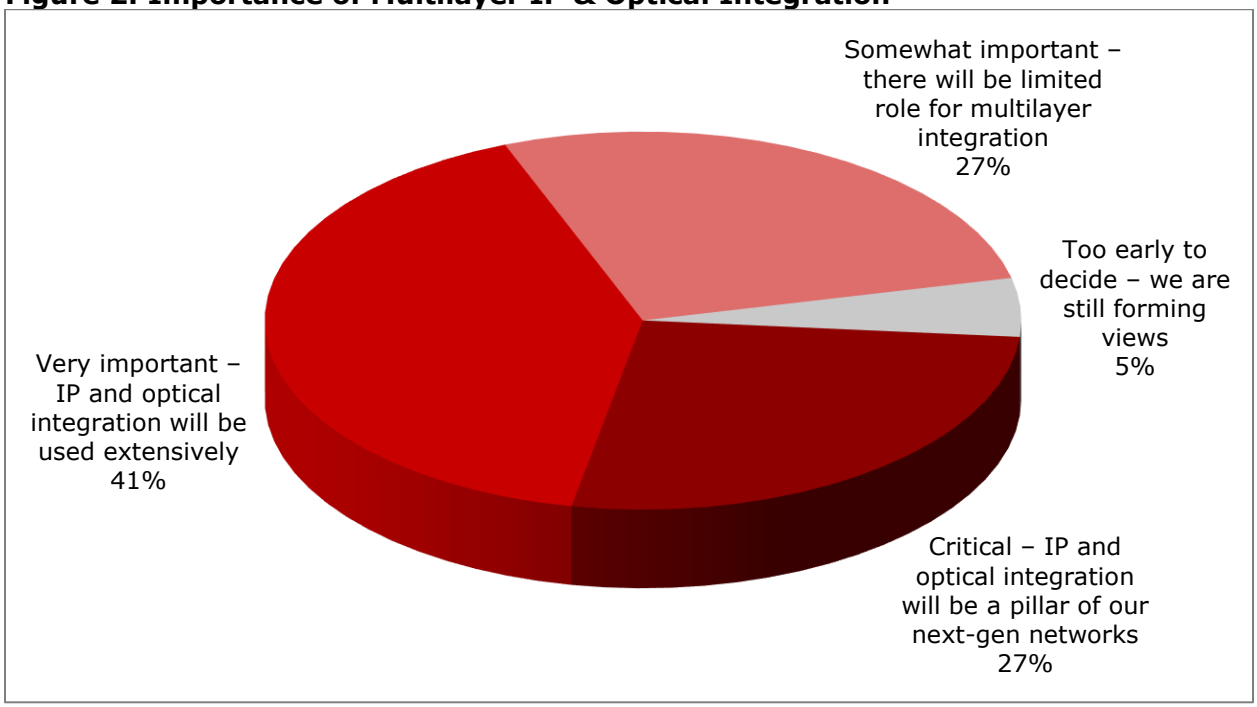
As a starting point, operators use multilayer visibility and analytics software to pull inventory data from the network itself and automatically correlate data between layers for a unified network view. Once a coordinated network view is built, it is used to feed existing management systems, significantly improving inventory accuracy. Here, the role of automation is in pulling real data from the network, in contrast to historical inventory systems that were built entirely with manual inputs. Although not talked about much publicly, it is widely known that operators' legacy inventory systems are highly inaccurate.

Correlated data can also be used to analyze the network and identify anomalies in its structure. Such anomalies are prevalent, since the vision of the network as dictated by its planning team is often not fully implemented by the operations team. This creates unplanned exposure to failures, inaccurate inventory data and suboptimal service characteristics.

Applying SDN control across layers opens new use cases for coordinated multilayer bandwidth-on-demand, multilayer network optimization boosting network utilization, and multilayer network restoration.

We know that software-based IP and optical layer integration is not driven by vendor *push* (like many of the physical integration efforts of the past), but rather is an example of operator *pull*. Operators are asking their suppliers to bring these layers together in an open and standards-based way. In our 2017 operator survey, more than two thirds of those surveyed reported that multilayer integration is at least "very important" to their next-generation networks, with 27 percent of the survey group listing it as "critical" (see **Figure 2**).

Figure 2: Importance of Multilayer IP & Optical Integration



Source: Charting the Path to Network Automation and Disaggregation: Carrier SDN Survey Analysis, Feb. 2018; N=139

Barriers to Adoption

Despite the high operator interest in multilayer integration (as shown in **Figure 2**), barriers to widespread adoption remain. Chief among these barriers is the lack of open standards, for two reasons: 1) open standards are required for large-scale interoperability across vendors, domains and layers; and 2) multilayer integration itself is relatively new, so relevant standards are less mature and less well-defined.

Encouragingly, Tier 1 network operators and their vendor partners recognize the urgency of standardization, and efforts are well underway. The Open Networking Foundation's (ONF) northbound Transport API (T-API) 2.0 specification for multi-vendor communication between SDN controllers and higher-layer orchestration is one example. In June 2018, the Optical Internetworking Forum (OIF) released results of a T-API 2.0 interoperability demonstration involving CenturyLink, China, Telecom, SK Telecom and Telefónica, along with six suppliers.

The MEF's standardization work in lifecycle service orchestration (LSO) is also important to standardize open APIs for interoperability between different management systems within service providers (i.e., north-south interfaces) and between different service providers (i.e., east-west interfaces). The rationale is that on-demand services can never truly be automated end-to-end if manual intervention is required at steps along the way – whether that involves crossing from one carrier to another, or even traversing different domains (and management systems) within a carrier. MEF LSO work will address optical, Ethernet and IP layers.

Beyond standardization, the top barriers cited by operators include prioritization of other projects ahead of multilayer integration and making the business case work. Heavy Reading believes that as standardization progresses, these two additional barriers will ease.

Additionally, defining practical use cases is critical to proving the business case to upper management and making these projects a higher priority internally. While early still, use cases are starting to emerge. In the next section, we describe three multilayer automation use cases that can provide immediate benefits for operators.

MULTILAYER INTEGRATION & AUTOMATION USE CASES

Network Modernization

The global installed base of Sonet/SDH equipment is aging, meeting or exceeding the 10- to 15-year lifespan for which it was intended – a situation that is reaching a crisis level for many operators. Replacing aging equipment and parts is becoming increasingly difficult and will ultimately become impossible, as equipment suppliers are no longer investing in the declining market, and some historical suppliers are no longer in business.

In addition, operators have seen their opex go up due to increased faults and service degradation, complex provisioning, high power consumption and large footprint, and the requirement to maintain separate networks: one for newer packet services and another for their legacy Sonet/SDH services.

Verizon is one Tier 1 operator that has been public about its plans to replace its legacy Sonet network with circuit emulation and an IP/MPLS core. In terms of footprint, Verizon told Heavy Reading that its network modernization will result in CO space savings of up to 90 percent. Many other Tier 1 operators globally are at various stages of addressing these

same issues, though less publicly. Based on its ongoing work with several Tier 1 operators, Sedona estimates that operational power, maintenance and inventory savings can total more than $200 million annually by eliminating a legacy network.

Automated, real-time network discovery plays a critical role in the modernization use case because operators need an accurate understanding of the ports and elements they are taking down and moving to the new networks. As one network operator explained, an operator will know that a TDM service works and meets SLAs but may often have a poor understanding of the exact route of that circuit through a complex TDM network of multiplexers and digital crossconnects. With dated, inaccurate inventory systems, a decommissioned port can quickly result in one or more service outages. Sonet/SDH networks carry high-margin private line services and high-value customer traffic, so these types of outages must be avoided.

Carrier M&A

Mergers and consolidations are an integral part of the telecom industry. Network operators use M&A to quickly increase their top-line revenue, increase their bottom-line profitability (through resulting cuts or "synergies") and quickly enter promising new markets (to boost top-line revenue and profitability). The target operational savings for large network mergers is typically around 15 percent. With competition only increasing and with new markets on the horizon (i.e., 5G), the M&A trend is certain to continue.

Once the financial deal is signed, however, the hard work of merging disparate networks begins. Integration includes merging different networks, vendors, technologies and business/ operations support systems (B/OSS). In most cases the merging entities are themselves merged entities that have not fully completed previous network integrations – which can take many years.

Merging operator inventory systems, historically, is a manual process, and the challenges outlined in the "Network Modernization" use case fully apply. Here, the merger is the catalyst for the network migration that must take place. Automated, real-time network discovery across the IP and optical layers addresses the challenges in the following ways:

- **Accuracy:** Accurate inventory systems reduces outages caused by merging networks as well as during future fail-overs. It also increases confidence on both sides of the merger to move forward.

- **Speed:** The faster migrations can be completed, the quicker cost savings can be achieved and new services can be introduced. Whether public or private, investors will monitor closely the speed with which merger goals are achieved.

- **Costs:** Eliminating redundant networks and processes as quickly as possible is a top priority among C-level executives, as the opex and capex drain reduces top-line and bottom-line revenues and delays financial goals. Additionally, service disruptions caused by inventory inaccuracies and manual errors in migrations can result in lost customers and bad publicity at a vulnerable time when competitors are hyper-vigilant.

Service-Aware Networking

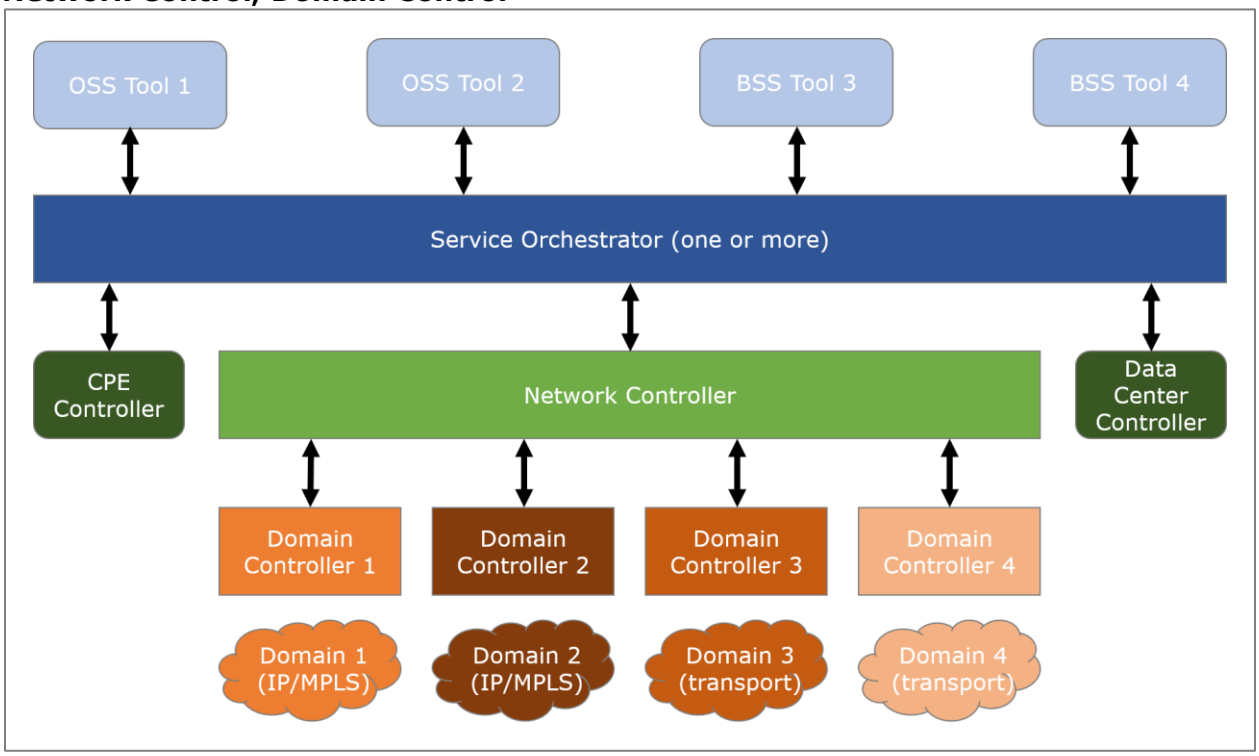
Today's Internet consists of a three-layer structure: an applications layer, a grooming layer and an optical transport layer. Application traffic usually passes through a grooming layer (typically IP/MPLS), which aggregates multiple flows into large pipes that run over the optical

network. In the absence of SDN integration, there has been little coordination among these layers, with resulting network inefficiencies. Tight coordination between applications and underlying networks is one of the "Holy Grails" of networking and a hot topic currently, under the umbrella term of "intent-based networking."

Going beyond global views and automated discovery, service-aware networking requires automated coordination among service orchestrators, network controllers and domain controllers. Service orchestrators operate closest to the applications, delivering application requirements to the multilayer network controller below. Thus, multi-vendor deployment requires interface standardization among service orchestrators, network controllers and individual domain controllers (described in "Barriers to Adoption"), as well as vendor-specific software innovations at all of the layers. Given the complexity, service-aware networking is a longer-term use case compared to the network migration and M&A use cases, which are here today. But this does not diminish the long-term value or operator interest in the end goal.

Figure 3 illustrates the emerging three-layer network control hierarchy, consisting of a service orchestration layer, a network control layer and a domain control layer. Note that the network controller sits between service orchestration above and the individual domain controllers below, abstracting the complex network structure into a uniform and simplified view needed by the service orchestrators and providing coordination between the layers, domains and vendors.

Figure 3: The Three-Layer Network Control Hierarchy – Service Orchestration, Network Control, Domain Control



Source: Sedona, 2018

The Application-Centric IP/Optical Network Orchestration (ACINO) project (part of the European Union's Horizon 2020 program) focused on the service-aware networking use case. In

this multi-year project, a hierarchical controller prototype was built using an open source controller, Open Network Operating System (ONOS), as well as an open source planning tool, Net2Plan.

The capabilities of the hierarchical controller were demonstrated in Telefónica's lab over a testbed of ADVA optical and Juniper routing equipment, using ADVA and Juniper domain controllers. Other use cases were tested in the lab using Sedona's NetFusion production-grade hierarchical controller, which controlled domain controllers from ADVA, Ciena, Coriant, Huawei, Infinera, Juniper and NEC using ONF's T-API northbound interface. Following several years of development work, completion was announced in April 2018.

CONCLUSIONS

WAN automation is fundamental to network operators' success and profitability, and Heavy Reading survey research shows that operators increasingly understand this reality. Among its key benefits, automating the WAN enables on-demand network changes, reduced provisioning times, new and differentiated revenue streams, lower opex by eliminating truck rolls, reduced capex through network efficiency gains, and greater overall network reliability.

Standards for interoperability across domains, vendors, network and control layers must mature. Encouragingly, standards are on the right track, and we highlight, in particular, the OIF and the MEF. As standards mature, so must work in developing and demonstrating use cases. This paper has highlighted three promising early use cases in which WAN automation applies:

- Network modernization
- Carrier M&A
- Service-aware networking

Over time, more use cases – delivering ever greater levels of automation – will arise. But operators can get started today.