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# Unleashing Managed SD-WAN With Closed-Loop Automation

## A Standards Based Approach to Increased Operational Efficiency and Network Agility

A Technical Paper prepared for SCTE•ISBE by

**Tom DiMicelli**

Senior Product Marketing Advisor

Ciena Corporation

7035 Ridge Road Hanover, Maryland 21076

410-694-5700

tdimicel@ciena.com

 

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# 1. Introduction

Managed SD-WAN services underpin many strategic enterprise initiatives and provide cable operators with a high-growth market. As the market matures and cable operators expand their SD-WAN service portfolio, they must broaden their service portfolios and improve their operational processes to ensure they maximize this opportunity.

This paper summarizes SD-WAN trends and growth forecasts and highlights both market and operational challenges associated with managed SD-WAN implementations today; it also describes how progress that has been made in industry standards bodies can help cable operators implement an open, standards-based closed-loop automation framework that overcome these issues.

# 2. SD-WAN Market Trends and Forecasts

Enterprises are embracing SD-WAN as the foundation of their strategic SaaS, cloud, and digital transformation initiatives. The 2019 SD-WAN Market Trends Survey[1] showed that 54 percent of survey respondents had already deployed SD-WAN, and that enterprise adoption could reach 90 percent.

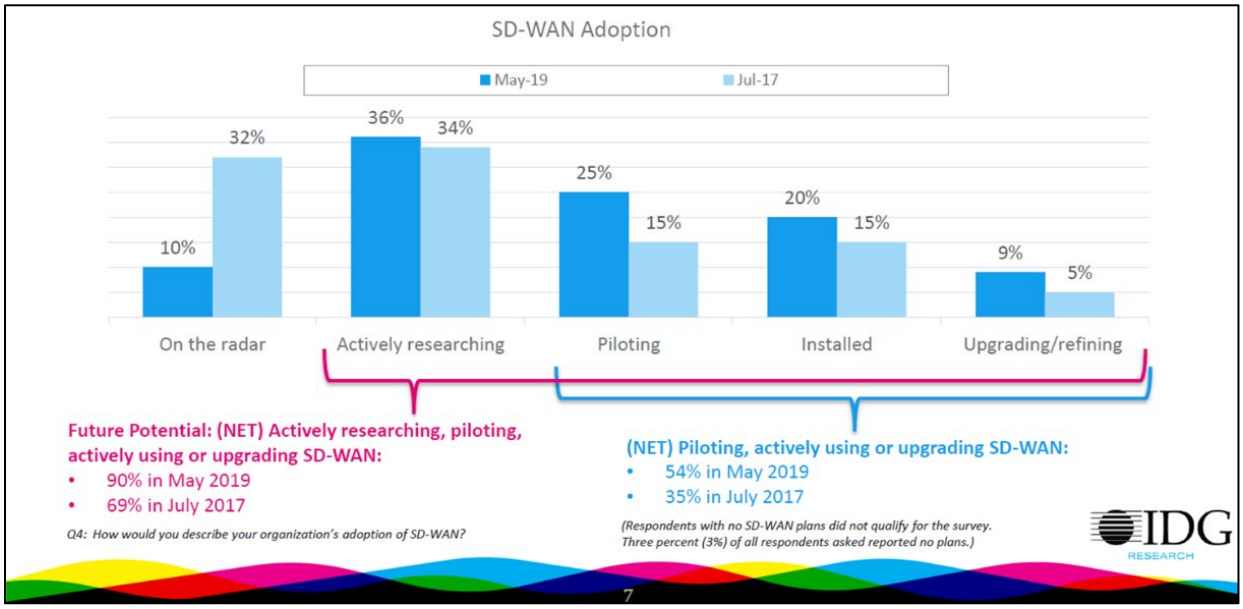


**Figure 1 – Enterprise SD-WAN adoption (source IDG)**

The results of this survey, and forecasts from other analysts, indicate that the SD-WAN market will likely grow at double digit rates for the foreseeable future. In fact, even though Vertical Systems Group lowered their 2020 U.S. managed SD-WAN revenue growth outlook due to pandemic-related disruptions, they also forecast high-growth rates through 2024,[2] as SD-WAN's ability to provide efficient connectivity to cloud-hosted applications are well-suited to post-pandemic business needs.

[1] IDG MarketPulse Research, 2019 SD-WAN Market Trends Survey on behalf of Masergy
[2] Vertical Systems Group STATFlash: 'How will COVID-19 impact SD-WAN?' See https://www.verticalsystems.com/2020/05/28/statflash-sdwan-covid-2020/

Enterprises continue to show a strong preference for managed SD-WAN services, with a combined 75 percent of respondents to IDG's 2020 SD-WAN Market Trends Report indicating that they currently utilize fully managed or co-managed service.[3] In line with these responses, Vertical System Group estimates that the number of billable U.S. installations of carrier managed SD-WAN services saw an 89 percent increase in 2019 - and they also recognized Comcast as a leader in this market.[4]

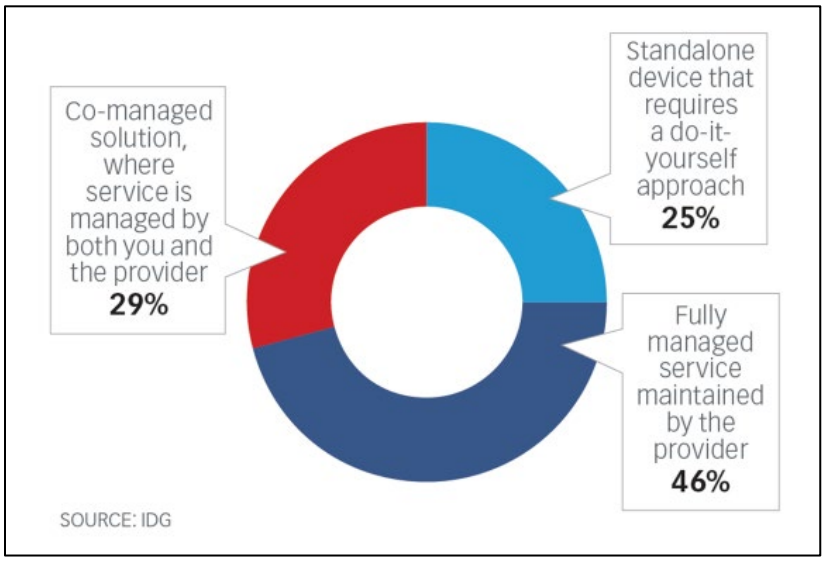


**Figure 2 – SD-WAN management preferences, source IDG**

## 3. Managed SD-WAN Service Evolution

For their initial managed SD-WAN offers, CSPs often deployed a single vendor's solution, which typically consisted of SD-WAN controller software and one or more Virtual Network Functions (VNFs), all bundled as a single package on an appliance or as software for deployment on a server.

As the SD-WAN market matures and segments, it is becoming clear that no one solution can address the full range of customer requirements and preferences.[5] Furthermore, CSPs that rely on a single vendors SD-WAN solution face heightened business risks: what happens if their vendor is acquired, fails to keep pace with market evolution, lacks one or more critical features, or develop support or quality issues?

Unfortunately, broadening their managed SD-WAN service portfolio is operationally challenging. In addition to investing resources to qualify and select vendors, the new solutions must be evaluated, tested and integrated with the B/OSS, new service design process must be established, and new methods of procedure (MOP) must be created for service activation and assurance. Additionally, activating and assuring managed SD-WAN services using traditional operations is both inefficient and expensive.

[3] IDG Market Pulse Research 2020 SD-WAN Market Trends Report: 'New Normal' Puts SD-WAN Digital Transformation in the Fast Lane" available at www.masergy.com/white-paper/2020-sd-wan-market-trends-report
[4] Vertical Systems Group, 2019 U.S. Carrier Managed SD-WAN Services Leaderboard, see www.verticalsystems.com/2020/04/21/2019-us-sd-wan-leaderboard/
[5] WANSPEAK blog: 'Service Providers Need More Than One Option for Managed SD-WAN', see https://blog.silver-peak.com/service-providers-need-more-than-one-option-for-managed-sd-wan

## 4. Managed SD-WAN using Legacy Operations

When a customer order is processed, relevant portions of the order are forwarded to the engineering team so that they can design the service and create a related provisioning work-order. To do this, engineers must gather data from the B/OSS as well as Network and Element Management Systems (NMS / EMS). These manual processes take hours per service endpoint, and it can take weeks or months to complete these tasks for a customer with dozens or even hundreds of branch locations.

Once complete, the work-order is split into task-specific work orders, each with their own MOP, and forwarded to technicians that will use Command Line Interfaces (CLI's) or NMS / EMS to configure the SD-WAN controller, SD-WAN appliances or uCPEs, VNFs, PE routers, and inter-provider interfaces. This manual configuration is tedious and time-consuming - configuring the SD-WAN controller alone can involve hundreds of inputs - and the process must be repeated for each branch sites that is part of the service. Further complicating this process, there are dependencies for workflow execution: equipment must be shipped, technicians scheduled, access to facilities arranged. Once again, this process takes weeks or months to schedule and complete.

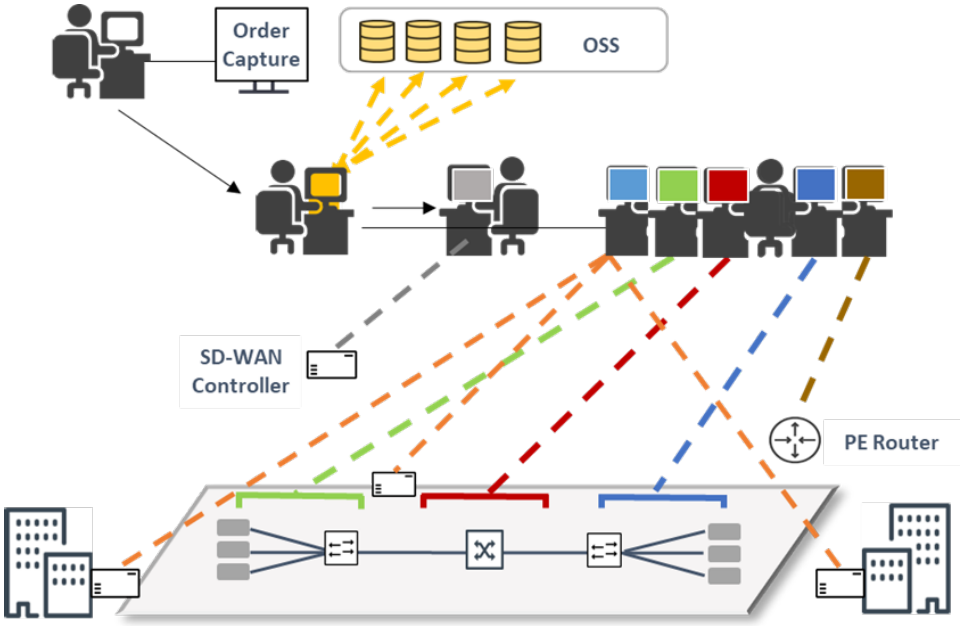


**Figure 3 – Manual SD-WAN service and network configuration**

Once the service is active, technicians must design and provision network and service monitoring and assurance. This is also a complex, manually intensive, and time-consuming activity, involving a wide variety of physical and virtual elements, network technologies, probes, and monitoring systems.

Because SD-WAN is an overlay technology that is disconnected from the underlay network, it is also difficult to use traditional trouble-to-resolve processes when performance issues occur. Fault isolation requires correlating data from a variety of independent service (overlay) and network (underlay) monitoring systems, making troubleshooting efforts slow, resource intensive, and frequently inaccurate. As a result, non-critical issues may become critical - and even service affecting - because they were not addressed correctly or in a timely manner.

# 5. The Business Impact of Legacy Operations

While Managed SD-WAN services are ideally matched to today's enterprise communications needs, designing, delivering, managing and assuring these services using traditional operational processes falls short of today's business environment, which calls for more velocity, agility, and visibility, at lower cost, from both the CSP and customer perspective.

Major limitations include

- Manual service design and work-order creation is slow, expensive, and prone to human error.
- Manual order process management is slow, opaque and error prone, leading to order fallout.
- Manual B/OSS interrogation and rekeying data into work-orders is slow, costly, and error-prone.
- Manual network configuration and service provisioning are slow, expensive, and error-prone—especially for NFV-based services—resulting in multi-week SD-WAN service activation per site.
- Manual intervention in fault isolation and remediation processes – especially alarm and event correlation between the SD-WAN overlay and network underlay – is too slow and difficult.

These limitations and related issues add cost and delay to the SD-WAN service lifecycle, which negatively impacts margins, impedes revenue recognition, and return on investment (ROI), and diminishes customer satisfaction. Worse yet, these issues are duplicated when a CSP adds new SD-WAN solutions to their portfolio, further increasing costs, complexity, and the burden on technical personnel.

# 6. SD-WAN-related Standardization Efforts

The MEF and the TM Forum and other organizations have developed standards to help CSPs build, deliver and manage services quickly and cost-effectively, using open interfaces and repeatable process. In large part, these efforts are complimentary and converge on similar architectures, protocols, and interfaces.[6]

## 6.1. MEF

The MEF[7] is an industry association of 200+ member companies that collaborate to enable the automated delivery of standardized services within and across multiple CSPs. SD-WAN service standardization has been conducted as part of the MEF 3.0 Global Services Framework.[8]

Important SD-WAN related MEF standardization activities include:

- MEF 70[9] - SD-WAN Service Attributes and Services – is the industry's first SD-WAN standard. It defines Managed SD-WAN Services as a specific use case for a MEF Third Network service and describes the requirements for an application-aware, overlay WAN connectivity service that uses policies to determine how application flows are directed over multiple underlay networks.

[6] Note that current standards and standards efforts at these two organizations are not designed to permit interoperability between SD-WAN solutions from different vendors.
[7] To learn more about the MEF, see www.mef.net/about-mef
[8] MEF 3.0, see www.mef.net/mef30/overview
[9] MEF 70 at www.mef.net/resources/technical-specifications/download?id=122&fileid=file1

 

- MEF W90[10] - draft SD-WAN Certification Test Requirements – is part of the broader MEF 3.0 certification program. It tests the service attributes and their behaviors as defined in MEF 70.
- MEF 55[11] defines a Lifecycle Service Orchestration (LSO) framework for standard, automated service lifecycle orchestration that applies to all MEF 3.0 services, including SD-WAN.

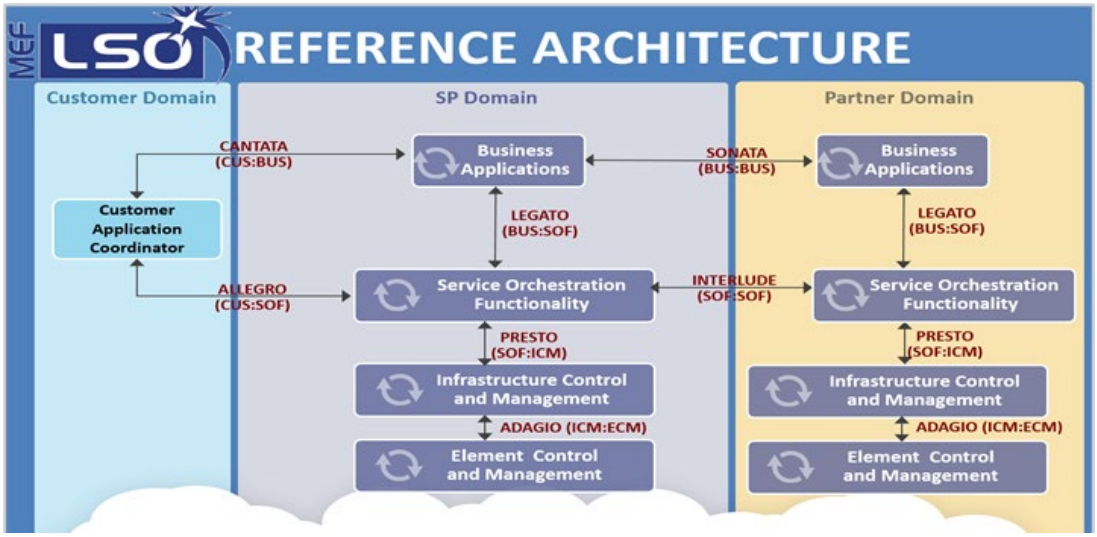


**Figure 4 – MEF LSO Reference Architecture diagram**

MEF LSO proposes to automate the service lifecycle across all network domains responsible for delivering MEF 3.0 Network Connectivity Services, which includes SD-WAN. As figure 4 indicates, MEF LSO also defines Management Interface Reference Points between LSO functional management entities (e.g., Cantata, Allegro, Legato, etc.); application programmable interfaces (APIs) at these reference points to facilitate service orchestrations and automation.

## 6.2. TM Forum

The TM Forum[12] is an association of over 850-member companies' customers across 180 countries that drives collaborative problem-solving to help CSPs transform their business operations, IT systems and ecosystems. Their Open Digital Architecture (ODA)[13] provides a layered architectural approach that separates areas of concerns and uses standard REST-based Open APIs to expose services within a layer to adjacent layers. This approach is markedly different from the tight vertical integration between the network and the B/OSS that is implemented in traditional CSP operations environments.

[10] MEF W90 - SD-WAN Certification Test Requirements at www.mef.net/mef-3-0-service-technology-certification.
[11] MEF 55 at www.mef.net/Assets/Technical_Specifications/PDF/MEF_55.pdf
[12] To learn more about the TM Forum, see www.tmforum.org/about-tm-forum/
[13] See www.tmforum.org/oda/

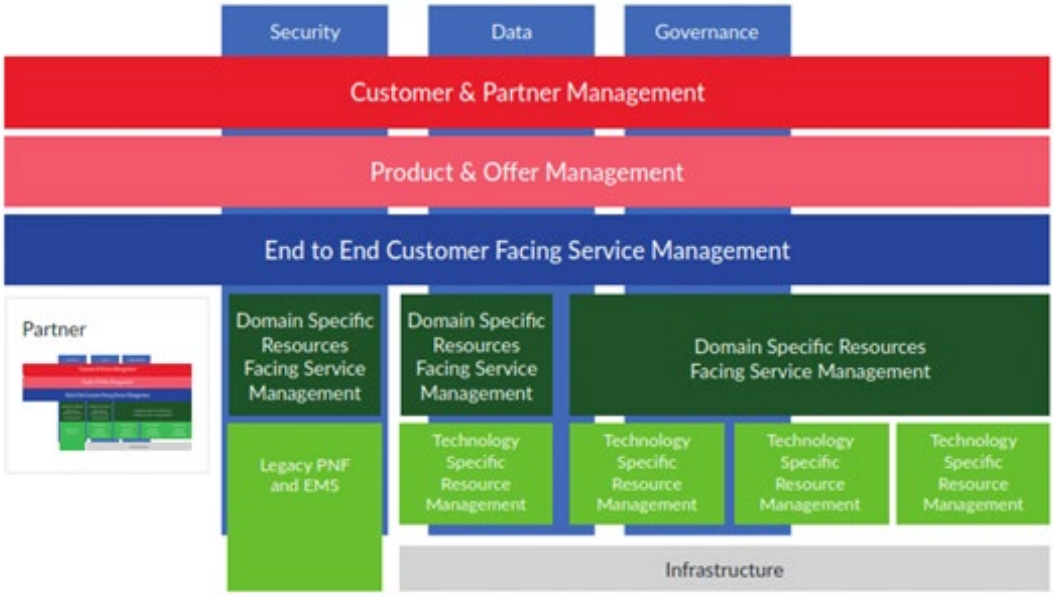


**Figure 5 – TM Forum Open Digital Architecture framework**

TM Forum's suite of 50+ REST-based Open APIs are reusable and enable standardized communications with B/OSS and management systems, making service creation and ongoing operations simpler and more efficient; additionally, they can be used to expose capabilities to partners. The use of standardized APIs also reduces the costs and risks associated with traditional B/OSS integration using proprietary interfaces.

As of July 2019, 18 leading CSPs and 48 leading technology vendors have signed the Open API Manifesto,[14] committing to include TM Forum Open APIs in their RFPs, and in products, respectively.

# 7. Automating SD-WAN operations

Today, CSPs can leverage standards from the MEF and TM Forum, together with advances in SDN and NFV technology to onboard new SD-WAN solutions and streamline the design, activation, and assurance of managed SD-WAN services in a closed-loop.

## Key Components of Closed-Loop SD-WAN Service Lifecycle Automation

The following systems work together to provide SD-WAN service lifecycle automation in a closed-loop.

- **Service order management system:** communicates with the Order Management System (OMS) and customer portals; maintains the service catalog; decomposes work orders; communicates with the orchestration system for order execution; coordinates the order workflow; and provides visibility into workflow status and issues, among other tasks and responsibilities,
- **Orchestration system:** communicates with a service order management system or OMS to receive service activation orders; orchestrates service design; communicates with SD-WAN controllers, domain layer controllers and NMS / EMS to configure provider edge (PE) routers, uCPE and other

[14] See www.tmforum.org/open-apis/open-api-manifesto/

 

elements; instantiate and chain VNFs as well as manage the VNF lifecycle; and communicate with assurance and analytics systems in a closed-loop, so that it can dynamically modify network paths to optimize resources or respond to issues when they arise.

- **Assurance and analytics system:** aggregates and analyzes network telemetry; monitors network and service health; dynamically correlates alarms and events from the SD-WAN overlay and network underlay to identify root-cause issues; and communicates with the orchestration system to enable resource optimization and to identify issues when they arise.

In addition to the basic functions listed above, these components must support open APIs, and provide a DevOps style ability to add new open APIs quickly and easily. Ideally, these components should also provide comprehensive visualization tools – graphically displaying workflow status, service path mapping across heterogeneous vendors, elements, and domains, offering a single unified view for monitoring all the resources.

Of course, beyond functionality, CSPs must ensure their vendors have the proven ability to support their systems and solutions at scale—large enterprises can have branches around the globe, and high expectations of pre- and post-deployment support.

Many different vendors provide one or more components that enable closed loop SD-WAN service lifecycle automation, and TM Forum Open APIs enable communications between these systems. This approach permits vendor innovation, and avoids vendor lock-in, and lets CSPs and their systems integration partners build 'best of breed' solutions that are closely aligned with their business goals.

CSPs should also be able to learn more about vendor capabilities by researching public proof of concept demonstrations, such as TM Forum Catalysts.[15] Another worthwhile and simple area to investigate is standards-compliance certification programs, such as those maintained by the MEF[16] and TM Forum[17].

## 8. Standards-based Managed SD-WAN Automation

Figure 6 depicts how a CSP can implement a MEF LSO architecture and use standardized APIs as the foundation for automated SD-WAN operations. MEF LSO management reference points are defined North – South between layers (e.g., between the business layer and service orchestration layer; and between the service orchestration layer and the infrastructure control and management layer, which includes the SD-WAN controller and domain controllers).

A variety of APIs can be used between different layers, including TMF APIs (TMF 641 Service Ordering API is depicted between business and service orchestration layers; the Open Networking Foundations (ONF) Transport API (TAPI) and several others are depicted between the service orchestration layer and the infrastructure control and management layer); TMF APIs are also depicted between systems within the service orchestration layer (TMF 641 and TMF 623 SLA Management API are depicted).

[15] TM Forum Catalyst program at www.tmforum.org/collaboration/catalyst-program/home/
[16] MEF Certification program at https://www.mef.net/certification/mef-certification-programs
[17] TM Forum conformance overview at https://www.tmforum.org/conformance-certification/open-api-conformance/ and vendor leaderboard at https://www.tmforum.org/conformance-certification/open-api-conformance/#table

In this simplified example, the service order management system receives an order from the OMS and communicates with the orchestration system for service design. It then decomposes the work order and coordinates the order workflow execution. The orchestration system sends configuration and provisioning instructions to the SD-WAN controllers and domain layer controllers in the infrastructure control and management layer for execution.

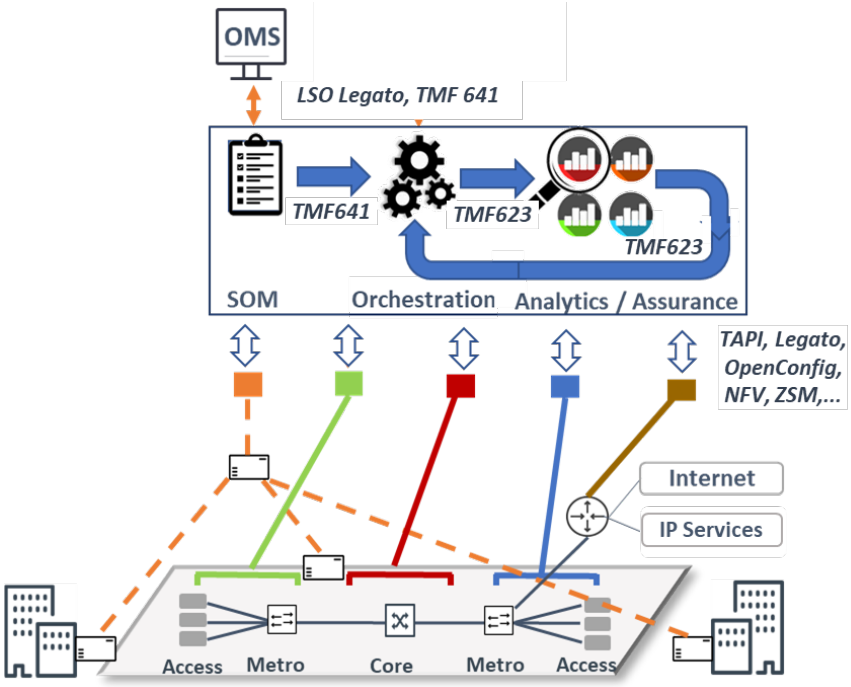


**Figure 6 – SD-WAN Automation framework**

Once the service is active, assurance is dynamically instantiated end-to-end across the service path. Remediation for service affecting conditions is typically triggered dynamically, while analytics automates the evaluation of all alarms and events to identify root cause conditions. Issue resolution can be fully automated, or a mix of human / automated operations can be used, based on policy.

## 9. The Business Impact of Standardized, Automated Operations

When CSPs implement standardized, automated operations to design, deliver and assure their managed SD-WAN services, there are significant advantages for both the CSP and their customers.

From the CSP perspective, the major advantages include:

- Standard-based APIs eliminate expensive proprietary B/OSS integration activities, catalog and APIs are re-used across use-cases, avoiding wasteful one-off development efforts.
- Automated order process management that eliminates hundreds of tedious, manual, and error-prone tasks and avoids expensive design errors that can negatively impact customer commits.
- Automated orchestration accelerates network configuration and service provisioning, especially for NFV-based and hybrid services—enabling rapid service activation per site.
- Alarm and event correlation between the SD-WAN overlay and network underlay streamlines troubleshooting and fault isolation activities and helps protect service level agreements (SLAs).

 

These advantages reduce cost and delay throughout the entire SD-WAN service lifecycle, helping CSPs improve margins, accelerate time to revenue and ROI, and increase customer satisfaction. Additionally, APIs, templates and MOPs can be reused with any new SD-WAN vendor solution, which accelerates new vendor and solution introductions.

## 10. Managed SD-WAN Automation in Action

Let us look at a few CSPs and recent catalyst demonstrations that have extensively incorporated TM Forum and MEF standards, and automation, into their managed SD-WAN services offerings

### TMF Catalyst Demonstration: *Automating Network as a Service*

SD-WAN was featured in the *Automating Network as a Service using Operational Domain Management (ODM), TM Forum Open APIs and MEF LSO Catalyst,*[18] which was championed by Telstra, Vodafone, Orange Business Services, AT&T and PCCW. The demo included DGIT Systems order management solution and the Blue Planet orchestration platform - both supported by Infosys – and leveraged MEF LSO with TM Forum Open APIs to dynamically activate SD-WAN and other MEF 3.0 services.

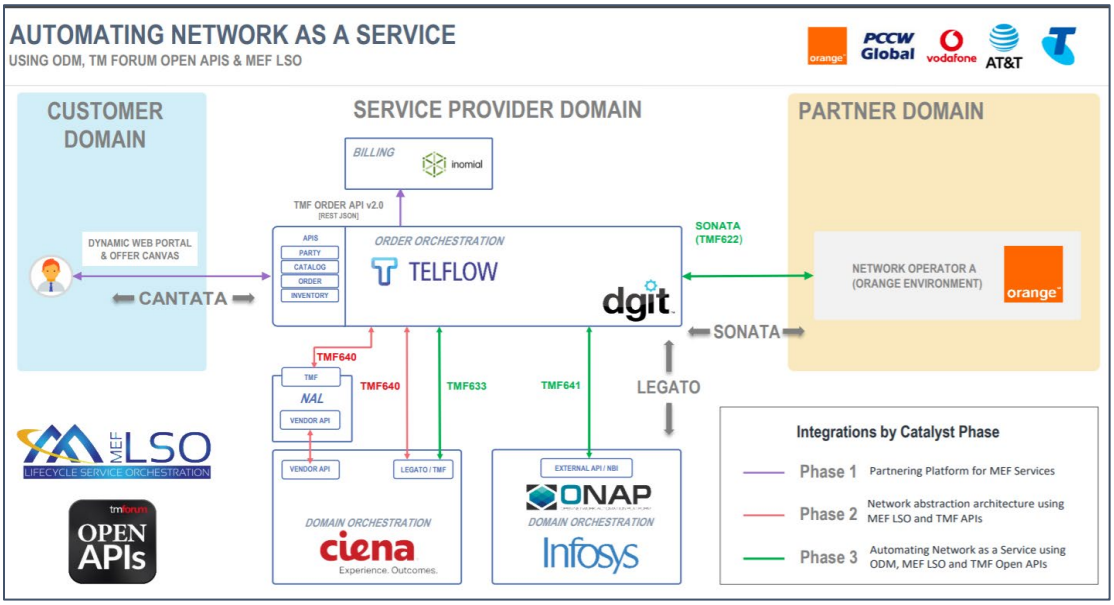


**Figure 7 – Automating Network as a Service Catalyst reference diagram**

[18] See https://www.tmforum.org/wp-content/uploads/2017/02/T.-Automating-Network-as-a-Service.pdf

 

## Comcast Business

Comcast Business - a subsidiary of Comcast Corporation, the second-largest broadcasting and cable television company in the world by revenue - was among the first cable operators to launch an SD-WAN service, among the few to achieve MEF 3.0 SD-WAN service certification, and the only MEF 3.0 SD-WAN Services certified CSP on the 2019 U.S. Carrier Managed SD-WAN Services Leaderboard. [19]

Their managed SD-WAN service is built on the ActiveCore SDN platform and leverages the internet or Comcast's nation-wide IP network as the network underlay, offering up to gigabit connectivity speeds.

Comcast Business is a 2020 LightReading Leading Lights Finalist in the Most Innovative SD-WAN Service category, and recently announced they would integrate Fortinet's virtual firewall appliances with ActiveCore to improve SD-WAN security by addressing threats such as malware.

## Windstream Enterprise

Windstream Enterprise is a leading provider of advanced network communications and technology solutions to enterprise customers across the U.S. and ranks fourth on Vertical Systems Group's 2019 U.S. Carrier Managed SD-WAN Services leaderboard.

As highlighted in a TM Forum case study,[20] Windstream's initial SD-WAN deployment relied on a manual service activation process, which had technicians collecting data from 10 independent systems, and then rekeying that data into the SD-WAN controller and PE router to configure those devices.

[19] See www.verticalsystems.com/2020/04/21/2019-us-sd-wan-leaderboard/
[20] See https://inform.tmforum.org/casestudy/windstream-use-intelligent-automation-to-cut-provisioning-time-by-80/

 

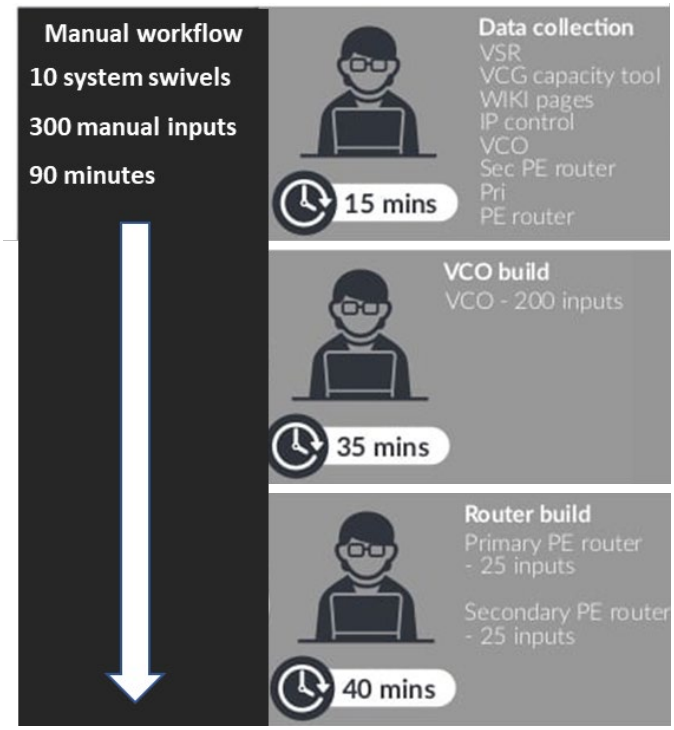


**Figure 8 – Windstream Enterprise legacy operational workflow for SD-WAN Services**

Recognizing that their outdated operational processes were constraining their market success, Windstream implemented TM Forum ODA and related APIs and an orchestration platform that automated service activation. Ultimately, Windstream reduced systems accessed by 90%, manual inputs by 99.7%, and the total number of technician minutes required for service fulfillment by 98.9%.


**Figure 9 - Windstream Enterprise's automated SD-WAN service activation workflow**

## 11. Conclusion

The SD-WAN market has moved into the mainstream, with even large conservative enterprises adopting managed SD-WAN services. Analysts are forecasting high double-digit growth rates through at least 2024, and while the current global pandemic may disrupt growth in the near-term, it is likely to accelerate adoption in the long term.

 

To stay ahead of the competition, CSPs must move beyond basic SD-WAN services and single-vendor solutions. Fusion Connect, Windstream and GTT Communications[21] are just three public examples of CSPs with multi-vendor managed SD-WAN portfolios, there are many others – including some with more than two vendors.

Of course, a broad portfolio alone is not enough. CSPs must also differentiate by providing a better customer experience through rapid delivery, deeper customer insight, and superior availability. And they must provide this experience efficiently if they are to fully profit from their efforts and investments.

Achieving a broad and compelling managed SD-WAN service portfolio and a superior, streamlined operations environment requires CSPs to implement open standards and automation – especially closed-loop service lifecycle automation. This modern approach allows CSPs to add new vendors and services without penalty, and removes slow, expensive, and error-prone manual intervention from SD-WAN service design, activation, and assurance processes.

Based on the progress that has been made at the MEF and TM Forum - with significant contributions from cable operators - CSPs can now deploy advanced orchestration, assurance and analytics systems in an open, modular and standards-based automation framework that addresses the entire SD-WAN service lifecycle.

CSPs that implement such solutions will be able to reduce operational expenses, maximize resource utilization and increase staff efficiency even as they add multiple SD-WAN vendors to their portfolio. Furthermore, they will be able to accelerate time to revenue and improve customer satisfaction, enabling them to lead and thrive in competitive markets, and adapt to ever-evolving market requirements.

[21] Fusion Connect recently announced the expansion of their managed SD-WAN service portfolio beyond VMware VeloCloud; they will soon offer the Fortinet Secure SD-WAN solution, which features a built-in next-gen firewall, web filtering and an intrusion prevention system. See https://www.channelpartnersonline.com/2020/08/26/fusion-connect-picks-fortinet-as-second-sd-wan-partner/

 

# Abbreviations

| | |
|---|---|
| APIs | application programmable interfaces |
| B/OSS | business / operations support system |
| CLI | command line interface |
| CPE | customer premise equipment |
| CSP | communications service provider |
| IP | Internet protocol |
| ISBE | International Society of Broadband Experts |
| LSO | lifecycle service orchestration |
| MOP | method of procedure |
| MSO | multi services operator |
| NCTA | The Internet & Television Association |
| ODA | Open Digital Architecture |
| OMS | Order management system |
| ONF | Open Networking Foundations |
| OPEX | operational expense |
| PE | provider edge |
| REST | representational state transfer |
| ROI | return on investment |
| SaaS | software-as-a-service |
| SCTE | Society of Cable Telecommunications Engineers |
| SDN | software defined network |
| SD-WAN | Software-Defined Wide Area Network |
| SLA | service level agreement |
| SOM | service order management |
| TAPI | transport API |
| uCPE | universal customer premise equipment |
| VNF | virtual network function |

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- MEF YouTube Channel at www.youtube.com/user/MEFCarrierEthernet
- MEF 3.0 SD-WAN services page at www.mef.net/mef30/overview

TM Forum

- TMF website at www.tmforum.org/about-tm-forum/
- Open Digital Architecture at www.tmforum.org/oda/
- Open API Suite at www.tmforum.org/open-apis/
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