



New Approaches Address End-to-End Network and Service Orchestration (E2ENSO) Challenges (Updated)

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Report Snapshot

Next generation networks and 5G are all about services delivered with high reliability, scalability and guaranteed performance End to End (E2E) across any Network.

A major challenge is that the Communications Service Provider (CSP) Network has become very complex with multiple domains:

- . 4G NSA and 5G SA from RAN to Core
- . CSP Edge and Hyperscaler Cloud
- . Fixed and Mobile Access
- . Hybrid Public Private Networks.

E2E Network and Service Orchestration (E2ENSO) therefore plays a critical role to ensure that revenue generating services operate seamlessly across these diverse domains. This white paper describes how advanced E2ENSO approaches make this possible today and describes revenue generating CSP opportunities for:

- . Managed Secure SD-WAN
- . Multi-Domain, Multi-Cloud Network Slicing.

Contents

Executive Summary	3
Network and Service Orchestration are becoming Complex with Multiple Domains and Clouds.....	3
E2ENSO Addresses the Challenge	3
Two Use Cases Demonstrate E2ENSO value	3
CSPs Benefit Immediately from E2ENSO	3
1. Challenges for Network and Service Orchestration	4
Service, Network and Resource Functionality.....	4
Virtualization, Edge Services and 5G add Orders of Magnitude more Complexity	5
‘Era of Immense Complexity in the Network’ is beginning	5
Creation of new Network and Service Management Architecture designed for Automation	5
Network Operations ‘Loss of Visibility’	6
2. Use Cases Demonstrate Value of E2E Network and Service Orchestration (E2ENSO)	8
<i>Use Case I. Managed Secure Enterprise SD-WAN</i>	8
Use Case I – SES Satellite Example	10
<i>Use Case II. Multi-Domain, Multi-Cloud Network Slicing</i>	11
Use Case II – MS Azure Example	12
‘Sweet spot’ for CSP Orchestrated Network Slicing is emerging.....	13
3. Amdocs E2ENSO Addresses the Challenges	14
Untangling next-generation network services complexities.....	15
Slicing the Edge’ - Optimizing Resources with ‘Function Placement’ at the Edge	15
4. Implications.....	16
<i>References</i>	16
<i>Additional References</i>	16
Analyst Contact.....	16

Executive Summary

Network and Service Orchestration are becoming Complex with Multiple Domains and Clouds

Next generation networks and 5G are all about services. To deliver these services End to End (E2E) Network and Service Orchestration (NSO) or E2ENSO is evolving. As the services and their underlying networks become increasingly complex to operate and manage E2ENSO plays a critical strategic role in the delivery and scaling of resources - with Life Cycle Management (LCM), service onboarding, instantiation, execution, management and E2E assurance.

Over the next two years edge services and increasingly disaggregated 5G network and service functions (VNFs, CNFs, NFs and SFs) will further complicate service delivery as their distributed processes explode across multiple telecoms and cloud domains - from the RAN to the edge or from the edge server to the hyperscaler data center. Almost every service will soon need to operate across multiple domains and technologies, traversing from fixed or mobile access to the edge and the core, across the telco cloud or between multiple CSP, private and hyperscaler clouds.

So how can Communications Service Providers (CSPs) handle such a massive increase in complexity without loss of performance or increase in E2E latency across this diverse Multi-Domain, Multi-Cloud environment?

E2ENSO Addresses the Challenge

E2ENSO is no longer simply 'management overhead' but is now a critical real time necessity for revenue generating services. By implementing a truly holistic E2ENSO operators can finally capture a higher return on their investment in new network infrastructure and cloud native software platforms. E2ENSO helps to translate their investment in software functionality and real time network resource control into service value through greater business agility, multi-vendor choice, faster time to market for service features, lower operating costs and improved E2E customer satisfaction.

This report describes how E2ENSO takes control of the flow of service revenues by abstracting the complexity of underlying diverse domain variations, guaranteeing high performance and SLA compliant delivery over fixed and wireless networks that are managed seamlessly from a 'single pane of glass'.

Two Use Cases Demonstrate E2ENSO value

In the report we describe two use cases that demonstrate how E2ENSO will help grow CSP revenues over the next decade. Specifically, they are:

- *Use case I. Managed Secure SD-WAN services*
- *Use case II. Multi-Domain, Multi-Cloud Network Slicing*

In the first Use Case we show how E2ENSO can dramatically simplify the operational complexities of today's managed Enterprise SD-WAN service.

In Use Case II we describe how E2ENSO makes it feasible to create and manage E2E Network Slices that operate seamlessly across multi-access, multi-vendor, multi-service provider domains under current 3GPP standards. The solution indicates how CSPs can offer Network Slicing as a Service (NSaaS) hosted in a hyperscaler cloud, operating across hybrid private and public cloud domains.

CSPs Benefit Immediately from E2ENSO

E2ENSO allows CSPs to immediately deliver new scalable, high reliability services to enterprises, small business users and consumers that meet all the performance, privacy and security requirements of both 5G wireless and legacy fixed broadband networks seamlessly, transparently and at lower cost.

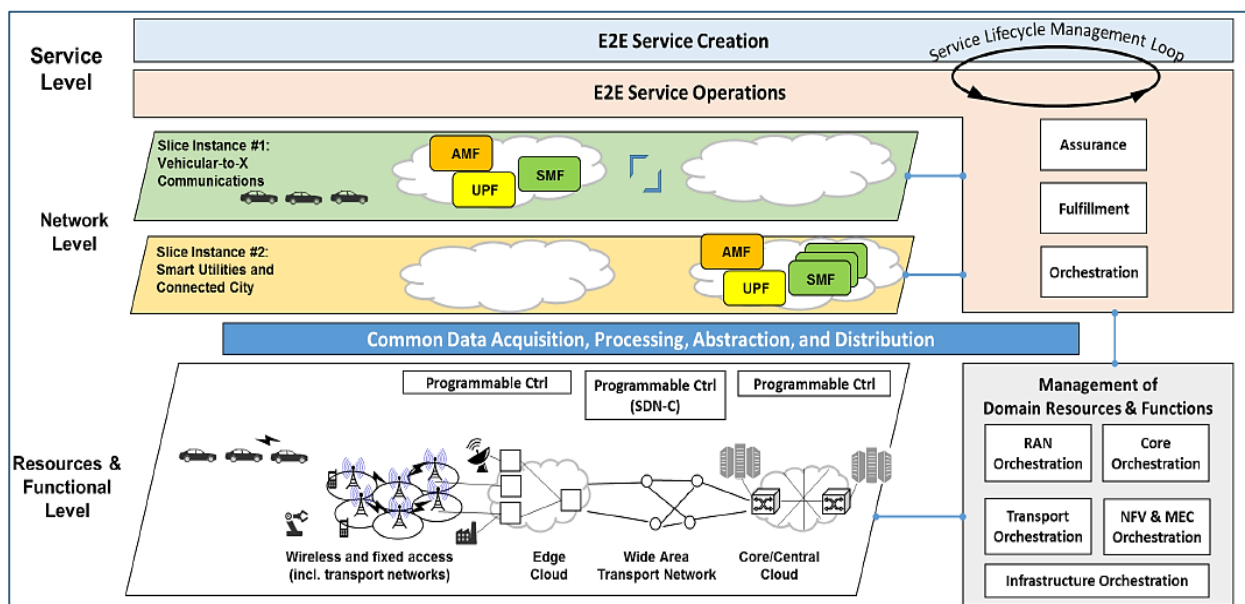
1. Challenges for Network and Service Orchestration

Next generation networks and 5G are all about services – especially new services that instantaneously meet the needs of business production and supply chains and consumer interactive services. To deliver these services Network and Service Orchestration (NSO) takes on a strategic role to ensure their enablement and End to End (E2E) assurance. However, as wireless communications networks transition from 4G to 5G they are becoming increasingly complex to operate and manage. NSO must now play a critical role with Life Cycle Management (LCM) of E2E services - from creation and instantiation, to execution and scaling of the many processes that deliver millions of simultaneous service flows.

Service, Network and Resource Functionality.

The chart below shows a typical architecture where **Service Level** functionality operates E2E – *over the top* – above the underlying complexity of network functionality, operations and resources. At the top right of the chart, *E2E Service Operations enable and operationalize Service Creation through Assurance, Fulfilment and Orchestration* as part of closed loop LCM. **Network Level** functions are shown in the middle, as configured for two examples of Network Slice Instances (NSIs) – *Vehicular to anything (V2x) and Smart Utilities and Connected City*. E2E service operations take care of the applications and end users while network level management takes care of reliable connectivity for those NSIs running on the underlying pool(s) of network resources. **Resources** where Functions are physically instantiated – are shown at the bottom for a variety of **Network Domains** including wireless and fixed access, edge cloud, WAN transport and Core/Central Cloud resources. On the right - the management plane *orchestrates all those resources across diverse ‘domains’ and feeds appropriate data and control plane information to unified Service LCM*.

Chart A. Overall Architecture showing Service, Network and Resource Levels



Source: 5G-PPP 5G PPP Architecture Working Group, View on 5G Architecture, Version 3.0¹ February 2020

Virtualization, Edge Services and 5G add Orders of Magnitude more Complexity

Over the last decade Network Function Virtualization (NFV) has made networking and service management much harder as Virtual Network Functions (VNFs) and physical network resources (PNFs) came to be instantiated, monitored and upgraded dynamically in ‘real time’.

More recently, business opportunities for localized service processing and storage at the ‘Edge’ based on Multi-Access Edge Computing (MEC) standards are triggering distributed servers and databases at large metro area and micro data centers – soon in conjunction with base station processing. Now 5G services are being disaggregated as cloud native functional modules or *microservices* – each of which needed to scale independently.

Both Edge and 5G network and service functions (VNFs, CNFs, NFs and SFs) will soon be distributed across multiple network and cloud domains, from the RAN to the edge across to the telco cloud or even the hyperscaler cloud. 5G and Edge Services are expected to *increase the number of manageable network entities by one or two orders of magnitude*.

As a result Network Operations Center (NOC) management processes have become not only critical but extremely complicated.

‘Era of Immense Complexity in the Network’ is beginning

Almost every service today must operate E2E across a network that spans multiple domains and technologies, traversing from fixed or mobile access to the edge and the core, or accessing the telco cloud and multiple hyperscaler clouds. Mark Newman Chief Analyst TMForum noted in a May 2021 Webinar “We are moving from an era of quite a small number of vendors (and types of networks)...to an era of quite complex dynamics ...and... immense complexity in the Network”².

Creation of new Network and Service Management Architecture designed for Automation

These dynamically virtualized, distributed Edge, 5G, multi-domain networks demand a *new service management architecture designed for automation* – referred to optimistically as ‘zero touch’. The ETSI ZSM (Zero-touch Service Management) group was formed to accelerate the required E2E architecture and solutions framework for zero-touch network and service management.³

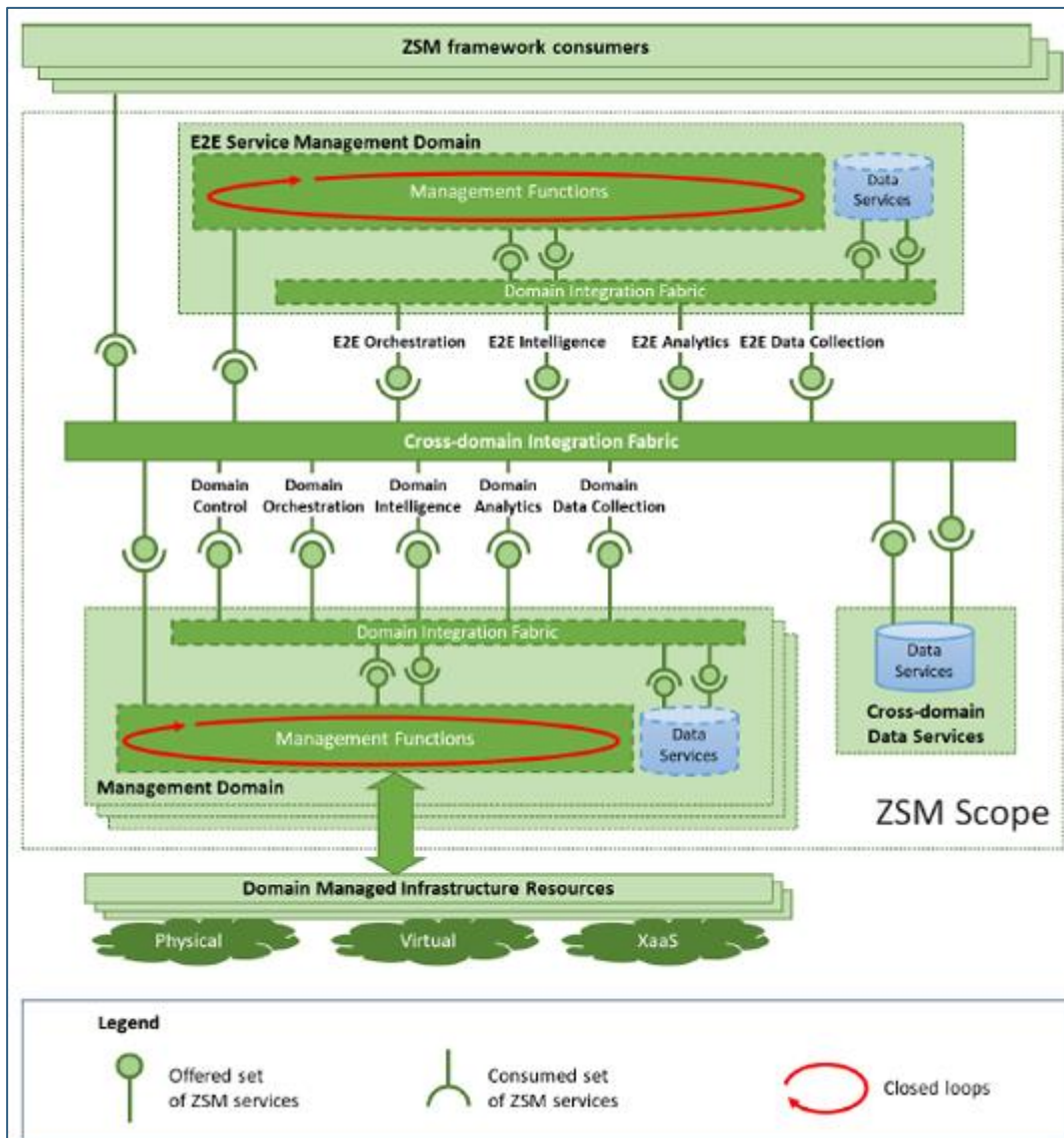
ETSI ZSM has now successfully proposed an architecture that supports one of most important revenue generating services – Multi-Domain Network Slicing.

Chart B. below shows the ZSM Reference Architecture and specifically:

- **Management Domains** separate management functions based on various types of boundaries based on technology, administrative control, organization or geography. Each management domain provides a set of ZSM management services
- **Cross-domain integration fabric** facilitates the provision of services and ensures access to end points in-all domains including communications between management functions, to facilitate the provisioning of ‘live’ management data and persistent data as required
- **E2E Service Management Domain (SMD)** is responsible for cross-domain management and coordination of E2E services.

AS the chart below shows E2E Service Management Domain (SMD) controls how E2E Orchestration, Intelligence Analytics and Data Collection leverage the **Cross Domain Integration Fabric** to manage the Domain specific versions of those functions in each of multiple **Management Domains**.

Chart B. ETSI Zero-touch Network and Service Management (ZSM) Reference Architecture



Source: ETSI WP N32 'Network Transformation (Orch. Service and Network Mgt. Framework)'⁴ Oct. 2019

Network Operations 'Loss of Visibility'

As complexity increased with virtualization, the Network Operations Center (NOC) lost visibility of potential problems e.g. scarcity of premium specialty processor resources or of physical data storage allocation. It has become harder and harder for NOC operators to correlate network and resource issues with E2E service performance. This has made it very challenging to simultaneously optimize physical resource load management and guarantee customer E2E SLA service quality requirements.

This loss of visibility and control often occurred because network and service data were contained in multiple domain specific inventory data silos. The number of these data silos has increased over time, as operators added new network technologies. In addition SDN/NFV Control User Plane Separation (CUPS) led to multiple screens and decoupled the monitoring of virtualized service functions (VNFs, SFs, NFs) from that of physical network functions (PNFs).

On top of that, many operators now find themselves running virtually dual systems as they begin to transition from 4G and 5G Non-Standalone Architecture (NSA) and soon to cloud native 5G Standalone (SA).

Until recently, NOC personnel were forced to use a variety of horizontal service operations center tools and processes to deal with this heterogeneous mix of siloed virtual, physical network domains and clouds. This fragmentation has dramatically exposed the complexities of multi-vendor and multi-domain management and impacted service providers' ability to meet their customers' emerging needs for innovative and agile digital services.

To address these challenges, **E2E Network and Service Orchestration (E2ENSO) has taken on a strategic role of both simplifying and abstracting the underlying complexity of these domain variations to allow complete operations control from a 'single pane of glass'.**

In 2021 it has become clear that E2ENSO is evolving from a theoretical option to a practical and essential necessity. By implementing a truly holistic E2E Service and Network Orchestration (E2ENSO) operators can now fully exploit the investments they have made in the network to gain greater business agility, bring new services to market faster and deliver them at lower operating cost with better CAPEX utilization and improved customer satisfaction¹.

2. Use Cases Demonstrate Value of E2E Network and Service Orchestration (E2ENSO)

To show the value of E2ENSO, below we examine two generic types of use cases that are critical for the growth of Communications Service Provider (CSP) revenues over the next decade. Specifically, they are:

- **Use case I. Managed Secure SD-WAN services**
- **Use case II. Multi-Domain, Multi-Cloud Network Slicing**

Use Case I. Managed Secure Enterprise SD-WAN

Problem

As more enterprises and SMEs have shifted their applications and workloads to cloud environments, traditional MPLS-based WAN architectures have become inefficient and hard to manage. This has motivated organizations to adopt managed SD-WAN services from CSPs. CSPs have responded by rapidly increasing the variety of SD-WAN vendor solutions they deploy in their networks to grow their customer base and meet the diverse requirements of different businesses. To differentiate their offerings from competitors and increase their value proposition most CSPs have enhanced their managed SD-WAN with security and value added service (VAS) bundles that utilize a wide range of ‘best-of-breed’ vendor solutions.

At a 2021 ‘SD-WAN Symposium’ Orange Business Services outlined key reasons that customers turn to CSPs for managed SD-WAN service.⁵ These typically center on requirements that a single SD-WAN vendor finds hard to meet, including:

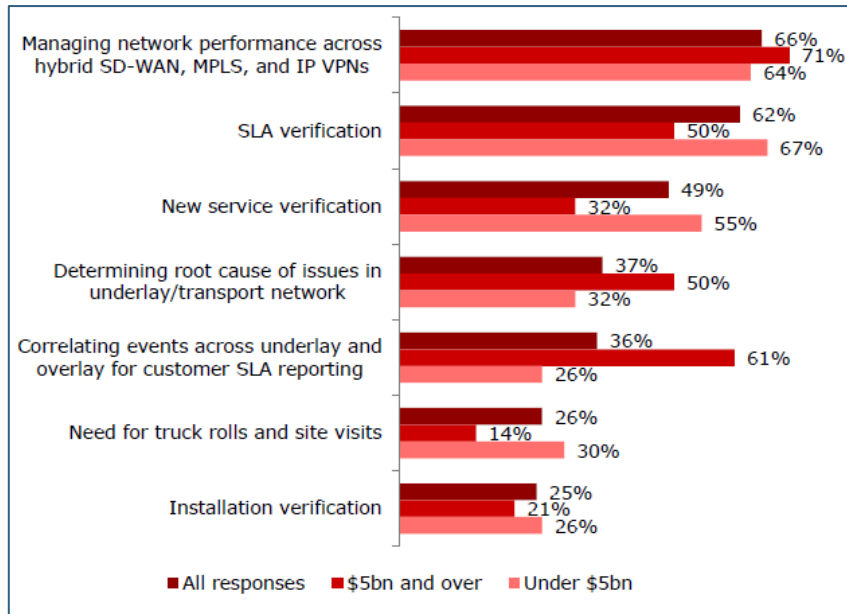
- Quality assurance of Virtualized SD-WAN when physical link monitoring is no longer meaningful.
- Flexible Hybrid Public Private Networks
- Hybrid Access for Multi-Cloud and Private Networks
- Options for ‘co-managed’ or fully managed SD-WAN
- Flexible choice of multiple SD-WAN vendors including Cisco (Viptela), Citrix, Fortinet, Palo Alto, Juniper, Nokia (Nuage), Oracle (Talari), HPE Aruba (Silver Peak) and VMware (Velocloud) etc.
- Multi-SD-WAN networks i.e. segments of SD-WANs from different vendors that may use different access transport networks with ‘local breakout’ etc. *Note These often result from mergers or company restructuring.*
- Security – especially at the Edge with and without Integrated **Secure Access Service Edge (SASE)**

A common hurdle to offering managed SD-WAN service is that most CSPs’ current service operations platforms do not allow a seamless upgrade path beyond traditional connectivity services. CSPs and their enterprise customers have often been forced to rely upon manual processes for provisioning and managing SD-WAN and virtualized network services. This significantly impedes CSPs’ ability to quickly spin up, manage and scale service upgrades. For CSP operations personnel correlating SD-WAN network underlay and service overlay events while managing full end-to-end service performance across multiple systems has been a major challenge.

Therefore despite the opportunity for revenue growth, the task of building and delivering SD-WAN offerings presents **new and unique challenges** for CSPs whether for **onboarding and integrating new vendor and partner solutions, creating new offerings, or delivering, managing and monetizing these services.**

A 2020 survey of operators prioritized some of the biggest CSP challenges in the delivery of ‘SD-WAN as a managed service’ are summarized in the chart below

Chart C. SD-WAN – Biggest Challenges for delivering SD-WAN as a Managed Service



Source: Heavy Reading Survey ‘The Future Managed SD-WAN Services’⁶ December 2020

These survey results indicate that CSPs must leverage the visibility and functional capabilities of E2E network and service orchestration (E2ENSO) to overcome these operational challenges and accelerate service automation that is able efficiently to manage hybrid SD-WAN networks that span multiple domains including:

- Physical and virtualized cloud SD-WAN functions
- SD-WAN deployment within the CSP network, the Hyperscaler cloud or on the enterprise premises.

Solution

E2ENSO now offers an approach that can dramatically simplify CSPs managed SD-WAN operational complexities based on:

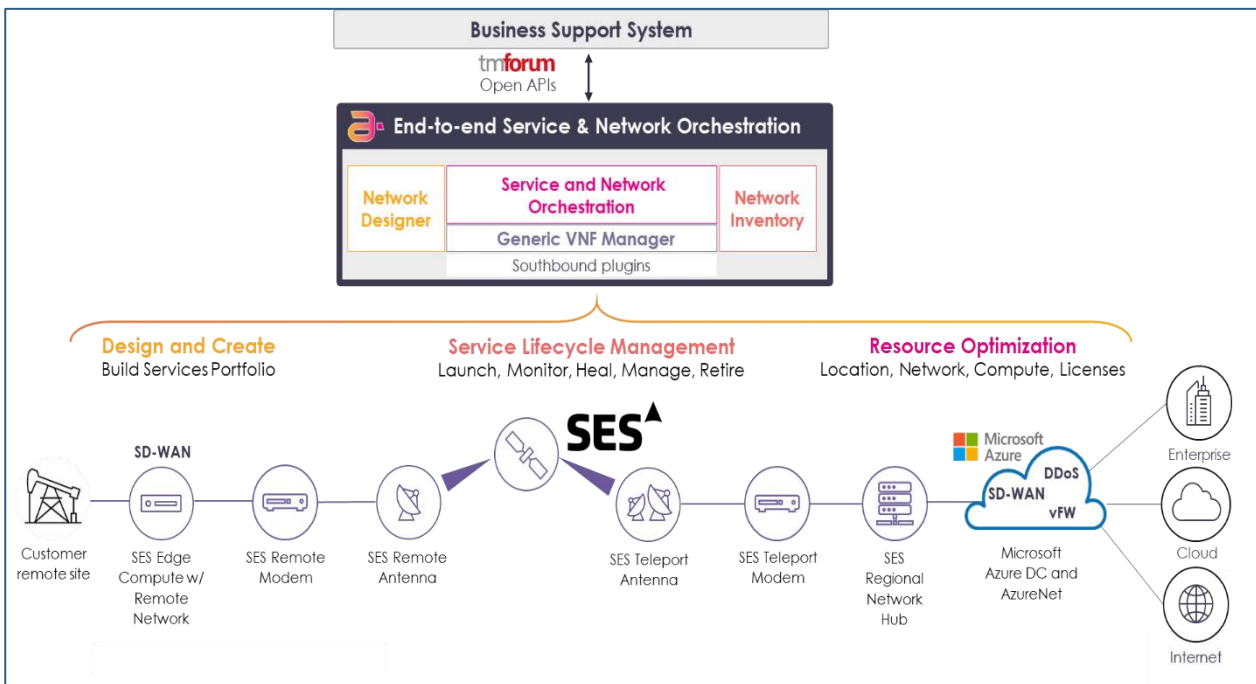
- **Hybrid SD-WAN, security and MPLS connectivity** handled with a single Multi-Domain Orchestration solution
- **Service Level Agreement (SLA) parameters** met with E2E Service Assurance and QoS
- **Automated service verification** established via catalog integration and request validation
- **Root cause and underlying event correlation** performed with integrated network monitoring and Automated Machine Learning (ML)
- **SD-WAN CPE/appliance installations and verification** replaced with remotely upgradeable firmware and uCPE
- **Installation verification** performed with automated remote monitoring.

Use Case I – SES Satellite Example

SES Satellites’ implementation of an E2E Network and Service Orchestration solution from Amdocs demonstrates the growing need for end-to-end service orchestration with integrated digital service lifecycle management for a **new generation of video and network SD-WAN services that span many domains**, including physical, virtual and cloud network functions, across satellite access, radio access, fiber transport and core infrastructure ⁷.

The solution – shown in the chart below -enables SES to manage increased scale and complexity by automating existing service and network operations, while at the same time increasing its capacity to accelerate the launch and delivery of innovative services for broadcasters, content owners, mobile operators, enterprises and vertical industry segments.

Chart D. Using a single multi-domain E2ENSO to Orchestrate Managed Secure SD-WAN and other L2/L3 connectivity services over a hybrid network



Source: Updated from Layer123 World Congress 2021: ‘Orchestrating 5G from Space’⁸ November 2021

Growth of CSP managed SD-WAN has accelerated dramatically during the COVID-19 pandemic and this combination of satellite, cloud, and terrestrial infrastructures has allowed SES to stay at the forefront of uninterrupted SD-WAN service delivery, by enabling increased distribution of data and empowering millions of individuals to work from home.

Use Case II. Multi-Domain, Multi-Cloud Network Slicing

The Promise of Network Slicing to enable the creation of secure, private logical E2E networks – each with distinct Quality of Service (QoS), Security etc. operating over a common shared physical network – has been delayed by lack of management and orchestration. E2ENSO fills the gap and makes ‘Network Sliding as a Service’ feasible in 2022.

In principle Network Slicing offers the *benefits of a dedicated private network with the economics of a shared public network*. Network Slicing has long been touted as a major revenue generator for Communications Service providers (CSPs) but has remained very hard to implement and operate over legacy LTE systems that lack advanced E2E Slice network and service management capabilities. As a result Network Slicing revenues have hitherto, largely failed to materialize.

Problem

Despite the evolution to 5G Standalone (SA), many 4G and 5G Non-Standalone (NSA) LTE networks will continue to operate and grow for many years. 4G service platforms will continue to deliver many ‘basic’ services such as RCS messaging, Voice over LTE (VoLTE), Unified Communications and IMS multi-media services as well as basic data i.e. User Plane Function (UPF) connectivity that can be upgraded with new 4G Release 15 features to interwork with a pure 5G SA core. **As they wait for ubiquitous 5G SA, CSPs urgently need a multi-domain network slicing approach that can deliver E2E Enterprise voice and data services for both Public 4G NSA and Private 5G SA Enterprise domains.** But without E2ENSO capabilities to manage and orchestrate these E2E Enterprise 4G NSA and 5G SA services seamlessly the hybrid network rapidly becomes an ‘operations nightmare’ of incompatible domain specific management and monitoring systems.

Solution: Multi-Domain Multi-Cloud Network Slice (NS) Management

The solution is to deploy an E2E Network Slice (NS) across the multiple technology and other domains, stretching from end users in the RAN to the edge servers or over alternate transport options to the core service platforms - some of which may even belong to different administrative domains.

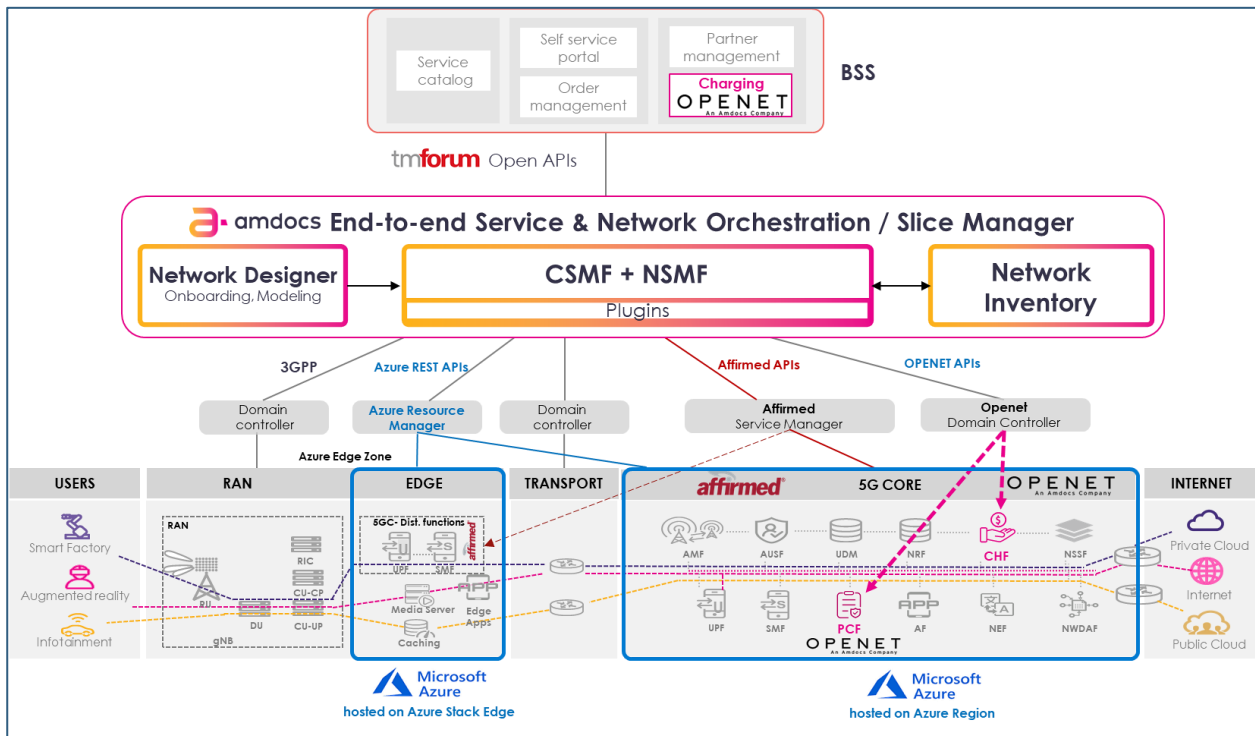
The process of establishing such multi-domain Network Slice Instances (NSIs) demands a *hierarchical network abstraction* that allows generic ‘consistent’ lower layer resource allocation and management. To achieve this, when a slice request is received several tasks must occur including:

- *Mapping of the service requirements onto capability requirements.*
- *Translating the capability requirements into:*
 - NSI resource requirements for compute, storage and networking resources.
 - NSI topology and connectivity type, policy, isolation and security requirements.
- *Identifying the infrastructure-domains with the required resources, that can assure the E2E NSI functional and operational requirements.*
- *Creating the federated NSI.*
- *Providing run-time coordination management operations across different domains for maintaining the end-to-end NSI service integrity.*

Use Case II – MS Azure Example

In the example shown in the chart below, the 5G Core service platform network functions are hosted for efficiency and scalability in both the MS Azure Regional Cloud and at the MS Azure Edge. The platform is able to offer services to a private 5G wireless network e.g. for a Smart Factory (shown on the left below); or for Augmented Reality (SR) and Infotainment as part of a complete hosted Microsoft Azure and Azure for Operators (AFO) capability. The solution operates seamlessly across multiple domains - Users, RAN, Edge, Transport, Core, Internet and Multiple Public Clouds to **allow CSPs to offer a dedicated Network Slice as a Service (NSaaS) to MVNOs, Platform as a Service (PaaS) to large Enterprise users and Software as a Service (SaaS) to small and medium enterprises (SMEs)** at a far lower price than a dedicated network and on premise solution. As announced on May 24th.2021⁹, this multi-domain E2ENSO (based on the Amdocs Intelligent Networking suite) integrates with Azure and **enables service providers to deploy and orchestrate 5G network functions on the Azure cloud.**

Chart E. Using a single Multi-Domain E2ENSO to Orchestrate 5G services over Telco RAN/Cloud, Transport and Public Cloud/Edge



Source: Updated from Light Reading ‘5G Orchestration & Service Assurance Digital Symposium’ ¹⁰ June 2021

End-to-End Slice management, using E2ENSO, therefore not only enables service providers to offer their enterprise customers **Secure Private Edge Solutions** that combine seamlessly with *hosted solutions for cost savings and scalability* but allows them to operate **Service Platforms seamlessly across metro area and regional networks** and to offer **‘Network Slicing as a Service’** without waiting for future 3GPP releases.

Multi-Domain Telco and Hyperscaler Cloud Benefits

Private LTE and 5G networks that demand multi-domain management for multi-domain access are already a reality. Now with 3GPP Release 16 for 5G SA, the management and orchestration details of Network Slicing services have been specified as well as the **mechanisms to allow Network Slices to operate seamlessly across multiple domains**. As CSPs deploy Release 16 in late 2021 and 2022 they can finally offer seamless delivery with guaranteed QoS and SLAs for services running over Network Slices across multiple domains – even including LTE Release 15 service VNFs - and Cloud Hosted platforms with CNFs or SFs.

Today E2ENSO enables CSPs immediately to leverage their strengths to deliver scalable, trusted, high reliability Network Slicing to large enterprises and small business users alike, while meeting all the QoS, security and privacy requirements for campus, metro area edge or cloud data center environments.

'Sweet spot' for CSP Orchestrated Network Slicing is emerging.

Enterprise networks inherently demand Multi-Domain, Multi-Access (Fixed, WiFi and Wireless) and Multi-Cloud Interworking. This combination potentially represents 'the sweet spot' for CSP Network Slicing services since it leverages CSPs' role as a secure, trusted, highly reliable neutral intermediary that both provides flexible, secure, guaranteed connectivity and offers E2E Services hosted not only by CSPs, but by the Cloud Hyperscalers or even Enterprises themselves.

3. Amdocs E2ENSO Addresses the Challenges

End to End Network and Service Orchestration are critical to handle the complexity of today’s hybrid multi-domain networks and to ensure that network and service operations can be automated with dramatically lower Total Cost of Operations (TCO).

Amdocs has developed a solution for E2ENSO that covers all aspects of service LCM – from onboarding, design and creation to orchestration, continuous monitoring and operation – providing a single harmonized system for management of policies, SLAs and network KPIs with automated fulfilment and closed-loop operations.

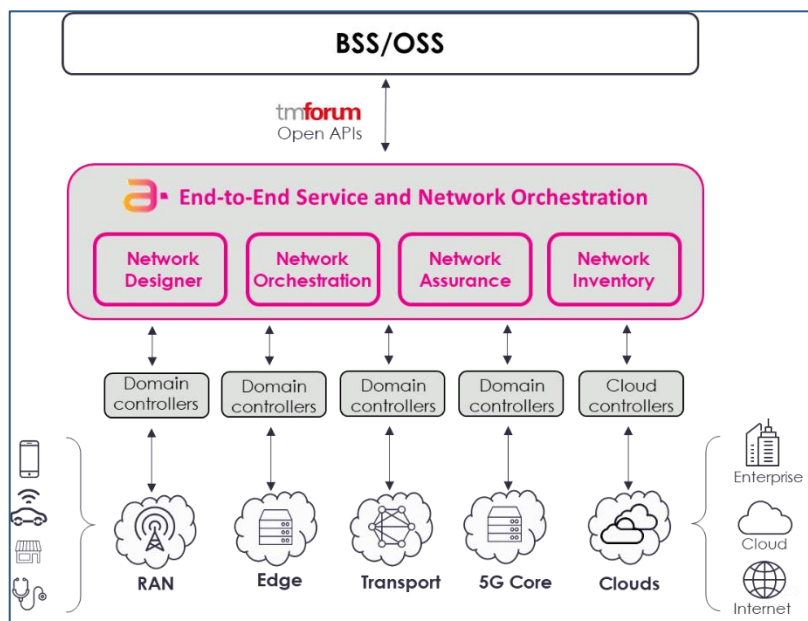
Specifically it provides:

- A single multi-vendor, multi-domain and hybrid network orchestrator
- End-to-end service lifecycle management of network and cloud services
- Standards-based, service-driven modeling for composing reusable service building blocks, as well as all cloud and network resources required to roll out and operate the service
- Automated continuous service fulfilment and closed-loop assurance through real-time enforcement of xNFs, networks and cloud resources, as well as service-related policies
- Open and vendor-agnostic solution, aligned with and based on industry-leading standards, including ETSI, TMF, ONAP and MEF
- Cloud-native, microservices-based and intelligent automation-infused for greater business agility, faster time to market and optimized OPEX

The chart below highlights how Amdocs E2E Service and Network Orchestrator:

- **Operates across heterogeneous domains** - whose controllers may be from multiple vendors
- **Abstracts their functional inputs/outputs** to standardize processes and enable automation
- **Activates E2E Services and Network Slice Management across all domains**
- **Provides standardized inputs via Open APIs** to the overall BSS and OSS systems – even those from vendors other than Amdocs.

Chart F. Amdocs End-to-End Service and Network Orchestration (E2ENSO) Platform



Source: Updated Amdocs ‘End to End Service and Network Orchestration’¹¹ Solution Brief

Untangling next-generation network services complexities

Amdocs E2ENSO solution, addresses complex multi-domain, multi-vendor service management challenges and can readily be implemented to address the two use cases described in this paper either for **Managed Secure SD-WAN services** or for **Multi-Domain, Multi-Cloud E2E Network Slicing** and for a multitude of additional use cases.

Amdocs E2ESNO helps service providers successfully build and deliver their combined managed SD-WAN and security services. Based on ETSI, MEF, TMF and ONAP standards, it leverages open-source and vendor-agnostic service modeling to reduce the complexity and cost of onboarding and integration of new vendors and new partner solutions as well as creation and implementation of new service offerings. The solution's unified services and resources inventory enables closed-loop operations to correlate network underlay and service overlay events and to assure end-to-end service performance, visibility, and control. Thus, it simplifies service lifecycle automation and orchestration of multi-vendor environments comprising SD-WANs, as well as various VAS VNFs and CNFs, thereby enabling service innovation, differentiation and agility.

Amdocs has not only enhanced its E2ESNO with additional capabilities but has also created the Amdocs **5G Slice Manager** solution for end-to-end lifecycle management of network slices. By supporting 3GPP defined Network Slicing Management Functions such as the CSMF, NSMF, and NSSMF, Amdocs solution provides end-to-end network slicing lifecycle management coordinating the RAN, Transport and Core network slice subnet operations and services, across multiple siloed operational domains.

The slice automation and orchestration module performs the Network Slice Management Function (NSMF) and instantiates the necessary VNFs, CNFs, PNFs, network resources, and connections end to end across the various network and cloud domains needed to deploy the service into the network. It interacts with each network or cloud domain orchestrator/controller as required. The 5G Slice Manager also performs the charging-triggering function that passes information about a slice's activation, utilization and performance to the charging function (CHF) itself. This enables CSPs to create comprehensive slice-level charging reports that include the slice or service elements as well as associated network resources, utilization, and performance.

Slicing the Edge' - Optimizing Resources with 'Function Placement' at the Edge

In addition to the basic E2ENSO functionality described above, Amdocs is also able to leverage Intel's **Converged Edge Reference Architecture (CERA)** to **optimize edge workloads and 'function placement'**. CSPs can use this to avoid 'stranded' processor or storage assets at the edge by leveraging CERA and the Intel® Smart Edge Open software toolkit (openNESS)¹² to onboard and manage network functions in real time. This allows the operator to assign or 'place' those functions on the exact edge server type required for processing each service with 'cloud-like agility' distributed across multiple data centers, campuses or metro area servers e.g. to deliver efficient private network application processing 'in the cloud', 'at the network edge' and on premise as needed.

4. Implications

To address the Use Cases described in Section 2 and meet the new network challenges of hybrid multi-domain, multi-vendor networking, operators need new tools, processes and automation that focus on E2E Network and Service Orchestration (E2ENSO). Amdocs solutions can deliver:

- *Multi-Domain orchestration*
- *Abstraction of diverse vendor inputs for seamless automatable functionality*
- *Full Lifecycle Service Management and Orchestration*
- *Multi-Vendor and Vendor Agnostic solutions*
- *Integrated Network and Resource Management and Orchestration with:*
 - *Lower Layer Real Time Monitoring for closed loop pro-active service protection and assurance*
 - *Intelligent Network Function Placement for Optimal Performance*
 - *Automated Abstraction of Service Functions for seamless service interoperability*
- *Open APIs and open standards based solutions integrated to create a modular flexible solution for easy customization and 3rd. party extensibility and interoperability*
- *Modular, cloud native, microservices-based architecture for IT-like deployment on private and public clouds*

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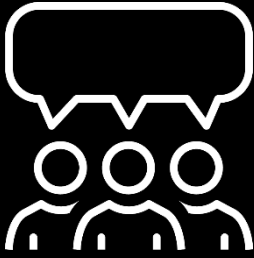
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