HYBRID NETWORKS: INTEGRATED PROVISIONING FOR VIRTUAL AND PHYSICAL NETWORKS

Sponsored by Affirmed Networks

EXECUTIVE SUMMARY

Today, networks are provisioned in two disparate steps: 1) resources are preprovisioned (forecasted and put into service via physical implementation and configuration of the resources and their monitoring for performance and security); 2) when a customer service order is received a service provisioning process is brought into play.

TODAY

The order is checked and accepted, the resources are allocated to the service order and the service instantiated and monitored. If the required resources are not available, the process is stopped and additional resources are added, delaying the service for the customer.

In the future, virtualized network resources will be able to be dynamically allocated in near-real time.

Customer services will be automatically provisioned and if more network, software, computing or storage resources are needed they will be created and monitored immediately.

Highlights

- An integrated process for the planning and implementation of hybrid virtual/physical network capacity is not yet well established.
- There will be an evolution, domain by domain, from pre-planned and pre-implemented network resource additions to on-demand. This will decrease network implementation times from months today to minutes tomorrow.
- The configuration and activation of network resources and the activation of customer-ordered services will become the critical path items. New solutions in these areas, such as the Affirmed Network Service Orchestration solution, will be necessary.

These dynamically deployed resource processes will be divided into various network domains with control of the resources in a domain automated via a set of domain orchestration systems. Although the set of domains expected to be useful are not fully fleshed out, it does seem clear that SDN and the mobile core network are two that will be among the first. The former is required for NFV connectivity as well as implementing slicing in the transport network; the latter represents a standard hunk of the network that requires integrated management.

The domain orchestration functions will require both resource and network provisioning capabilities. To provision the network, the domain management system must orchestrate the entire process: instantiating the virtual network functions (VNFs) on their required computing and storage platforms and integrating their inputs and outputs to the other elements. Then they must be configured with the required parameters and connected to the OSS service assurance systems that monitor them and the services they carry. Finally, as part of the service provisioning process, they must activate the elements with the service-specific information. The configuration and activation steps can be carried out manually (as most are today), use element management systems from the manufacturer of the VNFs or done in a modern system that integrates easily with multiple manufacturers via TOSCA or NETCONF standard, vendor-agnostic software.

Affirmed Networks has recently announced its Affirmed Orchestration Solution, comprising two modern multivendor systems that fill the gap in the current provisioning processes, the Affirmed Domain Management System (the first instantiation of which is for the mobile core network) and the Affirmed Service Activator that provides activation of customer services and configuration of virtualized network elements. These two systems and the standardized virtualized infrastructure managers and virtual network function managers complete the architecture for modern network resource and customer service provisioning.

INTRODUCTION

Networks and the services that ride them have been provisioned for over 100 years. For the first 50 years, that meant manual methods with paper records. Provisioning times were long. Network capacity requirements were assessed yearly (with 20 year fundamental planning views done as late as the 1980s) while service provisioning of customer orders followed standard intervals, usually 30 days for a standard telephone service to 90 days for a standard business service. By the turn of the century, the situation was radically different due to computerized records and process automation. Simple services could be provisioned within days, if not hours, and simple business services could be provisioned within a week. Network planning was done quarterly with aspirations of moving to monthly looks at capacity requirements.

Today, the industry is poised to take a tremendous leap in its operations agility through a combination of virtual network functions[1] and software systems to support and automate the resource and service provisioning processes. And since adding network capacity will mean installing and configuring software on in-place, standardized hardware[2], the resource provisioning time can also be greatly reduced[3]. But, again, this will require that right automation or network orchestration as it is now referred to.

To get the most out these new technologies, the network resource planning and provisioning processes must be radically re-imagined and married to the new, more automated service provisioning process to fulfill the customers' orders quickly and efficiently. This paper presents such a process, harmonizing the existing service provisioning processes in place at most CSPs with the newly-automated network resource provisioning process.

> The network resource planning and provisioning process must be re-imagined.

Types of Provisioning

There are two, logically distinct types of provisioning:

1. (Network) Resource Provisioning: Network resources must be installed and configured to prepare them for service.
2. (Customer) Service Provisioning: Customer services must be provisioned using the resources.

The first step is quite different for physical network functions (PNFs) and virtual network functions (VNFs), with radically different time scales. The second step is the same for both PNFs and VNFs. Today, as shown in Figure 1, network resources are preprovisioned. They are planned in forecasts and driven by engineering orders.

[1] VNFs are defined as software running on general-purpose computing hardware that mimics the functions of previously bespoke hardware with embedded software nearly always from the same vendor.

[2] Today, this mostly means x86-based 1U units in centralized data centers. Other technologies, such as GPUs for AI and big data analytics applications, are already joining the list. Other hardware may follow, including quantum computing platforms. In the future, the computing will be distributed throughout the network and the customers' premises.

[3] The needed data center and underlying connectivity capacities will need to be estimated and built out, often with PNFs. Because it is general-purpose hardware, it will be easier and cheaper to estimate and put in place.

The PNFs undergo a long network resource provisioning process as they are ordered, delivered, warehoused, distributed and installed. In contrast, the VNFs are quickly installed on general-purpose computing hardware, using automated orchestration software. Whether physical or virtual, they are then configured using either command-line or automated means[4]. Then they are added to the list of network resources to be monitored by service assurance systems for proper operation (network assurance provisioning). Again, that final step is often automated for VNFs but manual for PNFs.

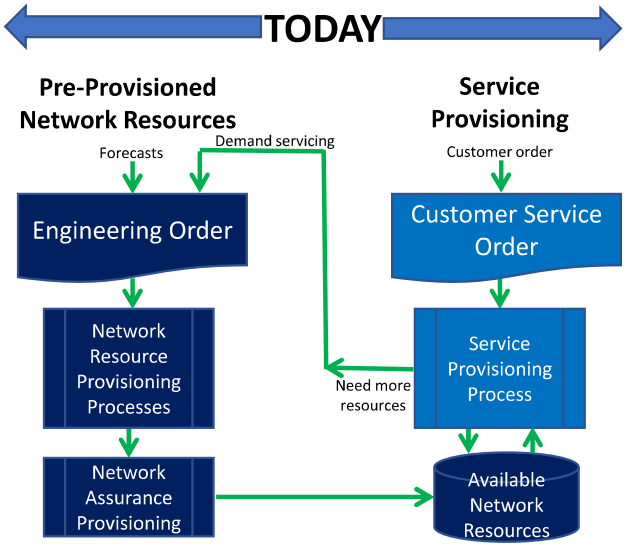

Figure 1. Current Network Provisioning & Service Provisioning Process
(Source: ACG Research, 2019)

The service provisioning process is initiated by a customer's order through a validated customer service order. In the service provisioning process, available resources are checked. If they are available, those resources are used and assigned to the customer service, usually in a flow-through automated operation.[5] If the resources are not available, the entire process is stopped, an engineering work order created to put in place the required network resources, and the service provisioning rescheduled.

Overview of Integrated Provisioning Process of the Future

In the future, forecasts will be used to drive the procurement process (getting the rights to spin up VNFs) but not the network provisioning process, in most cases[6]. That will come after a service order is processed (Figure 2).

[4] Most VNFs today are configured using the same systems and processes as PNFs, often using the same Element Management Systems (EMSs) and Network Management Systems (NMSs) as the physical elements. We call these virtual boxes, which do not provide the same benefits as when full automation is applied.

[5] Many enterprise services, such as IP-VPNs, SD-WANs, or UCS require complex, engineering designs. They require engineering orders and, often, additional resources to be installed and configured.

[6] There still will be cases where forecasts, based on expected orders (such as a new major business facility put in place that will need service), will drive network additions.

The result of this process is that network resources are quickly put in place only when they are needed. This decreases the total investment required (resources are not sitting idle ahead of forecasted usage) and increases the business agility of the CSP as it quickly puts in place and offers (and decommissions) new capabilities.

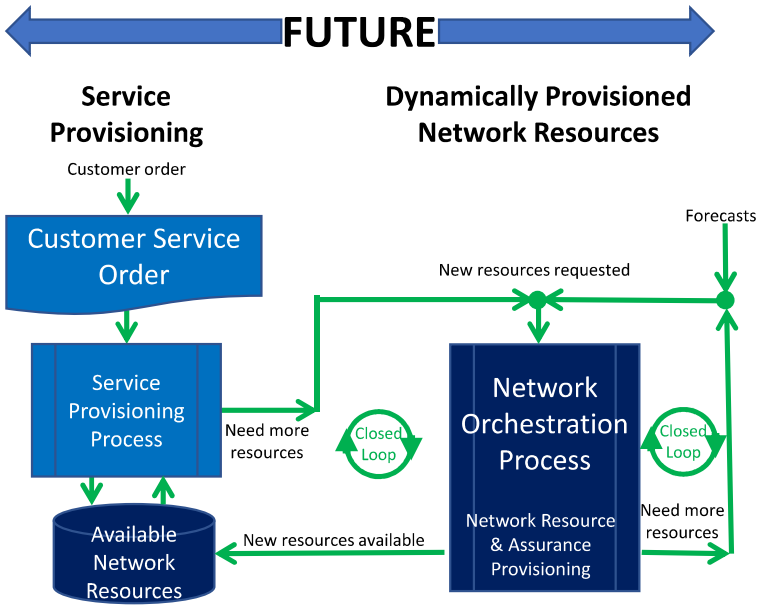

Figure 2. Future Integrated Provisioning Process
(Source: ACG Research, 2019)

MAKING IT WORK: THE INTEGRATED PROVISIONING SYSTEM ARCHITECTURE OF THE FUTURE

To instantiate the process shown in Figure 2 will take an extension of systems architecture today, as shown in Figure 3. The left part of the diagram represents the current systems in place (for PNFs and virtual boxes, VNFs treated like PNFs, the current state of affairs).

- CRM: Takes the customer order, verifies, etc.
- Order Orchestration: Decomposes the order into major constituent parts, passes off to order management systems internally and those of trading partners.
- Order Management: Sequences the steps for design, assignment, activation, and completion of the order. It interfaces with activation systems and domain orchestrators.
- Activation: Interfaces directly with the network element or via an element management system (EMS) or network management system (NMS) to configure and activate the order.

The right area diagrams the systems needed for extending the architecture to include dynamically provisioned VNFs.

- Domain Orchestrator(s)[7]: Control all of the resources within a defined equipment domain. They are responsible for:
  - Creating network resources (if needed).
  - Configuring the network resources.
  - Activating the network resources, including adding them to the list for fault and performance monitoring.
  - Activating the services that ride on the network resources, including adding them to the list for service assurance monitoring.
- Domain Controllers: Perform the domain management but for a subset of the larger domain.[8]
- VNF Managers (VNFM), Virtual Infrastructure Managers (VIM), and VNFs: Control the instantiation and implementation of the VNFs.

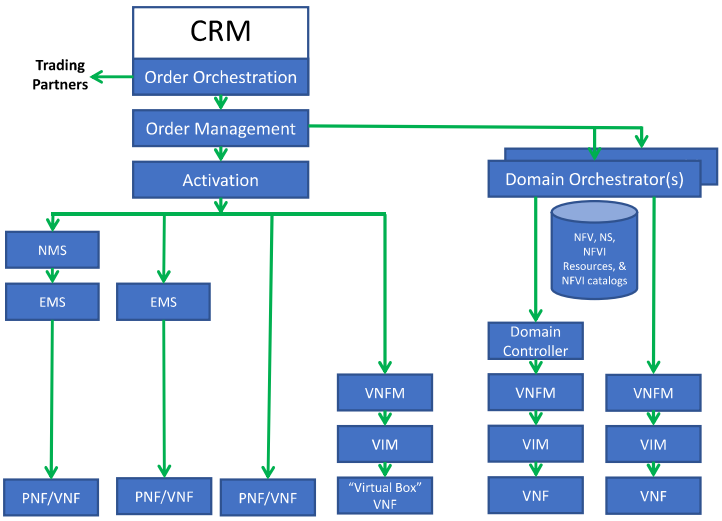

Figure 3. Integrated Provisioning Systems Architecture (Source: ACG Research, 2019)

EXAMPLE: AFFIRMED SERVICE ORCHESTRATION SOLUTION

The Affirmed Networks Service Orchestration Solution is an offering that provides overall network and service creation, configuration, and provisioning of services across virtual and physical network infrastructure. Today, there are two products in the solution: Affirmed Domain Orchestrator and the Affirmed Service Activator. The solution creates and configures network resources and creates, configures and activates customer services by automating overall network and service life-cycle management via

[7] The list of domains that will be adopted is still in question and will probably depend upon particular CSP's situations. It is clear that SD-WAN and mobile core networks (for 5G and maybe 4G) will be two of the domains.

[8] Many vendors already offer SDN controllers. Telefonica, for instance, is implementing multiple controllers from several vendors with the goal of replacing them in the future with a multivendor SDN domain orchestrator. See https://www.lightreading.com/carrier-sdn/transport-sdn/telefonica-on-mission-to-kill-sdn-as-we-know-it/d/d-id/750465?itc=lrnewsletter_emeaweekinreview&utm_source=lrnewsletter_emeaweekinreview&utm_medium=email&utm_campaign=03282019.

standardized, automated processes. It provides a real-time response to all network and service activation requests from a single platform, providing rapid activation of network and subscriber services. It supports out of the box use-cases, mobile services including 2/3/4 and 5G, IMS, Wi-Fi calling, VoLTE, consumer and enterprise CPE service enablement and fixed services, such as IPTV services, multi-play, Ethernet and IP/VPN.

It differentiates itself by its multivendor support, its ease of configuration, model-driven integration with network elements, and modern integration techniques with existing OSSs and BSS systems.

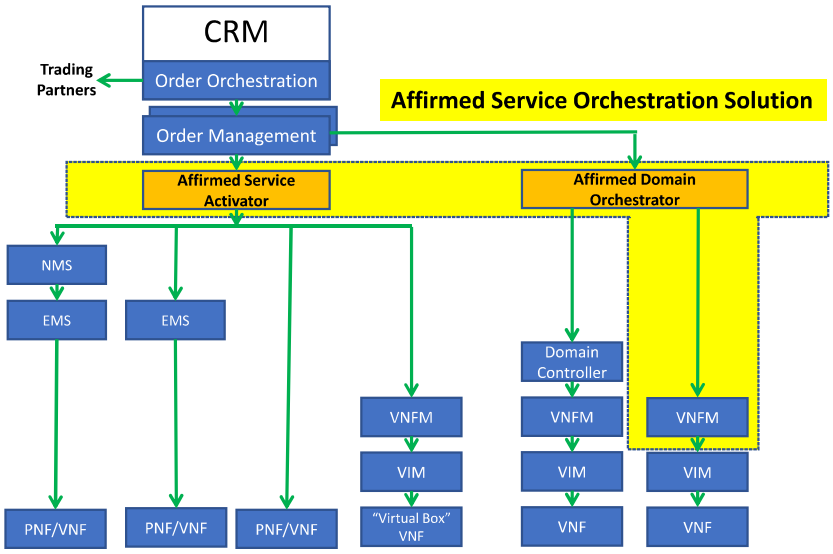

Figure 4. Affirmed Service Orchestration Solution (Source: ACG Research, 2019)

Affirmed Domain Orchestrator

The Affirmed Network Domain Orchestrator is a domain orchestration system. In its initial implementation, it manages enhanced mobile packet cores that can provision network resources for 2/3/4 and 5G networks by automating standardized network resource provisioning processes across virtualized, physical, and hybrid networks.

It differentiates itself by providing orchestration for both the Affirmed and multivendors' elements through an easy to use no-code process editor, model-driven equipment configuration capabilities, extensive library of element interfaces and process templates, and its proven ability to easily automate complex tasks.

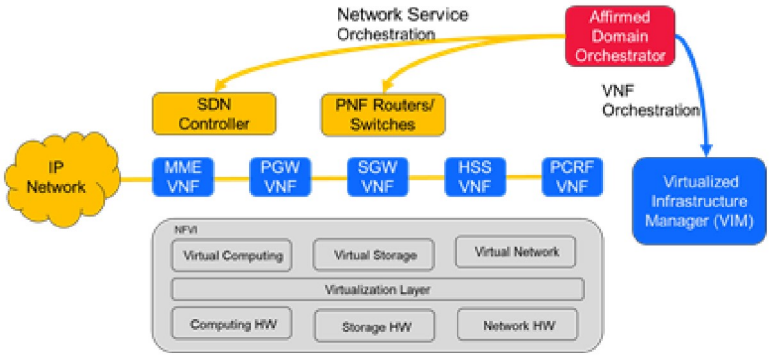

Figure 5. Affirmed Domain Orchestrator for Mobile Core (Source: Affirmed Networks, 2019)

Affirmed Domain Orchestrator Capabilities

- Model Driven VNF Onboarding: To quickly onboard and validate multivendor VNFs on the service provider's environment.
- End-to-End Orchestration: To automate the instantiation and configuration of network services, including all intra-data center and inter- data center network services, across multiple domains and multivendor scenarios.
- Element Management: To provide VNF specific life-cycle management, such as scaling and healing based on application-specific knowledge.
- Assurance: To monitor application and infrastructure alarms across domains and enabling policy-based and automated self-healing scenarios for the customer's services.

The process steps for these functions are shown in Figure 6.

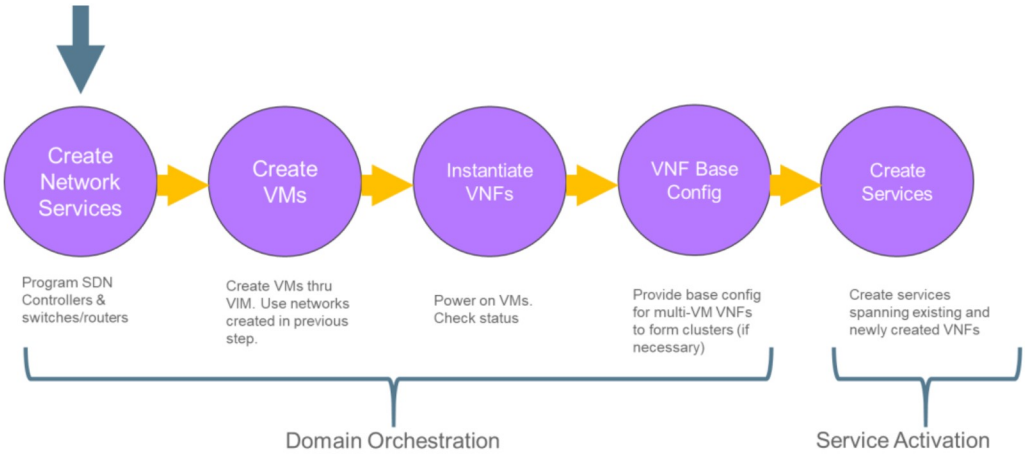

Figure 6. Affirmed Domain Orchestrator Functions (Source: Affirmed Networks, 2019)

Affirmed Service Activator

The second component of the Affirmed Domain Orchestration solution is the Affirmed Network Service Activator. It is an activation system that automates standardized processes for provisioning complex services on virtualized, physical, and hybrid networks. It is built on the Affirmed Service Automation platform.

It differentiates itself by its easy to use no-code drag-and-drop editor for complex processes, model-driven equipment configuration capabilities for multiple vendors' network devices, extensive libraries of element interfaces and process templates, modern integration with other BSS and OSS systems, intrinsic integration with service assurance, and its proven ability to easily automate complex tasks.

Underlying Platforms

Underpinning the Affirmed Domain Orchestration solution are two technology platforms: The Affirmed Generic VNF Manager(G-VNVM) and the Affirmed Service Automation Platform (ASAP). These are proven components used in multiple CSPs worldwide.

Generic VNF Manager

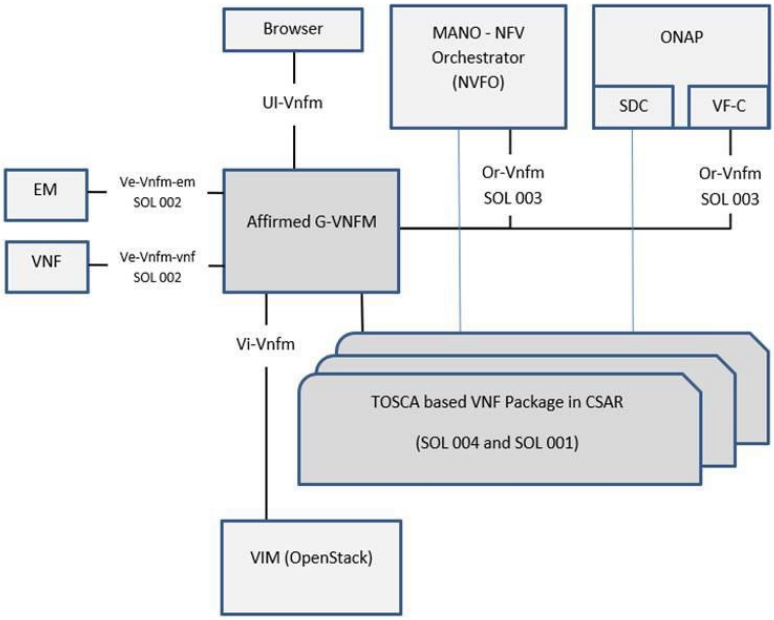

Figure 7. Affirmed Generic VNF Manager
(Source: Affirmed Networks, 2019)

The Affirmed Generic VNFM has the following major characteristics:

- ETSI MANO standards compliant.
- ONAP defacto standards complaint.
- Provides VNF lifecycle management for all VNFs, regardless of vendor.
- Can be used in a stand-alone environment or interworking with other NFV orchestrators.

Affirmed G-VNFM works in concert with other NFV-MANO functional blocks, such as the VIM and NFV orchestrator (NFVO), to help standardize the functions of virtual networking and increase the interoperability of software-defined networking elements. These standard components can help lower costs and increase new feature deployment and velocity by providing a standard framework for building NFV applications.

In the virtualized network world of NFV, scalability and speed of service deployments create new challenges in the areas of network management and orchestration. The VNFM is a key component of the

NFV-MANO, which helps standardize the functions of virtual networking and increases interoperability of software-defined networking elements. The VNFM is responsible for the life-cycle management of VNFs under the control of the NFVO, which it achieves by instructing the VIM.

- Instantiating of VNFs
- Scaling of VNFs
- Updating and/or upgrading VNFs
- Terminating VNFs

Affirmed Service Automation Platform

The Affirmed Networks ASAP is a Service Automation Platform for complex networks that can configure network functions, provision network resources, and activate complex services by automating standardized processes for virtualized, physical, and hybrid networks.

It is base technology for both the Affirmed Domain Orchestrator (which also in conjunction with the Affirmed G-VNFM, the Generic Virtual Network Function Manager) and the Affirmed Service Activator. It differentiates itself by its easy to use visual process editor (vGuilder), model-driven equipment configuration capabilities, extensive library of element interfaces and standard process templates, and its proven ability to easily automate complex tasks.

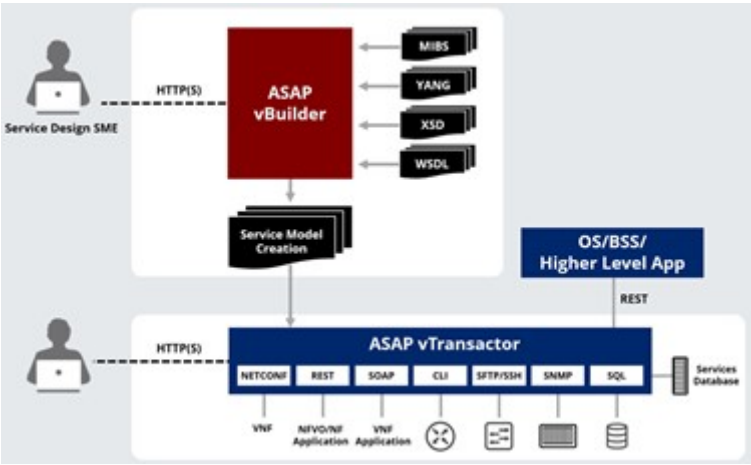

Figure 8. Affirmed Service Automation Platform (Source: Affirmed Networks, 2019)

Features

- Provides GUI-driven service creation screens with drag-and-drop commands.
- Supports service integration across complex, multivendor networks, including both physical and virtual instances of network elements.
- Monitors, modifies and synchronizes services across a wide ecosystem of network devices.
- Supports multiple model-driven and legacy interfaces (NETCONF, REST, SOAP, CLI, etc.).
- Provides device and network element agnostic.
- Delivers coding, less service creation, operational subject matter experts (SME) are empowered to create services (recipes) without the need of a programing language or coding requirements.
- Provides agent-less service execution, no need to support a client agent on the managed device.

Benefits

- Allows SMEs to quickly create new service definitions without complex coding.
- Frees OSS/BSS teams to concentrate on creating business logic rather than implementing it.
- Accelerates service deployment in the network.
- Eliminates provisioning and configuration errors that result from manual processes.
- Delivers northbound/southbound configuration synchronization between the ASAP platform and all deployed network functions.
- Provides rapid onboarding and rollback of new customer services instances in the network.
- Supports end-to-end testing and validation of services before and after production deployment.
- Simplifies service deployment in new regions.

CONCLUSION

Network and service provisioning are undergoing the greatest changes in the history of telecommunications, faster, more flexible, and more automated to provide unprecedented business agility and velocity. To create this new future does not require wholesale changes in the BSS and OSS infrastructure, but an evolution using proven domain-based techniques, melded with the new virtualized infrastructure and cloud technologies. Vendors such as Affirmed Networks are leading those changes with new service orchestration, provisioning, and activation solutions to work with the multivendor hybrid virtualized and physical networks of the future.

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