



Executive Summary

New services are driving strong traffic growth as well as creating demand for service personalization and novel consumption pricing models. Network operators usually have built their infrastructures separately by service with purpose-built solutions, creating large, complex networks that can slow service innovation and add cost. This can hinder operators in capturing market opportunities as life cycles for technologies, applications, and services decrease and as OTT and cloud service providers rapidly introduce new services and business models.

Network Function Virtualization (NFV), a network operator driven initiative, aims to control costs and accelerate revenue growth by leveraging standard IT virtualization and orchestration technologies to consolidate network equipment functions onto industry-standard high-volume servers, switches and storage.

Cisco Evolved Services Platform provides a comprehensive multivendor NFV solution that is based upon open standards and APIs. It is extensible by offering comprehensive modular capabilities that span the entire network operator architecture: cloud, video, mobile and fixed. It is elastic; it seamlessly and dynamically scales services and resources whenever and wherever they are needed. Cisco's NFV portfolio has the most extensive set of virtual network functions available on the market. The Cisco solution is offered through four alternative purchasing models that allow operators to fit the NFV solutions to their tolerance for implementation, operational and financial risk.

Three use cases illustrate the breadth of the Cisco Evolved Services Platform and NFV solution: 1) Virtual managed services lowers the operating cost for providers by placing a low functionality network interface device (instead of a highly functional customer premise device) and leveraging virtual network functions; 2) virtual premium mobile broadband virtualizes all elements of a secure, reliable, and private mobile Internet system; 3) multiscreen cloud DVR provides a multiscreen cloud DVR alternative to physical DVRs located in the home.

KEY FINDINGS

Cisco Evolved Services Platform provides a comprehensive NFV solution that reduces TCO and spurs revenue growth. In a study of three use cases Evolved Services Platform compared to the present mode of operations has:

- 65% OpEx reduction and 15% revenue boost for virtual managed services
- 43% TCO savings for EPC function and 44% TCO savings for the Gi-LAN function for virtual premium mobile broadband
- 15% TCO savings and 7% greater revenue for multiscreen cloud DVR

Introduction

Demand for cloud, video streaming, social networking, and mobile broadband services is not only driving traffic growth but new expectations for service personalization and consumption pricing models. Network operators have been employing a large and increasing variety of purpose-built network equipment to deliver new services, fulfill personalization expectations and implement consumption pricing models. This approach is pushing up costs to house, power and operate the network equipment as well as the costs to design, integrate and deploy the large variety of equipment. Cost pressure is being further compounded by shorter life cycles for technologies, applications and services. Costs, consequently, are not scaling well with traffic growth and are inhibiting timely and profitable service innovation.

Network operators' business models are further threatened by slow revenue growth that is lagging behind cost increases. Long time to market for new services is caused by the complexity to design, integrate and deploy purpose-built network equipment and the difficulty purpose-built network equipment causes in developing innovative and differentiated services. Revenue growth is further retarded by lengthy sell and fulfill cycles because of the complexity of configuring purpose-built network equipment. Purpose-built network equipment, therefore, is harming network operators' ability to profitably exploit strong demand growth, meet new customer expectations and respond to new competitive threats, particularly those of cloud and OTT service providers.

The Network Functions Virtualization (NFV) Initiative

Major network operators have banded together to lead specification of NFV to address the limitations of purpose-built network equipment. NFV aims to overcome these limitations by leveraging standard IT virtualization and orchestration technologies to consolidate network equipment functions onto industry-standard high-volume servers, switches and storage. NFV is applicable to any data or control plane function in fixed or mobile network infrastructures. The benefits of the NFV initiative include:

- Reduced equipment cost
- Reduced environmental cost (Power, cooling, and space)
- Reduced time to market (Increased service velocity)
- Targeted service introduction with rapid scale up or scale down (Increased elasticity)
- Enable a large and open ecosystem

Cisco Evolved Services Platform

Cisco provides the broadest and deepest NFV portfolio via its Evolved Services Platform to address network operators' cost control and revenue generation issues. Figure 1 provides an overview.

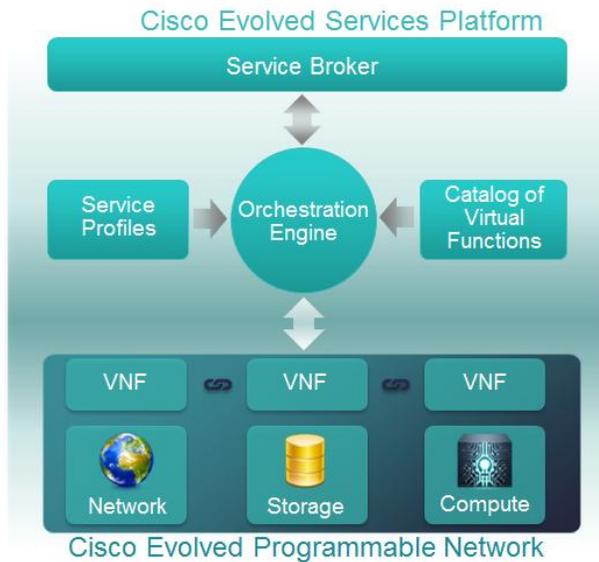


Figure 1 – Cisco Evolved Services Platform

The Evolved Services Platform provides automated, optimized and personalized services via virtualized network functions running on cloud data center technology. Evolved Services Platform elements include:

- **Service Broker:** A self-service active catalog and workflow system that links services orchestration with business logic that enables easy and efficient service delivery.
- **Orchestration Engine:** An automated provisioning and service chaining system that links physical and virtual network functions to enable elastic scaling of personalized services that are programmed via open APIs and interfaces. The role of each service profile is to provide a comprehensive set of service attributes and policies linked through the orchestration engine that allows the operators to dynamically deliver personalized services.
- **Catalog of Virtual Functions:** An extensible and modular set of virtualized network and applications functions that are linked to the service profiles that define each service available to customers. Table 1 shows the breadth and depth of Cisco’s NFV portfolio. However, an even wider range of virtual functions can be used because an open architecture using OpenStack is employed. This makes it easy to add third-party network functions to the virtual function catalog and for other NFV solutions to add Cisco virtual network functions to their catalogs.

- Switch (Nexus 1000v)
- Mobile Packet Core (QvPC)
 - MME, SGW, PGW, SGSN and GGSN
- Gi-LAN for Mobility (OpenWave, vASA, vPEF, vSCE)
- Edge Services Router (CSR 1000v)
- Policy Engine
- Streamer
- Quantum Service Bus (QSB)
- Security Appliance ASAv
- Self Optimizing Network for Mobility (Quantum SON)
- IOS-XR (vIOS-XR)
- Deep Packet Inspection (vSCE)
- Wide Area Application Services (vWAAS)
- Access network discovery and selection function (vANDSF)
- Analytics
- Transcoder
- Wireless LAN controller (vWLC)
- Video Recorder
- Network Analysis Module (vNAM)
- Web Security Appliance (vWSA)
- E-Mail Security & DLP Appliance (vESA)
- Intrusion Prevention System (vNG-IPS)
- Identity Services Engine (vISE)

Table 1 – Cisco Virtual Network Functions

Comprehensive NFV Solution

Cisco provides all components of the NFV solution. It includes:

- Broad and deep virtual network function catalog, the most extensive set of virtual network functions now offered. See Table 1.
- Orchestration and automation: Compute and storage services management is built on Cisco software offerings and leverages the OpenStack framework. Provisioning services provide NFV automation and management and are built on multivendor tools such as Cisco Prime Suite. Network services, including security, policy and WAN, are controlled by open SDN controllers such as OpenDaylight along with Cisco APIC where applicable.
- Cloud data center technology: Cisco Unified Computing System and servers that provide an industry-standard solution. They unify computing, networking, management, virtualization and storage access into a single, integrated architecture.
- Cross-domain capabilities: Cisco provides complete solutions for cloud, video, mobile and fixed domains.

Evolved Services Platform Embodies Openness

The orchestration engine of the Evolved Services Platform leverages open-stand platforms, such as OpenStack and Cisco’s innovations, to manage and configure virtual machines and to seamlessly and dynamically scale services and resources whenever and wherever needed (elastic services).

The Evolved Services Platform also leverages open SDN controller, such as OpenDaylight Project along with other Cisco innovations, to orchestrate network services. This includes providing software-defined network controller functions and support for the OpenFlow, Netconf Yang and other standard protocols. The open approach enables a large ecosystem of virtual function developers.

Cisco is a founder and platinum member of the OpenDaylight Project and is one of only three members that have contributed code to the OpenDaylight source code repository. The company is committed to contributing 10 source code developers to the project.

Cisco actively contributes and participates in several ETSI NFV working groups, contributes to technical papers and leads subgroups, such as the technical steering committee. Cisco also participates in various proof-of-concept projects, including the service chaining for network function selection project.

Cisco NFV Purchasing Models

Cisco provides the NFV solution to network operators through four alternative purchasing models. The models allow the operator to fit the NFV solution to its tolerance for implementation, operational and financial risk. They are:

- Virtual Functions: Each software, hardware or advanced services component is available separately. The network operator selects and integrates only the ones it needs to complement existing software and infrastructure used in its service deployment.
- Orchestrated: Selected virtualized functions and orchestration software modules are purchased together. This provides a solution that uses standards-based service chaining to deliver personalized and integrated service offerings.
- POD¹: Complete turn-key service-based preintegrated solution PODs, including all of the software, hardware and associated advanced services required to deploy a particular service offering.
- As a Service: A pay-as-you-go model, Cisco integrates and operates a turn-key solution POD as a cloud-based offer that delivers specific services offered by network operators to their customers.

Virtual Managed Service Use Case

Enterprise managed services, such as MPLS VPN, managed security service and managed router services, are some of the most important enterprise services. They are implemented today using hardware-based

¹ Performance Optimized Data Center: A purpose-built module of standard shipping container form-factor is shipped preconfigured with racks, cabling and equipment for power and cooling.

customer premise equipment (CPE) and service provider housed physical appliances (for example, VPN, firewall and WaaS). Once the CPE is in place there is a strong cost disincentive to replace or upgrade it. Consequently, different types, ages and versions of software and hardware have proliferated. For similar reasons a wide range of dissimilar service provider-based hardware and software also exists. The embedded equipment base, therefore, is difficult and expensive to modify and maintain. This also inhibits service and feature upgrades and downgrades (service elasticity).

Figure 2 Figure 1 illustrates a virtualized managed services solution.

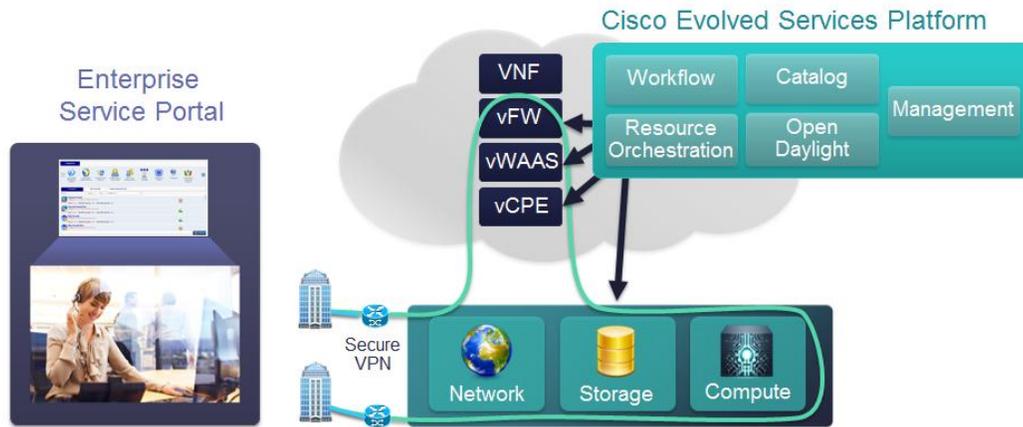


Figure 2 – Virtual Managed Services

The virtual managed services solution leverages a simple Network Interface Device (NID), and the CPE software is moved to a virtual function located in a cloud data center. The service provider-based network appliances are replaced by virtual network functions (vFW and vWAAS in this example) also located in the data center. The Evolved Services Platform provides the orchestration, service broker, control and management functions discussed in the preceding section.

The use case dramatically increases service velocity and reduces cost. The NID is a simple network element with minimal support requirements. It is shipped to the service subscriber in a plug-and-play configuration. This eliminates truck rolls, on-site customization and is standardized across all customer locations. Similarly, a consistent software version is used for all subscribers, and it is operated and maintained in a controlled cloud data center environment. The orchestration and automation capabilities of the Evolved Service Platform eliminate costly and slow manual processes, seamlessly and dynamically scale resources and support an enterprise service portal that gives subscribers control anywhere in the enterprise.

Compared to present mode of operations virtual managed services allows operators to lower their operating cost by 65 percent and the potential to boost revenue by 15 percent over five years. The investment in the virtual managed services solution provides 118 percent return on investment. Operation expense savings elements include 51 percent sales labor reduction, 75 percent service

fulfillment reduction, 60 percent shorter time to repair and 80 percent less maintenance expense over five years.

Virtual Premium Mobile Broadband Use Case

Wireless broadband technologies, such as LTE, WLAN and small cells, are delivering rich, collaborative connected experiences to anyone with a smartphone or a tablet. Many enterprises have adopted new devices and technologies to enable business-changing processes. Yet some industries, such as public safety, maritime, oil and gas, mining, transportation and defense, cannot rely on commercial networks to support their own services concurrently with other consumer services. It is feasible to construct a private LTE network using purpose-built hardware that serves a single enterprise and provides functions such as Evolved Packet Core (EPC), policy, mobile data offload (ANDSF) and Self-Organizing Network (SON). However, this approach suffers from the same high cost and long time to market cycles discussed previously, and they are compounded by lack of scale by a single customer network and the need to share radio heads with public networks. Cisco's virtual premium mobile broadband solution resolves these issues by virtualizing the required mobile networking functions and providing a vehicle for reliable and secure interworking with public mobile and WiFi networks. Figure 3 illustrates the solution.

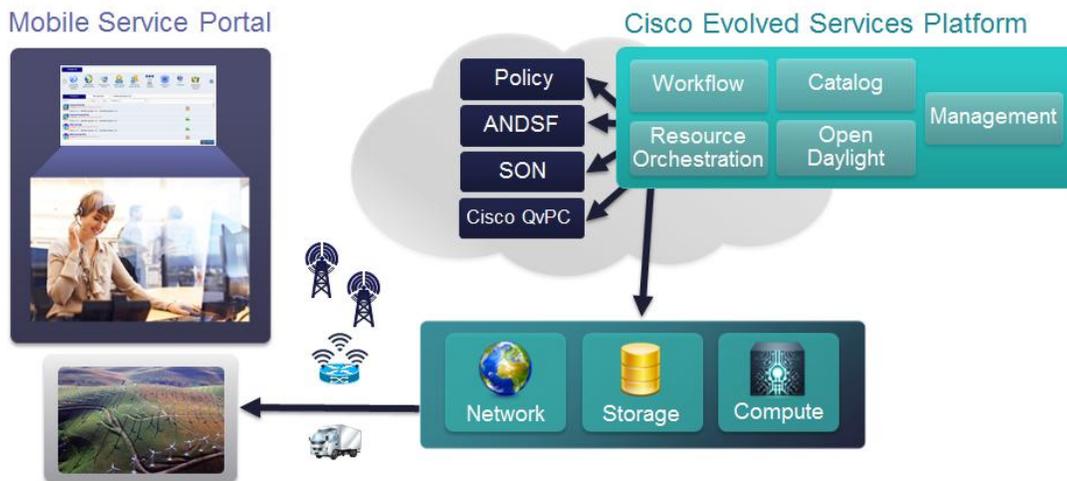


Figure 3 – Virtual Premium Mobile Broadband

The EPC functions (Cisco QvPC), SON, policy and mobile data offload functions are provided virtually in an industry-standard cloud data center. The Evolved Services Platform provides service broker, service profile and orchestration processes that make the premium mobile broadband services scale seamlessly and dynamically.

The virtual premium mobile broadband solution makes targeted deployments feasible for industries such as oil and gas, and mining. It provides the highly reliable and secure communications environment required of all premium mobile broadband use cases, and it provides secure interoperability with other commercial networks. Compared to a purpose-built premium mobile broadband the virtualized solution

has 43 percent total cost of ownership (TCO) savings over five years for the EPC function and 44 percent savings for the Gi-LAN (Interface between the private mobile network and the public Internet), derived mainly through lower operational costs.

Multiscreen Cloud DVR Use Case

Video operators' subscription video services are being threatened by OTT services and the proliferation of devices. Consumers want the freedom and flexibility to arrange their video content viewing around their own schedules, inside or outside the home. Currently, customers must program a physical DVR that is located in their homes to record premium live video content and may only view it on their directly connected home televisions.

The physical DVR installed base consists of many different types, ages and versions of software and hardware, making it difficult and costly to upgrade or change. Purpose-built hardware is deployed in the video operator's network to provide content management, scheduler, transcoder, cache and video streaming functions. This makes it difficult, slow and costly to add new services such as multiscreen video or "Try it you will like it" service promotions.

The multiscreen cloud DVR solution provides a multiscreen cloud DVR alternative to physical DVRs located in the home. Figure 4 illustrates the multiscreen cloud DVR solution.

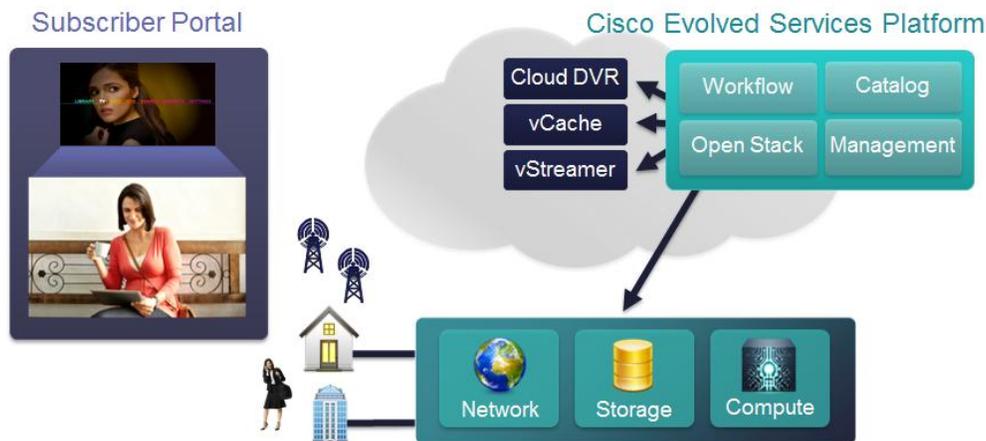


Figure 4 – Multiscreen Cloud DVR

The physical DVR is replaced by a solution that is hosted in an industry-standard cloud data center. Any video device, including smart TV, set top box, smartphone, tablet, laptop, connected gaming, home media server, OTT device (for example, Roku) or Internet DVD player, can access and control the same content. Viewers can restart live shows, catch up on past programs, schedule and play back recordings from any device anywhere. In addition, subscribers can add (or drop) DVR services instantly through a portal. This eliminates navigating voice response menus, scheduling home service calls and service

contract lock-ins that act as barriers to service adoption. This ease of use and flexibility contributes at least seven percent revenue uptake.

Video operators' TCO also is reduced through the Evolved Services Platform orchestration and automation capabilities and replacement of the complex and costly physical DVR operating environment with the simpler and thus lower cost multiscreen cloud DVR environment. This delivers at least 15 percent TCO savings.

Conclusion

As cloud-based services influence customer expectations for service personalization and novel consumption pricing models, network operators need greater agility to innovate and respond to market opportunities. Market dynamics require shorter life cycles for technologies, applications and services; and network operators need to capture new revenue streams to compete profitably.

NFV aims to control costs and accelerate revenue growth by leveraging standard IT virtualization and orchestration technologies to consolidate network equipment functions onto industry-standard high-volume servers, switches and storage.

Cisco Evolved Services Platform combined with Cisco's broad and deep portfolio of virtualized network functions provides a comprehensive NFV solution. It includes:

- Broad and deep virtual network function catalog
- Orchestration and automation
- Industry standard cloud data center technology
- Cross-domain capabilities

The Cisco solution is offered through four alternative purchasing models that allow operators to fit the NFV solutions to their tolerance for implementation, operational and financial risk.

Cisco's NFV solution employs a multivendor approach based upon open standards and APIs. It is extensible by offering comprehensive modular capabilities that span the entire network operator architecture: cloud, video, mobile and fixed. It is elastic; it seamlessly and dynamically scales service and resources whenever and wherever they are needed.

Three NFV use cases illustrate the breadth of the Evolved Services Platform and NFV solution:

- Virtual managed services drastically simplify the current mode of operations for operators and speed up service delivery by leveraging various virtual network functions. This reduces operations cost by 65 percent and boosts revenue by 15 percent as compared to the present mode of operations.

- Virtual premium mobile broadband virtualizes all elements of a secure, reliable, and private mobile Internet system. Compared to a purpose-built premium mobile broadband the virtualized solution has 43 percent TCO savings over five years for the EPC function and 44 percent savings for the Gi-LAN (Interface between the private mobile network and the public Internet).
- Multiscreen cloud DVR provides a multiscreen cloud DVR alternative to physical DVRs located in the home. Its ease of use and flexibility compared to the present mode of operations provides at least seven percent revenue uptake and reduces TCO by at least 15 percent.

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