White Paper

Cisco Open Network Environment: Adaptable Framework for the Internet of Everything

Prepare service provider networks to harness network value, increase business agility, and achieve greater operation efficiency.

What You Will Learn

Service providers are being affected by a variety of trends that are both influencing their ability to deliver services flexibly, efficiently, and cost effectively, and threatening the viability and competitiveness of their businesses. To successfully respond and adapt to these trends, they must innovate to find better ways to deliver new and existing services faster and more flexibly, efficiently, and cost effectively. They must meet customer demands for better experiences and deliver greater value. The approach that service providers use to address these challenges provides the foundation they can build on to improve the overall ROI of their infrastructure.

Programmable networks provide one approach to meeting some of these challenges. Virtualization of network functions is another approach providers are pursuing to improve flexibility and service agility and significantly transform their economic cost models. Operations- and services-automation software capabilities are also required to dynamically accelerate and monetize the creation of new services. Solutions must address many different use cases and opportunities, necessitating a comprehensive and holistic approach that orchestrates programmable networking technologies along with multiple other powerful solutions. That is the vision of the Cisco® Open Network Environment (sometimes referred to as Cisco ONE).

This document presents current approaches to network programmability and provides an overview of the Cisco Open Network Environment. It also presents several use cases employing the Cisco Open Network Environment framework and technologies presented.

Challenge: Rapid Market Transitions and Emerging Business Opportunities Demand New Ways of Building and Managing Service Provider Networks

The proliferation of connected devices, new types of video offerings, dramatic changes in traffic patterns, the increasing demands for mobility among subscribers, and other factors, are exhausting the capabilities of traditional approaches to service delivery. Many of the new business opportunities presented by the growing connectivity of people, data, processes, information, and devices (the Internet of Everything) center on the analysis and monetization data in motion. Data in motion consists of real- and near real-time data generated by mobile and fixed connections between people, things, and processes. One of the primary opportunities for operators is monetization of virtualized network and cloud services while optimizing access, transport, and cloud infrastructure. The characteristics of these evolving and highly dynamic new services have dramatically changed the business environment.

The ways that applications are developed and evolve have also changed. Some applications come and go in weeks or months. Smartphone application developers alone release hundreds of apps around the world each day. Profitability for service providers hinges not only on their ability to monetize new services, but also on their ability to optimize the use of their infrastructure at the same time by increasing performance and reducing costs.

Advanced application delivery is an infrastructure that simplifies and highly automates crucial operations on a much larger scale. It must also enable more pervasive and meaningful interactions between the applications and the network, supporting on-demand responses to application requests, accelerating service deployment, and improving the user experience.

Service providers are seeking to simplify management tasks while optimizing network behavior for applications running on shared infrastructure. They are seeking to meet these challenges by:

- Monetizing new services at a huge scale, from thousands to hundreds of millions of customers
- Optimizing service delivery across a layered and very heterogeneous network
- Effectively managing traffic and session growth while economically managing unpredictable network capacity requirements
- Increasing business agility to rapidly take advantage of new types of applications and partnerships
- Becoming a valued partner in the ecosystem of the new digital economy

Network Programmability: Industry Initiatives and Diverse Approaches

The most innovative and forward-looking service provider and enterprise network operators are aggressively attempting to provide more open programmatic access to their network functions and services to make them more agile, flexible, and interactive while at the same time optimally aligning costs with potential new revenues. Several industry initiatives address these requirements. Software-defined networking (SDN) is an Open Networking Foundation (ONF) development that separates the control and data planes, with network intelligence and state logically centralized and the underlying network infrastructure abstracted from the applications. Service providers hope that SDN will contribute to more flexible, dynamic, and cost-efficient networks and facilitate the simplification of operation processes.

Network functions virtualization (NFV) is another initiative that promotes the use of virtualization technology to make many network functions available on demand on dispersed virtual machines, high-volume servers, and storage resources located in data centers, on network nodes, and on end-user premises. Defined by an industry specification group of network operators, the NFV initiative aims to transform the way that service providers design their networks by evolving standard IT virtualization technology to consolidate many network equipment types onto industry-standard, high-volume servers, switches, and storage. The NFV strategy is well aligned with the Cisco Open Networking Environment approach, with network service functions distributed among specialized hardware equipment and general-purpose computing in a cloud-based environment.

Other important innovations transforming service provider environments include policy, analytics, cloud computing, cross-domain orchestration, unified management, and open source technologies. Open APIs are being defined by the networking industry as part of other open technologies that enable applications to interact in networks through the use of representational state transfer (REST), Simple Object Access Protocol (SOAP), JavaScript, and other web technologies. The Open Cloud initiative is an attempt by the industry to come up with a consensus definition of an open cloud environment with a ubiquitous open source cloud computing platform for public and private clouds.

Cisco believes that not one but all of these useful innovations are important evolutionary steps toward greater network efficiency and flexibility and the continued competitiveness and success of service providers. Each individual architecture and technology suite alone does not address all challenges and use cases. What is needed is a comprehensive and orchestrated approach that makes the entire network stack more programmable as a

whole and the rich data within it more accessible to applications. This approach must include the bottom transport layer up through the forwarding and control planes, service orchestration, management, and application layers.

Such a software-based framework should also abstract network functions and provide associated open interfaces. The approach should allow both centralized and decentralized placement of network components such as network devices, dedicated servers, and application servers, along with close interaction between applications and network functions, both physical and virtual. The approach should also combine the benefits of distributed and centralized control functions in a hybrid mode, so that the optimal model can be used for any and all specific use cases.

Today, several vendors are trying to address the need for greater network and application visibility and interaction in service provider networks using three main approaches to provide greater programmability and automation (Figure 1). One approach exposes the APIs to existing network products to deliver an open programmatic interface. A second approach provides centralized controllers that deliver an abstraction layer to handle service orchestration, workflow management, and other functions; this approach requires open and standard agents in the network products to be programmed. A third approach uses virtual overlays.

Figure 1. Popular Programmability and Automation Options Available from Device and Technology Vendors

However, an evolutionary approach to greater programmability is preferred, given the existing network investments of enterprises and service providers. Solutions must also support a broad range of use cases and applications. The characteristics of a WAN are not the same as those of a data center network. Therefore, service providers must have access to all these options and more, according to their business needs, along with a consistent, logical framework of innovative technologies to use in application development and to create more advanced service delivery business models. As shown in the virtual overlay model of Figure 1, virtual and physical resources must be supported with consistency in operations; otherwise, operation complexity may prevent potential cost savings from being achieved.

There are many existing and evolving use cases with specific needs and demands within service provider environments. Therefore, a highly adaptable framework is required that combines the value of the intelligent network with openness, programmability, and abstraction across all the major network layers.

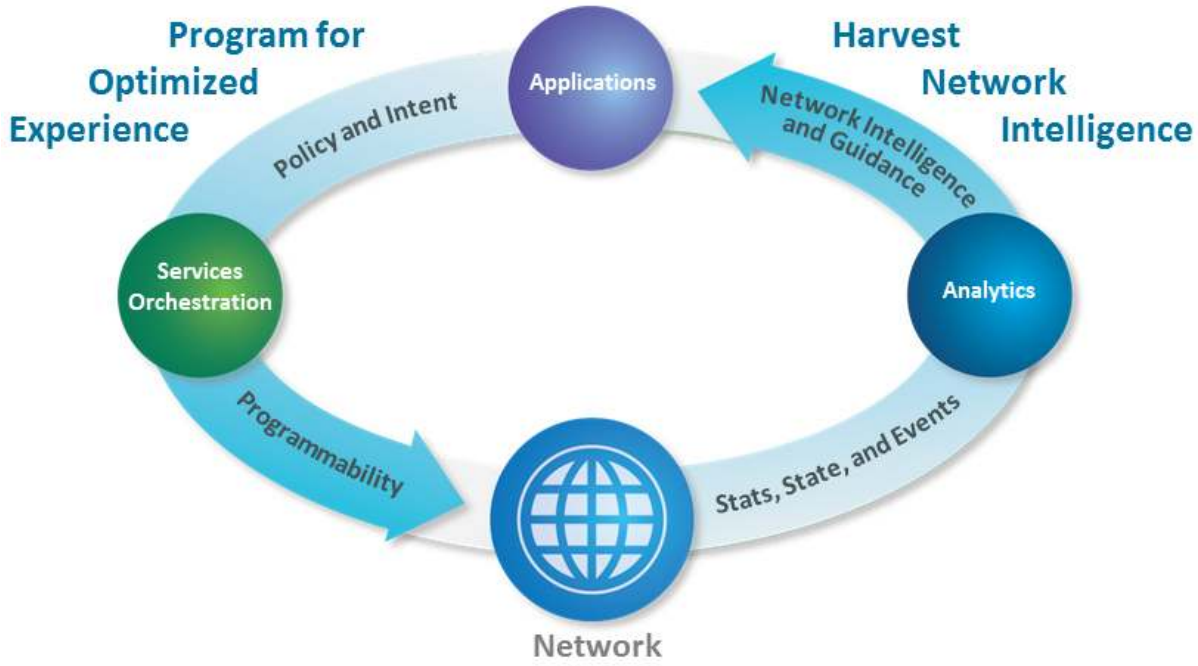
Solution: The Cisco Open Network Environment

The Cisco Open Network Environment is an open, customizable, and programmable software framework that can harness network value, increase business agility, and enable greater operation efficiency. Essentially, it enables customers to lower their capital expenditures (CapEx) and operating expenses (OpEx) and monetize new or existing services. “Open” means choice and flexibility for service providers: choice of protocols, industry standards, use-case-based deployment models, and integration experiences.

The foundation of the Cisco Open Network Environment is a bidirectional, continuous, closed feedback loop used to automate software processes, which are the building blocks of an intelligent communications path among four main components: network, analytics, applications, and services orchestration (Figure 2). This closed-loop communications path includes processes to:

- Get information from the network to perform analytics
- Provide intelligence and guidance to applications based on the analyzed information
- Apply business rules and policies to the orchestration systems
- Reprogram the network to adapt to current conditions and applications needs

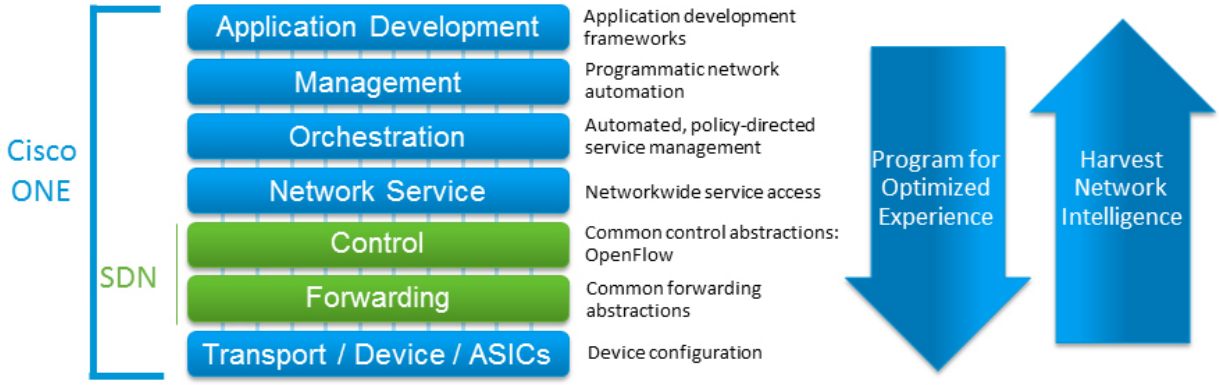
Figure 2. The Cisco Open Network Environment: Interaction Between Components for Service Creation



Typical service provider networks today are generating a tremendous amount of data that is difficult to collect and transform into information that can be used by various applications and services. This data includes millions of counters plus state, application, and customer information used by applications and tools, such as analytics engines, that policy engines can use in network programming, resulting in a better end-user experience and much improved resource utilization.

The Cisco Open Network Environment's dynamic closed-loop feedback of user, session, and application analytics delivered through policy programming uses one or more elements and virtual devices across the multiple planes in an intelligent networking system (Figure 3).

Figure 3. Cisco Open Network Environment Intelligent Networking System

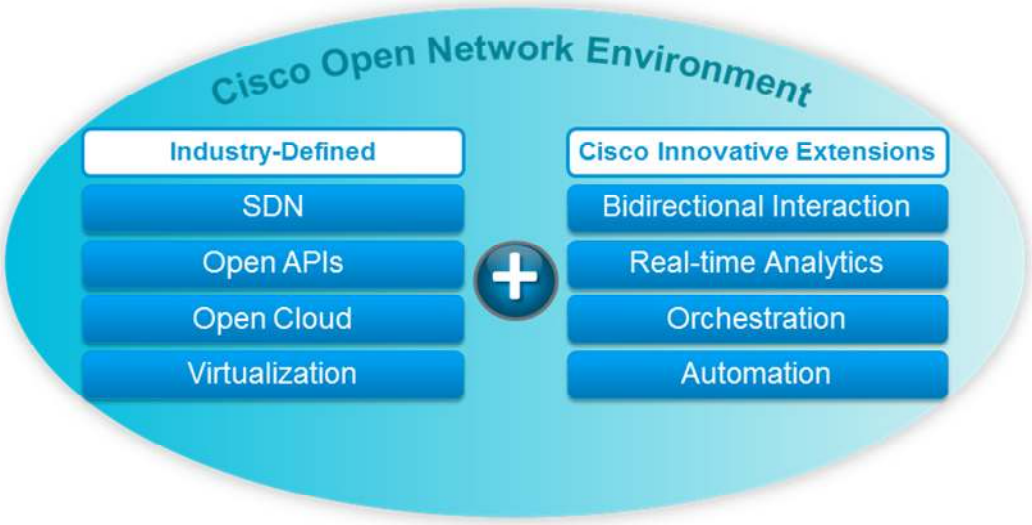


As the industry's most comprehensive framework for programmable networks, the Cisco Open Network Environment encompasses all the most promising open networking approaches, as described earlier, to achieve greater programmability and automation in networks. It includes:

- **Controllers and agents:** Cisco offers tools, technologies, and protocols that can be used to program network infrastructure and extract information across multiple entities. Protocols and technologies change over time, and application developers are more focused on actual tasks performed. Agents and controllers in the Cisco Open Network Environment will evolve across applicable platforms based on customer requirements and their use cases, including support for the Open Networking Foundations' OpenFlow and other standards that may be developed.
- **Programmable interfaces:** APIs for Cisco platforms are available that enable developers to write software applications that direct the operation of the network elements using custom business logic and to access data derived from capabilities built directly into network equipment. Cisco is providing an open software development kit that enables software developers to access, extend, or customize the comprehensive set of software functions provided by Cisco routers and switches running in Cisco IOS® Software, the Cisco IOS XR, and Cisco NX-OS Software.
- **Virtual overlays:** Large-scale virtualization of network infrastructure and service resources blurs the line between physical and logical network functions. In cloud and virtualization environments, one consistent goal is abstraction of network functions from the underlying physical network to allow greater flexibility and mobility of workload location and the efficient allocation of resources. This offering expands existing and widely deployed capabilities with REST APIs, OpenStack Quantum APIs, and multihypervisor support (including open source hypervisors and hypervisors from VMware, Microsoft, Citrix, and Red Hat).

As mentioned earlier, a variety of important industry initiatives are promoting programmable networking (shown in Figure 4 in the boxes at the bottom left). The Cisco Open Network Environment has expanded the focus beyond these initiatives to address broader challenges (shown in Figure 4 in the boxes at the bottom right).

Figure 4. Cisco Open Network Environment Scope



- **Orchestration:** In the same way that the various instruments in a symphony orchestra are brought together in musical orchestration, the infrastructure for computing, which has become increasingly complex, is now being orchestrated through software tools that manage configuration and chaining of the component functions required in service delivery. Current trends demand that this orchestration be achieved in near real time. Computing, networking, storage, and management resources are linked to business requests for applications, data, and infrastructure. Cisco is extending orchestration beyond the data center, where it is already familiar, to include the WAN, which becomes WAN orchestration. This end-to-end approach includes policies, service levels, workflows, network functions, provisioning, billing, metering, change management, and other service components that can be swiftly scaled up or down according to business requirements.
- **Automation:** With network, storage, computing, and management environments becoming increasingly complex, automation is needed to increase productivity beyond that provided by the manual processes used by IT. Automation of processes for provisioning, service creation, troubleshooting, and other activities are critical concerns of IT departments today. Cisco is working to automate service creation, developing tools for self-service interfaces and real-time interaction between applications and network infrastructure. Automated service provider environments will enable automated adjustment of network resources in response to business policies and shifting business requirements.
- **Bidirectional interaction:** The intelligent network is able to gather and use information to optimize service delivery. The bidirectional feedback loop mentioned earlier combines real-time analytics (such as up-to-the-second data about congestion and failures) with long-term analytics (such as subscriber behavior over time) to inform business policies that encompass marketing campaigns, pricing models, service-level agreements (SLAs), and more. The information can also be used to program the network to adapt to current network conditions and application needs and subscriber profiles.

- **Real-time analytics:** As mentioned previously, real-time analytics gathers data such as the state of the network, what a user is doing (for example, downloading a large, high-definition video), and where a user is located. When combined with long-term analytics, real-time analytics allows administrators and software tools to make immediate decisions related to network resources and business policies. Today, the use of real-time analytics is mostly restricted to simple adjustments (for example, to provide more or less bandwidth to a given user). The combined use of both types of analytics is unique. With this combination, and with automation and orchestration, the response by network administrators and automated systems can be more immediate, leading to a much better user experience and a more highly optimized network.

Cisco Open Network Environment Building Blocks and Software Suites

To implement the operation models and technologies discussed here, including various hybrids, the Cisco Open Network environment offers the building blocks and software suites listed here. Note that the product portfolio is evolving and will grow over time as the industry adopts and expands the underlying principle of network programmability.

- **Cisco ONE Platform Kit (onePK):** Cisco onePK is an easy-to-use toolkit that enables software developers with various skill sets to access, extend, or customize the comprehensive set of software functions provided by Cisco routers and switches and to provide the control needed to keep the network environment always on and secure. Cisco onePK provides a robust API library that allows users to create applications and services for their network needs. Applications can be written using Cisco onePK in C or Java using the development tools of choice and compiled to run as a process hosted on a Cisco switch or router, on a services blade, or on a separate Linux server. A secure channel communicates through a software abstraction layer and a variety of southbound APIs to the Cisco IOS, Cisco IOS XR, and Cisco NX-OS operating systems embedded on various Cisco platforms.
- **Cisco Nexus® 1000V Series Switches:** Cisco Nexus 1000V Series Switches provide a comprehensive and extensible architectural platform for virtual machine and cloud networking. The switches are designed to accelerate server virtualization and multitenant cloud deployments in a secure and operationally transparent manner. Fully compatible with popular industry virtualization platforms, the Cisco Nexus 1000V Series provides advanced virtual machine networking based on the Cisco NX-OS operating system and IEEE 802.1Q switching technology and Cisco vPath technology for efficient and optimized integration of virtual network services. It also supports Virtual Extensible LAN (VXLAN) technology for cloud networking. These capabilities help ensure that the virtual machine is a basic building block of the data center, with full switching capabilities and a variety of Layer 4 through 7 services in both dedicated and multitenant cloud environments. With the introduction of VXLAN on the Cisco Nexus 1000V Series, network isolation among virtual machines can scale beyond traditional VLANs for cloud-scale networking.
- **Cisco ONE controller:** The role of a controller is to provide APIs and programmability for specific functions that work across multiple entities and, usually, rely on an agent to preprocess or manage the local state on a particular device. The Cisco ONE controller has been designed to use southbound APIs such as Cisco onePK, OpenFlow, Path Computation Element (PCE) and Path Computation Client (PCC) Protocol (PCEP), and Interface to the Routing System (I2RS) that communicate with agent software on the Cisco ASR 9000 Series Aggregation Services Routers, Cisco Catalyst® 6500 and 3000 Series Switches, and Cisco Nexus 7000 and 3000 Series Switches.
- **Cisco nLight technology multilayer control plane:** This component of the Cisco Open Networking Environment has been designed using extensions to existing standards such as Generalized Multiprotocol Label Switching (GMPLS) and related protocols. It was designed to enable the sharing of the proper amount of

information between network layers and is an example of the introduction of SDN programmability into the network. Cisco nLight technology provisions failover and backup paths in real time without wasting resources.

- **Cisco Network Positioning System (NPS):** This technology provides network Layers 3 through 7 with application information about the best path to the content, improving consumer and business experiences while reducing costs. Cisco NPS works in conjunction with Cisco Quantum orchestration software and with the Cisco Prime™ portfolio of enterprise and service provider management offerings to extract and analyze network data to determine the optimal resource location (for example, in a data center) that traffic should access as well as the optimal path.
- **Cisco Quantum Software Suite:** This software addresses two important concerns of service providers: how to find new monetization opportunities and how to optimize networks for the best practical use. Cisco Quantum accelerates service deployment, quickly enabling multiple service scenarios while also providing simple access and correlation of intelligence from various points of the network. The suite is an innovative new component of the Cisco Open Network Environment framework for the delivery of new network services. Cisco Quantum intelligent software currently includes self-optimizing network capabilities, Radio Access Network (RAN) optimization, real-time analytics, policy, WAN orchestration, and abstraction functions that work together in the application environment through open APIs to enable an elastic and virtualized infrastructure in the data center and throughout the WAN and RAN. These Cisco technologies enable service providers to take advantage of new business opportunities while delivering new, better, and more personalized connected experiences and to monetize data in motion as they move toward the Internet of Everything.
- **NFV products:** Cisco has developed an array of products based on NFV principles and has already virtualized a variety of network functions, including those shown in Figure 5.

Figure 5. A Sampling of Cisco Virtualized Network Functions

Other Cisco products developed and based on NFV principles, include:

- Cisco Cloud Service Router (CSR) 1000V
- Cisco Prime Network Registrar (Domain Name System [DNS], Dynamic Host Configuration Protocol [DHCP], and IP address management [IPAM])
- Cisco Access Registrar (RADIUS and Diameter authentication, authorization, and accounting [AAA])

Cisco envisions architecture in which NFV is both a replacement for hardware-specific network functions and a complement to hardware-specific functions. The role of hardware in scaling and accelerating software functions remains the same, and Cisco is working toward both software- and hardware-based approaches that meet service provider performance requirements. Not every function can be migrated to general-purpose computing environments. Instead, the applicability of virtualization depends on the relative performance characteristics of the existing function and the specific operator's demands for service delivery.

As stated earlier, the set of product building blocks and software will continue to evolve, guided primarily by service provider needs and specific use cases. At any given time, several new products or software modules will be in proof-of-concept testing to verify their functions, performance, and capability to meet the business needs that instigated the development.

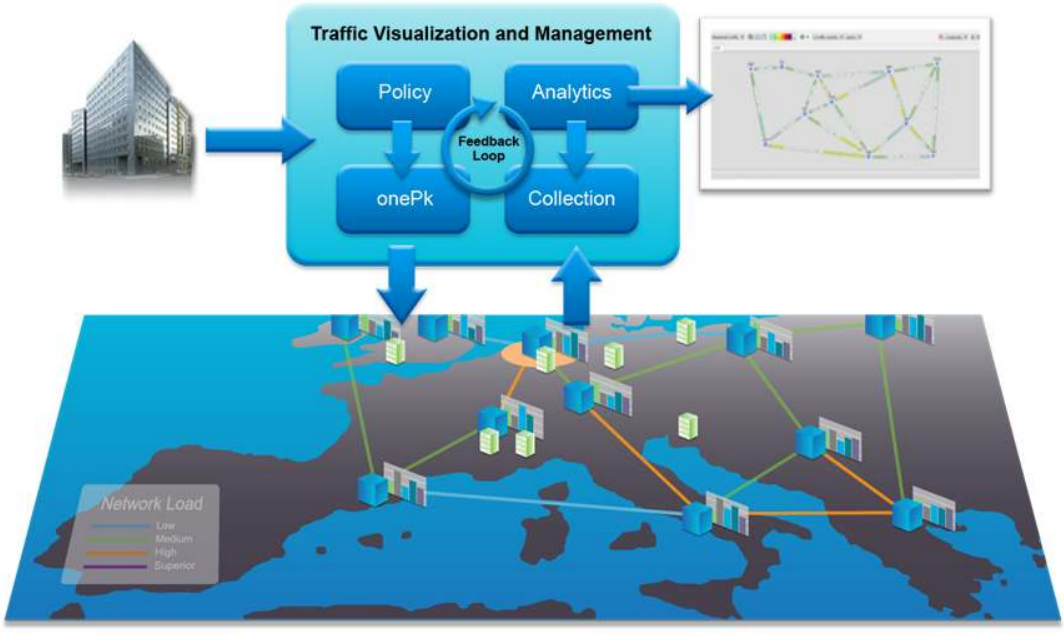
Use Cases for the Cisco Open Network Environment

The Cisco Open Network Environment encompasses a broad range of use cases. The uses cases presented here are just a sampling. Customers with specific challenges not discussed here are urged to follow up with Cisco to explore how Cisco Open Network Environment architectures and solutions can best meet their needs.

Use Case: Traffic Visualization and Management for Service Providers

Currently, the existing operations and administrative tools used by service providers to extract information from the network are complex, manual, and time consuming. They therefore require a significant amount of time to set up, and significant time is needed to change network configurations and apply business policies to help guarantee SLAs. With the Cisco Open Network Environment, new SLAs can be enabled and delivered in real time. Automated applications can be set up that get data, check policy, and set new conditions and adapt across multiple domains and network elements in real time (Figure 6). Cisco Open Network Environment technologies for traffic visualization and management include the Cisco OnePK toolkit, policy and analytics engines, and enhanced policy-based forwarding.

Figure 6. Traffic Visualization and Management



In the traffic visualization and management use case, the network connection between a business customer and a cloud service or content provider is optimized. Cisco ONE controllers and agents provide a bidirectional feedback loop with policy and analytics engines. The solution provides real-time multilayer monitoring of transport, IP MPLS, and services between a business user and the user's service provider and content providers. This information allows a provider to adapt to any network condition, including congestion and packet loss, and enables creation of new restoration paths to meet the business SLAs.

In the traffic visualization and management use case, the network notifies applications when there is a network change, a feature not seen at the application layer today. The Cisco Open Network Environment solution can measure this change in real time and adapt immediately to meet the SLA.

Use Case: Elastic Services Creation and Delivery for Simple, Integrated, Application-Based Service Ordering

In contrast to today's often fragmented and complex approach to the ordering of network services, in the elastic services delivery use case (Figure 7), the business workflow engine does not need to understand complex network tasks, and the Cisco Open Network Environment provides an easy way to introduce network services to higher-level workflows and sales processes. Service-specific controllers guide virtual machine orchestration platforms and automatically adjust to network and application changes. The multilayer and multiprotocol path computation function guides traffic engineering, helping ensure that network resources are available for optimal application performance.

Figure 7. Elastic Services Delivery Use Case

With elastic services delivery, an enterprise orders IT services through an online portal. The service provider's order processing system and workflow manager receives the order and verifies the request and handles all processes not relevant to the network infrastructure. The workflow manager activates the Cisco Prime Fulfillment suite, which handles the programming of the network and data center infrastructure, providing a central point to initiate service and application-specific provisioning and programming of network and data center resources.

This workflow manager understands the simple service request and manages the much more complex workflow that is associated with it by activating the data center orchestration platform by using an agent to launch a services controller. The controller understands which resources are required for the service and monitors the virtual machine orchestration platform to set up and configure relevant data center resources for the service. The workflow manager then communicates with the controller on the WAN side to request network resources to connect the various enterprise locations with their respective data centers based on their locations and service availability. Traffic demand is automatically correlated with the current traffic load and performance to determine the paths and resources for the application.

In this use case, the network complexity is hidden from higher-level applications, and the high level of automation increases overall business agility.

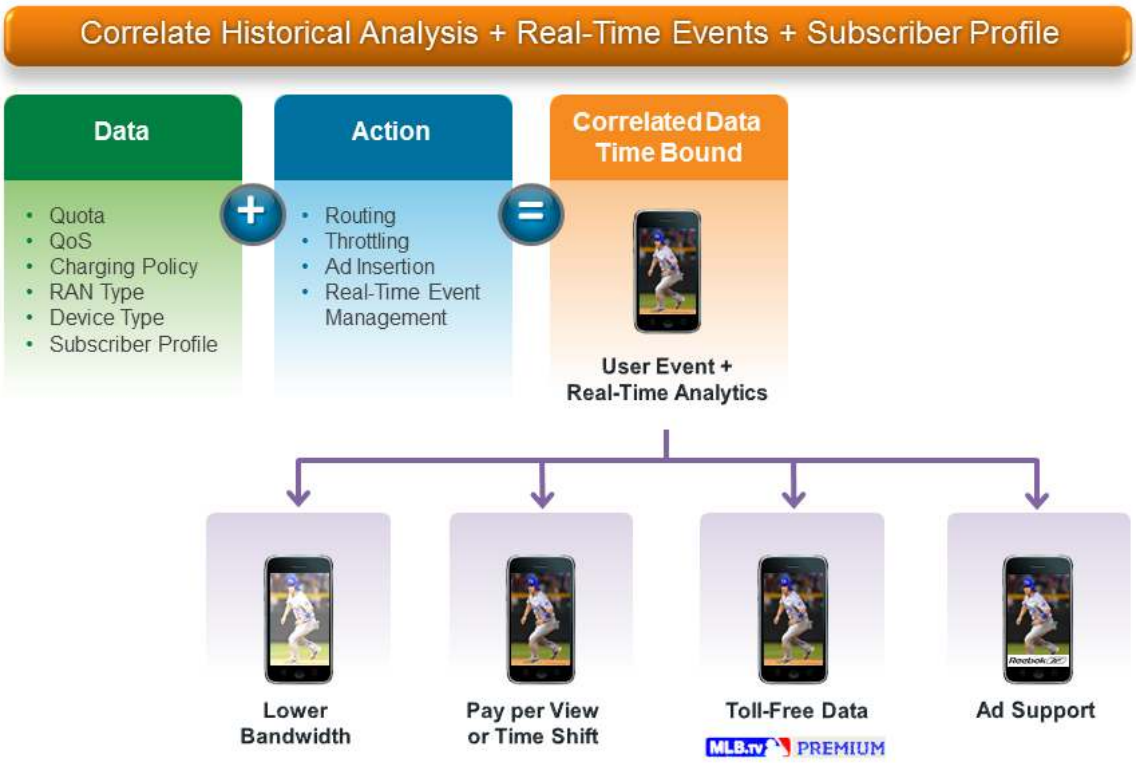
Use Case: Premium Video Everywhere

As mentioned earlier, today a lot of valuable and untapped information is hidden in the network; this use case monetizes this information. The combination of data collected about the user's behavior, real-time events analysis (for example, a fault occurred because the network is overloaded), and the subscriber's profile (for example, the services subscribed to and the subscriber's preferences) can be used for a variety of purposes by service providers. In Figure 7, video is used to demonstrate the value of the Cisco Open Network Environment's closed loop communications among network, analytics, applications, and orchestration. In this example, the provider can use information about the current user activity (user event) and current network state (real-time analytics) plus the longer-term information collected (historical analysis and user profile) to make intelligent business decisions to achieve the best outcome for both subscriber and network operations. For example, the provider might decide to reduce the amount of bandwidth available for the video and reprogram the network resources accordingly because the network is congested. The provider could also decide to incentivize a user who consumes a lot of video to view current video requests during off-peak hours instead of during peak-use hours for a lower price. The provider's application also could extend an offer that encourages the subscriber to upgrade service for a better, faster experience.

The toll-free data offer decision branch in the example enables the provider to challenge over-the-top services, which are often of low value to the provider and often result in a poor user video experience. In partnership with a content provider, the service provider's application, using the combined analytics, can suggest to the subscriber that the same video content be viewed on a partner site for a much better experience. For example, in Figure 8 the subscriber accesses a Major League Baseball site to watch games. In this case, the toll-free concept relates to the fact that Major League Baseball TV (MLB.TV) will pay the overage fees for the service. In another decision branch based on the combined analytics, advertising support may also be offered, with a content partner (for example MLB.TV) and the service provider sharing the advertising revenues.

These are just some of the new business models and special offers possible when more detailed information is available to service providers from multiple sources through solutions available in the Cisco Open Network Environment.

Figure 8. Premium Video Everywhere Use Case

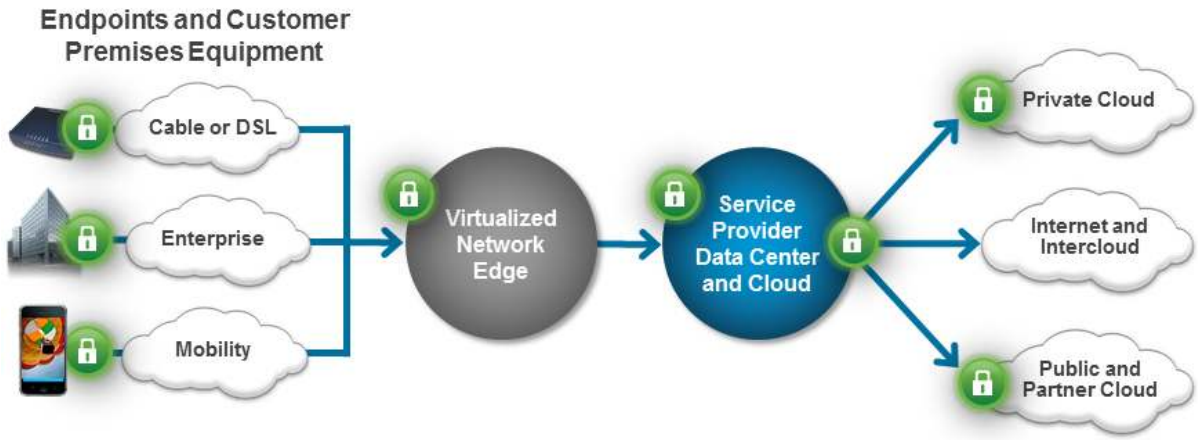


Use Case: Security as a Service

Installing and continuously maintaining security software and keeping security profiles current can be inconvenient. Timely upgrades are required, and these can be especially time consuming for users with multiple devices. Service providers can deliver a secure network and device infrastructure for subscribers as a service using solutions provided by the Cisco Open Network Environment.

Threat-mitigation processes, instantiated in virtual machines, can be quickly activated in response to threats and inserted into the service chain for near-real-time solutions as close to the source as possible. The products in the Cisco Open Network Environment provide the capability to program network endpoints through APIs, controllers, and orchestration software. Network and security policies can move with each subscriber's workloads. Network Admission Control (NAC) and deep packet inspection (DPI) can be used in the cloud to offer a clean-pipes solution. Security services can be dynamically chained together and instantiated to form a service chain to mitigate a specific threat or to provide a managed security service on distributed computing resources (Figure 9). This type of threat defense service can be applied to the network, data center, and cloud and the applications they serve.

Figure 9. Security as a Service Use Case



Cisco Open Network Environment Professional Services

To complement the products and technologies in the Cisco Open Network environment, Cisco offers a strategy workshop, proof-of-concept and other consulting offerings, and global 24-hours-a-day technical support to service providers who want to begin exploring use cases that encompass the Cisco Open Network Environment vision. Cisco professional services personnel work with provider customers to validate use cases, identify technical challenges, and develop a roadmap to support successful adoption of new technology initiatives that meet customer needs. The Cisco Open Network Environment team can help customers accelerate application deployment with Cisco onePK APIs and development kits, increase operation efficiency using OpenStack and Cisco Intelligent Automation orchestration tools, and help ensure a positive customer experience through successful proof-of-concept tests and preproduction pilot deployments.

Conclusion

To take advantage of today's opportunities and address the challenges as networking services and requirements rapidly evolve toward the Internet of Everything, service providers need a comprehensive and networkwide orchestrated approach that reduces operation complexity, enables openness and programmability for applications, and contributes to consistency in operation processes.

The Cisco Open Network Environment is a customizable software framework of use-case-based modular technologies that service providers can use to harness the full value of their intelligent networks. It provides openness, programmability, and abstraction at multiple layers along with a choice of protocols, industry standards, and use-case-based deployment models. The Cisco Open Network Environment provides the foundation for a dynamic feedback loop of user, session, and application analytics through policy programming. The Cisco Open Network Environment promotes a new software development model. Instead of only providing software for Cisco platforms and going through testing and pilot phases before the software is released, Cisco is making software available quickly for proof-of-concept testing by customers, enabling them to move as quickly as possible to full deployment.

The Cisco Open Network Environment protects the existing investments of our customers while extending the capabilities of proven infrastructure to reduce risk and deployment time. The features of the Cisco Open Network Environment can be deployed incrementally, according to each provider's most pressing needs. We encourage you to try Cisco next-generation Internet architecture solutions for mobile-, video-, and cloud-based services using the Cisco Open Network Environment framework today to start reaping the benefits of tomorrow's network and software innovation.

For More Information

- Cisco Open Network Environment: http://www.cisco.com/go/one
- Network Functions Virtualization Initiative – ETSI announcement: http://www.etsi.org/news-events/news/644-2013-01-isg-nfv-created
- The Internet of Everything: http://www.cisco.com/web/about/ac79/innov/IoE.html
- Cisco Quantum: http://www.cisco.com/en/US/products/ps12971/index.html

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