Cisco Evolved Programmable Network: Enabling the Shift to New Business Models

Virtualization of network functions is an approach that has been successfully implemented in the data center, and service providers are now trying to improve flexibility and service agility and significantly transform their economic cost models. Service provider-centric software capabilities for operations and services automation are also required to accelerate and monetize the creation of new services.

Service providers already face enormous demands on their network and data center assets from exploding mobility, video, and cloud-based applications. We are now in the era of the Internet of Everything (IoE) that will accelerate new metrics of scale never seen before. How can service providers reduce costs and improve efficiency and resource usage, even as they expand their business for new revenue-generating services?

According to The Cisco Visual Networking Index™ (Cisco VNI™), global network transformations will be accelerated by exponential growth in IP, cloud, mobile, video, and machine-to-machine (M2M) traffic growth. IP traffic alone will grow 300 percent to 1.4 zettabytes annually by 2017. With exponential growth comes opportunity. Cloud service providers have changed the rules of an age-old service-delivery game. Profitability is about rapidly delivering customer-focused, application-based services over lean, agile, automated IPv6 cloud-based networks.

In response to this game-changing shift, traditional telecommunication service providers will evolve their business models by taking advantage of innovations in software-defined networking (SDN) and Network Function Virtualization (NFV) technologies. Rewards of evolution will include intelligent flexibility for offering real-time repurposing of physical and virtual infrastructure - allowing providers to monetize and accelerate service delivery and capitalize on their unique link to the consumer and the data center.

Service provider cost and complexity are rising faster than revenue. To extract revenue from services, service providers are better positioned to connect end users to applications by joining data centers with programmable multilayer networks. In doing so, providers can redefine their value by simplifying operations and business process and accelerating time to revenue. The Cisco® Evolved Programmable Network (Cisco EPN) delivers an innovative multilayer programmable network infrastructure that enables all the positive business value of connecting users to applications.

Solutions must address many different markets and business opportunities, necessitating a comprehensive and holistic approach that orchestrates programmable networking technologies along with multiple additional unique and powerful network and cloud offerings.

The Cisco EPN provides an open and programmable network architecture that enables a new class of IPv6-based carrier cloud services and facilitates the shift to new business models. With the inherent policy and automation innovations, operators can optimize the usage of their network and data center assets, helping them reduce operating expenses by 65 percent while accelerating new revenue growth at up to five times their current rates.
Cisco Evolved Programmable Network Overview

The Cisco Evolved Programmable Network is the natural evolution of the Cisco IP Next-Generation Network (IP NGN). The Cisco IP NGN established a substructure for ubiquitous IP transport and network services. The Cisco EPN improves the network infrastructure by uniting physical and virtual devices to form an end-to-end, unified multilayer fabric for an open programmable and elastic network extending into the data center.

The Cisco EPN is the foundation layer of the Cisco Open Network Architecture for Service Providers that integrates the physical and virtual network, compute, and storage infrastructure that works together with the Cisco Evolved Services Platform (ESP) to create a common operational model, allowing automation and orchestration of resources and services (Figure 1). Using open application programming interfaces (APIs) across and between all layers of the Cisco Open Network Architecture, network operators can automate a new class of IPv6-based carrier cloud services across both multivendor and traditional environments. The Cisco Open Network Architecture is Cisco’s vision for an open, programmable framework that allows service providers to harness untapped network value, improve business agility, and simplify operations while setting the stage for new business models, revenue, and profits.

Figure 1. Cisco Open Network Architecture

Business Benefits

The Cisco Evolved Programmable Network works dynamically together with the policy and automation capabilities of the Cisco Evolved Services Platform to quickly deploy new personalized offerings through innovative services modules and help providers:

- Simplify multilayer network operations with less-complex, automated workflows that yield up to 80-percent reduction in operational complexity.
- Significantly reduce the service-creation lifecycle. A cloud-based video service can move from concept to revenue in 6 weeks, compared to years in a traditional environment.
- Gain visibility, control, and multilayer optimization of the network through computing and control functions that use open APIs. As a result, user-directed Internet services can be provided, cutting production cycles by 75 percent.
Programmable Networking

Operators need solutions that can handle the increasing bandwidth demands of today's mobile-, cloud-, and video-based networks yet manage trillions of machine-directed events that are already happening in real time around the world. To do so will require both new hardware and software technologies as well as systems innovations. Operators do not rebuild their infrastructure overnight, so new capabilities must be incorporated into their existing deployments, while preserving what is working in the areas of resiliency, scale, and rich features. However, by selecting the right IP network infrastructure today you can help ensure that as technologies such as NFV, SDN, and open source APIs are used, the objectives of greater service agility, less complexity, and increased profits are achieved.

Service provider networks are static, complex, and inefficient. As complicated and intensive as the network and operations support and billings systems (OSS/BSS) seem, they hold the keys for operators to gain competitive advantage. In addition, a pragmatic migration approach is required to shift from the current operating model to an intelligent, converged architecture capable of autonomic change based on customer service demands. Cisco Evolved Programmable Network delivers innovative advances in virtualization and programmability while providing the automation and real-time analytics needed to intelligently converge, virtualize, and automate services.

What should carriers consider as they look to transform their business?

- The breadth of infrastructure solutions offers an opportunity to deliver meaningful levels of network convergence to simplify and reduce operational costs. The data center and network are fusing together with the advent of cloud-based service offerings, making it critical to be able to shift and scale bandwidth, control, and compute resources to meet business demands.
- Comprehensive orchestration capabilities should be open and provide multivendor support for best-of-class innovations and services.
- A suite of Virtual Network Functions that span across mobile, video, security, and managed business services provides the best opportunity to take full advantage of cloud resources.
- Validated design and performance guides are needed across both network and cloud service offerings.

The Cisco EPN was designed to use SDN, NFV, and open source technologies to enable the delivery of innovative service offerings based on the following key architectural tenets:

- **Open**: This architecture combines best-in-class capabilities from an open ecosystem of technologies from any vendor to deliver services in the ways that customers prefer.
- **Elastic**: Elastic architecture enables operators to dynamically scale existing services while optimizing network and data center assets, creating the “offers” that can be deployed anywhere and scaled on demand when and where they are needed.
- **Extensible**: This comprehensive suite of capabilities enables applications to be linked to service attributes and policies that allow the operator to dynamically deliver personalized services.
- **Virtualized**: Network Function Virtualization (NFV) is an essential capability for enabling new business models and cloud-based service offerings. Cisco has developed an extensive set of virtualized network functions (VNFs) across all technology domains to enable operators to create dynamic services that span the physical and virtual elements of the Cisco Evolved Programmable Network.
- **Secure:** Intelligent threat protection with network-enforced common Policy-Based Routing (PBR), secure unified access, and content authorization capabilities are based on user context management, enabling operators to secure the transition to cloud-based service offerings. Threat-mitigation processes, instantiated in physical or virtual elements, can be quickly activated in response to threats and inserted into the service graph as close to the source as possible, enabling near real-time security solutions. This type of threat defense service can be applied to the network, data center, and cloud and the applications they serve.

- **Resilient:** Elastic scale and dynamic resource allocation improve our ability to predict the unpredictable and enable the Cisco EPN to be able to withstand or recover quickly from difficult situations. Zero-packet, zero-topology loss (ZPL/ZTL), vector packet processing (VPP), and In-Service Software Upgrade (ISSU) capabilities enable operators to deliver “always-on” premium services at scale with guaranteed service-level agreements (SLAs).

### Evolved Programmable Network: Enabling New Service Offerings

Providers can expect to transform the business models when they harness the combined power of the Cisco Evolved Programmable Network and Evolved Services Platform (ESP). In today’s environments, many services require a complex operation of hardware, management tools, and business processes. As a result, deploying new services often takes many months. Cisco ESP services modules can provide prepackaged, end-customer solutions that can be turned up in minutes and scaled elastically across the Cisco EPN as business needs dictate.

The modules also provide a unified, transparent services environment that allows service providers to collect and derive untapped business value with rich, real-time, and long-term analytics. Service providers could engage their customers in new ways, allowing the customers to add new virtual managed network services, upgrade to cloud digital video recording (DVR) in their home, or activate a new premium mobile broadband service or bandwidth on demand using a self-service platform that automatically provisions them in minutes.

### Virtualized Managed Services

Service providers can use the modular software capabilities of the Cisco ESP to rapidly create and deploy new network services across their physical and virtualized infrastructure - the Cisco EPN - as illustrated in Figure 2. Here, each of the virtualized managed service capabilities, such as firewall, load balancer, and wide-area acceleration, are deployed as a VNF on virtual machines operating on standard compute server blades located in a service provider data center.

In today’s environments, operators would have to manually interconnect and provision all physical devices involved in the service separately, using multiple management applications or operations environments. Using the Cisco approach for virtualized managed services instead yields significant advantages over the traditional approach. Operators can realize a revenue increase of up to 15 percent from revenue acceleration, higher attach rates, cross-selling services, and increasing down-market customers. In addition, the operator can reduce its operating expenses (OpEx) by up to 65 percent with savings from sales labor, service fulfillment, time to repair, and maintenance costs. Enterprises can also focus on innovating while realizing significant total cost of ownership (TCO) savings. Early results estimate the enterprise can realize an 80-percent faster application delivery time and a 30-percent reduction in data center infrastructure cost.
In this example, the network operator can create a catalog of customized service offers that they make available through the active service catalog. The operator uses the business logic of the service and resource orchestration modules to start the virtual machines, activate the VNFs, and dynamically create the specific service chain across the physical and virtual elements of the Cisco Evolved Programmable Network, creating appropriate linkages that support the service profile and steer the customer traffic through them.

**Figure 2.** Virtualized Managed Services (vCPE)

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**Key Technology Innovations**

A systems approach is critical to migrating operator infrastructure to gain the business benefits of a Cisco Evolved Programmable Network. Operators that wish to garner these benefits must consider many of the advances in hardware and software enabled by SDN, NFV, service orchestration, and open API technologies. The Cisco ESP serves as the modular orchestration engine, which provides business logic and policy application software modules to automate service delivery while optimizing the use of network and data center assets. These innovations extend across the physical and virtual elements from unified access, core, edge, and optical, and into the data center as illustrated in Figure 3. A few examples of these technology innovations include:

- Advanced silicon
- Network virtualization (nV)
- Network as a fabric
- IP + Optical convergence
- Open APIs
Advanced Silicon
Cisco leads the industry in advanced silicon for networking applications, and recently we developed the nPower X1 Family of network processors with key advances that include the ability to support massively scalable bandwidth. With more than four billion transistors, providing the ability to deliver 400 Gbps on a single chip, the nPower X1 enables multiterabit scale and the raw processing power to manage trillions of machine-directed events. It’s an application-specific integrated circuit (ASIC) built to power advances in SDN and NFV technologies.

The nPower X1 silicon enables highly scalable control planes with a programmable network processing unit and advanced memory management so that service providers can customize code sizes - almost infinitely - for virtually any instance, and yet it’s optimized to manage hundreds of millions of transactions per second. This capability offers in-real-time re-programming to meet the needs of dynamic event processing for the Internet of Everything (IoE). The nPower X1 also offers industry-leading compute scale, allowing it to reach entirely new levels of processing information, moving from millions of operations per second (MOPS) to now trillions of operations per second (TOPS). In fact, the multicore processing of IoE events means that the nPower chip is capable of adapting to the “machine speed” rates that are required in “new” conversations between people and things, people and smart devices, and things to one another.

Network Virtualization
Cisco network virtualization (nV) technology intelligently blends the network edge, aggregation, and access layers into a single system, deliver up to 70-percent OpEx savings, increase network capacities, and accelerate end-to-end IPv6 service deployments. Cisco nV technology enables the aggregation and access nodes to be treated as a single virtual entity, enabling zero-touch deployments, integrated analytics, and single-click software upgrades. Cisco has expanded the nV technology to scale the support for virtual network extensions and autonomic operations into a single system that may span fixed, mobile, and cable access; edge; as well as optical networking elements.
Network as a Fabric

It’s not just advances in silicon but system-level innovations that are required to build what can be called a “central nervous system” for the network. Advanced virtualization capabilities of Cisco IOS® XR software allow virtual router instances to run on virtual machines, enabling service slicing for elastic on-demand delivery across the Cisco service provider router portfolio (for example, Cisco Prime™ Network Control System [NCS], Cisco Carrier Routing System [CRS], and Cisco Aggregation Services Routers [ASRs]). This virtualization capability can be integrated transparently with the Cisco Unified Computing System™ (Cisco UCS®) and the Cisco UCS Director Dynamic Fabric Automation software that enables workload mobility in the data center. Working together allows for flexibility to shift and redirect core, edge, and optical functions in real time, while combining the innovative capabilities of nPower silicon with the best-in-class general-purpose silicon to take advantage of the compute functions in the data center across the operator network.

Simplifying the Network: IP + Optical Convergence

Many of the cloud and over-the-top (OTT) providers are using 100-Gbps optical transport technologies to connect their data centers for maximum scale and reduced cost. Furthermore, they’re minimizing the layers involved, running IP directly over dense wavelength-division multiplexing (DWDM) to cut down on the amount of equipment needed and simplify operations. The 100-Gbps service represents a timely and critical boost in transport services. It’s a critical enabler for service provider network and data center interconnects to scale in response to service evolution and ever-increasing bandwidth demands.

In order to optimize the benefits of 100-Gbps service, many aspects of the network also must be optimized, and that optimization involves reevaluating current network architectures. IP and optical networks have operated independently, preventing integration and limiting the ability to share network intelligence in real time. But these two layers cannot continue to operate as completely separate entities. They need to interact with one another and allow operators to react to customer demand within minutes rather than months.

Networking technologies such as Cisco nLight™ technology defines a multilayer control plane that allows service providers to integrate the management of these previously independent network layers and intelligently share relevant information. Using this approach, service providers can reduce network capital expenditures (CapEx) and operating expenses (OpEx) while meeting or improving SLAs for mobile, video, and cloud services.

Through a series of network enhancements, it’s possible to converge the IP and optical layers to create a control plane where the two can dynamically share information, adding intelligence for real-time updates between the two and making each layer aware when the architecture changes. With this model, much of the human intervention is eliminated, as well as errors associated with that intervention, thereby accelerating service delivery so that service providers can more quickly fulfill their customers’ requests and get revenue-generating services to market faster.

The Cisco nLight control plane uses a client-server model based on standardized Generic Multiprotocol Label Switching (GMPLS) where information, in the form of service-based parameters, flows from the “client”, the IP router interface, to the “server”, the DWDM network, and conversely. Relevant information is harvested one layer at a time and then shared across layers to automate network deployment and service creation. The Cisco nLight control plane supports Packet over DWDM, Packet over Packet Transport, Packet over Optical Transport Network (OTN), and multiple layers of Packet over any Transport over DWDM.
Previous generations of DWDM equipment have not supported software-configured “any-to-any” connectivity. Directing any add-drop channel (client) to any multidegree composite signal (trunk) required manual fiber recabling. The recent advent of colorless, contentionless, and omnidirectional capability in reconfigurable optical add-drop multiplexer (ROADM) equipment makes software-configured “any-to-any” DWDM connectivity a reality. This added ROADM function means that Cisco nLight control-plane technology can be meaningfully extended to the DWDM layer to cover ROADM features for zero-touch optical agility for the first time. The addition of Flex Spectrum technology is another innovation within the ROADM that allows the network operator to match the bandwidth required to the optimal amount of optical spectrum consumed.

With the per-layer technology advancements and Cisco nLight control-plane automation, the 100-Gbps service between two business locations can now be fully automated across the IP and optical transport layers. A converged network management system that uses the Cisco nLight control plane to signal across layers enables the IP and optical network operators to create and optimize their deployments. Both operational groups can see and understand the end-to-end workflow and authorize the resources for their respective portions of the network.

Multilayer optical control-plane technologies such as Cisco nLight technology allows service providers to integrate these previously independent network layers and intelligently share information. Combined with flexible DWDM architectures, service providers can reduce network CapEx and OpEx while meeting or improving SLAs for mobile, video, and cloud services.

**Optical Components**

Although we have seen major advances in both photonic and electrical transmission technologies, and electronics have been predictably reducing size and cost in accordance with Moore’s Law, the same could not be said for optics. Even as optical interfaces reach 100 Gbps, the physical size of the modules and the excessive heat and power they draw are limiting the ability to scale network elements, data centers, and networks.

ASICs used in data center routers, switches, and servers are becoming smaller, faster, and more power-efficient, benefiting from the complementary metal-oxide semiconductor (CMOS) fabrication processes. In optical solutions, however, most of the photonic elements, such as modulators and switches, are independently manufactured and assembled from exotic compounds and complex packaging, with each part optimized for a specific function. As a result, optical solutions remain expensive, time-consuming to create, and inefficient in terms of power consumption.

Cisco is changing the optical components industry with CMOS photonics, integrating photonic elements directly onto a small CMOS die in the same way that electronic ASICs are fabricated. Cisco is leading the way in applying Moore’s Law to optics with Cisco CPAK pluggable transceivers that will help assure operators that next-generation optical solutions will meet the IP traffic demands of the future (Figure 4).

**Figure 4.** Cisco 100-Gbps CPAK Pluggable Optical Module
Cisco CPAK Modules are less than one-third the size of Cisco CFP Modules, and they dissipate less than one-third the power. As a result, they can support more than ten 100-Gbps CPAK ports in the space that’s allotted for 4 CFP modules, allowing the optics on a terabit-capacity line card to dissipate less than 55W of transceiver power. That’s compared with today’s 10-Gbps transceivers, which generate about 48W to produce 480 Gbps - less than half the capacity. The use of industry-standard CMOS technology also means the CPAK is easier to manufacture with higher yields than the CFP. Ultimately, the compelling economics and potential of terabit/second performance of CMOS Photonics technology will promote widespread adoption of CPAK, and these benefits may be applied to further advances in optical networking.

Open APIs
Cisco leads and contributes key technology innovations to many of the industry forums, standards, and open source communities to promote innovations that are used across the Cisco Evolved Programmable Network. Some examples of the innovations from the Open Network Forum, OpenDaylight, and IETF that add significant value to the Cisco Evolved Programmable Network follow:

- **Generic Multiprotocol Label Switching (GMPLS)**
- **Interface to the Routing System (I2RS)**
- **Internet Protocol Version 6 (IPv6)**
- **Link State Border Gateway Protocol (BGP-LS)**
- **Network Configuration Protocol (NETCONF)**
- **Path Computation Element Communication Protocol (PCEP)**
- **Policy-Based Routing (PBR)**
- **Representational State Transfer (REST)**
- **Segment Routing**
- **Vector Packet Processing (VPP)**

Why Cisco?
The Cisco Evolved Programmable Network (EPN) provides the essential capabilities that service providers need to expand their business models and accelerate time to revenue for new services. Cisco software and hardware solutions offer the following benefits:

- **Easy to buy**: The Cisco EPN provides flexible purchasing opportunities for both physical and virtual assets, allowing for the provider’s architecture to be open, programmable, virtualized, resilient, and secure across the core, edge, access, optical, and data center.
- **Easy to deploy**: The Cisco EPN working in conjunction with the Cisco ESP requires fewer tools and is based on entirely open interfaces to enable multivendor deployment.
- **Easy to sell**: Cisco EPN automation and orchestration capabilities help simplify the creation of new services, accelerate the sales process, and improve time to market while increasing revenue growth from personalized high-value services.
- **Easy to manage**: Service providers using the Cisco EPN can dynamically shift application and service workloads between resources to reduce costs.
For More Information

To learn more, contact your local Cisco account representative, or visit the following resources:

- Cisco Evolved Programmable Network
- Cisco Evolved Services Platform
- Cisco Videoscape Multiscreen Cloud DVR
- Cisco WAN Automation Engine
- Open Daylight Framework