Empowered by Innovation NEC

Award-winning Software-defined Networking NEC ProgrammableFlow® Networking Suite

ProgrammableFlow

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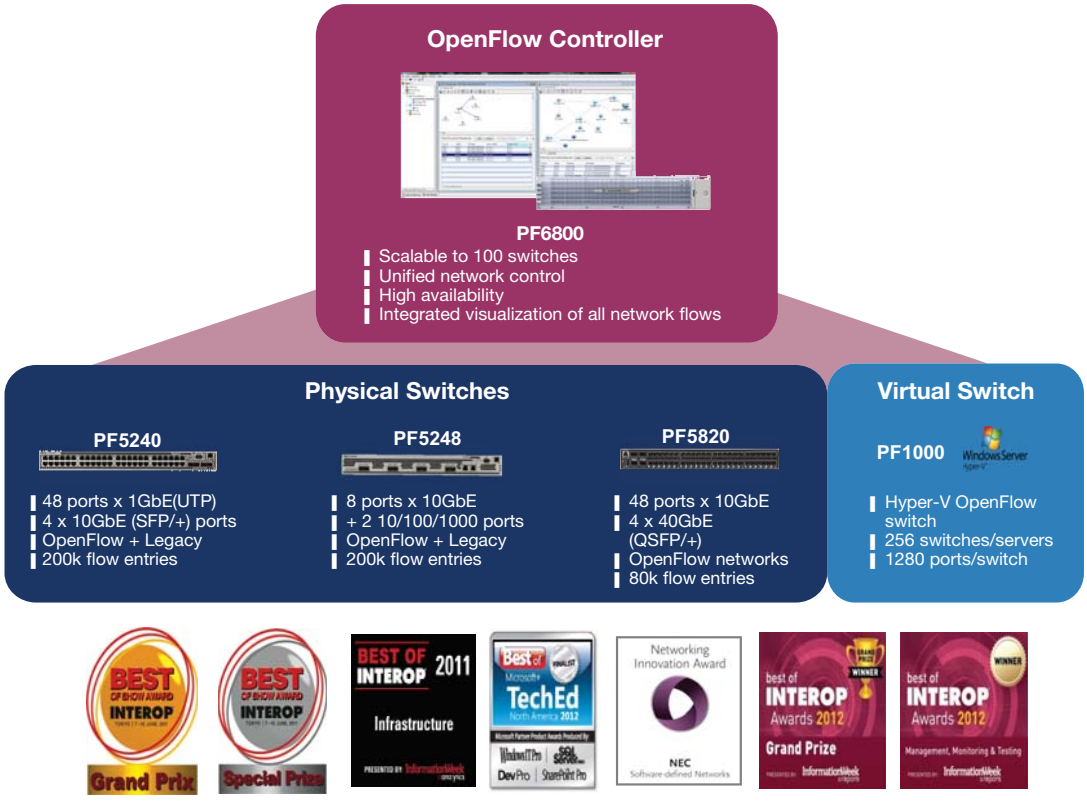
NEC ProgrammableFlow Networking Suite, the first commercially available Software-Defined Network solution to leverage the OpenFlow protocol, enables full network virtualization and allows enterprises, data centers and service providers to easily and cost-effectively deploy, control, monitor and manage secure multi-tenant networks.

The Award-winning NEC ProgrammableFlow Networking Suite



At a Glance

- Simple, scalable, secure, application-aware networks with a complete enterprise and carrier-class Software-defined Networking (SDN) solution, including the award-winning ProgrammableFlow PF6800 SDN controller, physical and virtual network switches, and an Ecosystem of partners.
- Best-in-Class interoperability and investment protection, including support of the 1.3 OpenFlow1 standard, and demonstrated operations with multiple switch vendors
- Network-wide virtualization, featuring a high performance, resilient network fabric offering high availability and management of network flows up to 1 Terabyte
- Granular, end-to-end network visibility and control from a central point for dynamic, policy-based network management featuring advanced automation
- Multi-tenant capabilities enable isolated, secure networking to meet stringent compliance and regulatory requirements
- Integrated network and compute orchestration with OpenStack and Microsoft System Center Virtual Machine Manager for greater agility and streamlined operations

* ProgrammableFlow Networking Suite continues to be compatible with OpenFlow 1.0, in addition to the new 1.3 support

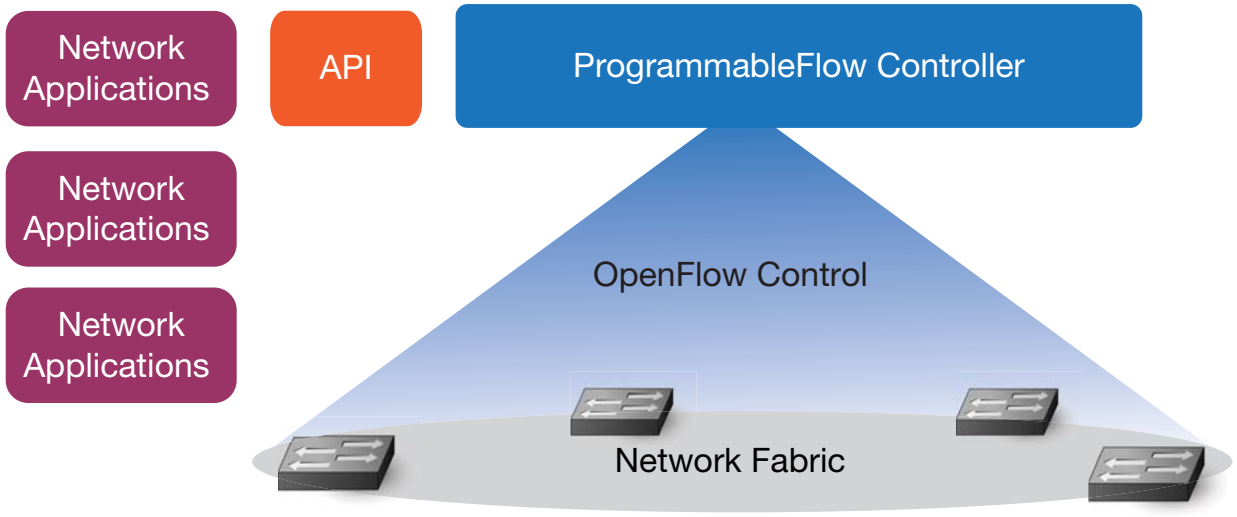
Overview

While today you can spin up hundreds of virtual machines in literally minutes, it will typically take weeks or even longer to provision the supporting network services. This bottleneck, a direct result of the static nature of legacy networks, coupled with extreme complexity, vendor lock-in, and a dependence on error-prone manual processes, are examples of the driving forces behind a new, open and programmable network paradigm.

OpenFlow based Software-defined Networking attacks these issues head-on, de-coupling network control from data flow, and then centralizing and automating configuration and control. The result: An open, simple, scalable and secure network suitable to the changing business needs of today.

The OpenFlow-based NEC ProgrammableFlow Networking Suite was the first enterprise-class SDN solution to be commercially available, operating today in production environments on a global basis. First introduced in May of 2011, the current Version 5 offers a high-performance, carrier-strength network fabric, complete with a centralized SDN controller that supports the OpenFlow 1.3 protocol, physical and virtual switches, including hybrid offerings that can work in both OpenFlow and traditional networks.

Network programmability is key to providing faster and better services



Key features and benefits of ProgrammableFlow Networking Suite

High-performance network fabric maximizes server virtualization investments

Traditional networks often create barriers for organizations to get the most from their server virtualization. ProgrammableFlow, providing a highly reliable end-to-end network fabric, manages both physical and virtual networks with seamless integration into a virtual server environment. This enables servers and virtual machines to be provisioned, migrated and decommissioned without requiring network reconfiguration. Network and security policies follow virtual machine migrations automatically.

This can save countless hours of network administration time, no longer needed to manually adjust routers and switches to network changes. These manual processes are also subject to human error, sometimes resulting in availability issues that would be averted with a fully automated, centralized solution.

ProgrammableFlow Network Fabric increases the efficiency of your entire IT investment. Multi-path networking uses multiple links to move traffic from a central point to a given destination. Now, with Version 5 and OpenFlow 1.3, ProgrammableFlow Networks will recognize links and distribute traffic over equivalent cost paths ranging from 1GbE up to 1 Terabyte. Administrators can take advantage of multiple links to redirect traffic to a path with more available bandwidth.

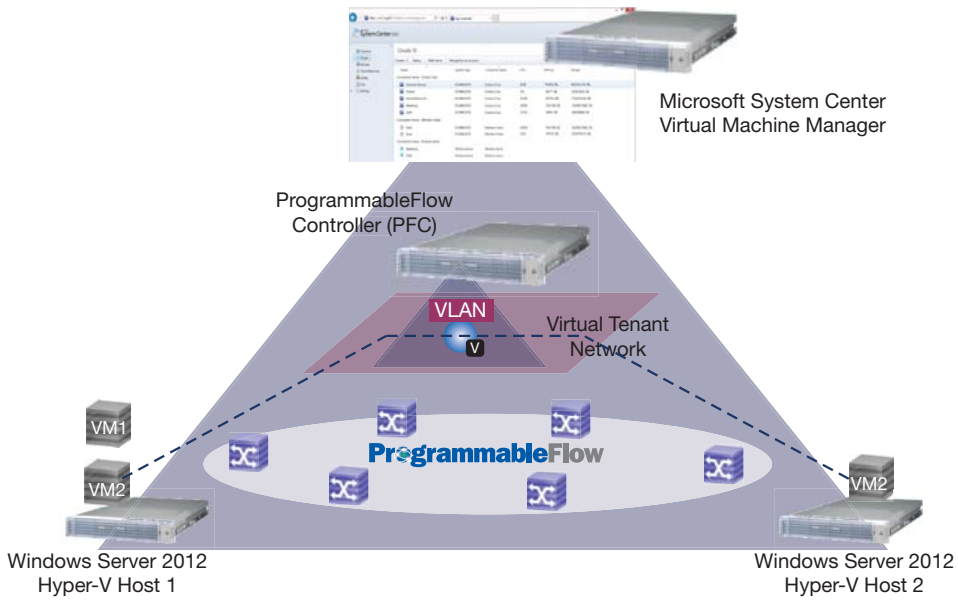
Integrated network and server orchestration for streamlined operations

NEC offers the first OpenFlow-based virtual switch. The PF1000 vSwitch extends the benefits of ProgrammableFlow SDN to Microsoft Hyper-V customers, with a single control plane across both physical and virtual network environments. With the PF1000, NEC supports VM mobility, automatically detecting VM migration and reprogramming the OpenFlow rules to ensure seamless traffic migration to the new location. These capabilities also enable customers to increase network utilization levels without concern for service level disruption, realizing a truly converged network infrastructure affordably.

Now, Version 5 of ProgrammableFlow Fabric also integrates this environment with Microsoft System Center Virtual Machine Manager for streamlined compute and network orchestration. This solution extends the full benefits of ProgrammableFlow SDN to Microsoft Hyper-V environments, including providing virtual L2 and L3 networks with Quality of Service (QoS) end to end, and IPv6 support across an OpenFlow enabled switch fabric.

ProgrammableFlow Networking also integrates with OpenStack, leveraging the Grizzly plug-in. This will provide both open compute and network platforms, and with Grizzly, gives larger enterprises new levels of stability.

ProgrammableFlow integrated with Microsoft System Center Virtual Machine Manager provides integrated compute and network orchestration



Network programmability for accelerated delivery of services

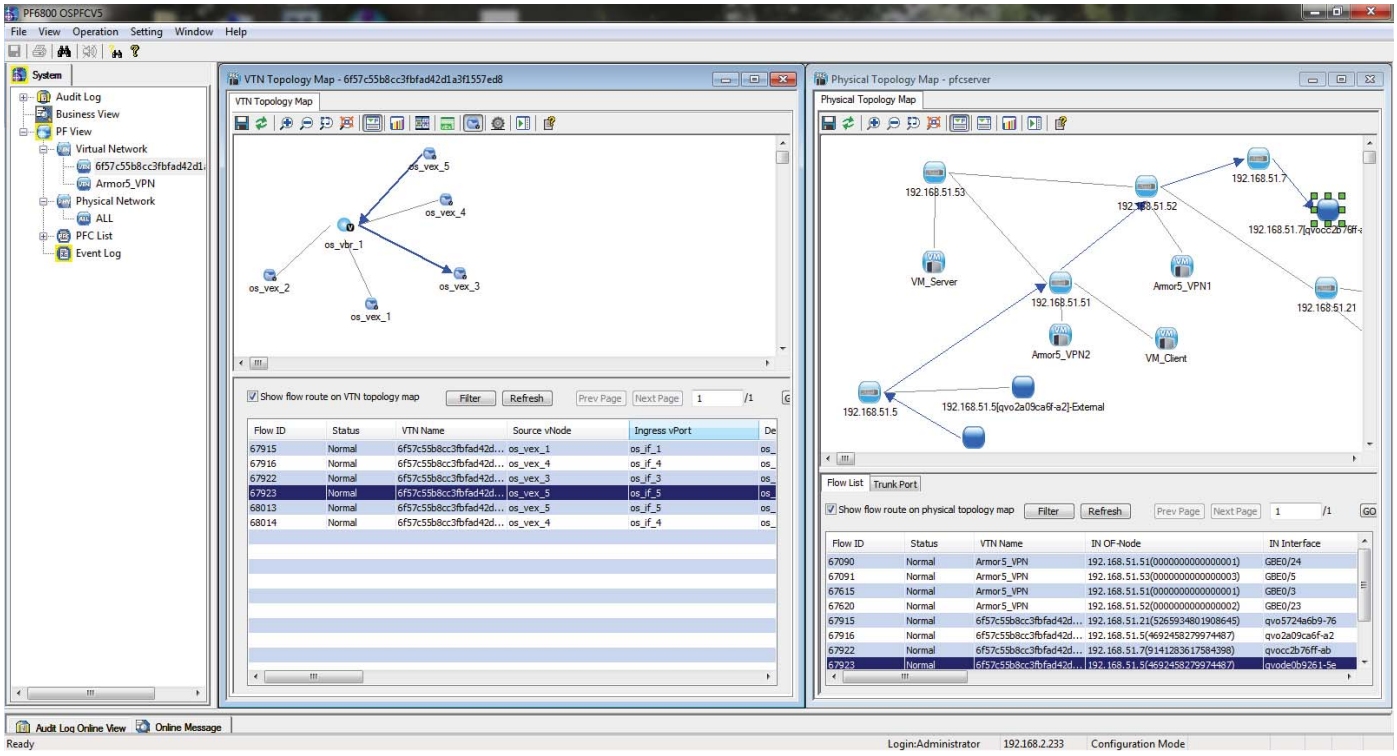
OpenFlow and ProgrammableFlow technology decouple the data path from the control path, so organizations can now easily introduce changes into the network and customize it to suit their business needs. A programmable network in the future will be essential to position enterprises and solution providers for significant competitive advantage. Programmable interfaces, available both Northbound and Southbound from the ProgrammableFlow controller, will allow customers to take advantage of rich development and network services that are now becoming available.

NEC has established the first OpenFlow-based SDN ecosystem, featuring both northbound and southbound partners to add value to your NEC network investment, providing both interoperable OpenFlow-based switching and L4-L7 services. Today this includes three key IT segments: increased network optimization, manageability and availability. Already these areas are populated with NEC and third party solutions, supporting greater business agility, streamlining and accelerating delivery of services and beginning to show the promise of an open, standards-based ecosystem.

End-to-end network visualization

Integrated into the NEC SDN controller software is a network monitoring function, now providing customers with end-to-end network visualization. Depicting both physical and virtual networks from a single pane, traffic and bottlenecks can be visualized in real time. Now, the complete end-to-end flow is depicted graphically, and control and corresponding action can be taken as needed.

Integrated Visualization with the PF6800 provides both physical and virtual network views, and depicts end-to-end network flows



Network automation delivers OpEx savings

The ProgrammableFlow Fabric leverages OpenFlow to move the complex and error-prone CLI interfaces into an open and standardized interface. This network automation and configuration works with switches from multiple vendors to provide point-and-click virtual network design and automated topology discovery.

Discovery operates automatically for all devices on the network. Flows can be moved off of devices without interrupting network sessions and when an end point, such as a VM, moves physical locations, the policy automatically moves with it. A design for automation extends to third-party systems that can make on-demand calls to the API to create, edit and delete virtual networks, as well as to add and remove policies.

This significant benefit has resulted in production customers reducing ongoing network administration expenses as much as 80%, in combination with the resource efficiency (power and footprint) provided by ProgrammableFlow.

Policy-based routing enables business agility

The ProgrammableFlow Fabric enables the network to be fully responsive to the needs of the business—network traffic can be customized dynamically based on traffic type or application. Legacy networks do not control network traffic based on business policy, and cannot make changes as rapidly as the business moves. The closest solution is the policy-based routing capability in high-end routers. However, policy-based routing is limited to simple header field matches and can only map the packet to a specific router interface as opposed to an end-system.

ProgrammableFlow Fabric allows complex conditions to be defined over a combination of multiple packet header fields such as MAC addresses, IP address, port number, and protocol type, enabling intelligent routing decisions. The final destination of a packet could be an address, or an intermediate appliance or service module such as a firewall or load balancer. Such functionality is not available in traditional networks. With ProgrammableFlow, network restrictions do not curtail business performance and priorities.

Secure, multi-tenant networking provides needed isolation

ProgrammableFlow provides greater flexibility and new business models for private and public cloud deployments. The fabric allows multiple virtual networks to securely share a common physical infrastructure. Because they are completely isolated and operate with different policies, each network fabric can be customized without impacting other services.

NEC's Virtual Tenant Network (VTN) allows each tenant to define their own customized layer-2 or layer-3 network and leverage inter-tenant isolation to effectively create a secured slice of the underlying physical network. VTN features:

- Network isolation—Network segments can be configured centrally and enforced throughout the network without switch configuration. This critical feature directly addresses many companies and enterprise needs to segment or isolate parts of the business securely.
- Virtual network—Virtual bridge and router functions provide L2/L3 network services.
- VFilter—The virtual filters in ProgrammableFlow can be leveraged to define Access Control Lists (ACLs) of various degrees of complexity.

Best-in-Class interoperability protects from vendor lock-in

OpenFlow 1.3 is a production-ready, data center class technology, and the foundation for ProgrammableFlow Version 5. Supporting 1.3, with backwards support for OpenFlow 1.0, places NEC again in a leadership position as the most interoperable controller on the market today.

NEC has been involved since 2007 with the development of the OpenFlow protocol. The NEC Leadership team recognized, through their relationship with Stanford University, that this technology could be highly disruptive and provide answers to many of the issues impacting networking today. NEC chose then, along with Deutsche Telekom, to fund The Clean Slate Lab, the birthplace of OpenFlow at Stanford University.

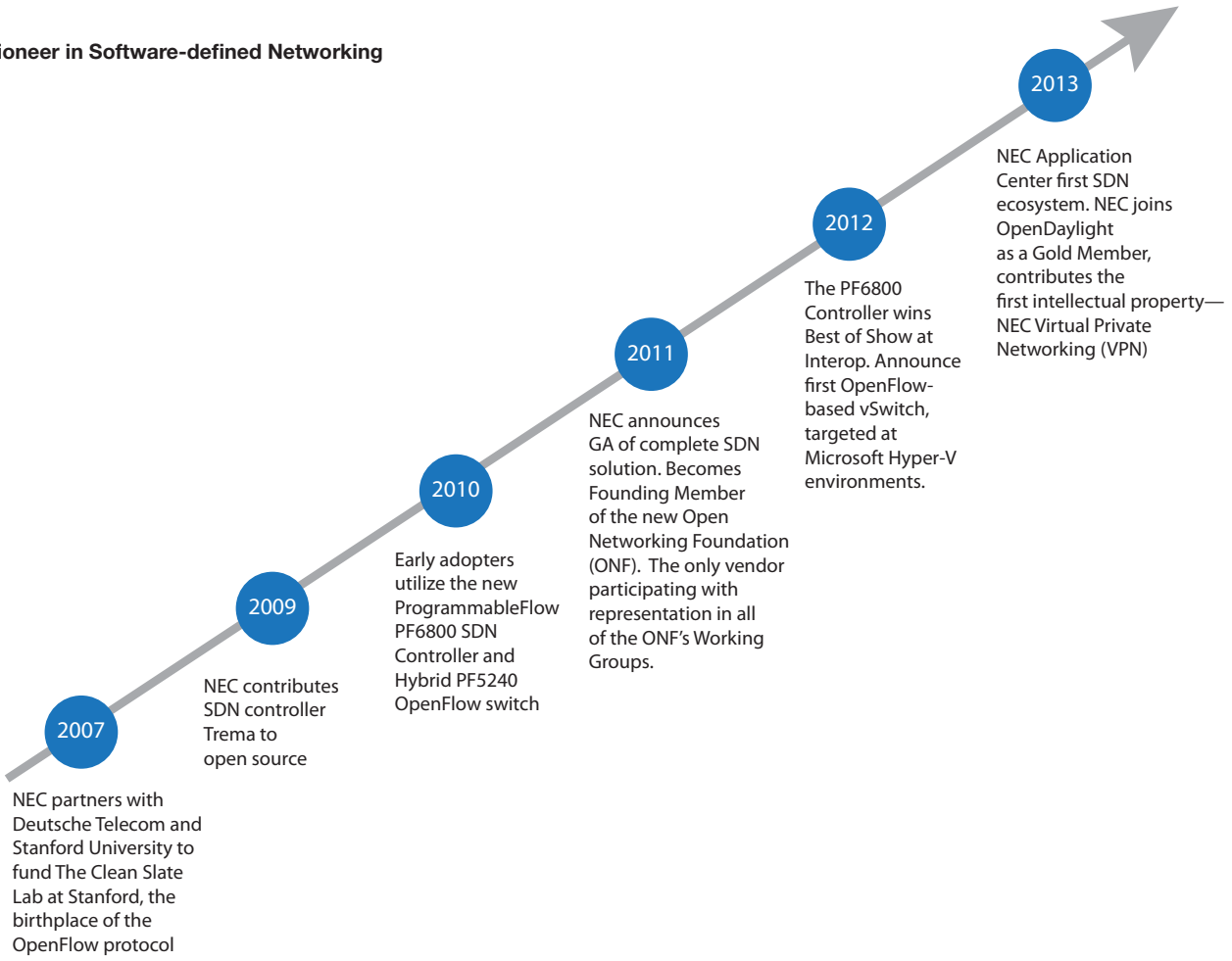
Later, NEC stepped forward as a Founding Member of the ONF, and, more recently, contributed funding as a Founding Member of the InCNTRE Interoperability Testing Lab at Indiana University. NEC has participated in multiple PlugFests over the past 3 years, bringing the entire ProgrammableFlow portfolio to test with potential partners.

NEC is committed to an open, standardized networking solution, avoiding vendor lock-in and offering best-in-class interoperability.

A Gold member of OpenDaylight

NEC is a gold member of the vendor-led open source community, OpenDaylight. OpenDaylight's mission is to facilitate a community-led, industry-supported open source framework, including code and architecture, to accelerate and advance a common, robust Software-defined Networking platform. NEC was an early contributor of code to the project, including the Virtual Tenant Networking technology incorporated into the ProgrammableFlow Networking Suite.

NEC: A pioneer in Software-defined Networking



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