Secure Real-Time
Communications

Network Function Virtualization Primer

Understanding NFV, Its Benefits, and Its Applications

White Paper

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Introduction

Over the last four years a major change has exploded onto the networking landscape—Network Function Virtualization (NFV). NFV is a major change in how networks are architected and operate, and its the result of fundamental transformations in the network and technology. The focus of this white paper is to define NFV and discuss how it is transforming networks.

NFV—The Basics

Networks evolved from software that ran in servers. In fact, the first router nodes were Unix servers running software. As network speeds increased, optimized appliances emerged to perform the networking functions. These included routers and switches. Over time, an additional set of appliances emerged that provided enhanced packet services or "network functions", typically based on deeper inspection of the packets or the actual stream of packets. These appliances ranged from WAN accelerators to Virtual Private Network (VPN) nodes, firewalls, application switches, and Session Border Controllers (SBCs). As each of these classes of products emerged, optimized hardware was typically required because general-purpose computing was too slow to accommodate the required packet processing speeds. As they were focused to the task, the processing generally was implemented where the task was to be accomplished. The result was that these functions were deployed nodally throughout the network, often at the very edge of the network. Figure 1 shows a typical network with this nodal edge deployment.

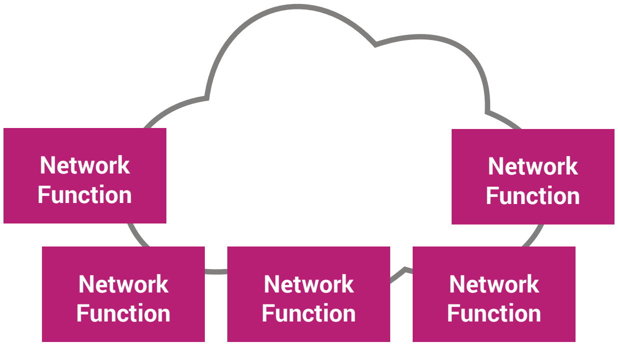


Figure 1: Nodal Edge Appliances

However, with the inexorable march of Moore's Law, processors eventually grew in processing performance to be able to accommodate these functions. Over time, it became possible to implement each of the network functions in a traditional processor architecture as software. The result was that the appliance could be changed from being purpose-specific to general-purpose computers (commercial off-the-shelf or COTS). However, service providers saw the limitations of these dedicated devices, whether they were hardware-optimized or COTS-based. Deploying a network was a very hardware and design focused activity, and the resulting system was not well suited to changes in the traffic patterns that are typical, even based on time-of-day usage patterns.

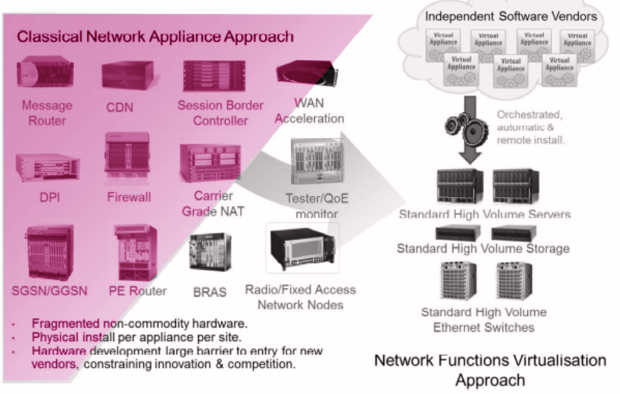


Figure 2: NFV Vision

At the same time, networks were evolving as well. The edges of the network were getting faster due to increased use of fiber and lightweight protocols. The result was that it was much less expensive to carry traffic back from the edge of the network to a central location. Finally, in data centers the technology of virtualization was enabling applications to share processors/servers, enabling much more efficient management of processing than traditional dedicated architectures.

Service providers saw these technologies as enabling a solution that would accelerate deployment of new services and revenue, while at the same time optimizing utilization and efficiency. The capability to move the range of nodal appliance–based functions into a virtualized environment is the core of NFV, as shown in Figure 2.

The result is a combination of moving the network functions from dedicated nodes to a general-purpose virtualized computing environment, either distributed in the network or in a data center. Figure 3 shows how NFV aggregates the processing of network traffic into nodes located out in the edge network or in data centers, typically located regionally, between the edge networks and the core. In most carrier deployments, multiple regional data centers provide services and processing located closer to customers to reduce latency and improve performance. These data centers are aggregated with a high-speed core network.

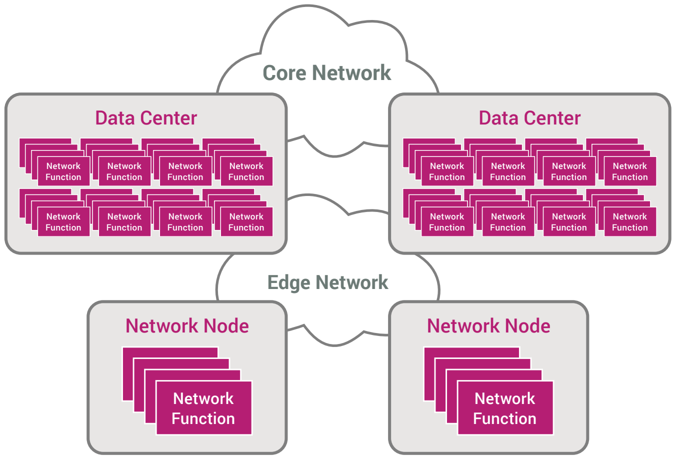


Figure 3: Distributed NFV Architecture

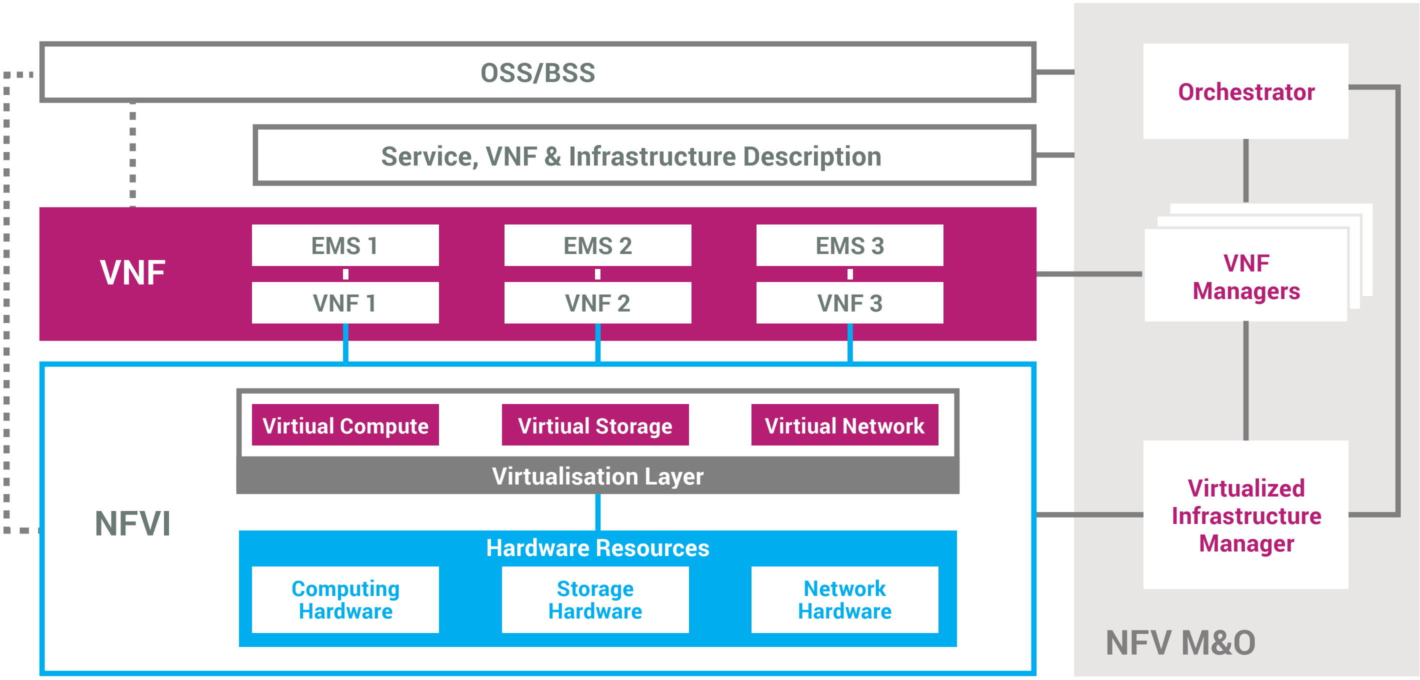
Service providers have seen how standard IT virtualization technologies were dramatically reducing costs and accelerating deployments in data centers around the world. Out of this came the realization that an effective mechanism for deploying advanced network functions would accelerate service innovation and provisioning. The result was that several providers banded together and created an NFV focus within the European Telecommunications Standards Institute (ETSI). The creation of an NFV focus within ETSI resulted in the foundation of NFV's basic requirements and architecture. The ETSI Industry Specification Group for Network Functions Virtualization (ETSI ISG NFV) was launched in January 2013, when it brought together seven leading telecom network operators, including AT&T, BT, Deutsche Telekom, Orange, Telecom Italia, Telefonica, and Verizon.

NFV Standards—Beyond Traditional Virtualization

In data centers around the world, virtualization has transformed the way computing processes are accomplished. From a world where each individual application had to have a server assigned, virtualization enables a virtual machine to provide services to the application, while a hypervisor manages multiple instances of virtual machines on a single server. The result can be a dramatic reduction in cost and an improvement in efficiency. Multiple applications requiring lower computing power can share a single server and server resources can be moved between applications, optimizing overall usage and reducing costs even further.

Orchestrating the deployment of Virtual Network Functions (VNFs) includes a number of factors. These are considered in the emerging standards for NFV. Orchestration incudes monitoring the capacity and utilization of deployed VNF and loading/unloading them as resource requirements change. Orchestration can also include enabling a set of VNFs to provide an advanced integrated network service. These can be automatically installed and sequenced to operate on the traffic flow in a dynamic process to enable the rapid deployment and scaling of services. By having standards for the deployment and operation of VNFs, individual functions can be deployed and launched quickly, optimizing the network operations. Figure 4 shows the ETSI standards suite for NFV and VNF deployment.

One key advantage of NFV is the ability to scale across the overall NFV facilities of the service provider in an elastic manner as demands grow and ebb. The NFV model also adds flexibility, allowing service providers to launch, improve, and incrementally optimize services using software updates rather than wholesale hardware replacement. NFV also creates an "ecosystem" of third-party software vendors that can use the standards to provide innovate capabilities.



In a traditional telecom network, network elements are defined as logical systems, usually connected to specific physical hardware or facilities, used to deliver a service. In the NFV, these elements become virtualized as software installations are placed on commodity hardware. An NFV platform is designed to host various VNFs at a location in the network where functions can best be accommodated. The deployment points can be distributed into the network, or can be aggregated into specific locations. Some of the VNF examples include the following:

- Application Acceleration
- Application Delivery Controllers/Load Balancers
- DDoS Protection
- Deep-packet Inspection
- Evolved Packet Core (EPC) functions
- Intrusion Prevention
- Network Brokering, Tapping, or Monitoring
- Policy Management
- Session Border Controller
- Virtual Firewalls
- Virtual Routing & Switching
- WAN Optimization Controller

The Benefits of NFV

The benefits of NFV are multifold. NFV virtualizes network services via software to enable operators to:

- **Accelerate Time-to-Market:** NFV reduces the time to deploy new networking services that support changing business requirements, enables seizing new market opportunities, and improves return on investment in new services. As a VNF can be deployed into an existing NFV environment, NFV lowers the risks associated with rolling out new services. This enables providers to easily trial and evolve services to determine what best meets the needs of customers.

- **Deliver Agility, Elasticity, and Flexibility:** With virtualization, service providers can quickly scale service capacity to address changing demands. The ability to deliver new services via software on any industry-standard server hardware accelerates the capability to innovate and add value for customers.

- **Reduce CapEx Costs:** NFV reduces the need to purchase purpose-built hardware and supports pay-as-you-grow models. It also can reduce or eliminate wasteful overprovisioning.

- **Reduce OpEX Costs:** Being able to run multiple virtual machine instances on a single server, rather than needing multiple instances of proprietary hardware, reduces space, power, and cooling requirements of equipment. The virtual nature of deployments, combined with orchestration, dramatically simplifies the rollout and management of network services.

- **Network Optimization:** NFV is focused on optimizing network services. NFV decouples network functions such as DNS, caching, deep packet inspection, etc., from proprietary hardware appliances. The result is that these functions can now run in an on-demand software to accelerate service innovation and provisioning, particularly within the overall service provider network.

- **Integration:** NFV ensures that the network can integrate with and support the demands of virtualized architectures, particularly those with multi-tenancy requirements. These capabilities are critical to assure customers that their services are isolated and secure in the new NFV environment.

Overall, NFV is a game changer for service providers. With a well-designed NFV management environment, VNFs can be deployed into the network where they are required. The result is a significant reduction in costs, while accelerating the deployment of services.

NFV for Real-Time Services

As NFV adoption has accelerated, using NFV to deploy real-time flow services has become an option. While many of the requirements and operational capabilities are similar, real-time services require additional operational considerations to maintain latency and other performance characteristics.

As real-time services generally fluctuate on time domains, using NFV can dramatically impact costs as deployments can scale elastically to the needs of a specific area or region on a time frame basis. This flexibility is critical in managing the escalating percentage of both traditional voice communications and emerging video communications. The ability to rapidly provision and orchestrate advanced real-time services into the NFV environment enables rapid services delivery while avoiding costly dedicated hardware and specialized devices. Having real-time services well integrated into the NFV deployment model dramatically increases both responsiveness and scalability while reducing overall costs.

The New Service Provider Network Architecture

NFV is ushering in a new era of networks. Network operators can analyze their traffic and overall geographic/logical network topology to decide where to add NFV service capability. NFV capability can be added at different points in the network, from a location such as a traditional central office or Point-of-Presence, back to the core data centers.

Provisioning the right capacity at these points is critical. The value of moving VNFs closer to the edge of the network is the elimination of transporting traffic to a central site. However, this is only of value if that traffic can be reduced at the edge. Otherwise, encapsulating the traffic on the path to the data center and centralized NFV can be used to manage both security and virtual function. A clear architectural value learned from virtualization in data centers is that the larger the virtual location and the more functions, the better the overall efficiency is, especially if there is no impact on overall traffic models.

As functions are deployed into the NFV environment, orchestration can automatically manage the other network functions to assure that the services and value are delivered and managed. By combining NFV management with overall network orchestration, network functions, services, transport, and capacity can all be managed to optimize services, performance, capacity, and cost.

Time for a New Networking Paradigm

Today's networks are increasingly being driven by new technologies and services. From video delivery to real-time services, including WebRTC and IoT, the demands on the network are changing and the demands are more complicated than ever. NFV is the best tool to enable service providers to both accommodate these services and accelerate their capabilities to deliver these services cost effectively. Defining architectures to take advantage of NFV and defining how deployment will be managed is a critical step for service providers.

Simultaneously, there have been huge steps forward in the processing capabilities of off-the-shelf network computing hardware and the associated developer tools and standards. The result is that there is a major transformation in networking, from hardware to software, taking place. This is the underlying change driving NFV—the movement to capabilities defined purely in software.

The result is that the functional capabilities can be decoupled from specific hardware, ensuring that capabilities are no longer constrained by specialized hardware or location. This enables service providers to build next generation networks that can:

- **Drive Innovation:** Enabling service providers and the overall ecosystem to create new types of applications, services and business models. The virtual capability enables rapid prototyping and cost-effective trial deployments.

- **Offer New Services:** Enabling service providers to create and adopt new revenue-generating services. The capability to centralize services also allows lower-volume services to be effectively deployed.

- **Reduce Overall CapEx:** Moving to COTS hardware or white-label switches reduces the cost significantly. The effective use of resources that is enabled by virtualization reduces the total capacity required.

- **Reduce OpEX:** Implementing NFV and supporting automation and algorithm control through increased programmability of network elements simplifies the design, deployment, management, and operation of networks. The capability to automatically scale services based on demand reduces operator loads and increases customer satisfaction.

- **Deliver Agility and Flexibility:** NFV is a critical element in enabling organizations to rapidly deploy new applications, services and infrastructure to quickly meet their changing requirements.

Ribbon is a leader in NFV. The company's VNF portfolio includes: Session Border Control (SBC), Centralized Policy and Routing (PSX), Element Management System (EMS), Advanced Media Server (AMS), Converged Intelligent Messaging (CIM), Diameter Signaling Control (DSC), and Call Session Control (C3). In addition Ribbon provides a VNF Manager to perform full lifecycle management of the multiple Ribbon VNFs.

About Ribbon Communications

Ribbon is a company with two decades of leadership in real-time communications. Built on world class technology and intellectual property, Ribbon delivers intelligent, secure, embedded real-time communications for today's world. The company transforms fixed, mobile and enterprise networks from legacy environments to secure IP and cloud-based architectures, enabling highly productive communications for consumers and businesses. With locations in 28 countries around the globe, Ribbon's innovative, market-leading portfolio empowers service providers and enterprises with rapid service creation in a fully virtualized environment. The company's Kandy Communications Platform as a Service (CPaaS) delivers a comprehensive set of advanced embedded communications capabilities that enables this transformation.

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