# Network Functions Virtualization

A Dell point of view

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# Table of Acronyms

| Acronym | Meaning |
|---|---|
| NFV | Network Functions Virtualization |
| ONF | Open Networking Foundation |
| ETSI | European Telecommunications Standards Institute |
| SDN | Software-defined Networking |
| OPNFV | Open Platform for NFV |
| COTS | Commercial Off-The-Shelf Servers |
| NVO | Network Virtualization Overlay |
| MANO | Management and Orchestration |
| VIM | Virtualized Infrastructure Manager(s) |

# 1 Response to services demand is open

The revolutionary growth of network access is truly a modern marvel as networks continue to expand in reach and capacity — now connecting nearly half the world's population. Despite overwhelming demand, technology consumption continues to grow at an increasingly rapid pace.

In 2010, roughly 1.8 billion people had access to the Internet. By 2020, 5 billion people will have multiple connected devices, doubling scale in only a few years. The massive expansion of the "Internet of Things" is expected to grow beyond 16 billion devices by 2016, and to more than 50 billion devices by 2020. Mobile devices are now ubiquitous technology service extensions, providing life-changing access to billions of connected consumers across the globe. Who will feed these new market opportunities?

Historically, providers worked with vendors to supply network service markets using point solutions constructed for a specific purpose. These traditionally closed models, which pioneered previous generations of service delivery, lack the technological and economic feasibility to competitively meet the demand for next-generation services. Being locked in by proprietary hardware and software limits the pace of innovation when compared to the rapid advancement of openly accessible compute environments.

With a need for greater access and support for open technologies, the world's largest technology service suppliers and operators formed the Open Networking Foundation and the Open Compute Project. These and other open movements prove that the competitive edge is no longer found behind closed ecosystems and lock-in architectures but has moved to the open community, centered around open technologies and the sustainable and shared ecosystems that will define the future of the global economy.

Dell stands unique among our peers in our bold embrace of open technologies, having

- Enabled the formation of the CloudNFV project to deliver the industry's first and only open ecosystem implementation of the ETSI NFV Framework
- Helped to establish the Open Platform for NFV (OPNFV.org) with the Linux Foundation as a founding member and secretary

Dell offers open NFV starter kits to help accelerate the evolution of systems architectures with open technologies. Our premium service and industry-leading experts help you craft the optimal strategy to accelerate your claim to the profound opportunities of this new era.

*"In this fast-paced, uncertain time, one thing is certain: If we aren't the ones inventing the future, someone else will be."* – Michael Dell

# 2 Understanding NFV

## 2.1 What is NFV?

The past decade has brought forth the emergence of cloud computing and shown the profound impact that hyperscale architectures have had on data center design, performance and efficiency.

While "the cloud" can be a loaded term, if each of us were to imagine a picture of our ideal cloud, we would each have a very similar vision:

1. Agile, on-demand provisioning of new services and service architectures
2. Open and standards-based hardware and software components
3. Support for workloads with varied SLA requirements across a common infrastructure
4. Common MANO and operational lifecycle to converge operational silos
5. Implicit user and mobility-aware, end-to-end security and policy model
6. Autonomic elastic workload scaling
7. Modern, open APIs for every logical component
8. Powerful developer tools and platform services to accelerate innovation and new service delivery

Whether your organization is large or small, we all want our experience with computing to be as elegant and powerful as our ideal vision of what the cloud can be.

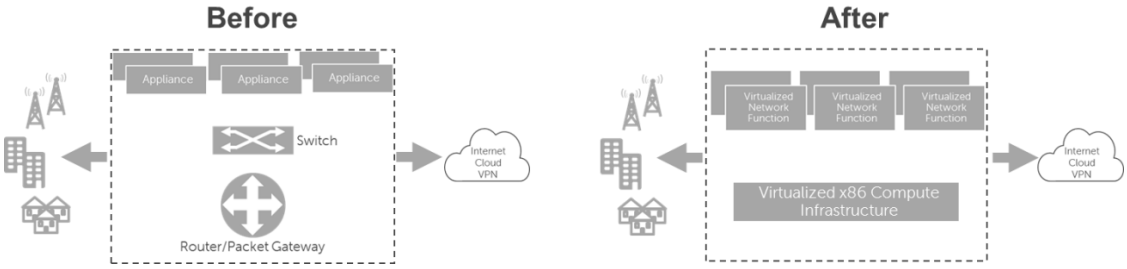



Figure 1 NFV: Carrier operations before and after

NFV is the application of these well-known cloud computing concepts to service provider environments – essentially, it is the effort to turn all service provider technology and operations into experiences that are as elegant and efficient as the best of cloud computing.

## 2.2 Functional comparison

Three key factors emerge when breaking down the components that give hyperscale architectures agility and efficiency benefits over traditional carrier infrastructure:

1. A common, general-purpose COTS-based infrastructure
2. Open hardware and software ecosystems
3. Hardware and application virtualization to free applications from physical limitation and accelerate service innovation

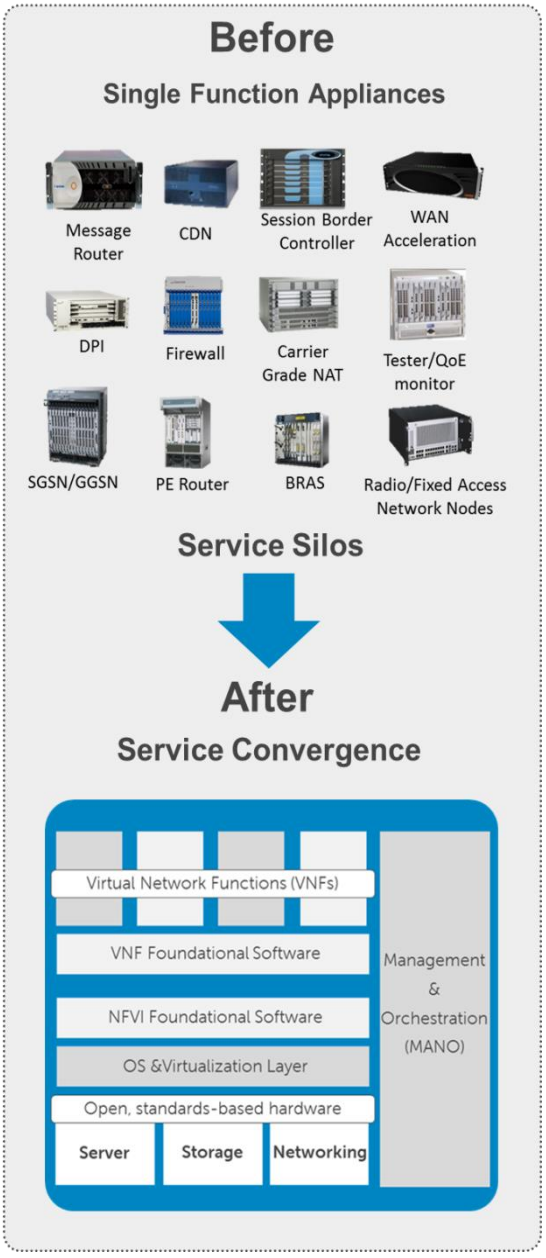



Figure 2 NFV service transformation

Carrier networks and services are largely powered by specialized applications running on specialized hardware that has yet to experience the powerful economic benefits of open, general-purpose infrastructure, open independent supplier ecosystems or hardware virtualization.

NFV technology provides the opportunity to "fast forward" legacy environments to realize the impact of all three of these revolutionary technology disruptions to bring incredibly powerful, hyper-accelerated benefits.

However, the ability to virtualize network functions is only one part of the promise of NFV. There is nothing inherent in a virtual function that requires a more modern operational lifecycle, or feature improvements.

NFV has the potential to go beyond virtualization alone by providing a comprehensive, end-to-end framework with a common architecture and operational lifecycle for virtual functions that span across all carrier use cases and operations. And when aligned with industry standards, NFV frameworks can offer a simple and accelerated onramp to the innovative array of startups and new revenue opportunities in the open computing ecosystem.

# 3 The NFV market opportunity

NFV has already gained broad industry traction and is poised to play a significant role in the future of carrier operations. Beyond the projected 8x growth of the NFV market over the next three years, a recent Infonetics survey revealed that over 97% of carriers are planning investments in SDN and NFV technology.

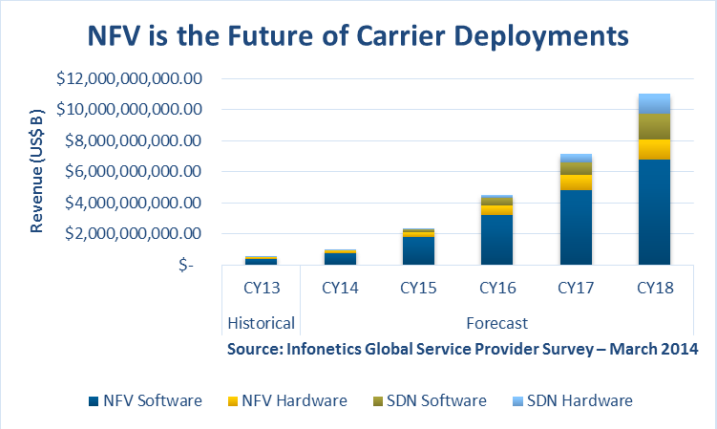



Figure 3 Infonetics – NFV market growth

## 3.1 Why carriers are motivated

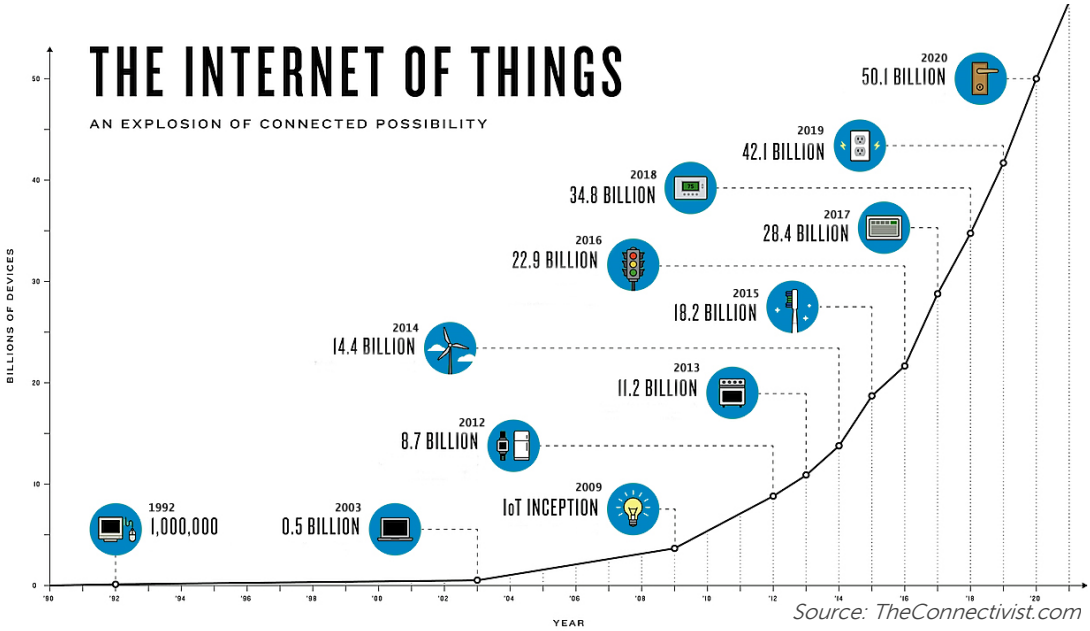



Figure 4 The Internet of Things – explosive growth curve for connected devices

While the cost and operational benefits of NFV technology are profound, NFV is key to tapping into the massive opportunity and explosion of devices of the Internet of Things. This includes billions of devices representing tens of thousands of use cases, and thousands of new vertical technology ecosystems each needing robust connectivity and technology services. As these devices become connected, new ecosystems will arise – the question is, which service providers will have the capability and the agility to capture the most of this massive market expansion?

As shown in figure 5, this is the primary motivation expressed by carriers — to quickly scale services up and down and to leverage the agility of software to deliver a rapid funnel of new revenue-generating services. A second motivation is to access the cost and operational benefits of general-purpose data center infrastructure.

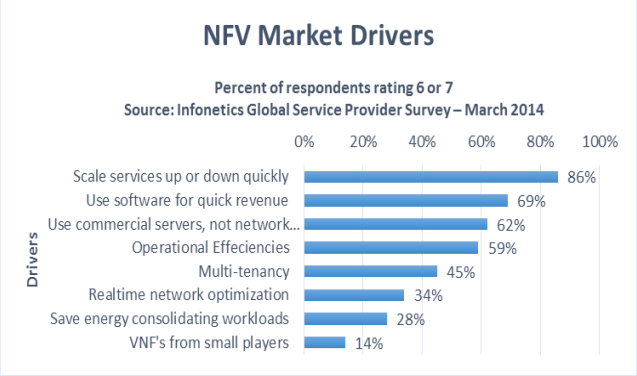



Figure 5 Infonetics – NFV market Drivers

## 3.2 Carrier priorities for NFV

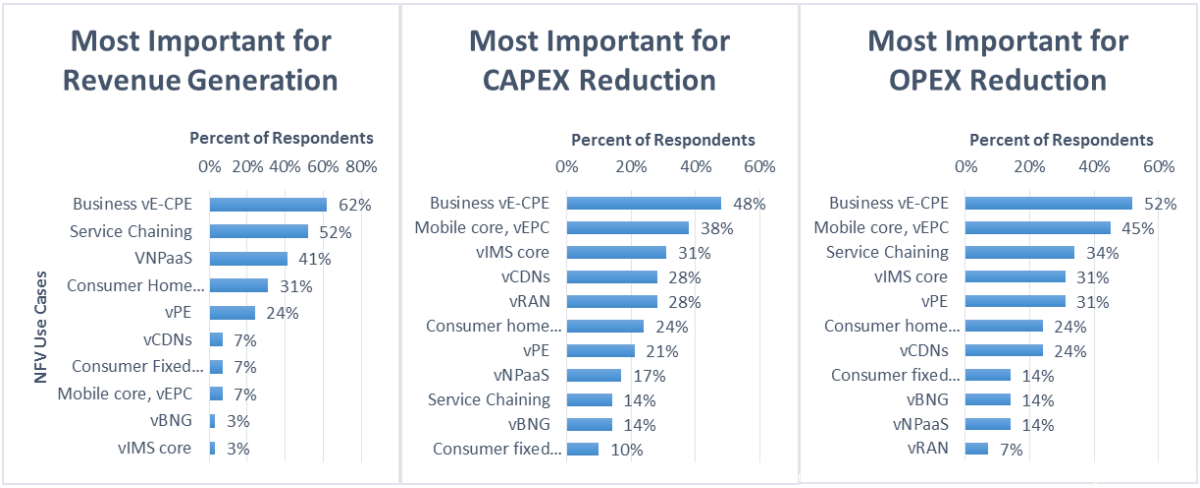



Figure 6 Infonetics survey results – carrier priorities for NFV

NFV is not a small undertaking (see figure 6), as it spans a gamut of use cases that collectively represent an entire reinvention of carrier operations.

A potential trap when crafting an NFV strategy is looking at these use cases in isolation. While each service domain represents an operational silo, an intelligent NFV strategy can provide a common foundational architecture that can start as small as a single use case and scale seamlessly, providing a platform to accelerate ongoing service evolution while converging operational silos.

Another key strategic element of an NFV solution is how it rationalizes individual virtual network functions with a complete service architecture. The ability to spin up a single virtual machine with the touch of a button is a powerful effect, however, services cannot be provisioned and revenue cannot be generated unless these functions are provisioned as a complete solution and not an isolated function. The Dell NFV platform delivers each of these key powerful capabilities.

# 4 NFV: The Dell approach

Carrier evolution goes far beyond simple access to virtualized applications. The latest hyperscale architectures that empower the world's largest data centers have set the bar in every aspect of operational effeciency and performance. These powerful architectures now represent the minimum viable target for data center economics; those that cannot attain this level of effeciency simply cannot be competetive in the market for the next generation of Internet services.

Dell's heritage in open systems led us to become an early leader and key supplier for the most advanced cloud computing deployments in the world. Dell is a founding member or key player in the following organizations:

- The OpenStack Foundation
- The Open Networking Foundation
- The Open Compute Project
- The Linux Foundation's Open Platform for NFV
- Platinum Member of OpenDaylight Project

Dell's leadership in cloud-computing architectures combined with our bold embrace of open technologies positions us to help carriers bridge the gap between traditional service infrastructures and modern hyperscale computing environments.

**Dell NFV Platform Launch**
Analyst Coverage Infonetics RESEARCH

*"NFV has the full attention of the telecom industry. Although others don't offer such openness, Dell's open approach matches what service providers want. Dell certainly has the key infrastructure technology layer – the compute, storage, and networking – as well as a broad reach across the industry for potential VNF software providers. I think a lot of operators will be interested in their handy packaging and simplification of the process via starter kits, and this will help speed adoption."* – Michael Howard, Infonetics

## 4.1 Introducing the Dell NFV platform

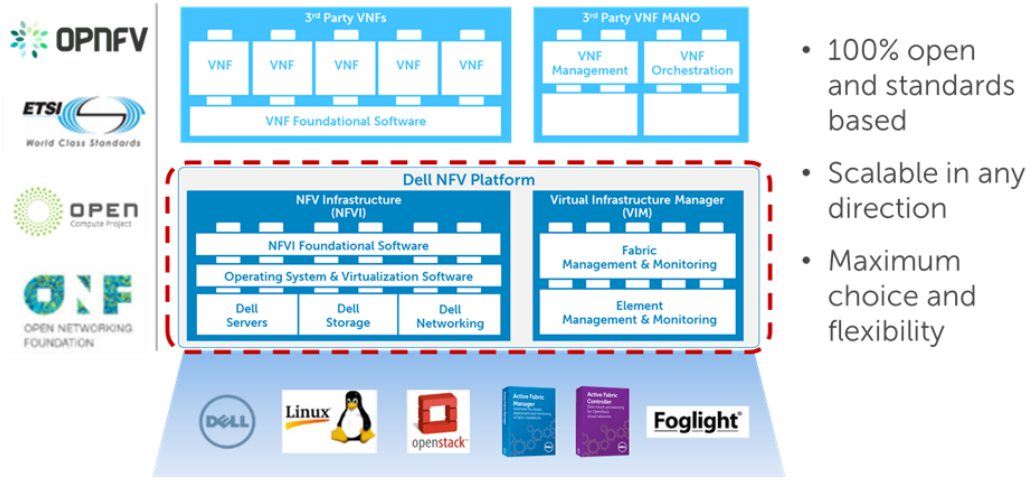



Figure 7 The Dell NFV platform

The Dell NFV platform comprises the latest technologies from Dell combined with software from open ecosystem partners to form fully converged, virtualized infrastructure to execute a wide range VNFs. It also includes foundational software and open interfaces for MANO to enable simple operation and ease of integration. From a deployment perspective, our NFV platform can be dimensioned and equipped for applications virtually anywhere at any scale in a carrier environment.

The Dell NFV platform delivers three distinct advantages:

1. **100% open and standards based**

   Dell leads the industry's first and only open ecosystem implementation of the ETSI NFV framework and is a founding member and officer in the Linux Foundations' Open Platform for NFV. The Dell NFV platform is fully aligned and validated with these key industry standards.

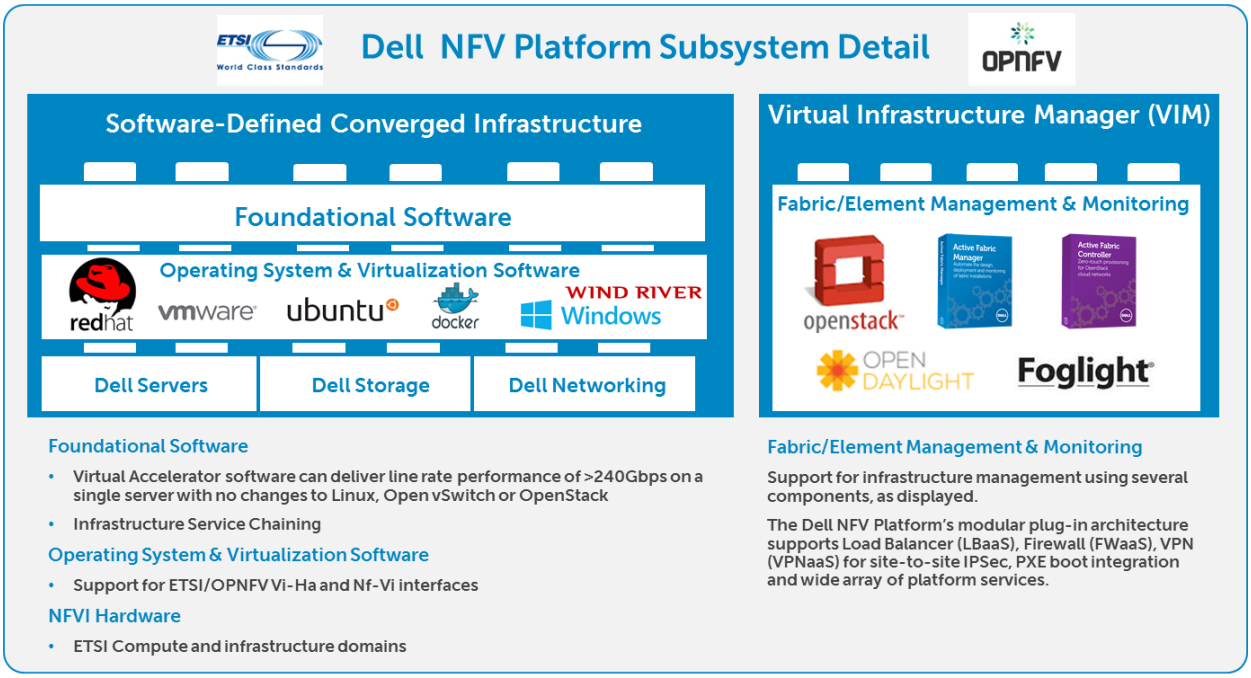
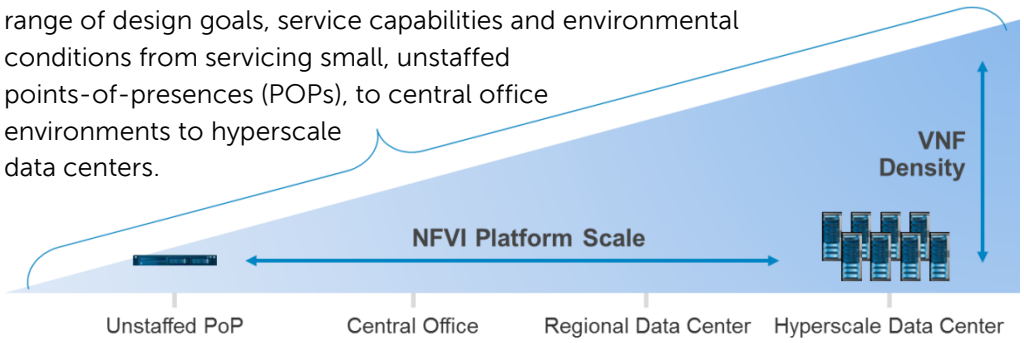



Figure 8 Dell NFV platform ETSI/OPNFV aligned subsystems

Dell invests heavily to foster an open partner ecosystem in all functional areas. This includes partnerships with Intel with their Open Network Platform reference architecture and Data Plane Technologies Kit (DPDK), and Red Hat and Canonical with their open source Linux and OpenStack distributions. Through industry collaboration, and open source and open standard initiatives, developers and end-customers can gain unprecedented access to technology underpinnings allowing for rapid innovation and customization.

2. **Scalable in any direction**

The Dell NFV platform can scale easily — up, down, or out — to accommodate a wide range of design goals, service capabilities and environmental conditions from servicing small, unstaffed points-of-presences (POPs), to central office environments to hyperscale data centers.




This includes options for Network Equipment Building Standards (NEBS) compliant compute platforms and containerized solutions for outdoor plant deployments of various sizes.

### 3. Maximum choice and flexibility

The Dell NFV platform provides a choice of software stacks to complement our infrastructure and management software with support for different Linux and OpenStack distributions plus a wide-range of VNF and MANO options for virtually any NFV deployment.

Our open and non-competitive strategy ensures access to your choice of VNF and MANO providers and empowers us to provide the industry's broadest array of validated standards-aligned use cases and reference architectures.

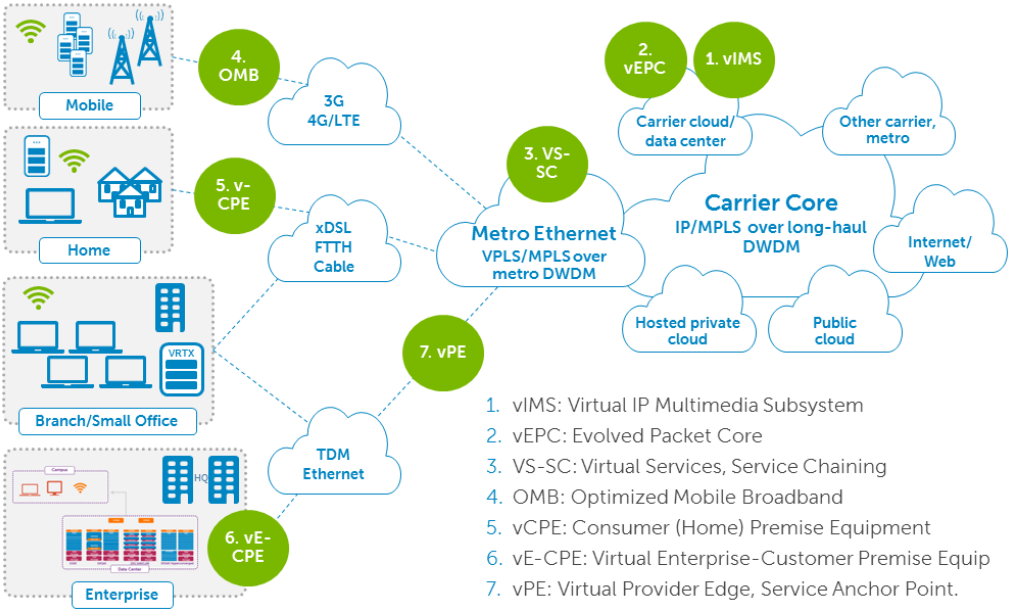



Figure 9 Dell NFV proof-of concept deployments

# 5 Dell NFV starter kits

To facilitate trials and early deployments, Dell NFV starter kits are available based on preset configurations of hardware and software. Starter kits include Dell Networking open switches for 10/40GbE connectivity combined with Dell PowerEdge rack or blade/converged systems plus Linux and Openstack software to enable a platform-as-a-service environment for VNFs.

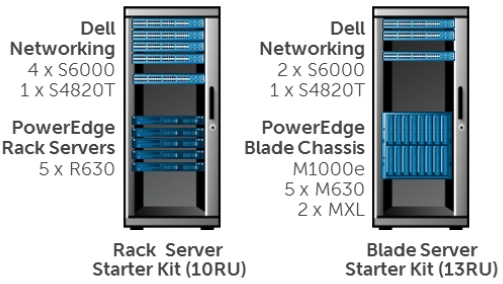



Figure 10 Dell NFV rack and blade server starter kits

Along with a deep partner ecosystem, Dell will help define the NFV framework jointly and collaboratively with streamlined architecture environments that operationalize network services in a fraction the time.

Dell NFV starter kits — three simple steps:

1. Select compute form factor (blade/rack)
2. Select Linux and Openstack distribution
3. Select options: data plane acceleration, element/fabric management

# 6 Conclusion

The next wave of Internet growth is here. Billions of new devices are connecting to the network; millions of users are procuring new cloud services and providing a massive opportunity for new revenue generation. The key question is, are you ready?

NFV technology has already demonstrated the ability to revolutionize carrier cost structures and operational flexibility while providing the agility needed to execute with new revenue opportunities.

Dell makes NFV simple with comprehensive end-to-end NFV infrastructure paired with standards-aligned reference architectures that can accommodate any scale of deployment. To further simplify NFV adoption, Dell also offers NFV starter kits that make it easy for carriers to accelerate the pathway to the massive new revenue growth opportunities, delivering the next generation of Internet services.

Dell would like to be your partner in building the next generation of the Internet. We invite you to meet our team and jointly design a custom proof of concept to accelerate your journey into NFV today.

Learn more about Dell's open NFV solutions at Dell.com/NFV.