TECHNOLOGY PERSPECTIVE

TELECOMMUNICATIONS INDUSTRY MODERNIZES TO KEEP PACE WITH CHANGE

Intel and Red Hat have collaborated on SDN technology advancements with other partners, such as Nuage Networks, a company that specializes in SDN solutions for service providers. These collaboration efforts have produced several products certified for use on Red Hat® Enterprise Linux® running on Intel® architecture-based servers.

Although building infrastructures based on SDN/NFV principles can be demanding and complex, Intel and Red Hat each offer support and consulting services to reduce the time to value for these deployments.

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THE TELECOMMUNICATIONS INDUSTRY DIGITAL TRANSFORMATION

Digital transformation has positively affected many industries—including healthcare, financial services, energy, and retail. With the commoditization of core services, telcos are seeking integrated solutions—such as cloud services and big data analytics—to create new revenue streams and expand their market reach. This digital disruption offers opportunities for the telco industry to use emerging technologies to establish innovative services and business models. For example, machine-to-machine (M2M), or embedded mobile, creates numerous opportunities for growth.

Another set of emerging technologies, software-defined networking (SDN) and network functions virtualization (NFV), are vastly expanding the agility and scalability of communications service providers (CSPs) and improving the efficiency and use of network resources. With these technologies, telcos can lower capital and operational costs (CapEx and OpEx) while establishing more flexible business processes.

Data-led customer experiences are part of another significant trend for telcos. Many companies are using artificial intelligence (AI) and data analytics to interact with customers more personally. Additional AI techniques, such as voice recognition and sentiment analysis, are also being refined for widespread use.

Intel and Red Hat have collaborated to develop solutions that support full, customer-centric digital transformation of organizational and operating models within the telco industry.

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SOFTWARE-DEFINED NETWORKING, REFINED

"At this point in time, we see our efforts across multiple SDI layers—including OpenStack and Open vSwitch in addition to OpenDaylight—come together in a coordinated way. This allows us to expose platform capabilities all the way to the top of the SDI stack."

URI ELZER
CHIEF TECHNOLOGY OFFICER
SOFTWARE DEFINED NETWORKING,
INTEL CORPORATION

Like many other enterprises, telco service providers have traditionally relied on proprietary hardware and software infrastructures. However, to reduce costs and increase flexibility, telco companies have begun embracing open source technology and standardized operating environments (SOEs), as well as virtualized environments.

As a result, telcos are increasingly adopting SDN/NFV solutions. Numerous successful deployments have demonstrated the viability of the technology and led to increased investment in these solutions. According to a 2015 survey of 214 IT organizations by Computer Economics, SDN was rated as the top technology investment for 2016. SDN also obtained the highest satisfaction rating in the study and was valued as a low-risk, high-reward technology.[1]

As a platinum member of the OpenDaylight Project, Red Hat is committed to helping accelerate widespread adoption of SDN and advancing related technologies, including NFV. The abstraction of network control functions through SDN frameworks makes it possible to easily manage and configure network architectures using virtualized software components and appliances instead of physical network hardware, such as routers and switches. SDN also provides automation capabilities to substantially reduce maintenance and reconfiguration tasks. Intel is a founder and platinum member of the project, as well as a leading proponent of software-defined infrastructure (SDI).[2]

Intel and Red Hat have collaborated on SDN technology advancements with other partners, such as Nuage Networks, a company that specializes in SDN solutions for service providers. These collaborative efforts have produced several products certified for use on Red Hat® Enterprise Linux® running on Intel® architecture-based servers. SDN products from 6Wind, Avi Networks, Big Switch Networks, and Midokura have been successfully tested for use with Red Hat OpenStack® Platform, as well as Red Hat Enterprise Linux.

SIMPLIFYING LARGE-SCALE SDN/NFV DEPLOYMENTS

Because SDN/NFV-based deployments for telco organizations typically contain components from many vendors—often spanning the complete hardware and software environment—interoperability is vital. Intel and Red Hat have created reference architectures to streamline development and simplify these deployments. Intel® Open Network Platform (Intel® ONP) offers a comprehensive set of recommended building blocks, from the hardware foundation to the software environment (Figure 1).

1 *"Software-defined networking tops leading technologies list for 2016." Red Hat. 2016. verticalindustriesblog.redhat.com/software-defined-networking-tops-leading-technologies-list-for-2016/#more-698*
2 *"OpenDaylight Member Spotlight: Intel." Linux Foundation Collaborative Projects. 2014. opendaylight.org/news/blogs/2014/12/opendaylight-member-spotlight-intel*

"Increasingly, OpenStack is seen as the virtual infrastructure platform of choice for NFV, with many of the world's largest communication companies implementing solutions with OpenStack today."

NIR YECHIEL
SENIOR TECHNICAL PRODUCT MANAGER, RED HAT

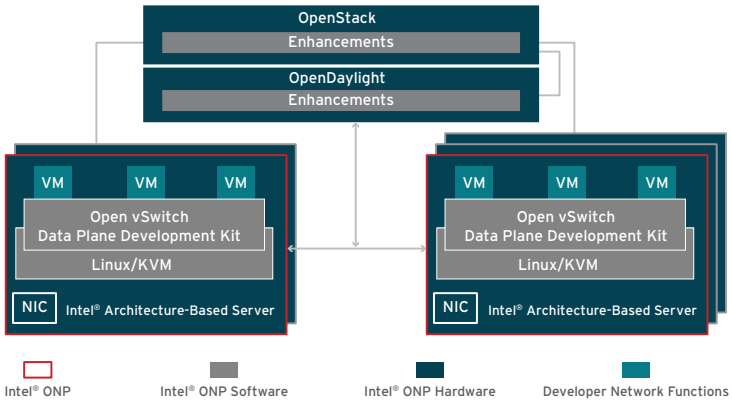

Figure 1. Intel® Open Network Platform (Intel® ONP) overview

Similarly, Red Hat's reference architecture for deployment of mobile networks details the building of high-availability networks for CSPs. This architecture is based on industry-standard equipment, system orchestration, and NFV technology. Red Hat's NFV reference architecture for deployment of mobile networks can help CSPs evaluate available options for virtualized environments, gain a better understanding of the supporting technologies—such as virtual network functions (VNFs)—and implement a mobile network that meets their core business requirements (Figure 2).

Learn more about these architecture design considerations in the reference architecture at https://access.redhat.com/articles/2821501.

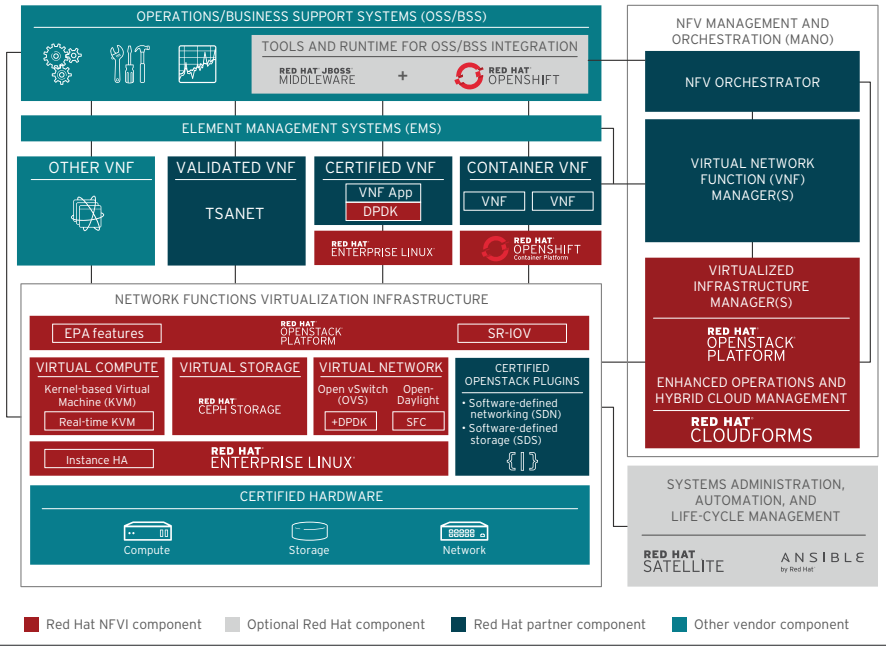

Figure 2. Red Hat NFV and VNF architecture

SDN capabilities are integrated into Red Hat OpenStack Platform 10, providing support for virtualized, comprehensive telco infrastructure. Designed for maximum flexibility, this platform acts as an infrastructure manager and offers different datapath options—including Open vSwitch, Data Plane Development Kit-accelerated Open vSwitch, or single root input/output virtualization (SR-IOV)—for network connectivity to VNFs, depending on environment and requirements.

MEETING STORAGE DEMANDS

Big data and data analytics require massive volumes of data storage that must dynamically accommodate structured and unstructured data. In addition, modernized IT infrastructures must be able to handle data generated and storage in various structures, including block, file, and object storage. Software-defined storage (SDS) can be a valuable tool for telcos adopting modern IT infrastructures. Instead of using traditional, physical storage devices that are managed and configured manually, SDS environments host storage resources in a flexible pool to be allocated as needed. Treating storage devices as software-based replicas creates opportunities to automate processes, increase flexibility, and reduce storage costs.

Red Hat Storage offers an open, SDS platform that scales across physical, virtual, and cloud resources to help telcos meet rising data requirements. The Red Hat Storage portfolio includes Red Hat Gluster Storage and Red Hat Ceph Storage.

- **Red Hat Gluster Storage** provides an open, cost-effective data management platform that can scale out to accommodate the requirements of public, private, and hybrid cloud environments. Telcos can securely manage high-volume data—unstructured or semistructured—at a fraction of the cost of traditional, monolithic storage. In addition, Red Hat Gluster Storage is effective for large-scale data analytics, rich media delivery, and virtualization workloads.
- **Red Hat Ceph Storage** is a modern storage system engineered for petabyte-scale deployments associated with cloud-based infrastructures. This self-healing and self-managing platform effectively handles exponential data growth with no single point of failure. Red Hat Ceph Storage integrates with several OpenStack services, including Nova, Cinder, Glance, Keystone, and Swift.

Effective middleware is also essential to modernized IT infrastructures. Telcos must often manage hundreds of environments, from datacenters to field devices, and need to bridge their components. Red Hat JBoss® Middleware solutions, including Red Hat JBoss Fuse, Red Hat JBoss A-MQ, and Red Hat JBoss Data Virtualization, connect separate applications—for example, linking a database to a web server. As a result, telcos can expand interoperability across diverse network environments.

Intel also offers effective solutions to replace legacy storage systems with large-scale storage for massive data demands. Distributed storage architectures built using Intel® Xeon® processor-based servers dedicate servers to different roles, including application servers, storage nodes, or metadata servers (Figure 3). Servers are configured with appropriate compute I/O and memory capacities for their individual roles. When storage demands increase, capacity can be increased by adding servers. Specific data can be requested from an application server, located by the metadata server, and retrieved from the corresponding storage node. As telco data volumes grow, this architecture can ensure fast access to cloud-based data and on-demand scalability to accommodate even more growth.

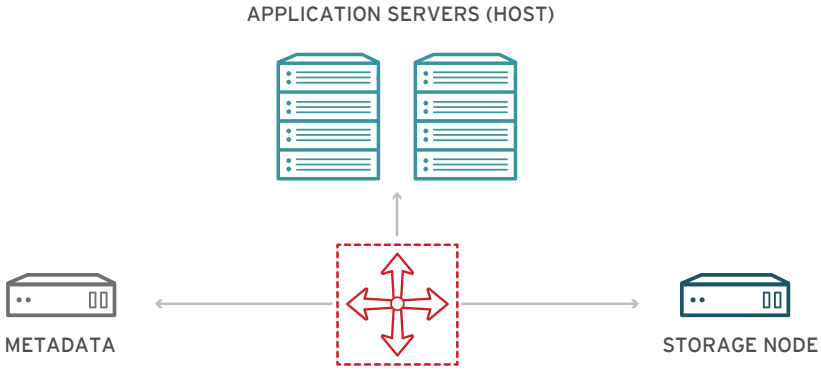

Figure 3. Distributed storage architecture

To protect stored data, certain Intel processors offer built-in encryption and decryption instructions to accelerate encryption operations. Available in the Intel Xeon and Intel® Core™ processor families, seven Intel® Advanced Encryption Standard New Instructions (Intel® AES-NI) improve on the AES algorithm to support cost-effective encryption in IT infrastructures. Telcos can also use Intel AES-NI to enhance storage security without sacrificing performance.

Storage systems based on standard, high-volume servers can be constructed using Intel reference designs for industry-standard storage and SDN infrastructures. Support for open source initiatives—including Ceph and OpenStack Swift object stores—is provided in reference architecture frameworks.

IMPROVING NETWORK BANDWIDTH AND DATACENTER FLEXIBILITY

Advanced technologies from Intel include features that support numerous SDN and cloud-ready networking capabilities. Intel® Ethernet Switch silicon products target datacenter and communications infrastructures to substantially improve traffic flow in virtual environments. For example, the Intel® Ethernet Switch FRM6700 Series supports the following SDN features:

- Flow tables
- Virtual, extensible local area network (LAN) and network virtualization using generic routing encapsulation
- Intel® Flexpipe™ technology
- Flexible port configurations and tunneling
- Routing, congestion management, and advanced load balancing
- Low latency using output-queued shared memory architecture

Without a way to regulate bandwidth, congestion can slow CSP networks. Using advanced Ethernet technologies from Intel, connections can be upgraded to eliminate bottlenecks and speed I/O operations. For example, I/O bandwidth can be significantly enhanced with Intel® Ethernet 10/40 Gigabit Server Adapters. Intel® Gigabit Ethernet Controllers, optimized for virtualized network applications, feature high bandwidth and vSwitch acceleration. To take advantage of the benefits of virtualization and server consolidation, enterprises can use the Intel® Ethernet Converged Network

Adapter XL710 Series to substantially increase throughput compared to previous generations and alleviate I/O bottlenecks. These benefits can be further extended by moving from one to four 10GbE (Gigabit Ethernet) connections.

Service assurance, security, and predictable latency are also important considerations for CSPs. Intel® Resource Director Technology (Intel® RDT) provides valuable capabilities for enterprise NFV deployments, including Cache Allocation Technology (CAT), Cache Monitoring Technology (CMT), Code and Data Prioritization (CDP), and Memory Bandwidth Management (MBM). With this tool, NFV workload profiling methods that rely on CAT can be applied to accomplish consistent performance across an SDN/NFV infrastructure.

Learn more at intel.com/content/www/us/en/architecture-and-technology/resource-director-technology.html.

ESTABLISHING EFFECTIVE TELCO I.T. MODERNIZATION

Previously defined by certain tenets—such as maintaining reliable, highly available service delivery with proprietary hardware and software and manually configuring physical network infrastructure—the telco industry must meet several key challenges resulting from the disruptive change within software-defined, virtualized environments. Intel and Red Hat offer components that address the following challenges:

- **Reliability**. Through collaborative engineering, Red Hat and Intel offer innovative SDN/NFV solutions that are jointly tested and perfected for reliability. Intel's work on hybrid cloud and converged cloud technologies demonstrates high levels of reliability, with availability of 99.9%.[3] Red Hat Satellite provides high-level interoperability for reliable management of cloud infrastructure components in support of digital transformation initiatives.
- **Agility**. With virtualized network technologies that Intel and Red Hat have helped advance, IT professionals can provision network resources from a single, central portal or automate provisioning using application programming interfaces (APIs) or other tools. Ansible by Red Hat streamlines this type of automation across IT infrastructures. In addition, Red Hat OpenShift and Ansible Tower by Red Hat deliver the agility telcos need to quickly develop and deploy innovative applications and services and stay ahead of the competition.
- **Security**. With silicon-based Intel® Trusted Execution Technology (Intel® TXT) and Security-Enhanced Linux (SELinux)—included in Red Hat Enterprise Linux—CSPs gain foundational security protections that can be further enhanced with firewalls, virus and malware protection, and other tools.
- **Automation**. Automating operations is a top requirement for CSPs. Ansible by Red Hat, combined with OpenStack, can automate common tasks at multiple levels of IT environments.
- **Interoperability**. Complex IT infrastructures can be simplified by establishing SOEs with components that are proven to work well together. From SDN/NFV reference architectures to full support for open standards, tested and validated solutions from Intel and Red Hat meet high interoperability standards.

3 Mahankali, Sridhar, Sanjay Rungta. "Adopting Software-Defined Networking in the Enterprise." Intel. 2014.

INDUSTRY USE CASES

As they engage in IT modernization of their network architectures, telco providers are taking advantage of advances in network virtualization and cloud-ready technologies. Learn more in the following industry use cases.

TRANSFORMING NETWORKS WITH NETWORK FUNCTIONS VIRTUALIZATION INFRASTRUCTURES (NFVIS)

Open standards and a growing open ecosystem have simplified planning and implementation of network functions virtualization infrastructures (NFVIs). Intel and Hewlett Packard Enterprise (HPE) have incorporated SDN principles and NFV components in a viable commercial platform based on the Intel ONP reference architecture.

Intel ONP provides a blueprint for developing an interoperable hardware and software platform that can accommodate NFV components and capabilities. Its hardware platform, based on high-volume servers powered by Intel Xeon processors, hosts an open source software environment optimized for performance and reliability.

The HPE OpenNFV reference architecture specifies how the latest SDN/NFV technologies can be integrated to build a complete NFVI for transitioning to NFV environments. In addition, HPE has established OpenNFV labs to accelerate NFV deployments, minimize risk, and validate capabilities for CSP applications.

HPE and Intel have confirmed the viability of Intel ONP-based NFVI technologies running on ProLiant server platforms to support NFV deployments.

"Engineering and technical support that we received from Intel enabled us to make tremendous progress on the testing, especially as we got deeper into points involving the Intel ONP architecture, DPDK, and Open vSwitch," said Al Sanders, R&D project manager of HPE's NFV Infrastructure Lab. "Having the Intel team on board proved very useful in dealing with the complexities of the infrastructure and determining the best ways to tune and optimize at a very low level to ensure top performance."

Learn more at intel.se/content/www/se/sv/communications/hp-onp-packet-processing-benchmark-paper.html.

BUILDING COMMERCIAL NFV SOLUTIONS FOR TELCO

Building SDN/NFV infrastructures can be simplified by uniting companies with complementary technologies and proven interoperable solutions. Joint engineering work by Dell, Red Hat, and Intel has focused on delivering a commercial NFV platform to accommodate telco industry requirements. This collaborative engagement combined work from two industry initiatives—the ETSI NFV architectural framework and Intel ONP—to develop the Dell NFV Platform.

The Dell NFV Platform represents a key evaluation and development target for SDN and NFV developers. Its NFV infrastructure environment uses Intel architecture-based servers, Dell PowerEdge R730 rack servers, and Red Hat Enterprise Linux. This system served as the basis for testing packet processing using industry-standard routing techniques. Test results indicated that performance levels met telco firms' requirements for migrations from existing platforms to virtualized frameworks.

Detailed test results can be found at dell.com/learn/us/en/45/business~solutions~whitepapers~en/documents~dell-red-hat-and-intel-onp-white-paper.pdf.

"Both Dell and Intel are longtime Red Hat partners and have worked with us for many years to help bring open source innovation to enterprise customers," said Darrel Jordan-Smith, vice president of worldwide telecom service provider sales at Red Hat. "By working with Dell and Intel on OpenStack and NFV initiatives, we are working together to bring carrier-grade solutions to CSPs who are looking to NFV to help modernize their businesses and bring new services to customers faster than ever before."

SUPPORTING LONG-TERM MARKET VIABILITY

Telecommunications companies require new infrastructures to meet industry standards, gain high interoperability, adapt flexibly to changing market conditions, and support growth and new business opportunities. To meet these needs, Intel and Red Hat take advantage of the latest network virtualization technology to offer cost-effective and reliable open source solutions. To further reduce the cost of operations and maintenance, these solutions feature industry-standard hardware powered by Intel Xeon processors and network components, such as a wide range of Ethernet controllers and adapters that support I/O virtualization.

Although building infrastructures based on SDN/NFV principles can be demanding and complex, Intel and Red Hat each offer support and consulting services to reduce the time to value for these deployments.

Digital transformation changes in the telco industry will favor companies that embrace agile, data-supported, and customer-centric infrastructures constructed using effective hardware and software, such as collaborative solutions from Intel and Red Hat.

ABOUT INTEL

Intel Makes Possible the Most Amazing Experiences of the Future

You may know us for our processors. But we do so much more. Intel invents at the boundaries of technology to make amazing experiences possible for business and society, and for every person on Earth.

Harnessing the capability of the cloud, the ubiquity of the Internet of Things, the latest advances in memory and programmable solutions, and the promise of always-on 5G connectivity, Intel is disrupting industries and solving global challenges. Leading on policy, diversity, inclusion, education, and sustainability, we create value for our stockholders, customers, and society.

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ABOUT RED HAT

Red Hat is the world's leading provider of open source software solutions, using a community-powered approach to provide reliable and high-performing cloud, Linux, middleware, storage, and virtualization technologies. Red Hat also offers award-winning support, training, and consulting services. As a connective hub in a global network of enterprises, partners, and open source communities, Red Hat helps create relevant, innovative technologies that liberate resources for growth and prepare customers for the future of IT.

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