

# Modernizing application infrastructure for 5G

## Highlights

Modernize your infrastructure for 5G with proven Red Hat and Intel technology.

Support 5G Standalone (SA) from the edge to the core with Red Hat OpenShift running on Intel Xeon Scalable Processors and Intel Optane technology.

Deliver a uniform cloud-native data services platform with Red Hat OpenShift Data Foundation, helping to move from OpenStack to OpenShift.

Scale critical operations support systems (OSS) and business support systems (BSS) with Intel Optane Persistent Memory while deriving important insights with innovative analytics.

## The promise and challenge of 5G infrastructure

5G is bringing a new era of innovation and possibilities to the telecommunications (telco) industry, offering high speeds, low latency, and new application delivery models. As a business platform, 5G can unlock considerable value for consumers and enterprises alike. Yet for all the promise of this new technology, communications service providers (CSPs) must modernize their infrastructure to fully realize 5G benefits and keep pace with an increasingly data-centric world. Everything from edge and core networks to operations support systems (OSS) and business support systems (BSS) is ripe for modernization.<sup>1</sup> Fully modernized infrastructure will allow CSPs to extend beyond network services to offer new workload-optimized application services, elastic data services, and dynamic service packages. Those that embrace this unprecedented business transformation will realize new, more reliable revenue streams, tightly integrate with their enterprise customers, and derive more value from their own data.

Unlike legacy telecommunications networks that are largely proprietary and vertically integrated, 5G implies a highly automated and innovation-driven, service-based architecture. Designed as a fundamentally cloud-native technology, 5G is implemented in virtualized software layers on industry-standard servers—spanning from the core to the edge of the network. Along with high bandwidth and low latency, capabilities like network slicing and prioritization will foster new use cases such as high-capacity ingest, virtual cinema, geospatial video surveillance, telemedicine, remote surgeries, and augmented and virtual reality experiences.

Edge computing is particularly important in a 5G world. The combination of edge computing with 5G speeds and low latency is already supporting new applications and use cases. Moving compute and analytics resources closer to the points where data is generated saves valuable time and keeps large amounts of traffic off of public cloud networks. New telecommunications cloud models are emerging with large numbers of smaller interoperable clouds that will interact with public clouds. Establishing these new cloud networks represents considerable opportunity for carriers and CSPs.

As CSPs transform their business from traditional telco services toward becoming a modern provider of digital services, they must digitize their own internal business systems. Along this path they face multiple challenges, including:

- ▶ Transitioning from virtual machines (VMs) to containers to support virtual network functions (VNFs), cloud-native functions (CNFs), and microservices.
- ▶ Embracing Kubernetes container orchestration technology along with end-to-end data services for hybrid cloud computing.
- ▶ Integrating across hybrid multicloud infrastructure in a cost-effective fashion.

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<sup>1</sup> *"Global Digital Business Support System (BSS) market size to grow at a CAGR of 15.2%." Cision PR Newswire, 11 Dec. 2018. Market research indicates that the global digital BSS market will grow from US\$2.8 billion in 2018 to US\$5.8 billion by 2023, at a compound annual growth rate (CAGR) of 15.2 percent. This massive expansion of data and new usage models will place new demands on BSS infrastructure.*

- ▶ Employing specialized compute, storage, and network hardware to accelerate and optimize key customer and internal workloads.
- ▶ Overcoming the perceived risks of moving from proprietary infrastructure to deploying on an open platform.
- ▶ Automating all aspects of their business, including call centers and network operations.
- ▶ Managing customer data and respecting regulatory requirements.
- ▶ Harnessing the power of artificial intelligence and machine learning (AI/ML) to place data at the heart of the business operations.
- ▶ Monetizing the edge while creating more business value for enterprise customers.
- ▶ Ensuring their business can integrate seamlessly with the broader digital value chain (e.g., expose their value through APIs in order to foster agile business partnerships with cloud service providers).
- ▶ Forging a long-term technology strategy and the right vendor partnerships to facilitate the transformation journey and ensure an effective outcome.

### An innovation-driven platform from silicon to software

With our combined experience serving telecommunications leaders and innovators, Intel and Red Hat are committed to helping CSPs modernize their network and application infrastructure. Our partnership combines extensive silicon expertise with open software innovation, informed by extensive experience working with telecommunications firms around the globe. Constant joint development, integration, and testing efforts ensure the complete hardware, software, and networking stack works together effectively to offer:

Red Hat and Intel have partnered extensively to deliver solutions for telecommunications service providers that help them modernize infrastructure and embrace 5G Standalone (5G SA).

- ▶ **Cloud-native architecture.** Red Hat® OpenShift® and Red Hat OpenShift Data Foundation combine with Intel's processor, storage, and networking products to provide a complete and fully cloud-native platform for elastic application and data services scalability. Red Hat and Intel partner to create joint reference architectures for solutions specifically engineered for telecommunications use cases.
- ▶ **Full life cycle integration.** Close collaboration between Red Hat and Intel helps ensure Day 0 integration between hardware, middleware, and the application. Day 1 and Day 2 configuration of networks and network operations is straightforward, with ongoing network and operations automation supporting life cycle management through an open platform.
- ▶ **End-to-end ecosystem.** The partnership has resulted in an open developer ecosystem, supported by systems integrator (SI) partners. Access to a joint certification lab gives independent software vendors (ISVs) and SIs the ability to test and validate applications before commercial deployment.

The platform is optimized to support all workloads, from traditional telco workloads such as fixed access, to new service-based workloads such as 5G standalone (5G SA) core, as well as an open radio access network (RAN) and edge. In addition, the platform is built on cloud-native principles and includes security, data management, and built-in AI/ML optimizations.

## Modernizing telecommunications infrastructure with Red Hat and Intel

Telecommunications services based on 5G will be a critical agent for digital transformation in the enterprise. When fully realized, 5G will let enterprises partner with their carriers and service providers to build solutions that simply were not possible with earlier-generation networks. Service providers will be able to offer tailored workload-based services and connectivity—with prioritization of data traffic, performance guarantees, and enhanced security. Network slicing will allow multiple virtual networks to run on the same shared infrastructure.

The Red Hat and Intel partnership is designed to allow service providers to reduce risks as they modernize their infrastructure to embrace 5G. Using an open platform guarantees choice and reduces financial risk while end-to-end orchestration minimizes ecosystem operational risk. Certification and blueprints ensure reliable network design and management. Joint reference architectures reduce the complexity of multicloud systems and provide integration throughout the stack, while spanning the full telecommunications ecosystem. Red Hat and Intel reference architectures and other joint collaborations encompass:

- ▶ **Access edge (5G)**, a cloud-native Access Edge RAN solution with certified commercial partners using Intel vRAN and Red Hat OpenShift in a joint reference architecture (Figure 1).
- ▶ **Near edge (cable)**, enabling the virtual Cable Modem Termination System (vCMTS) on a containerized platform accomplishing CMTS virtualization with Red Hat OpenShift and developing container optimization systems.
- ▶ **Wireless core**, featuring a cloud-native 5G wireless solution and ecosystem certification in containerized environments for commercial partners.
- ▶ **Wireline and converged access**, enabling virtual central office (VCO) on Red Hat OpenShift with vendor partners.
- ▶ **Enterprise networking** that unlocks the promise of universal customer premises equipment (CPE) and new business models for network and nonnetwork services.
- ▶ **Private wireless**, helping traditional CSPs use open private wireless solutions to deploy cloud-native private wireless solutions at scale.

Red Hat OpenShift is a hybrid cloud, enterprise Kubernetes platform, trusted by 2,000+ organizations.

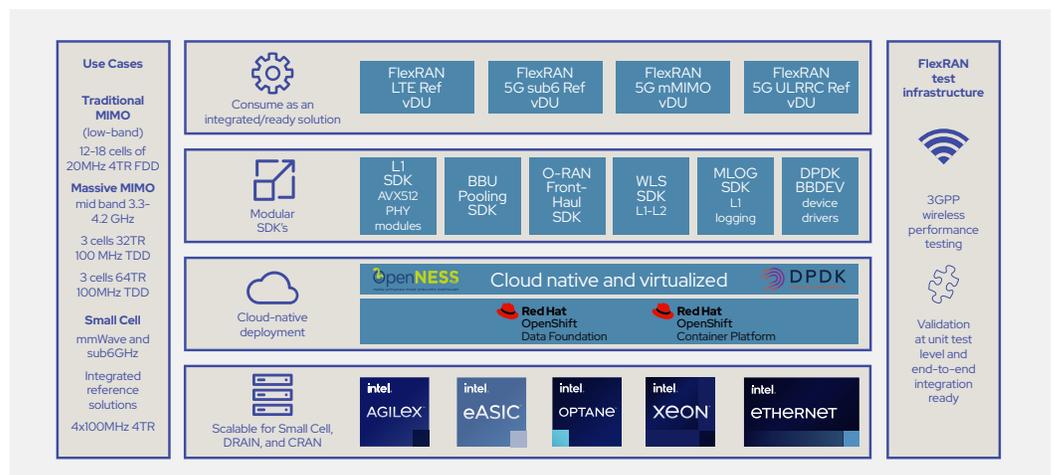


Figure 1. Cloud-native Intel vRAN architecture running on Red Hat OpenShift

Red Hat OpenShift Platform Plus is a single, hybrid cloud platform for innovation without limitation that lets you deliver multicloud security, compliance, and data management across infrastructures for consistency across the software supply chain.

## Red Hat OpenShift: An open foundation for 5G infrastructure

Within Red Hat and Intel's 5G reference architectures, applications and services run on orchestrated layers based on containers powered by Red Hat OpenShift, the industry's most secure and comprehensive enterprise-grade container platform. Based on industry standards Docker and Kubernetes, Red Hat OpenShift acts as a hybrid-cloud enterprise Kubernetes application platform, providing:

- ▶ **Container host and runtime.** Red Hat OpenShift ships with Red Hat Enterprise Linux® CoreOS for the Kubernetes master, and supports Red Hat Enterprise Linux for worker nodes. Red Hat OpenShift is compliant with the Open Container Initiative (OCI), an open governance structure around container formats and runtimes.
- ▶ **Enterprise Kubernetes.** Red Hat OpenShift improves on the upstream Kubernetes with bug fixes, security hardening, and provider network-grade performance and scale. The product is tested with dozens of technologies and is a robust tightly integrated platform supported over a [predictable life cycle](#).
- ▶ **Validated integrations.** Ideal for telecommunications solutions, Red Hat OpenShift includes software-defined networking, and additional common networking solutions are validated. Red Hat OpenShift also validates numerous storage and storage third-party plug-ins for every release.
- ▶ **Integrated container registry.** Red Hat OpenShift ships with an integrated, private container registry that can be installed as a part of the cluster or as a standalone service. Teams with greater requirements can also use Red Hat Quay for this purpose.
- ▶ **Developer workflows.** Streamlined workflows help teams get to production in less time, easing operations including built-in GitOps pipelines and source-to-image technology to go straight from application code to container. The platform is extensible to new frameworks such as ServiceMesh with Istio and serverless with Knative.
- ▶ **Access to services.** Red Hat OpenShift helps administrators and application support teams with service brokers, validated third-party solutions, and Kubernetes operators through the embedded OperatorHub.
- ▶ **Support.** Support is a key requirement for CSPs. Red Hat OpenShift is a modern cloud-native application platform that assures that telco-grade support SLAs remain in place, allowing you to focus on managing your business operations.

### Red Hat OpenShift Platform Plus

To ease the transition to fully modern infrastructure, telecommunications providers need complete solutions with tested components that are designed to work together and ready to run. [Red Hat OpenShift Platform Plus](#) satisfies this requirement by providing a single hybrid cloud platform for innovative applications and their data. The platform lets you build, deploy, run, and manage fully modern containerized applications with comprehensive security at scale to support your digital transformation journey. Red Hat OpenShift Platform Plus includes Red Hat OpenShift Container Platform as well as the following advanced components:

- ▶ **Red Hat Advanced Cluster Management for Kubernetes.** Managing Kubernetes clusters can pose significant challenges. [Red Hat Advanced Cluster Management for Kubernetes](#) offers end-to-end management visibility and control with a single view to manage your Kubernetes clusters.

Intel Xeon Scalable processors offer a balanced architecture for many types of workloads and performance levels, that let you place your workloads securely where they perform best—from the edge to the core.

- ▶ **Red Hat Advanced Cluster Security for Kubernetes.** Strong security is essential as telecommunications providers become more deeply involved in their clients' enterprise applications. Red Hat Advanced Cluster Security for Kubernetes is a Kubernetes-native container security solution that lets you more securely build, deploy, and run cloud-native enterprise applications.
- ▶ **Red Hat OpenShift Data Foundation Essentials.** Data-centric 5G applications need scalable data services that run anywhere and everywhere in the hybrid cloud. [Red Hat OpenShift Data Foundation](#) is persistent software-defined storage integrated with and optimized for Red Hat OpenShift. Based on leading industry technologies that provide petabyte-scale persistent cloud storage, a Kubernetes storage operator, and multicloud object gateway technology, OpenShift Data Foundation runs anywhere that Red Hat OpenShift does—on-premise or in hybrid cloud environments.
- ▶ **Red Hat Quay.** CSPs need effective ways to securely store and deploy containerized applications in a Red Hat OpenShift environment. [Red Hat Quay](#) is a private container registry that stores, builds, and deploys container images. It analyzes container images for security vulnerabilities.

## Red Hat and Intel technology for modern infrastructure

Given the wide-ranging impacts of 5G, most CSPs need to modernize infrastructure across their organization. Red Hat and Intel technology lets organizations achieve diverse modernization efforts based on a common open platform, reducing risk and accelerating infrastructure roll-outs.

### Modernization at the edge

Some of the most promising 5G applications depend directly on extremely low latency. Self-driving cars and virtual and augmented reality require response times in the tens of milliseconds. Many Internet of Things (IoT) applications likewise have safety and quality control implications that are highly dependent on very low latency. Hosting these applications in a centralized cloud may ultimately render them non-viable. Edge computing and modernized 5G infrastructure are key to the success of these and other initiatives.

To reduce latency, service providers are increasingly looking to edge computing to process workloads and analyze data closer to end-user devices.<sup>2</sup> There is more network bandwidth available at the edge of the network, and latency is lower the closer to the user device or data collection point the workload can be deployed. Given their close proximity to client devices, service providers have a unique opportunity in deploying edge computing resources.

With 5G network infrastructure built on industry-standard servers with software-defined networking and data services, the compute, storage, and network scalability of those platforms is essential to guarantee sufficient application performance. Intel Xeon Scalable processors benefit from decades of innovation in support of customers' most demanding workloads. With a balanced architecture, these processors are optimized for many workload types and performance levels including cloud, enterprise, high-performance computing (HPC), network, security, and IoT. With a wide range of powerful cores and multiple frequency, feature, and power levels, Intel Xeon Scalable processors are ideal for systems that serve both edge and core workloads.

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<sup>2</sup> Enterprise and service provider spending on hardware, software, and services for edge solutions is forecast to sustain growth through 2025 when spending will reach nearly \$274 billion, according to IDC Press Release, "[New IDC Spending Guide Forecasts Double-Digit Growth for Investments in Edge Computing](#)," January 2022.

Engineered as the data and storage services platform for Red Hat OpenShift, Red Hat OpenShift Data Foundation is software-defined storage for containers.

Intel Optane Persistent Memory (PMem) redefines traditional architectures, offering a large and persistent memory tier at an affordable cost. With breakthrough performance levels in memory-intensive workloads and fast storage capacity, Intel Optane PMem accelerates IT transformation to support the demands of the data era.

Intel Optane persistent memory is optimized for and designed to work with the latest 2nd Generation Intel Xeon Scalable processors. One Intel Optane persistent memory per channel is supported, providing up to 3 TiB of Intel Optane persistent memory on a single socket. An eight-socket system built with Intel Xeon Scalable processors could access up to 24 TiB of system memory. This combination of hardware components represents engineering across the hardware stack that delivers higher performance and capacity.

### **Modernizing the core network**

For most networks, 5G adoption represents an evolution. Many providers currently implement 5G using their existing 4G network as a stopgap. While this approach accomplishes 5G connectivity, older infrastructure imposes limitations in terms of both speed and flexibility. 5G SA realizes the ultra-low latency of 5G by operating with a true 5G core. Yet many telecommunication companies are anxious that CNFs will not work consistently in the core network environment.

Red Hat and Intel solutions combine silicon expertise with software innovation. Intel provides best-in-class silicon and platform innovation for the wireless core. Red Hat OpenShift brings strong orchestration, performance, and resource management. CNFs can be managed on top of Red Hat OpenShift throughout their life cycle, bringing security, simplicity, and scalability. Importantly, Red Hat and Intel's test beds certify CNFs before putting them out to market, reducing risks and increasing operational efficiency. A vibrant ISV ecosystem supported by certification provides confidence in a cloud-native 5G SA core.

### **Modernizing data services**

Data services are a critical component of cloud-native infrastructure since applications need data services that are available across the hybrid cloud. Many telecommunications networks currently implement NFV using OpenStack, and software-defined Ceph storage is consistently the most popular OpenStack storage solution.<sup>3</sup> Because OpenShift Data Foundation uses Ceph as its data storage layer, it represents an ideal migration path for those with existing Ceph or Red Hat Ceph® Storage clusters. CSPs can experiment with container-based applications without having to migrate their data.

OpenShift Data Foundation offers two modes of storage to accommodate the broadest range of applications. Traditional internal-mode storage schedules applications and OpenShift Data Foundation pods on the same Red Hat OpenShift cluster, offering simplified management, deployment speed, and agility. Pods can either be converged onto the same nodes or disaggregated on different nodes, allowing organizations to balance compute and storage resources. External mode, in contrast, supports mixed media and also decouples storage from Red Hat OpenShift clusters, allowing multiple Red Hat OpenShift clusters to consume storage from a single, external storage cluster.<sup>4</sup>

Intel Optane Solid State Drive (SSD) technology is critical for optimizing performance for different workloads running on OpenShift Data Foundation. Intel Optane SSDs can offload and accelerate the Ceph metadata cache to accelerate application performance and also increase the performance of the Kubernetes etcd database. The SSDs take the write pressure off of the Ceph storage media, creating a solution that is optimized for both input/output (I/O) operations per second (IOPS) and total cost. Featuring a memory-like capability inside an SSD form factor, Intel Optane SSDs are

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<sup>3</sup> [OpenStack Survey Report](#).

<sup>4</sup> *External mode is available with Red Hat OpenShift Data Foundation Advanced Edition.*

fundamentally different from other SSDs. This design gives them lower latency, higher IOPS performance, and greater endurance. For example, Intel Optane SSDs support an industry-leading 100 drive writes per day (DWPD)<sup>5</sup>.

### **Rapidly scaling and optimizing data services for specific workloads**

Modern telecommunications services serve a multidimensional role in consumers' lives, touching everything from financial services to healthcare to entertainment and education. At the same time, telecommunications providers are making significant investments in new digital services to stay competitive and benefit from new revenue streams. These parallel trends are resulting in massive data growth inside telecommunications networks.

To simplify data services scalability, Intel offers [workload-optimized data node configurations for OpenShift Data Foundation](#). Based on Intel Xeon Scalable processors, Intel Optane technology, and Intel Ethernet technology, the data node configurations offer a range of choices. Intel data nodes for Red Hat OpenShift are powered by OpenShift Data Foundation Advanced Edition. Telecommunications providers can efficiently procure and deploy the appropriate data nodes from their favorite vendor for specific workloads, including:

- ▶ Data nodes optimized for edge infrastructure.
- ▶ Data nodes optimized for capacity.
- ▶ Data nodes optimized for I/O performance.

### **Modernizing and scaling operations and business support systems (OSS/BSS)**

As telecommunications companies become more data centric, their operations support systems (OSS) and business support systems (BSS) are receiving increasing focus. Typically implemented as large in-memory databases, these systems are large and growing. Not only must they operate at peak performance as they scale to accommodate more customers, but the data stored in them represents a vital source of innovation.

AI and ML are increasingly used to derive new insights from the vital business and customer data in these systems. Service consumption can be tracked in real time, with emerging trends identified proactively. Organizations can also identify their highest value customers, offering timely personalized communications and offerings based on customers' historic use of telecommunications services.

BSS systems can greatly benefit by taking advantage of latency reductions enabled by Intel Optane Persistent Memory (PMem). Intel Optane PMem provides a unique combination of affordable larger capacity and support for data persistence. It combines byte-addressability similar to dynamic random-access memory (DRAM) with optional persistence similar to storage. Intel Optane PMem offers two distinct operating modes: Memory Mode and App Direct Mode. Memory Mode behaves exactly like traditional, volatile (nonpersistent) system memory at lower cost, enabling higher capacities within a constant system budget. Modules are available in capacities of 128GB, 256GB, and 512GB.

Refreshing OSS and BSS systems with the latest Intel Xeon Scalable processors and adding memory capacity with Intel Optane PMem can make a real difference for large in-memory database systems and analytics while lowering costs over systems equipped with DRAM alone.

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<sup>5</sup> Intel® product brief: [Intel® Optane™ SSD P5800X Series](#).

**Learn more**

Learn more about [Intel network transformation for 5G](#) and the [Red Hat and Intel partnership](#).

**About Red Hat**

Red Hat helps customers standardize across environments, develop cloud-native applications, and integrate, automate, secure, and manage complex environments with [award-winning](#) support, training, and consulting services.

**f** facebook.com/redhatinc  
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**North America**  
1 888 REDHAT1  
www.redhat.com

**Europe, Middle East,  
and Africa**  
00800 7334 2835  
europe@redhat.com

**Asia Pacific**  
+65 6490 4200  
apac@redhat.com

**Latin America**  
+54 11 4329 7300  
info-latam@redhat.com