

Disaggregation and Virtualization within the Juniper Networks Mobile Cloud Architecture

White Paper

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Executive Summary

This white paper discusses disaggregation and virtualization in the context of mobile environments in general, and in the context of the Juniper Networks Mobile Cloud Architecture in particular.

The content in this white paper is also available in PPT (blueprint) and video formats at [Network Design and Architecture Center: Mobile Cloud](#).

Challenges and Trends

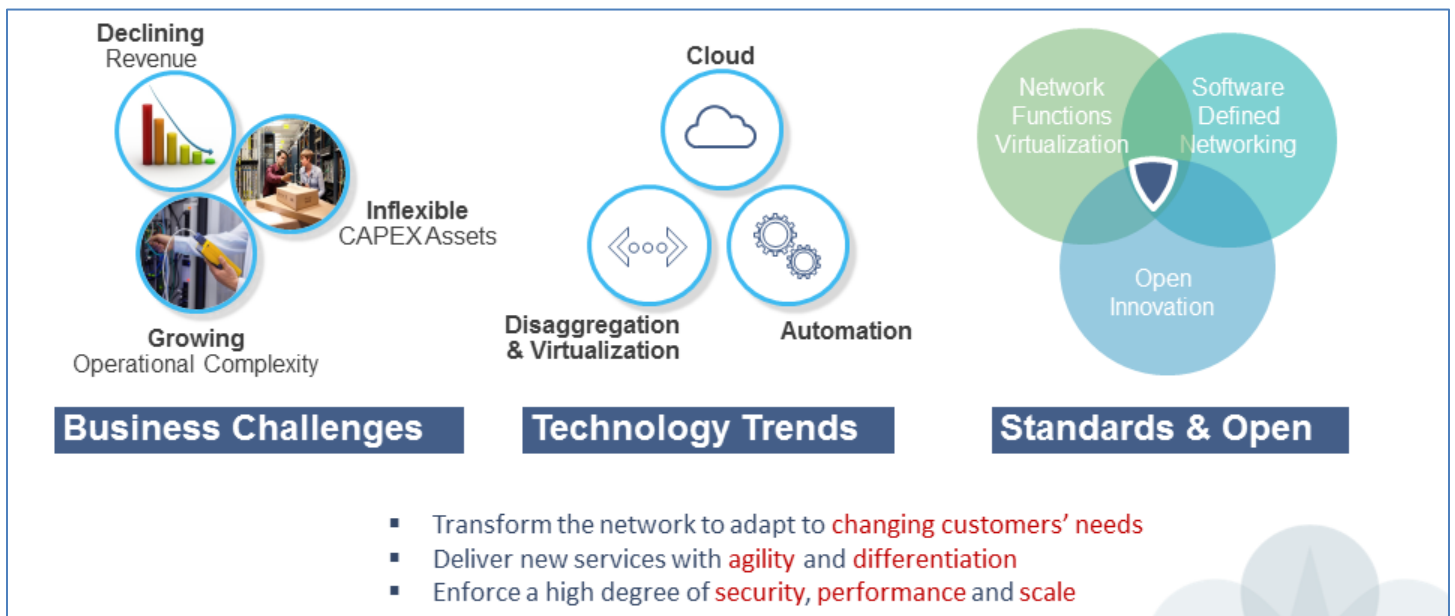


Figure 1: Disaggregation and Virtualization - Challenges and Trends

Conversations around disaggregation and virtualization have so far been on the increase of challenges faced by operators as revenue and cost become inflexible and under pressure. In addition, complexity is increasing with various new services that need to be adapted to always more demanding customers.

In parallel to these trends is the evolution of technology. Clouds, increased automation, virtualization technologies, are employed in order to deal with this growing complexity. Standards evolve with open innovation where computing is moving towards openness and towards communities that work together. The mix of these trends open opportunities to create a transformation of networks in order to adapt more rapidly to customer needs, to deliver new services with more agility and differentiation, while still enforcing a high degree of security, good performance and scale.

Strategy

Vision for an Open Architecture

Any conversation around virtualization starts with disaggregation.

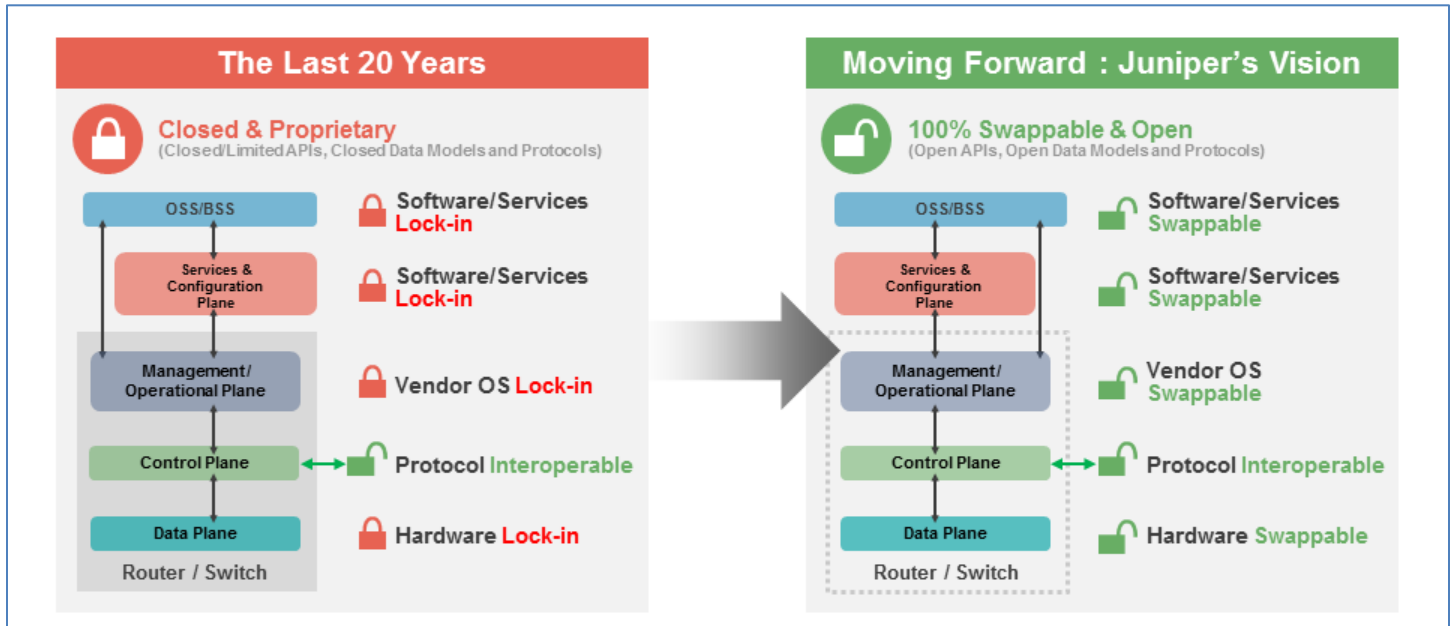


Figure 2: Vision for an Open Architecture

As shown in Figure 2, network systems of the past have generally relied on protocols and control planes for inter-system communication. Protocols needed to be interoperable because machines just need to speak to other machines. However, this has generally been the only interoperable part of the network; other elements have been developed in a closed environment mostly driven by vendors' constraints leading to their customers becoming locked within their solution.

Moving forward, Juniper's vision is that everything in a system will be open and will be swappable:

- The hardware layer will become completely open and could be swapped by other hardware
- Protocols will remain interoperable and open
- The operating system will be swappable, creating a flexible environment where the OS can be used on various types of hardware
- The operations and services software stacks could also become completely open and swappable

This will unquestionably change how systems will be built and deployed.

Juniper Networks Open Architecture

Juniper Networks open architecture defines open systems by disaggregating hardware and software, as shown in Figure 3. This means that, using Juniper devices and the Junos OS, you can mix and match hardware and software, including

using 3rd-party software on Juniper hardware, and vice-versa. Disaggregation also enables various combinations that leverage open source applications.

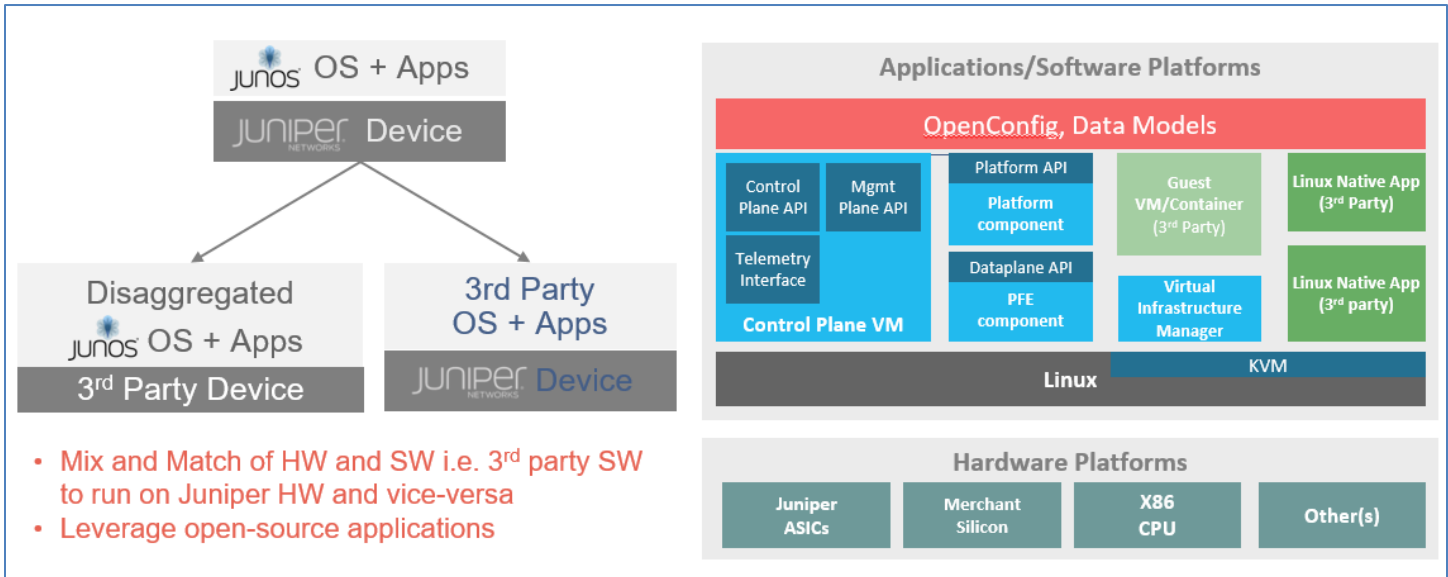


Figure 3: Juniper Networks Open Architecture

Hardware platforms can take the form of Juniper ASICs, merchant silicon, Intel x86 CPUs or any other supported hardware platform.

Software platforms start with an operating system with virtualization capabilities. On top of this are several elements:

- A virtual infrastructure manager
- A virtualized control plane that communicates to the various hardware and software elements through APIs
- A virtualized packet forwarding engine, which allows packets to move in and out the virtual system
- A component that will manage the whole system as a virtual platform
- Other virtual machines and native applications running in parallel and complementing the processing of information flowing through this virtualized system

The software layer interacts with upper-layer applications through data models coming from the OpenConfig world, in order to be fully managed by any kind of management system in a standard way.

Put together, Juniper’s systems provide a framework for disaggregation and open the door to virtualizing almost all elements of the architecture, thereby allowing differentiation between hardware and software in a very flexible way.

Robust Partner Ecosystem of Integrated VNFs

This flexibility could not be achieved without having a very open way to work with different systems, vendors, and solutions. Juniper’s virtualized solutions are able to interact with a variety of vendors’ systems, as shown in Figure 4.

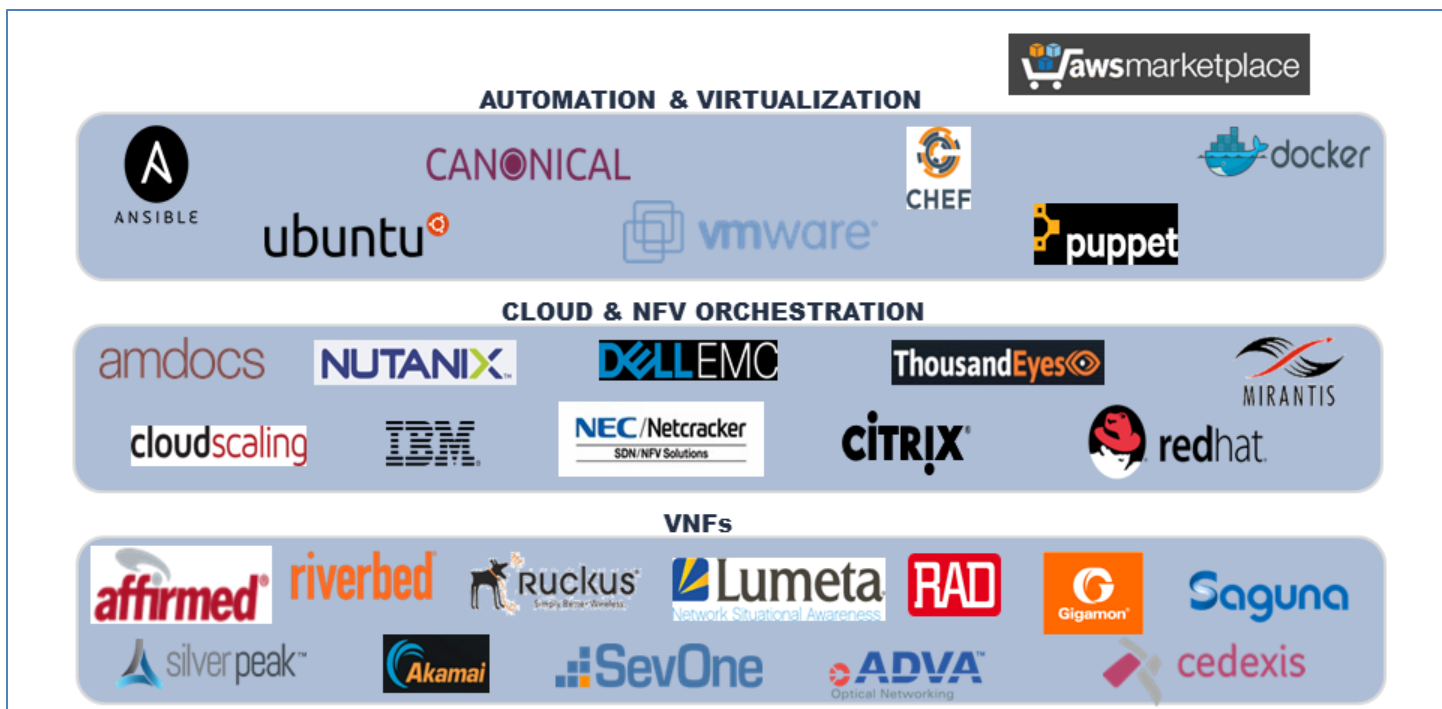


Figure 4: Virtualized Partner Ecosystem

Partners include VNF vendors, such as Affirmed Networks, as well as providers of orchestration systems to build clouds, all of which can be automated through providers of automation and virtualization systems. Juniper has built these strategic partnerships to ensure interoperability with as many solutions as possible.

Virtualization and Cloud Networking

While open architectures and integrated VNF ecosystems are important elements in the Mobile Cloud Architecture, another framework is needed to support a virtualized solution: a cloud networking environment to allow VNFs to connect to one another.

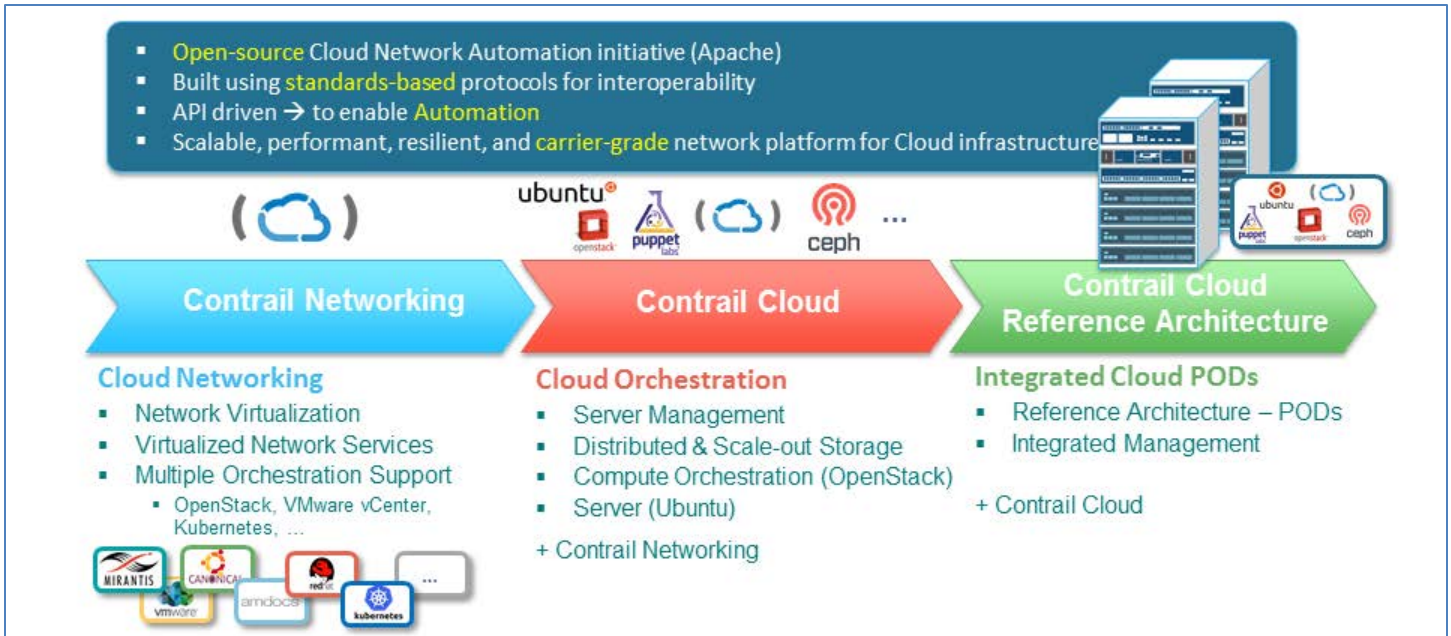


Figure 5: Juniper Networks Contrail

The Contrail solution is a carrier-grade SDN platform for service provider cloud infrastructure. Contrail is a completely open-source system, developed using standards-based protocols such as BGP to ensure it can interoperate with existing physical networks. The system is completely open with APIs that allow it to interface with automation tools and management systems.

Juniper’s Contrail offering ensures that self-developed VNFs can be completely controlled by this SDN infrastructure.

Contrail Networking

Contrail Networking is a simple, open, and agile SDN solution that automates and orchestrates the creation of highly scalable virtual networks. Contrail Networking provides virtual network capability through virtual routers, or vRouters. Manageable by standard orchestration systems, vRouters are added to compute nodes to provide the routing function of the platform.

For more information on Contrail Networking, see <http://www.juniper.net/us/en/products-services/sdn/contrail/contrail-networking/>.

Contrail Cloud Platform

Contrail Cloud Platform is an integrated turnkey cloud management platform that is hardened from open source technologies including OpenStack, OpenContrail, Ceph, and Puppet. The Contrail Networking system is part of this larger Contrail Cloud Platform offering.

For more information on Contrail Cloud Platform, see <http://www.juniper.net/us/en/products-services/sdn/contrail/contrail-cloud/>.

Contrail Cloud Reference Architecture

The elements noted above are bundled into the Contrail Cloud Reference Architecture. This reference architecture is a set of verified cloud systems that, combined with Juniper switching and routing platforms, facilitate the design and deployment of an integrated compute, network, and storage system that runs Contrail Cloud Platform to provide an all-in-one turnkey cloud solution for NFV. This reference architecture includes specifications for a standard system design, provides a predefined bill of materials, and includes tools and scripts for automated installation.

For more information on Contrail Cloud Platform, see <https://www.juniper.net/assets/us/en/local/pdf/solutionbriefs/3510523-en.pdf>.

Software-Defined Operations with AppFormix

Another mechanism available to provide the ability to deploy virtualization efficiently is through Juniper’s acquisition of AppFormix. AppFormix’s technology provides operators with the ability to deploy clouds and optimize this infrastructure in real-time using a fully automated solution that leverages machine-learning techniques to provide an ‘intent-driven’ solution.

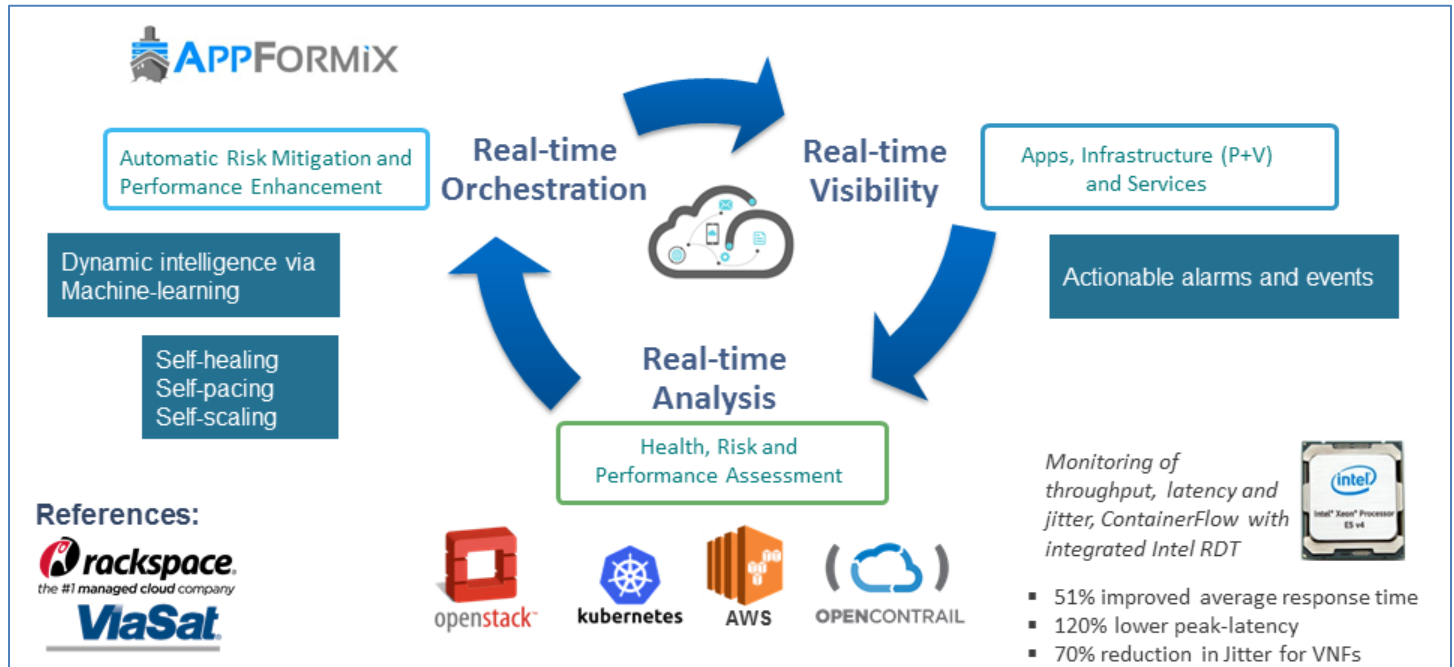


Figure 6: Improving Cloud Orchestration with AppFormix

As shown in Figure 6, this solution includes three key elements:

- Real-time visibility—provided by looking at the Intel processor’s telemetry capabilities and leveraging this information to determine resource utilization, response times, and behavior of VNFs, the AppFormix solution provides real-time visibility of applications, physical and virtual infrastructure, and services running on top of it.
- Real-time analysis—uses the data collected above to analyze the health of the system, and make assessments of risk and performance
- Real-time orchestration—based on the results of analysis, specify actions to orchestrate in real-time to mitigate risk and enhance performance, though alarms and events that can be enforced by the system itself.

These elements, working together, provide a solution that is self-healing, self-pacing, and self-scaling, providing full automation of a virtualized environment.

Current customers, including Rackspace and ViaSat Inc., are deploying this solution into data centers, and are exploring deployment options further out in the network.

Use Cases

Based on the technologies discussed above, several use cases can be defined for virtualized solutions.

Secure Mobile Virtualization

As a long-time security leader in the networking space, Juniper has moved the technology built into its SRX Series Services Gateway product line into a virtualized environment. This means that the Contrail-based SDN environment, shown in Figure 7, which manages compute nodes and virtual networks through vRouters, can interconnect networks through rules that can be secured by a virtual firewall system. Juniper provides this capability through its vSRX integrated virtual firewall and cSRX container firewall. These products provide the ability to interconnect virtual networks while also enforcing security.

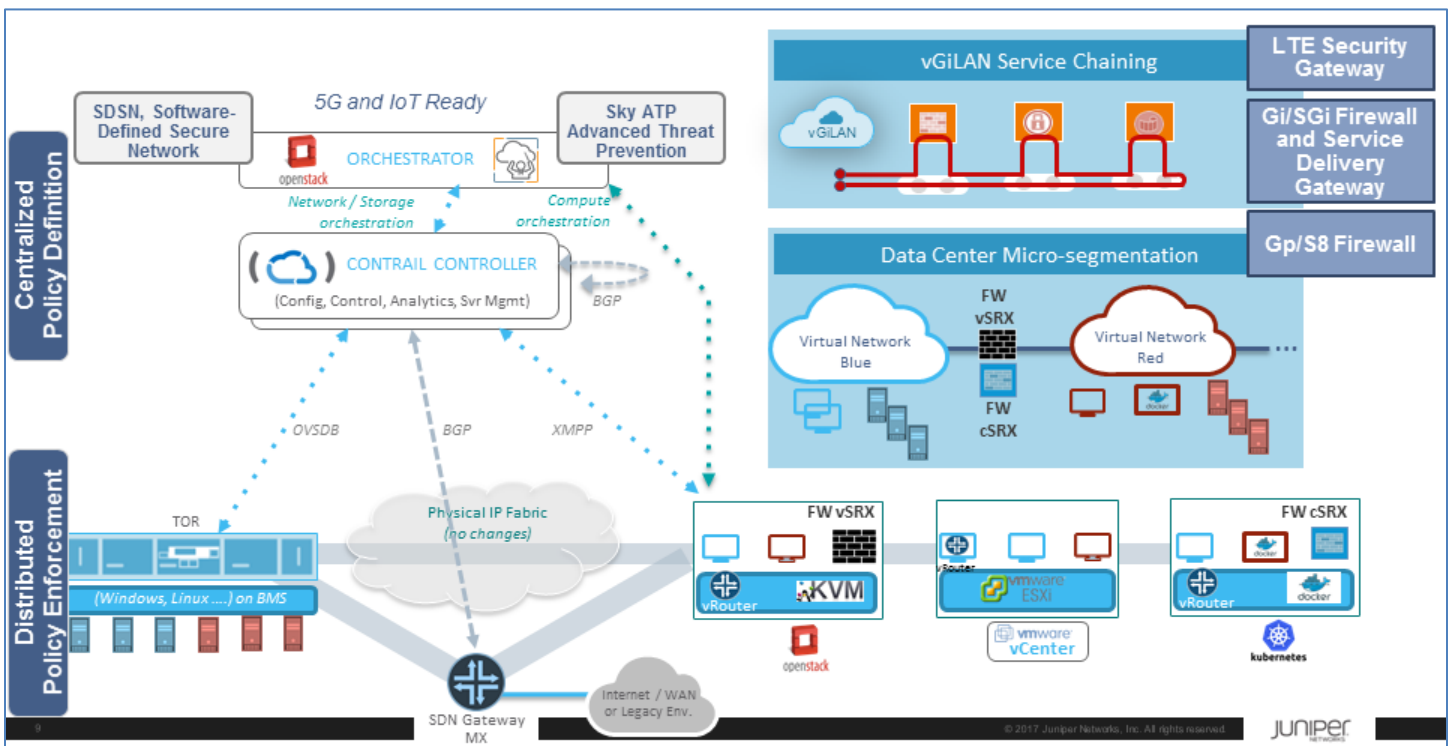


Figure 7: Use Case—Virtualized and Orchestrated Security

In mobile environments, these products can function as an LTE security gateway, a Gi firewall, or a Gp firewall. These functions can be enforced within a data center or a POP between virtual networks, as well as on the GiLAN to create a chain of services that include virtual firewall capabilities.

This solution can be managed under Juniper’s Software-Defined Secure Network (SDSN) architecture, and leverages Juniper’s cloud-based Sky Advanced Threat Prevention (ATP) security solution, which uses state-of-the-art machine learning and real-time information from the cloud to provide anti-malware protection. The solution distributes policy enforcement, while centralizing policy definition.

vSRX

As noted earlier, Juniper’s SRX Series product line has been virtualized into the vSRX virtual firewall.

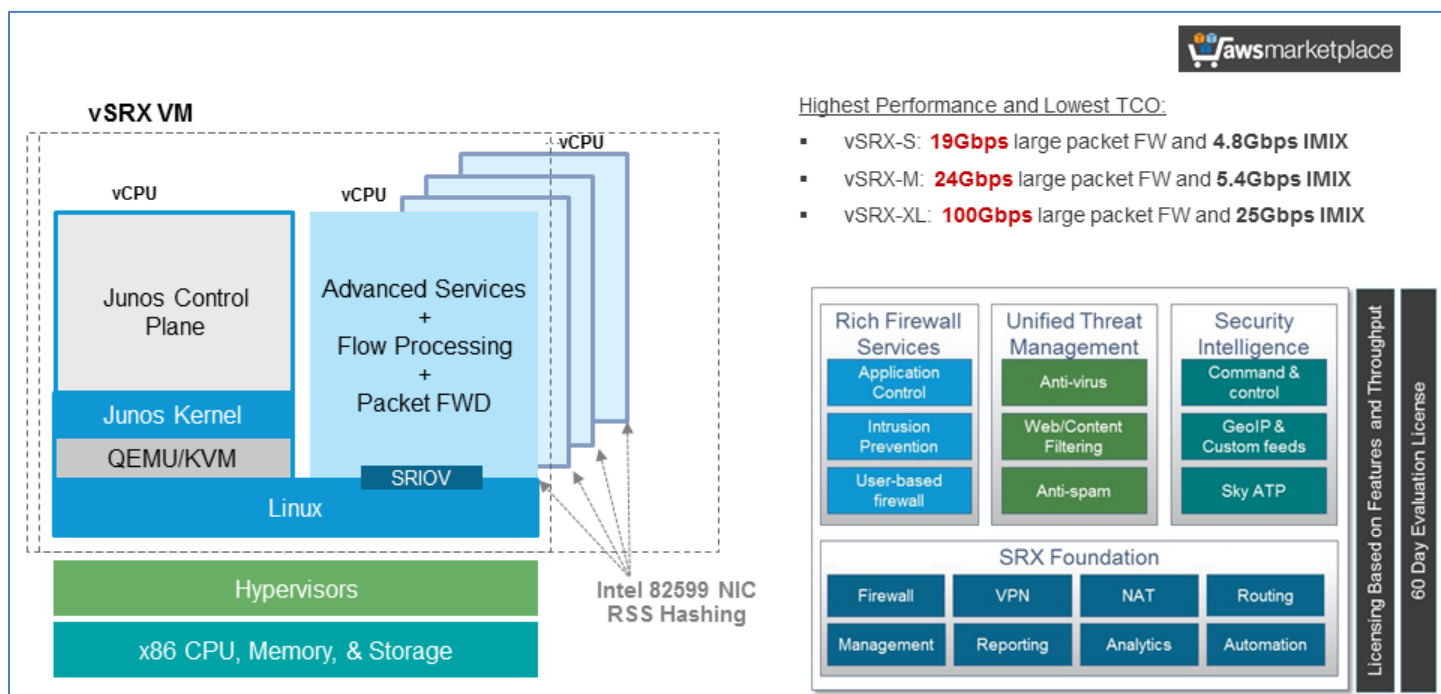


Figure 8: vSRX—Industry’s Fastest Virtual Firewall

As shown in Figure 8, the vSRX platform includes all the same foundational features and functionality as physical SRX devices, including IPsec VPNs, NAT, firewall, analytics, and so on. The vSRX also includes more advanced functionality with rich firewall services such as intrusion prevention, unified threat management (UTM) capabilities such as anti-virus and web filtering, and support for security intelligence solutions such as Sky ATP.

With vSRX, all this functionality now runs on an x86 platform, in a virtual environment based on VMs, where the control plane runs on a virtual CPU (vCPU) and the forwarding plane, which forwards packets and provides security functions, runs on a vCPU as well. This platform has been developed by scaling multiple vCPUs to achieve the highest performance on the market today, providing adaptable capacity up to 100Gbps. The performance of a vSRX can be tailored for a particular function and load depending on its location in the network. Flexible adaptation to new conditions can be achieved by scaling out or in the vSRX capacity.

cSRX

Advancing this effort even further, Juniper has adapted the vSRX into the first containerized firewall on the market, cSRX.

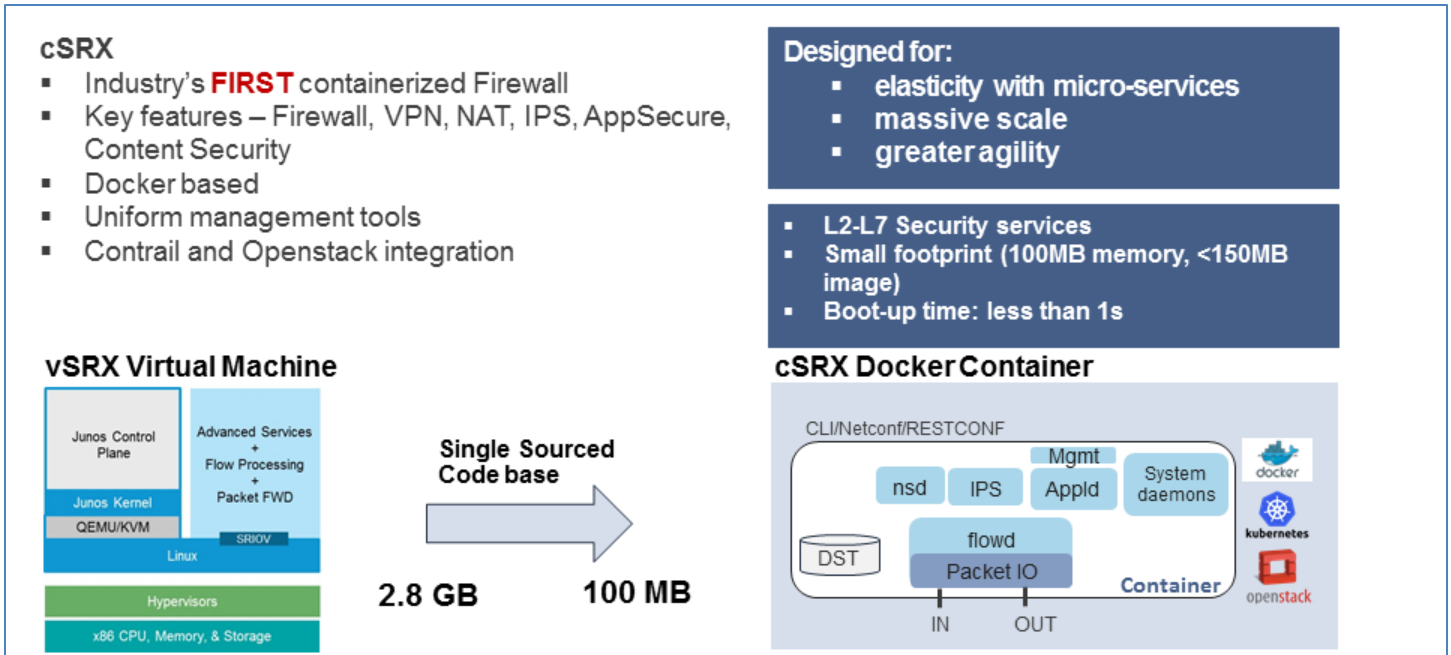


Figure 9: cSRX—Industry’s First Containerized Firewall

As shown in Figure 9, this solution migrates the source code of the vSRX into a container infrastructure, bringing all the same features and functionality into a small footprint—from over 2 GB of memory for vSRX down to just 100 MB for cSRX. More importantly, boot time is reduced from several minutes with the VM-based environment to less than one second for the cSRX.

This very efficient setup provides high elasticity to implement micro-services, the ability to scale in and out massively and rapidly, and the ability to start new virtual firewall instances when and where you need them, in a very flexible manner. These benefits provide a very different way of deploying security. This is very complementary to a virtualized solution such as the vSRX.

Virtual Routing

Another use case area centers on the virtualization of routing. Much like the virtualization of the SRX Series product family for security, Juniper has decoupled the hardware and software elements of its flagship MX Series 3D Universal Edge Routers product line, virtualizing the software portion in the form of the vMX.

The vMX platform can be used in several contexts, as shown in Figure 10.

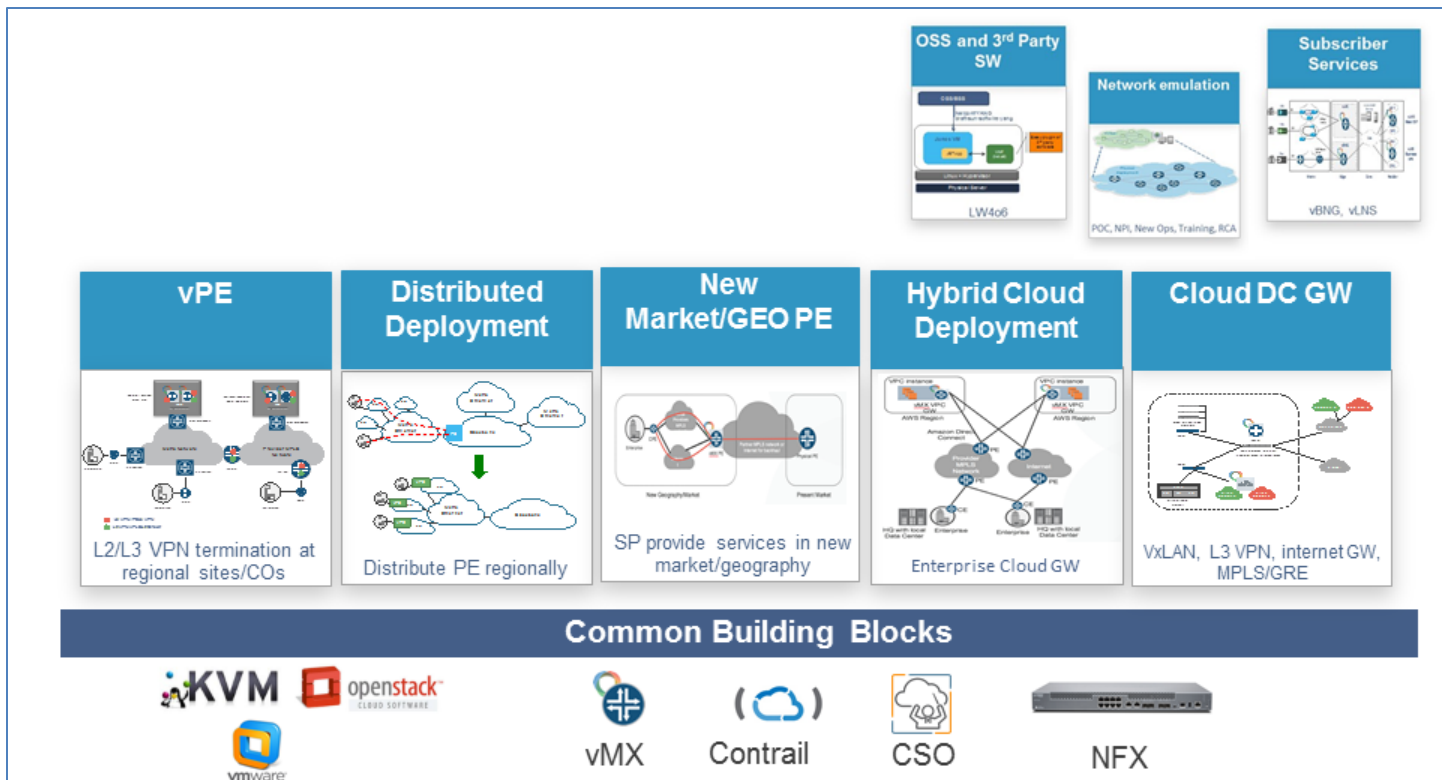


Figure 10: vMX-Virtual Router Use Cases

Typical use cases for vMX devices center on the PE function:

- Virtual PE-vMX provides virtualized PE solution for Layer 2 and Layer 3 VPNs
- Distributed deployment-vMX provides the option to implement PE functionality further down in the network towards the access
- New Markets-vMX enables quicker testing and deployment to provide services in a new market or a new region

Other use cases include:

- Hybrid cloud deployment-Due to its rich functionality, the vMX platform can act as a gateway between an enterprise and public cloud
- Cloud data center interconnect-Leveraging its Layer 2 and Layer 3 routing, and MPLS capabilities, the vMX platform can be used as a data center gateway or data center interconnect.

Particularly interesting additional use cases exist around network emulation. Using the vMX platform, you can create and test virtualized networks before actually deploying them, as well as virtual labs for testing purposes.

vMX

As noted earlier, Juniper’s MX Series product line has been virtualized into the vMX platform.

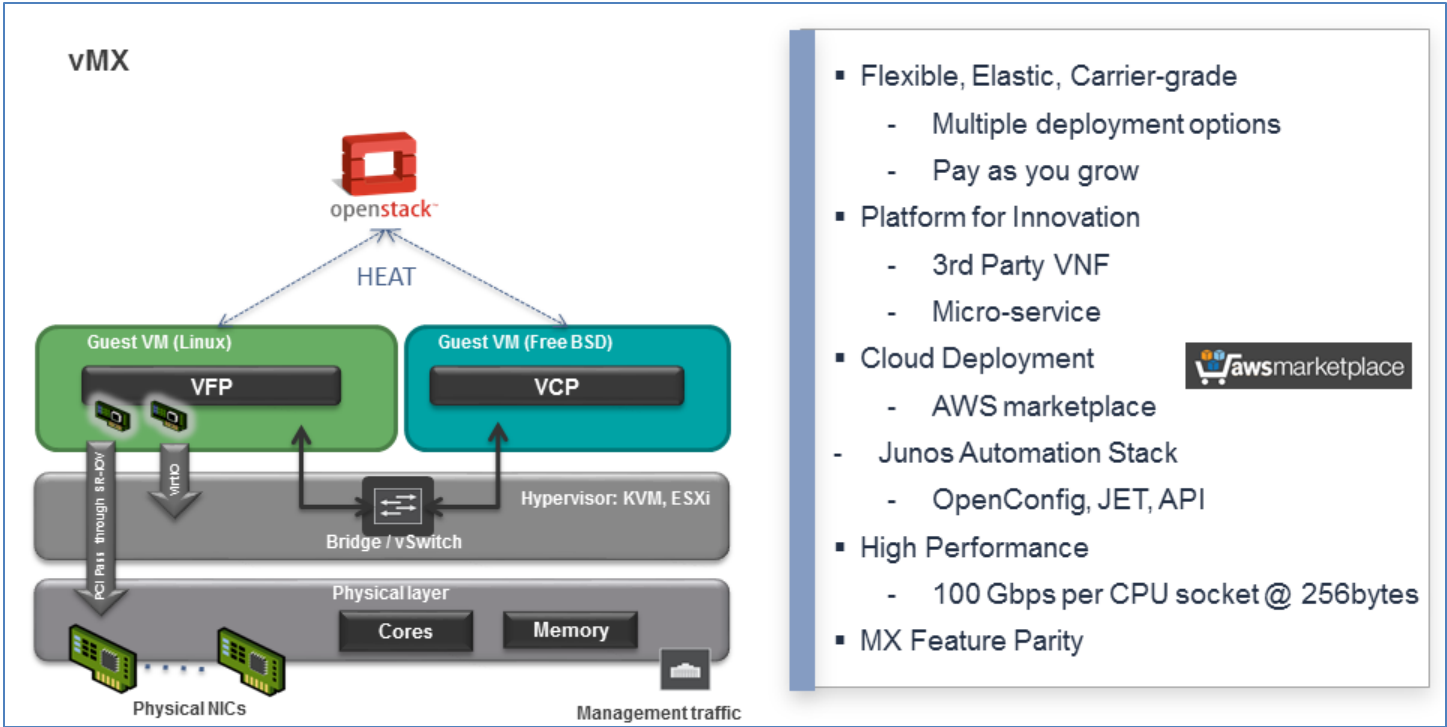


Figure 11: vMX–Carrier-Grade Virtual Router

As shown in Figure 11, the vMX platform is hosted on a physical compute device. On top of this sits a hypervisor with multiple VMs. One VM hosts a virtual forwarding plane, which can use various techniques to forward packets through the physical interfaces, while another VM hosts the virtual control plane.

The vMX platform is a carrier-grade router, providing full feature parity with physical MX Series devices. It is highly scalable and supports multiple deployment options, providing cost-to-capacity flexibility. The platform provides APIs to provide interfaces with 3rd-party VNFs, allowing you to integrate the vMX platform into virtualized environments to provide routing functionality as if it was a physical router. It can also be deployed in cloud environments, and it is available in the AWS marketplace, enabling the device to be deployed easily and efficiently.

Despite being a virtualized platform, the vMX device has excellent performance, providing up to 100 Gbps per CPU socket.

Virtual Mobile Packet Core

This use case centers on a solution Juniper has developed with Affirmed Networks, a leading vendor of virtual EPC solutions. This partnership provides a complete end-to-end solution specifically designed for cloud-based deployments. This 5G and IoT-ready solution provides high performance, is scalable and automated, and includes open technologies to enable integration with other systems.

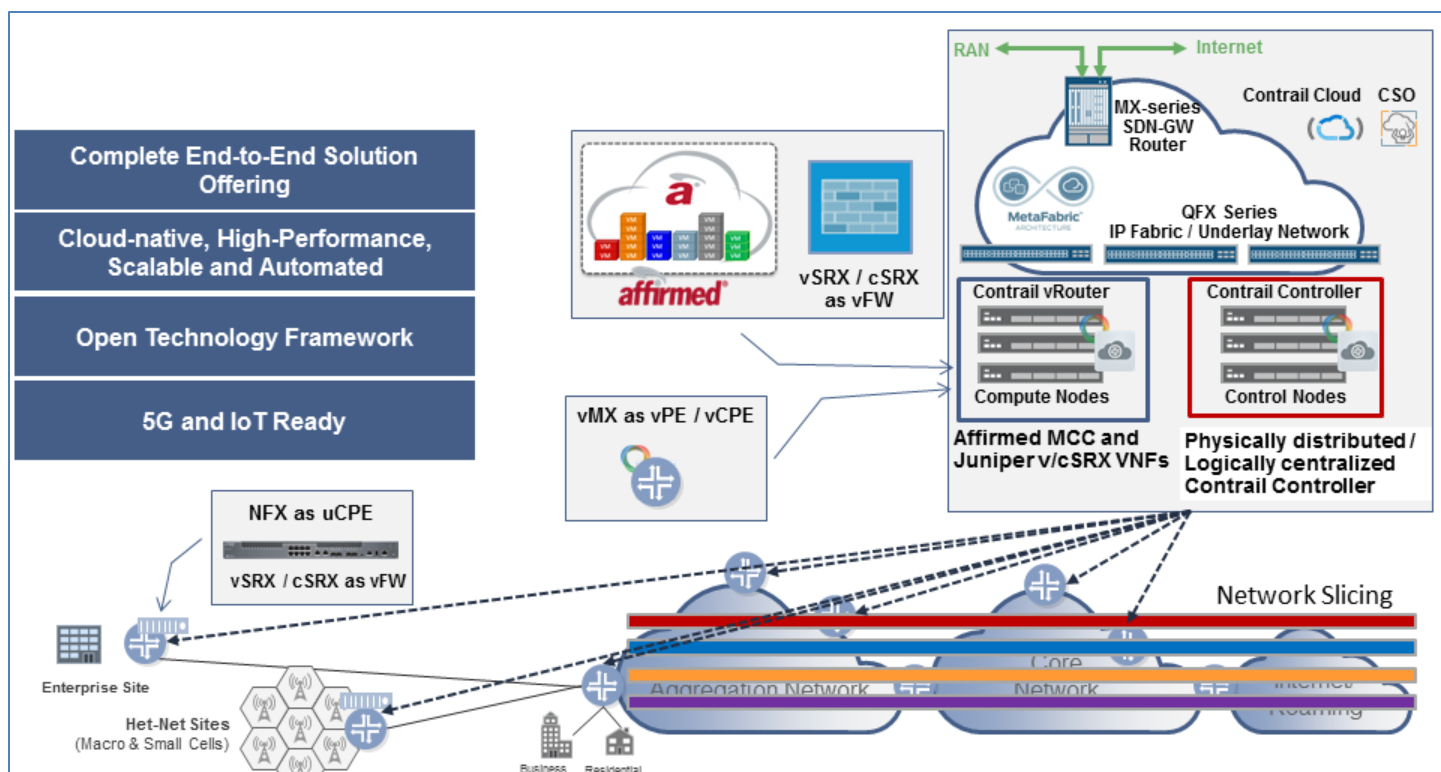


Figure 12: SDN-Enabled vEPC for a 5G-Ready Architecture

As shown in Figure 12, the Contrail Cloud infrastructure hosts an Affirmed MCC running in a VM as a virtual EPC. The security component of the solution is provided by a vSRX or a cSRX firewall. This solution, embedded into Contrail which interconnects using vRouters, interfaces with the rest of the network through a vMX acting as a virtual PE device. The solution can also be deployed in low-scale environments, using Juniper’s NFX platform as a universal CPE (uCPE) solution to interconnect the enterprise sites to the mobile packet core sites.

You can deploy the vEPC solution for large sites requiring high scale, such as IoT deployments with millions of sessions. You can also distribute functionality further out into the network, adapting local regions with ‘islands’ of connections, including as an enterprise-specific solution.

This solution is packaged with network slicing in mind, due to its full integration with the vMX platform and Contrail vRouters, providing excellent interconnectivity between networks.

For more information on the Affirmed Networks-Juniper Networks joint solution, see <https://www.juniper.net/assets/de/de/local/pdf/solutionbriefs/3510564-en.pdf>.

Services

The complexity of deploying solutions in a virtualized world is greater than ever before. With the separation between hardware, which could be provided by multiple vendors, and software, which is a new way to deploy network functionalities, makes using Juniper Networks’ service offerings more relevant than ever.

As shown in Figure 13, Juniper can provide support for the full network lifecycle, from planning through the build and into operation.

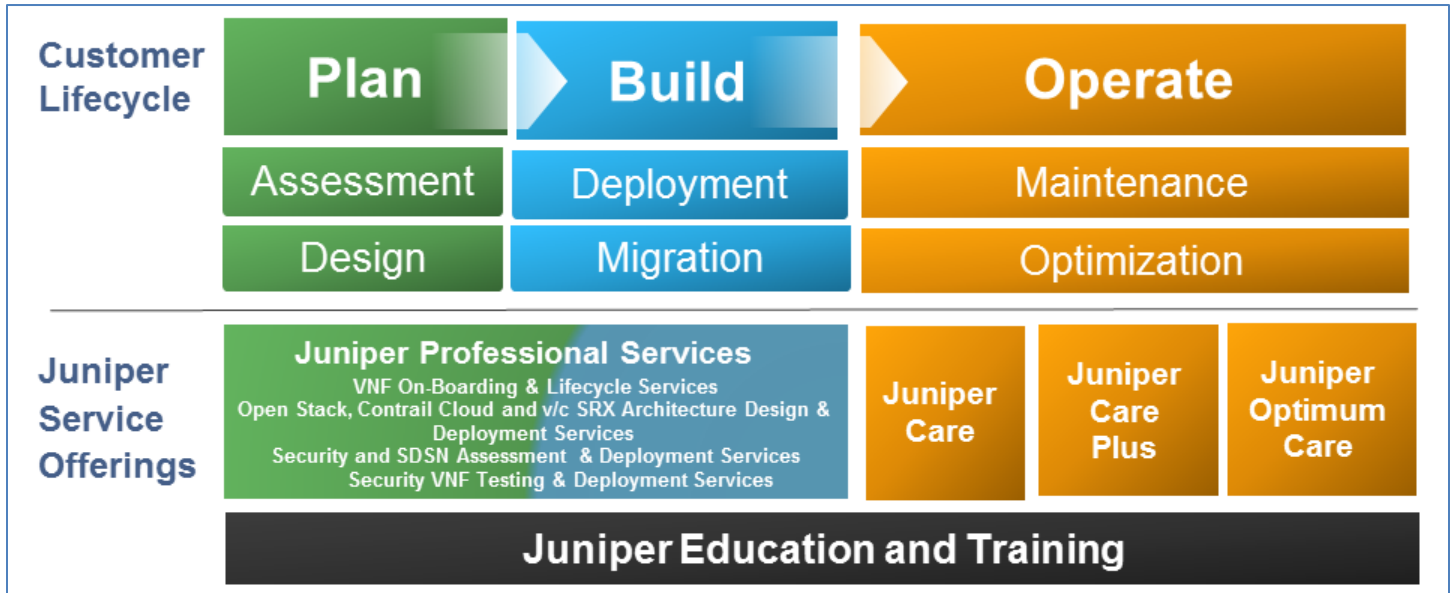


Figure 13: Services Supporting the Customer Lifecycle

Juniper Professional Services can assist with VNF onboarding, lifecycle services, and design and deployment services for all virtualized elements in the network, as well as security assessments and testing.

Education and training is a key step in a successful deployment, as the new world of virtualized networking requires knowledge and skills that go beyond the current experience of most network engineers. Training is available through Juniper’s [Education Services](#).

Proof Points

The benefits of Juniper’s solutions for disaggregation and virtualization can be defined through several proof points, listed in Figure 14.

Figure 14: Proof Points and Benefits

Disaggregation and Virtualization Within the Juniper Networks Mobile Cloud Architecture

Disaggregation and virtualization is a fundamental component of Juniper’s Mobile Cloud Architecture as it bridges the gap between hardware solutions and pure software solutions. As shown in Figure 15, Juniper provides disaggregation and virtualization solutions through its vSRX, cSRX, and vMX platforms, as well as Contrail with its integrated 3rd-party VNFs such as Affirmed Networks’ vEPC.

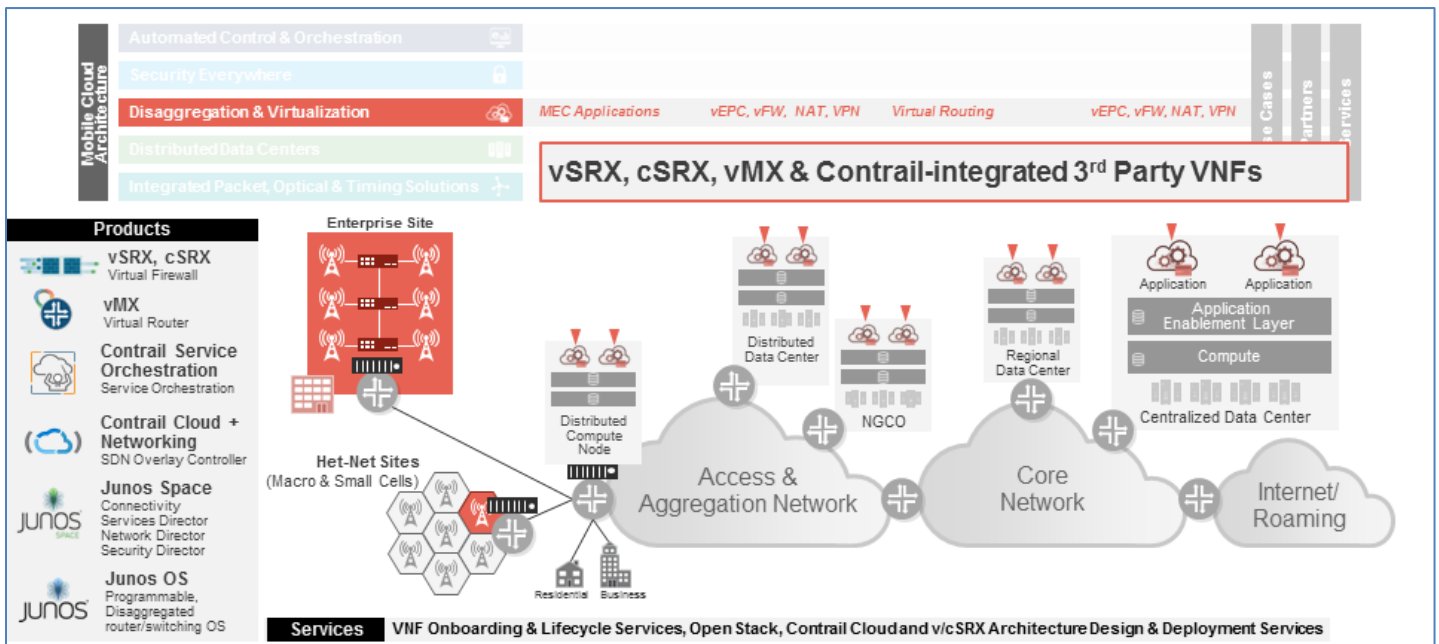


Figure 15: Disaggregation & Virtualization within Juniper’s Mobile Cloud Architecture

For More Information

Disaggregation and virtualization is one of five solution areas within the Juniper Networks mobile cloud architecture, as shown in Figure 16.

Mobile Cloud Architecture	Automated Control & Orchestration	Industry's most deployed SDN solution for multi-vendor and multi-layer network automation.
	Security Everywhere	Industry's most innovative and comprehensive platform to secure the distributed telco cloud.
	Disaggregation & Virtualization	Pioneer in utilizing an open framework to ensure a seamless migration to carrier-grade NFV.
	Distributed Data Centers	Complete, automated and secure solutions for mini DCs at the edge and large DCs in the core.
	Integrated Packet, Optical & Timing Solutions	Integrated solutions from a global leader and innovator in packet networking and optical DCI.

Figure 16: Juniper Networks Mobile Cloud Architecture—Solution Areas

For further detail on the other solution areas, see [Network Design and Architecture Center: Mobile Cloud](#).