THE ALL-IP SECURE DISTRIBUTED TELCO CLOUD

HOW JUNIPER NETWORKS FUTURE-PROOFS YOUR MOBILE NETWORK

Mobile data traffic is growing at an exponential rate, thanks to an explosion of new apps and services (and the bandwidth required to support them), increasing numbers of users on newer and faster networks, and burgeoning numbers of 4G handsets—and we haven't even begun to see how 5G will impact the scene. Perhaps the most significant global drivers of data growth today are mobile apps (particularly mobile video apps) and over-the-top (OTT) service delivery. Users are demanding faster download speeds, and they are easily frustrated by delays and buffering. These challenges are only going to grow greater as we move into the Internet of Things (IoT) era, in which the number of connected devices or "things" will grow by several orders of magnitude and support for low-latency and high-bandwidth infrastructure will become absolute necessities for certain applications.

To meet these challenges, network operators have been scrambling to cost-effectively deliver both high-bandwidth and low-latency services. And the evolution of mobile networking has been taking place not just in the solutions that connect cell towers to mobile devices, but—just as important—in the wireline network infrastructure,

including both the hardware and software, that is responsible for backhauling mobile traffic and also interconnecting data centers. It is this part of the network infrastructure that is evolving toward what Juniper Networks refers to as an all-IP, secure, distributed telco cloud.

The traditional methods for building network infrastructure will no longer suffice. If service providers plan to offer merely the same centralized network functions on physical appliances, they will not be able to successfully compete in the 21st century. Clinging to the old hardware-centric ways will mean that they can no longer grow their business cost-effectively or react quickly to changing market, customer, and network requirements. Facing the future will be impossible.

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On the horizon is the 5G network, which will provide high-bandwidth connectivity and further fuel traffic growth. The 5G network will support massive numbers of connected devices and provide connectivity for a virtual tsunami of new applications and use cases, including smart homes and vehicles, extremely-high-speed media delivery, and critical infrastructure and industry processes—in essence, the realization of massive IoT. IoT will generate millions of data packets, quickly adding up to insane data growth. Only with a well-designed, secure, distributed IP- and cloud-native network, empowered by cutting-edge virtualization and automation technologies, will providers attain the operational flexibility that will be required to keep costs in check and enable cutting-edge, revenue-generating services.

Various aspects of 5G and IoT standards and technologies are still being determined; however, both will require a networking and computing environment that is IP- and cloud-native. Future-proofing networks for 5G and IoT will be critical to

ensuring a company's survival. Some of the leading-edge service providers—including all service providers that were "born in the cloud"—are already reaping significant benefits of an all-IP, highly virtualized, and automated secure distributed telco cloud, including:

- **Rapid and differentiated service creation** and delivery enabled by unprecedented agility
- **Pay-as-you-grow economics** provided by massive scalability, flexibility, and performance
- **New revenue-generating low-latency services** enabled by distributed compute at the edge
- **Simplified and cost-efficient network operations** made possible with advanced automation
- A more **trusted and secure network** to handle increased threat volume and attack sophistication

TECHNOLOGY TRENDS

As the market faces its challenges and begins its transformation, there is a growing consensus on the architecture to come. Key to the telecom industry's transformation is the rise of new technologies such as software defined networking (SDN) and network functions virtualization (NFV)—which are paving the way toward an industry characterized by open interoperability and multi-vendor/layer/technology network automation and orchestration. The network of tomorrow will favor automation over manual

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In this way, the technology underpinning the mobile networks of tomorrow is increasingly the distributed cloud scenario. Traditional physical telecommunication assets are running formerly hardware-bound solutions in software, thereby lowering cost, increasing flexibility, and providing the ability to quickly spin new services up and down. As a result of this shift toward a software-defined architecture, operators can efficiently scale capacity and can also virtualize many network functions, allowing them to run anywhere—including at the edge of the mobile network.

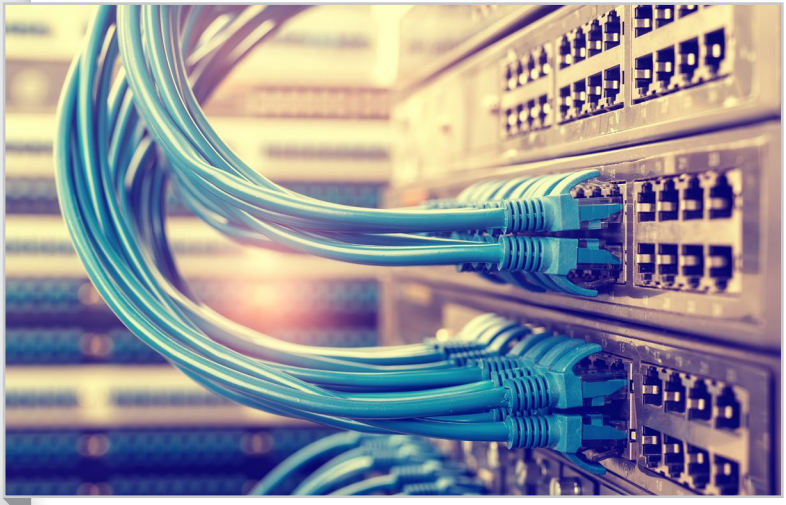
Now is the time for service providers to migrate their networks toward an all-IP, distributed, cloud-based architecture—if they haven't already begun. The network architecture decisions that service providers will make over the next year will play a large role in determining their future success or failure. The primary benefit of distributed data centers is that they prepare operators to better meet the low-latency and high-bandwidth demands that the evolution to 5G and IoT promises. Moving compute and storage resources closer to the end user enables a provider the opportunity to offer low-latency services and also minimizes the amount of traffic that needs to be backhauled to a more centralized data center for processing. Handling a subset of that traffic locally will minimize the bandwidth resources needed in the access, aggregation, and core networks.

This is not to say that next-generation networks will be completely virtualized with all software functions running on commercial off-the-shelf (COTS) x86 processors. Rather, they will be a hybrid of physical and virtual network functions. Where high performance is needed, physical network elements with custom silicon will still be necessary. For example, the forwarding plane of core routing and switching—the backbone of the network—will still take place on physical elements. Although a virtualized network has obvious flexibility benefits, the strong performance advantages of physical networking assets means that determining the right balance of physical and virtual functions will be necessary in tomorrow's network, based on what is needed to support the services and applications riding on it.

In light of the explosion in high-bandwidth services and applications, there are several key challenges today that are inhibiting innovation and also making it very difficult for service providers to manage TCO with their current network infrastructure. First, most optical network systems today are closed, which means that optical network elements and transponders will only interoperate with other optical network elements and transponders from the same vendor. This translates to optical vendor lock-in that can often increase cost and hinder innovation. Second, most networks deployed today use separate packet and optical systems, which can result in a lack of visibility and coordination across layers, leading to a sub-optimal solution with increased complexity and cost. Also, because of this lack of coordination across layers, provisioning new services can take months, resulting in lost revenue for the service provider. The good news is that these challenges can be overcome with a distributed telco cloud architecture that takes advantage of the latest technology innovations in packet optical networking.

And with this evolving architecture comes the need for a new approach to security. Security has always been crucial for service providers and enterprises, but it can be a complex job when administrators must deal with many-purposed devices distributed

across multiple locations. To effectively counter the new and increasingly intricate attacks of the future, a cloud-based security model, with distributed detection and enforcement, is needed. This kind of solution allows for new threats to be identified at different points in the network. New threats can be identified and new policies to combat them can be determined using both industry feeds and network analytics. Then, new policies can be quickly pushed to the distributed enforcement points. Juniper calls this the Software Defined Secure Network (SDSN).



Juniper Networks—which is at the forefront of this network revolution—has long provided cutting-edge solutions for the physical network elements that support routing, switching, and security. Today, the company is already fully immersed in NFV and SDN deployments which provide a solid foundation that will be necessary to cost-effectively support the new applications and services that will be introduced with the evolution to IoT and 5G.

FIVE SOLUTIONS OF JUNIPER NETWORKS' MOBILE CLOUD ARCHITECTURE

Juniper is ready to tackle the challenges and trends impacting mobile networks today and tomorrow, offering a value proposition composed of five powerful solution areas.

1. INTEGRATED PACKET, OPTICAL, AND TIMING SOLUTIONS.

As the technology innovator and a market leader in packet networking—and also a market leader in optical data center interconnect solutions—Juniper has the unique perspective and experience to provide integrated end-to-end packet optical networking solutions. Juniper pioneered IP at a massive scale, and its router performance, throughput, scale, slot density, and power efficiency still lead the industry today.

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Juniper's packet optical strategy is built on several pillars. First, Juniper has been a pioneer in supporting an open architecture with interoperable solutions supporting open interfaces and interworking across layers (L0 to L3). Second, Juniper offers a simplified and flexible network architecture that offers a seamless choice between packet and optical integration and disaggregation on all layers, all with a common end-to-end software architecture and management system. A disaggregated packet optical solution, with full logical integration but with separate Dense Wavelength Division Multiplexing (DWDM) and routing/switching nodes, offers the benefits of optimized flexibility and scalability. On the other hand, an integrated packet optical solution, with both logical and physical integration (DWDM and routing/switching in a single node), offers true end-to-end packet optical convergence (data, management, and control planes) with the benefits of optimized footprint, power, and cost. Last but not least, Juniper offers a fully automated packet optical solution, with multi-layer intelligence, control, and optimization, that can reduce end-to-end service provisioning times from months to days or even minutes, which will increase a service provider's top line and reduce customer churn.

Mobile operators will face unprecedented operational challenges with the rise of 5G. As mobile networks begin migrating from LTE to LTE Advanced (LTE-A) and 5G, mobile backhaul networks will need to endure some changes—in particular, synchronization will play a decisive role in optimizing performance and ensuring quality of experience. Both LTE-A and 5G systems will require strict phase/time synchronization for the purposes of avoiding interference between cells and enabling real-time IoT applications. Juniper's IEEE-1588v2 Precision Time Protocol (PTP) implementation enables its routers and switches to deliver sync services that meet these mobile network challenges.

"Following its acquisition of Brilliant Telecommunications 6 years ago," says Philip Lamoureux, Architect Specialist, Juniper Networks, "Juniper integrated the PTP solution—the standard method for providing network-based precision timing—into its product line. That best-of-breed technology is now in all Juniper routers, allowing the implementation of precision phase and frequency timing anywhere, in any network—a clear point of differentiation."

2. DISTRIBUTED DATA CENTERS.

The new cloud landscape —public, private and hybrid—is spread across multiple geographically distributed data centers. This array of computing power can be difficult to build, connect, and secure. It requires a new kind of data center architecture, optimized for the cloud and engineered for agility and automation.

"Mobile network operators have some of the best real estate on the planet," says Lamoureux, "as do mixed network operators—operators that provide both wireline and wireless services. Mobile Telephone Switching Offices (MTSOs), the old offices of the original cellular network, are now the prime real estate of the mobile network, often more valuable than cell towers. Using these old offices as distributed mini data centers for 4G and 5G makes a lot of sense."

A distributed data center architecture not only prepares operators for meeting the forthcoming requirements of 5G networks but also improves latency performance in current 4G networks. Many of today's applications can already take advantage of lower latencies, including some of the IoT vehicle-to-infrastructure applications arriving on the market. Multi-access Edge Computing (MEC) is an emerging ETSI standard that will provide a virtualized compute environment that application developers and service providers can use to provide low-latency services to end users. MEC sites essentially provide a cloud environment very close to the edge of the mobile network.

Another driver toward distribution is to minimize the amount of traffic backhauled to a centralized data center for processing. As data traffic increases, operators would rather not see everything brought back to a centralized point, just to get out to a peering point. The answer is to make access to peering points more distributed and closer to the edge—removing that traffic from the backhaul and core networks sooner rather than later. To deploy a distributed data center architecture, Juniper offers a broad portfolio of switches that can support mini data centers at the edge, supporting MEC, up to large-scale data centers that are more centralized.

3. DISAGGREGATION AND VIRTUALIZATION.

The vision for the new open, distributed architecture involves the disaggregation of hardware and software platforms. Today, operators can purchase a virtualized Juniper router or security product and obtain the same feature functionality that is available on the company's carrier-grade physical devices. These virtual network functions (VNFs) can be placed anywhere in the network and can run on standard off-the-shelf x86 processors, resulting in a new level of freedom and agility that enables operators to more easily provide customized services and applications.

"One of our products is the Contrail Cloud Platform," says Lamoureux, referring to Juniper's turnkey platform for building open, automated,

service-ready telco clouds. "It's an overlay to the virtualization architecture, a way to create a network that supports VNFs from Juniper and also other vendors. Ultimately, an operator wants an easy way to network those VNFs together, which are called service chains. Operators also want the flexibility to create the same service chain in two different locations to provide geographical redundancy in case of a network outage. Contrail does just that. It provides a way to create mini data centers of VNFs anywhere in the network."

Because Juniper supports an open architecture with vendor interoperability, the company works with

many best-of-breed partners, both large and small. Juniper has a particularly strong partner ecosystem for mobile. For example, Contrail is tested and integrated with many third-party VNFs. Therefore, service providers will not be locked into a small number of vendors and can instead choose best-of-breed solutions for their mobile networks, including those from leading-edge technology startup companies.

4. SECURITY EVERYWHERE.
The old network security model will not suffice in the network of tomorrow. Operators will no longer be able to depend on perimeter security devices once the border becomes distributed and amorphous. In addition, threats are becoming far more sophisticated, and operators will need to be able to detect, differentiate, and then—when a new threat vector is determined—quickly respond with a policy and enforce mitigation as close to the source as possible.

In the new network reality, security must be built in throughout the infrastructure. A centralized security policy layer is necessary, supported by distributed detection and enforcement, and leveraging cloud-based threat intelligence. And the key word is comprehensive—the solution needs to touch every aspect of the network, including all physical and virtual assets end-to-end, from the access and aggregation network to the core network.

Juniper offers a comprehensive suite of products that centralize security policy and automate security. Juniper's SDSN solution allows operators to manage their entire network as a single enforcement domain where every element is a policy enforcement point. A key value of the solution is that it offers instant threat intelligence and detection at the point where the advanced threat vector first enters the network, which limits the footprint of the impact.

"We collect threats from many sources, and then push out those new policies for mitigation to every router, switch, and security appliance in the network," says Lamoureux. "And it doesn't even have to be a Juniper network element. We're taking in mainstream threat feeds from major sources, but we also have local threat protection in addition to the big engines."

5. AUTOMATED CONTROL AND ORCHESTRATION.
Automation has been in Juniper's DNA since the very beginning. The Junos operating system was designed from the ground up with programmable interfaces that give customers the ability to take advantage of scripting and automation languages like Python and Ansible to programmatically address the provisioning of services across domains. In this way, all Juniper routers and switches are programmable.

Juniper's service automation solution—Contrail

Service Orchestration (CSO)—provides the management platform and single point-and-click experience necessary to bring many of the pieces of the new architecture together. With a vision for multi-vendor, multi-layer, and multi-technology support, CSO is a comprehensive platform that can enable service providers to deliver network services quickly and efficiently, thereby reducing operations costs.

With its five comprehensive mobile solutions, Juniper offers a future-proof foundation today, from the cell site to the distributed data center infrastructure.

"When operators are facing the complexity of rolling out new services," says Lamoureux, "they need to know how to make it all work together. They want to bring new enterprise customers onboard, add new services, and establish routing policies for new sites, but how do they do it?"

CSO provides a robust service management and troubleshooting vantage point, and it delivers a personalized self-service portal for end users. Best of all, CSO is built to integrate with the Contrail Cloud Platform to create a cohesive and flexible NFV management and orchestration software stack that can address the bounty of NFV use cases that will characterize the network of tomorrow.

CONCLUSION

To satisfy the needs of tomorrow's users, mobile networks must get ready today to deliver faster data rates and lower delays. Moving to technologies that support an all-IP, secure, distributed telco cloud is the answer, enabling more responsive applications that sit closer to users. With the continued momentum of wireline and wireless convergence, mobile and fixed services will increasingly ride on the same common infrastructure, consisting of data centers and the networks that interconnect them.

As 5G and IoT become realities, the foundational architecture beneath them must attain new levels of flexibility, agility, automation, and efficiency. The consensus is that this new modern architecture will rely on technologies such as NFV and SDN to enable the necessary flexibility and automation to scale and deploy network functions instantaneously, which will be required to support the coming tidal wave of mobile applications and use cases.

With its five comprehensive mobile solutions, Juniper offers a future-proof foundation today, from the cell site to the distributed data center infrastructure. For more details about the products and professional services that support the five solutions of Juniper's Mobile Cloud Architecture, please contact your local Juniper sales representative or visit www.juniper.net.

ABOUT JUNIPER NETWORKS

Juniper Networks (NYSE: JNPR) is in the business of network innovation. From devices to data centers, from consumers to cloud providers, Juniper Networks delivers the software, silicon and systems that transform the experience and economics of networking. The company serves customers and partners worldwide. Additional information can be found at www.juniper.net or connect with Juniper on Twitter and Facebook.