# CLUSTER ACROSS MULTIPLE CLOUDS

*A Juke Multicloud Whitepaper*

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# EXECUTIVE SUMMARY

*This whitepaper explores the difficulties of distributed computing with and without Kubernetes, and it identifies the challenges introduced when adding multicloud into the mix. It also explores a new tool used in this environment, Juniper Networks® Juke Multicloud Storage and Compute Platform, which enables a stretched cluster on top of multiple Kubernetes clusters.*

## Introduction

Kubernetes is a tool for building platforms that make infrastructure fungible in a way that was inconceivable just five years ago. As the popularity of public cloud computing made containers mainstream for deploying applications, innumerable products were introduced to manage container infrastructure. Kubernetes won this battle; the challenge now is to build on top of the Kubernetes platform to create a secure multicloud enterprise.

## Kubernetes Is Taking Over the World

As a standard, Kubernetes has gained the confidence of developers worldwide. Today, it is in the process of revolutionizing how companies apply IT infrastructure to solve their existing compute problems. Kubernetes transforms the hardware problem by enabling an "infrastructure as code" approach to IT operations, making repeatability, agility, and security simpler and easier.

Infrastructure as code enables IT automation, which in turn enables organizations to flexibly and efficiently take advantage of resources around the globe. Juniper Networks Juke Multicloud Storage and Compute Platform allows Kubernetes to operate in both hybrid and multicloud environments, providing persistent storage for ephemeral workloads wherever they need to operate.

The Kubernetes API is a great tool when it comes to automating a deployment pipeline. The API makes deployments faster and more reliable, allowing companies to avoid paying the virtualization resource and licensing tax for an ever-increasing number of workloads. Kubernetes makes it very easy to run numerous containers on the same host, maximizing server efficiency and reducing costs. Juke also makes it easy to run Kubernetes on multiple infrastructures, with a unified storage platform that is available to all workloads.

## Distributed Computing Is Hard

While Kubernetes has proven itself as a transformative technology, its success does not change the fact that distributed computing is difficult—for vendors and application developers alike. To quote Pete Corey, long time developer and blogger:

> *"(W)orking with distributed systems is unexpectedly hard. The moment you add a second CPU or spin up a new server instance, you're entering a brave new (but really, not so new) world of computing that requires you to more deeply consider every line of code you write... **Distributed systems are hard**. When building distributed systems, you need to be prepared to be working with data that may be inconsistent or outdated. Conflicts should be an expected outcome that are designed into the system and strategically planned for."*

Kubernetes solves the problem of managing a single cluster composed of containerized hosts by wrangling the network, applying basic policy and configuration, and setting up and tearing down individual containers.

Kubernetes offers an API that allows it to be programmatically manipulated; it consumes YAML files and acts upon the configurations contained within them. Kubernetes automates and orchestrates containers distributed across hosts (called "pods" in Kubernetes-speak) of a single cluster, but this only scratches the surface of the distributed systems problem that large organizations face today.

Managing multiple Kubernetes clusters in on-premises data centers, as well as across multiple clouds, is **particularly difficult** because it makes the normal challenges of container clustering, networking, and deployment automation even worse. Multiple clusters across multiple infrastructures introduce additional variables and points of concern; issues such as high latency, slow data synchronization, differing performance characteristics, and unpredictable WAN performance must all be taken into account when designing, managing, and maintaining a globally distributed IT infrastructure.

While multicloud and multisite deployments introduce a new level of complexity to an already challenging situation, avoiding the challenge is not a viable solution, especially for organizations operating at (or beyond) enterprise scale. Business needs are pushing IT teams to flexibly deploy workloads across infrastructures, and to rapidly clone, burst, and then destroy workloads anywhere, where, when, and as needed.

As of this moment, a Kubernetes cluster deployment spanning multiple regions and sites poses a quandary; while there have been efforts to solve this problem, such as the Ubernetes project and the recent Federation v2, there is still no way to run **a distributed system of distributed systems**—that is, a cluster spanning multiple clusters.

With Juke Multicloud, however, Juniper has taken a significant step toward creating a secure and automated multicloud that solves the problem of creating a distributed system of distributed systems.

Kubernetes is not designed to support a single cluster that spans multiple infrastructures. During its initial gestation, it even went against published best practices for creating a cluster which spanned multiple availability zones within a public cloud. As Kubernetes evolved, it eventually gained the ability to create a multi-zone cluster; however, there is still risk involved in attempting to create a Kubernetes cluster spanning multiple regions.

With Juke Multicloud, Juniper is solving this problem by not only enabling the effective and efficient management of multiple Kubernetes clusters spanning multiple infrastructures, but also by providing a resilient, performant, and globally distributed persistent storage layer. Juke Multicloud's storage and management capabilities allow organizations to operate workloads on-premises, across multiple public clouds, and all the way out to the edge using a single, unified storage layer that transcends infrastructure boundaries.

Juke Multicloud is not only solving the problem of wrangling a distributed system of distributed systems, it's doing so across completely different environments provided by completely different vendors: EC2, GCP, and on-premises.

## Juke Software-Defined Storage for Enterprise Multicloud

Juniper Networks Juke Multicloud Storage and Compute Platform is a software-defined management solution that automates and orchestrates the creation of highly scalable virtual storage and compute resources for container application development by directly addressing the challenges of running applications across private and public cloud resources.

Juke Multicloud solves the agility problem that prevents developers from deploying workloads that may need to exist on-premises as well as across multiple other infrastructures, including public clouds or edge computing environments. Juke Multicloud automates the provisioning of compute and storage resources across multiple infrastructures using a Web UI that runs on open REST APIs.

Juke Multicloud also allows both compute and storage resources to be automatically provisioned on demand. Policy-driven compute and storage placement rules are executed beneath a virtualization layer that appears to a container as simply a block device.
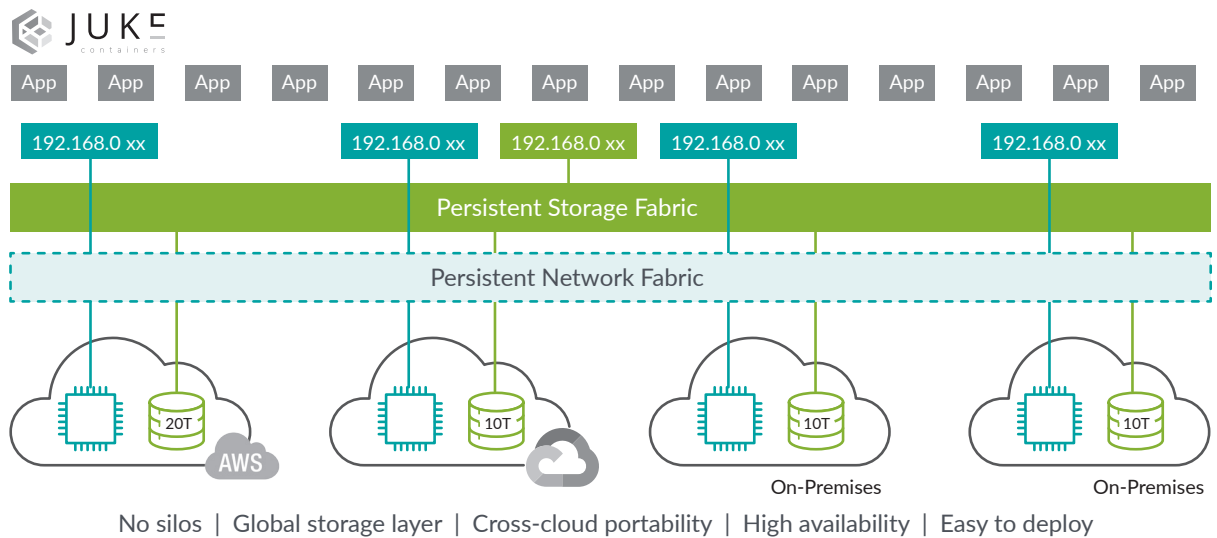
No silos | Global storage layer | Cross-cloud portability | High availability | Easy to deploy

*Figure 1: Juke Multicloud architecture*

Juke Multicloud allows developers to focus on writing stateful multicloud applications without having to manage complex infrastructure. Developers can focus on creating secure, efficient code and leave the details of storage, distributed systems, and container management to Juke Multicloud. This also elevates the experience for infrastructure and operations teams, making storage administration easier than ever.

Presented to containers as simple block devices, Juke Multicloud provides a cross-cloud storage layer that automates away the complexity of IT operations. This takes a lot of the "ops" out of DevOps, allowing developers to focus on application development. Architects, administrators, and site reliability engineers (SREs) set policies relating to both compute and storage resources, and these policies are managed and enforced by Juke Multicloud automatically and transparently.

With Juke Multicloud, resources are deployed in line with IT policy attributes: performance, proximity, cost, reliability, regulatory compliance (such as GDPR), and more. Using Juke Multicloud, developers can use compute and storage resources on demand, quickly and easily, with the confidence that they are cost-, performance-, and policy-compliant with company and architectural objectives.

Every Kubernetes pod has some amount of local storage. Juke Multicloud claims this storage and adds it to a single global storage pool; this pool is then carved up as needed while building in resiliency based on policy.

Using Juke Multicloud, operations teams can create virtual volumes and then define automation rules for resiliency, geographic placement, and cross-site replication. For example, one rule set might be "maintain two disk images in each of Asia and U.S. cloud sites, and two copies in the primary on-premises data center."

Juke Multicloud's latency-aware file system is constantly evaluating relative performance of the device mesh. As a container writes to the Juke Multicloud block device, the Juke Multicloud file system is evaluating, write-by-write, the latency of all devices contributing storage to the global pool.

The Juke Multicloud file system identifies the lowest latency devices that meet policy requirements, makes writes and ACKs to and from the fastest device, and sends a copy of the writes to all other devices that need them, as dictated by policy. This delivers local device performance while maintaining global resilience and distribution of data policy.

Policy-driven enforcement of storage not only assures that data copies exist, even when individual pods are destroyed—it allows security considerations including regulatory compliance and data sovereignty to be easily addressed. Juke Multicloud solves the highly complex problems related to handling storage in a distributed system of distributed systems, where any element within that system can be created or destroyed in an automated fashion, and latency between nodes is variable.

## Conclusion

With Juniper Networks Juke Multicloud Storage and Compute Platform, organizations can transcend the tyranny imposed by the speed of light without giving up the ability to create and destroy workloads as needed to meet demand. Juke Multicloud enables organizations of any size to create a globally distributed, secure, and automated multicloud with an ease that takes most of the ops out of DevOps.

## About Juniper Networks

Juniper Networks brings simplicity to networking with products, solutions, and services that connect the world. Through engineering innovation, we remove the constraints and complexities of networking in the cloud era to solve the toughest challenges our customers and partners face daily. At Juniper Networks, we believe that the network is a resource for sharing knowledge and human advancement that changes the world. We are committed to imagining groundbreaking ways to deliver automated, scalable, and secure networks to move at the speed of business.

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