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Nutanix Special Edition

Next-Generation Hyperconverged Infrastructure

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anytime, anywhere

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modern services

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Scott D. Lowe

Lawrence C. Miller

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**by Scott D. Lowe and
Lawrence C. Miller**

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Introduction

Over the past decade, a lot has been written about hyper-converged infrastructure (HCI). But so much has changed over the years as HCI has evolved from a niche technology to a cornerstone in the datacenter and in the cloud.

Next-generation HCI goes beyond solving the myriad storage challenges in traditional datacenters to form the very core of an enterprise-wide operating platform that spans your on-premises and cloud environments.

This isn't hyperbole. This isn't prognostication. This is real. It's here today.

About This Book

This 58-page guide takes you on a journey from the earliest days of HCI through today and into a bountiful and secure future. After reading this book, you'll understand how Nutanix has positioned its next-generation HCI solution as a centralized launching point for all of your current and future needs.

Foolish Assumptions

It's been said that most assumptions have outlived their usefulness, but we assume a few things nonetheless!

Mainly, we assume you have a basic understanding of virtualization, storage, cloud, and datacenter computing. The general audience for this book is anyone in IT who wants to learn more about how next-generation HCI can help address evolving business needs.

Icons Used in This Book

Throughout this book, we occasionally use special icons to call attention to important information. Here's what to expect:



REMEMBER

This icon points out important information you should commit to your nonvolatile memory, your gray matter, or your noggin — along with anniversaries and birthdays.



TECHNICAL
STUFF

You won't find a map of the human genome here, but if you seek to attain the seventh level of NERD-vana, perk up! This icon explains the jargon beneath the jargon.



TIP

Tips are appreciated, never expected — and we sure hope you'll appreciate these useful nuggets of information.

Beyond the Book

There's only so much we can cover in 58 short pages, so if you find yourself at the end of this book, thinking, "Gosh, this was an amazing book, where can I learn more?" just go to www.nutanix.com.

- » Discovering the key challenges facing IT departments in the modern era
- » Learning the ins and outs of datacenter architectures
- » Understanding how hyperconverged infrastructure drives transformation

Chapter 1

Understanding Enterprise IT Challenges

Since the introduction of the very first mainframe back in the middle of the twentieth century, what the industry now refers to as *enterprise IT* has undergone a number of paradigm shifts.

What started as a highly targeted service focused almost solely on specific back-office operations has blossomed into a force unto itself, and one that has revolutionized business.

Today, that back-office expense line has morphed into a function that carries a multitude of expectations to affect expenses and revenue across all business units. It's reshaped the business landscape, but the changes haven't always gone according to plan. CIOs face new challenges and roadblocks every day.

How Enterprise IT Groups Are More Challenged Than Ever

Evolution can be a messy business as organisms grow in unexpected ways. The same can be said for enterprise IT, a group whose evolution has brought it to a front-and-center role in many a business.

This evolution and the myriad promises made about what enterprise IT can accomplish have resulted in a situation in which enterprise IT now bears more challenges than ever before.

Driving new revenue opportunities

Long gone are the days when “management information systems” and “computer services” were little more than expense lines in the budget. Today, business leaders are turning to IT to enable the business and drive top-line revenue.

Shifting from a technology to a business mindset

For decades, pundits publicly lamented the divide between IT and the business. The unfortunate truth is that the divide is, all too often, real. In the not-too-distant past, CIOs and IT decision makers differentiated their companies via infrastructure. The best servers, storage, and networks put the company ahead of its competitors.

Why was this? After all, applications should have been the focus — at least that’s the case when viewed from a modern perspective. Back then, though, infrastructure was deployed on-premises and more powerful infrastructure meant more powerful applications.

That was considered a business-centric differentiator, but it was ultimately frustrating to the business. As the CIO role evolved, the business expected more from IT than just shiny, new infrastructure every few years. However, infrastructure was such a core part of the IT identity that it was difficult for many CIOs to refocus on the activities that the business really needed.

The cloud has upended the infrastructure paradigm, allowing CIOs to think in more business-centric terms. The shift was abrupt for many CIOs who had become comfortable with infrastructure. For those who resisted, the divide worsened, as CEOs and other business decision makers discovered the benefits of the cloud on their own and “shadow IT” began to push corporate IT departments out of the spotlight.

Enabling innovation

Why is the change in focus from the technical operation to the business value so important for CIOs and IT in general? More than ever, organizations are turning to technology to enable innovation, but they are tired of infrastructure getting in the way. Legacy architecture has proven to be inflexible and expensive and, as business leaders seek to better align IT and the business, everyone is aware that the process begins with ensuring that infrastructure doesn't hold the business back.



REMEMBER

As business leaders have become more comfortable with technology and as they've gained a better understanding of what's possible, their tolerance for the traditional objections from IT is growing thin. One of the key drivers of this shift is the cloud, which enables new workloads to be deployed relatively easily in the cloud — with or without support from IT.

This development raises new concerns and challenges for IT as business units simply go around IT to get what they want. As the cloud grows increasingly accessible, this is easier to do than ever. It does, however, introduce multiple areas of risk to the organization, including security challenges and potential service overlap that can create inefficiencies.

Supporting digital transformation

On the innovation front, we would be remiss if we didn't talk about digital transformation, something of a buzzword du jour, but one that is important to understand. Digital transformation isn't just closing the IT/business divide. It's a fundamental cultural transformation that requires the melding of IT with customer service to enable new ways of reaching and retaining customers. Whether that initiative is as deceptively simple as being able to keep track of where your pizza is in the delivery process, or something more substantial, these efforts are ingraining technology into the business in deep and profound ways.

Infrastructure simply can't get in the way. The initiatives that are derived from these efforts must be able to assume that infrastructure is there to consume. Legacy infrastructure doesn't fit the bill, but hybrid cloud scenarios that seamlessly combine on-premises and public cloud solutions do.

Optimizing costs

No matter how far IT rises in stature in an organization, you'll find people who want to use it to drive costs out of the organization. Or, more properly, they want to leverage technology to optimize cost structures.

Of course, cost optimization is an enterprise-wide effort that includes optimizing IT costs. Thus, as IT is being asked to provide assistance to other business units to help them optimize expense items, IT is being forced to look inwardly at how it operates to ensure that it's as efficient as possible.



TIP

We use the word *optimize* intentionally. Organizations that only seek to slash costs without consideration for the impact — including IT-related costs — are not going to find themselves on a positive trajectory. As the saying goes, “You can’t cut your way to prosperity.” Still, you can be smart about how you’re spending.

Addressing constantly emerging security concerns

Myriad market themes have conglomerated into where the industry finds itself today. Thanks to proliferation of data, devices, clouds, Internet users, and more, security has become a boardroom issue. News stories hit the wire every week with lurid details regarding the latest data breach that has left millions of records exposed or about a malware attack that has crippled a city government or even a hospital.

The security issue isn’t going away . . . ever. As organizations seek to further integrate their business and technologies, the value of business and customer data grows, and the complexity of IT inherently increases risk, the issue of security becomes even more important. Moreover, enterprise IT’s scope of responsibility continues to have its lines blurred. Not long ago, IT only had to keep hackers out of the four walls of the on-premises datacenter. With the rise of the public and private cloud, those lines blurred. Today, enterprises must secure a new perimeter around these public and private clouds, as well as *hybrid* cloud environments that leverage two or more separate cloud resources — for example, two different private clouds (perhaps an on-premises private cloud and a hosted private cloud), two different public clouds — for example, Amazon Web Services (AWS) and Microsoft Azure — or a public and private cloud.

Multi-cloud environments, consisting of multiple public, private, and/or hybrid clouds, also introduce new security challenges. According to the “RightScale 2019 State of the Cloud Report,” 84 percent of enterprises now have a multi-cloud strategy, averaging almost five clouds per organization. Even more recently, edge computing activities have further eroded what were once solid boundaries, spelling doom for the previously reliable efficacy of physical datacenter doors and the edge firewall. Today, the need for perimeter security still exists, but it’s being augmented by a plethora of other security services as IT departments scramble to keep pace with attackers.



REMEMBER

A hybrid cloud provides application and data interoperability between two or more clouds, whereas multi-cloud does not necessarily provide interoperability between clouds. For example, an organization might use both AWS and Microsoft Azure public cloud resources as stand-alone environments, in which case it would be considered a multi-cloud environment. However, if that same organization connected its AWS and Microsoft Azure public cloud resources so that applications and data could be exchanged between these two public clouds, it would be considered a hybrid cloud environment. Put another way, a hybrid cloud environment is always a multi-cloud environment (because it consists of two or more clouds) but a multi-cloud environment is not always a hybrid cloud environment (because it does not necessarily provide interoperability between the clouds).

Understanding Datacenter Architecture Options

Although enterprise IT departments face challenges today that couldn’t even have been dreamed up a couple of decades ago, all kinds of opportunities are available to them to address these issues head on. To do that, IT leaders and professionals need a clear understanding of the options at their disposal.

They need to be able to assess whether these options can solve their needs.

Why three-tier infrastructure is a one-trick pony

We'll get this out of the way: Legacy three-tier architecture is not going to help you solve the IT challenges ahead of you.



REMEMBER

But what is three-tier architecture? Simply put, it's a bunch of servers, storage systems, and network fabrics used to create a computing environment for your applications. At first glance, it's easy to understand the allure of such environments. After all, you buy your favorite servers and storage and then connect it all together with your favorite networking gear.

You get to buy “best of breed” in every component! What could possibly go wrong?

Well, unless your idea of fun is working late on a Saturday night trying to figure out why the #&!*\$ host bus adapter (HBA) won't talk to the #&@! storage array, you'll quickly get your first glimpse into some of the challenges in these environments and the frustration they can bring. However, there's more at play.

Although it's true that you get some resource flexibility in terms of being able to independently scale resources, it comes at the cost of complexity, interoperability, and, well, cost.



REMEMBER

On the complexity front, you have to do some deep planning to build the whole thing. On the interoperability side, you have to procure gear that minimizes the potential for vendors to point their fingers at one another in blame while you sit between them waiting for resolution. All of this complexity comes at a cost. The more moving pieces you have, the more expensive putting them together will be.

Try looking a little deeper into the complexity part of this issue. In addition to making sure everything works together, you have to deal with a number of administrative consoles to configure and manage various aspects of the solution. Need to create a logical unit number (LUN)? Fire up the storage management interface. Need to configure a host to connect to the storage? Start up a second, completely different admin tool and fumble around for the answer.

In large enterprises that have people dedicated to functions, this approach might seem to be acceptable, but in the midmarket and smaller organizations where people have to wear a lot of hats, it's frustrating. Even in large enterprises, it's far from a desirable solution as you consider the desire for organizations to shift spending to digital transformation efforts. This means that you may have fewer dollars available to cover specialized IT skills.

Stumbling across public cloud challenges

Maybe the solution is to throw away that three-tier gear and jump head first into the cloud.

Or maybe not.



REMEMBER

First of all, this domain has a serious skills shortage. There are more jobs than there are qualified people. Even so, companies are looking for ways to reasonably leverage the public cloud, generally choosing to implement hybrid cloud solutions.

Increasingly, businesses are adopting multiple clouds, creating multi-cloud architectures that multiply the potential capability but also multiply the complexity and the potential for security issues.

Many an organization has jumped into the public cloud only to discover — after they started getting their monthly invoices — that the water was ice cold. Many businesses failed to understand all the potential costs of the cloud, which include data transfer fees, processing fees, storage fees, and more.

Without overarching insight into one public cloud, let alone many, in multi-cloud scenarios, organizations left themselves open to serious financial risk.

Then there's security. Every platform introduces a new set of security policies and rules and they don't always align. Those prospective employees whom you already can't find also need to understand the nuances inherent in different cloud platforms.

Other potential cloud challenges revolve around loss of control and limited visibility into data and operations. Significant concerns surround how to ensure data and application services are

always available in the cloud and how to ensure regulatory compliance, for example, with regard to data residency requirements.

This is not to say that the public cloud is bad . . . not at all. It's good, but it requires constant vigilance, in terms of cost monitoring and security controls, to make sure that you don't fall victim to a preventable situation. It also requires a cohesive cloud strategy that enables your organization to determine which application workloads are appropriate for the cloud rather than an "all in" cloud-only approach.

Converged infrastructure versus problem-solving

In the middle of the first decade of this century, someone somewhere came to the realization that the complexity surrounding three-tier architectures was real.

With that proclamation, converged infrastructure was born.

Looking at it side-by-side with a traditional three-tier approach yields no discernable differences between the two paradigms. They both have servers. They both have storage. They both have a networking fabric of some kind.

Where convergence diverges from legacy, though, is in the procurement and support model. With a traditional three-tier environment, you, the lucky customer, get to spec every aspect of the environment, buy the pieces and build it all, hoping that everything works at the end. With convergence, that hard work is done for you. DIY no more.

When you buy a converged infrastructure solution, you're eliminating procurement and deployment pain in return for a few more dollars spent up front. On an ongoing basis, you're also given the promise of eliminating interoperability issues because converged infrastructure solutions are supposed to be well- tested.

That's where the benefit ends. Although you may have some administrative overlay that helps manage the environment, you're largely using separate management tools, just as you did with three-tier infrastructure. So, operationally, you don't receive a whole lot of benefit.

From a support perspective, perhaps the biggest benefit to converged infrastructure is that you typically get a single phone

number to call for any support need in the environment. That's a fantastic benefit because it can reduce, although it may not eliminate, vendor finger-pointing when issues arise.

Introducing hyperconverged infrastructure

A funny thing happened on the way to the datacenter. Suddenly, what once required dedicated hardware became a software component. This change was due in large part to companies like Intel releasing processors packed with more and more cores every year. What once used to be single instruction pipelines quickly became massively parallel and provided servers with an incredible amount of computing power.

At the same time, the storage market began a decade-long upheaval as businesses sought to rid themselves of overly complex and slow storage in favor of newer, simpler storage solutions that featured flash technology.

This shift resulted in the introduction of software-defined storage and a related technology that has come to be known as *hyperconverged infrastructure* (HCI).



REMEMBER

HCI effectively eliminates storage as a tier of infrastructure in the datacenter. Rather than existing as a separate resource, storage and compute resources are added to server hosts and managed by software. They simply become additional resources to be consumed by the business as needed.

Like most modern workloads, HCI leverages virtualization technology. In fact, the hypervisor is an integral part of each node in a HCI cluster. In short, HCI consolidates servers, storage, the hypervisor, and some network functions into a software-centric solution deployed on commodity hardware.

Finding the hybrid cloud sweet spot

HCI has emerged as an integral component in the hybrid cloud. Why? Simply put, HCI is about as cloudlike, from an infrastructure perspective — it offers rapid, on-demand scalability, interoperability, and elasticity — as you can find in an on-premises environment. With the right HCI solution, you'll find that the on-ramp to the hybrid cloud becomes easier to navigate than you ever thought possible.

- » Learning the basics of hyperconverged infrastructure
- » Defining next-generation hyperconverged infrastructure
- » Enabling the enterprise cloud with next-generation hyperconverged infrastructure

Chapter 2

Defining and Extending Hyperconverged Infrastructure

Hyperconverged infrastructure (HCI) has matured rapidly over the past decade. Early iterations of the technology, although fantastic, don't hold a candle to what's possible with current solutions.

In this chapter, you learn about the basics of HCI and its evolution to a next-generation solution for today and the future.

Discovering Hyperconverged Infrastructure

HCI is basically a conglomeration of servers for compute, storage, and a hypervisor. This is what you might call “HCI 1.0,” with newer versions following quickly.

Identifying performance, resilience, and scalability features

Within HCI, each node participates as a part of a cluster of nodes providing both storage capacity and resiliency. All the software-based storage management constructs — including data protection — are distributed across the cluster.



TECHNICAL
STUFF

System resilience and overall performance increase in a Nutanix next-generation HCI as the cluster scales out, with data protection functions that include:

- » **Tunable redundancy:** This feature replaces traditional hardware-centric redundant array of independent disks (RAID) storage technology, providing continuous data availability for applications by automatically reading from other nodes in the cluster in the event of a drive or node failure.
- » **Erasure coding technology:** Nutanix EC-X provides resilience and increases usable capacity by up to 75 percent by using tunable redundancy for hot data and erasure coding for cold data.
- » **Integrity checks:** Various features proactively identify and fix issues related to data consistency and integrity, bit rot failures, and hard disk corruption.
- » **Availability domains:** These allow a Nutanix cluster to survive the failure of a node or block with intelligent data placement (also known as “node awareness”) combined with tunable redundancy to ensure that a cluster can tolerate a node failure without losing access to any of its data.



TECHNICAL
STUFF

Traditional approaches to HCI often use scale-up technologies that have hard limits or introduce single points of failure in the stack. The scale-out capabilities in Nutanix next-generation HCI simplify the ability to add capacity on demand. That’s one of the most significant benefits of the technology. Figure 2-1 illustrates the linear scale-out performance in a Nutanix next-generation HCI.

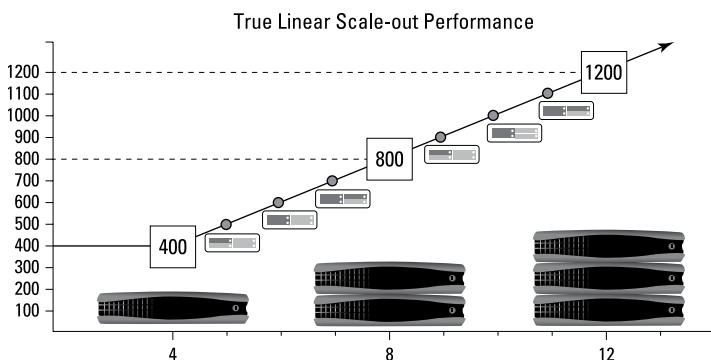


FIGURE 2-1: Linear scale-out in Nutanix next-generation HCI.

Delineating hardware and software in HCI

“HCI is software!” “HCI is hardware!”

You’ll hear arguments from both sides on this topic. The answer is: It’s both. HCI is hardware, but it’s also software and this is where the real magic happens. The underlying hardware, although important, is interchangeable, as long as its general capabilities can support whatever workloads you intend to operate.



TIP

Nutanix focuses on the software in next-generation HCI and makes it available across a broad ecosystem of supported hardware from various vendors. Nutanix also offers complete turnkey solutions (hardware and software) for organizations that want something they can simply rack, stack, and turn on.

As vendors release new versions of their software and hardware, you can upgrade your next-generation HCI to leverage any new features that have been introduced.

Implementing a fractional consumption model

HCI effectively eliminates the need for forklift upgrades every three to five years, in which you buy new storage and then migrate all your applications and data from your old storage to your new storage. Forklift upgrades are not only expensive, but also time-consuming and risk-laden.

What if we told you these forklift upgrades are no longer necessary?

You've probably already guessed that the solution is next-generation HCI. With this technology, when the time comes to retire nodes and replace them with newer ones, you simply add the new node to your cluster, let it integrate, and then tell the cluster's admin console that an old node is being taken out of service. The cluster control software evacuates that node and severs its connection to the cluster.

After that, you remove the node from its rack and take it out of service. Rinse and repeat for each node that you need to replace.

The beauty of this approach is that *no manual migration* is needed, which means no service disruption and no application downtime. The software layer does all the hard work.

Likewise, when you need more capacity or computing power, you just add nodes. That's it. You don't need to go through an intensive process to determine next steps. Just click Go.

From an operational perspective, next-generation HCI allows you to implement what amounts to a fractional consumption model. If you've managed a three-tier environment, you're certainly familiar with the virtually impossible task of trying to anticipate your organization's storage capacity and performance needs over the next three to five years. You inevitably end up either over buying hardware and hoping that you'll "grow into it" before the technology becomes outdated, or under buying and having to go back to your CFO for more money to address the poor performance that your users are experiencing as a result.



REMEMBER

If you buy too much, you've effectively wasted money by purchasing hardware that you may never use. If you don't buy enough, you'll have to buy more hardware mid-cycle. Of course, if you get it perfect, all is golden, but how often does that happen?

Next-generation HCI allows you to scale on-demand without requiring a massive capital investment each time your needs change. You buy what you need for right now and when your needs grow, you add another node.

Realigning IT silos toward business outcomes

Today, companies are seeking to minimize their reliance on deep technical skills to maintain their datacenter infrastructure. They'd rather invest in IT staff resources that can focus on strategic initiatives and deliver digital transformation projects that add business value.

The set-it-and-forget-it simplicity of next-generation HCI can be a boon in such environments because it removes the shackles that force IT so often to be an infrastructure-centric entity and enables an IT organization that is more squarely focused on business outcomes.

Expanding beyond Storage Virtualization

Although HCI began as a storage virtualization solution, it has evolved, and expanded to include capabilities such as file and object storage for unstructured data, cloud-native persistent storage for containers, deeper application integration (for example, copy data management for databases), advanced networking and security functionality, automation and orchestration leveraging artificial intelligence (AI) and machine learning (ML).

Solving the unstructured data management problem

Have you ever considered what would happen if you took a storage architecture that was designed to store terabytes of data and increased the requirements by three to four orders of magnitude? The rapid growth of unstructured data on legacy storage infrastructure, which represents 80 percent of all stored data, is creating just such a problem: IDC predicts that by 2025 there will be five times more data worldwide.

Massive data growth breaks old storage management methods and requires new thinking. Next-generation HCI brings the benefits of cloud to your on-premises storage with a simple, scalable, and intelligent solution to consolidate file, block, and object storage. With a unified management plane to manage all storage services and simply scale out or scale up capacity, next-generation HCI modernizes your storage setup and simplifies operations.

Providing persistent storage for containers

Containers have taken the software world by storm. By bundling application code with the required dependencies in a format that is simple to share and move, developers can create with confidence and operators can deploy without fear. While the benefits of containers are clear, new challenges have arisen from the inherent ephemeral nature of containers. Many storage solutions aim to solve this problem by connecting to storage, but simply providing persistent storage isn't enough. Because containers now run production enterprise-grade applications, it is critical that the storage used provides the enterprise features required to run in a modern environment, such as resiliency, availability, disaster recovery, and capacity optimization. This is exactly what a next-generation HCI solution, such as Nutanix Container Storage Services leveraging Acropolis Block Storage Services (ABS), delivers for both Docker and Kubernetes environments.

Enabling deep application integration

Modern enterprises live or die by their applications, and thus the underlying infrastructure must be robust, resilient, and powerful enough to run the full gamut of workloads — and run them well. Whether it's databases, enterprise resource planning (ERP), big data, unified communications, or virtual desktop infrastructure (VDI), businesses no longer have to turn to bare metal for performance, three-tier architectures for virtualization, or public cloud for agility. Next-generation HCI now delivers all of these benefits, as well as simplicity, efficiency, and scalability. Several next-generation HCI solutions are available from Nutanix to enable deep application integration. They include:

- » **Nutanix Calm** is a hybrid cloud application lifecycle manager that lets you model your applications in easy-to-consume blueprints, deploy them on the clouds of your choice, and manage them throughout their entire lifecycle.
- » **Nutanix Frame** is a cloud-native, public-cloud service that delivers any Windows or Linux application or desktop to an end-user's web browser. Frame enables enterprises to continuously integrate and deliver virtual apps and desktops

at any scale, in any region, with the apps and services that end-users consume, all running on your preferred clouds.

» **Nutanix Era** is a software suite that automates and simplifies database management, bringing one-click simplicity and invisible operations to database provisioning and lifecycle management (LCM). Nutanix Era enables database admins to provision, clone, refresh, and restore their databases to any point in time.

Connecting and securing HCI with a smart networking fabric

A next-generation HCI solution can enable tight integration between HCI/virtualization and networking vendors that offer smart fabrics for both HCI node configuration and virtual machine (VM)-level software-defined abstractions.

The smart fabric handles the heavy lifting of software-defined networking (SDN) based on the telemetry and context that it learns from the virtualization in HCI. This enables the same SDN use cases — such as zero-touch hardware configuration, virtual local area network (VLAN) creation and pruning, and layer stretched networking — and also allows customers to choose from best-of-breed networking solutions that will not only address their HCI needs, but *all* of their networking needs. This integration reduces the friction between virtualization and networking teams. It's a win-win for both teams.

The integration between next-generation HCI and smart network fabrics also enables robust security capabilities, including complete encryption for data and management communications, role-based access control (RBAC), key management, and micro-segmentation (discussed in Chapter 6). Now it's a win-win-win for everyone — virtualization, networking, and security teams!

Nutanix Flow delivers advanced networking and security services, providing visibility into the virtual network, application-centric protection from network threats, and automation of common networking operations. Flow allows organizations to deploy software-defined virtual networking without the complexity of installing and managing additional products that have separate

management and independent software maintenance requirements. Key capabilities include:

- » **Application visualization.** Setting the right application-centric network policies requires a complete understanding of workload behavior. Nutanix Flow provides detailed visualization of communications between VMs, making it simple and straightforward to set the right policies for the environment.
- » **Network isolation and micro-segmentation.** Micro-segmentation provides granular control and governance of all traffic into and out of a VM or groups of VMs. It ensures that only permitted traffic between application tiers or other logical boundaries is allowed and protects against advanced threats propagating within the virtual environment. Network policies are attached to VMs and applications, rather than network segments — such as virtual local area networks (VLANs) — or network identifiers such as IP addresses.
- » **Service insertion and chaining.** Flow functionality can be extended to leverage virtualized network functions from third-party software. These services are inserted in-line or in tap-mode with VM traffic, and can be easily enabled for all traffic, or deployed only for specific network traffic. Common network functions include virtual firewalls, load balancers, threat detection, and application performance monitoring.
- » **Network automation.** Flow provides application programming interface (API)-based notifications enabling third-party network devices to observe VM lifecycle events, such as the instantiation of a new VM into the environment. This enables automation of typical network configuration changes, such as the provisioning of VLANs or dynamically updating firewall and load balancer policies.



TIP

Next-generation HCI solutions such as Nutanix Xi Beam extend advanced networking and security capabilities to multi-cloud and highly distributed environments. Learn more about Xi Beam at nutanix.com/products/beam.

DEPLOYING A MULTI-CLOUD GOVERNANCE FRAMEWORK

Governance isn't always the most exciting topic, but it's essential, particularly as the workload environment now extends beyond the four walls of the on-premises datacenter to include public, private, hybrid, and multi-cloud environments.

A successful cloud governance framework includes several important elements. Although every framework is customized to the organization operating it, your framework should include controls pertaining to finance, operations, security, workload provisioning, and inventory, among others.

Understanding the general elements is a good start but understanding the *why* is equally important. A strong governance framework offers a number of benefits including:

- Alignment of operational cloud spend to business objectives
- Stronger security posture when deploying new workloads and managing current ones
- Automated enforcement of important policy elements to ensure compliance

In the modern era, your governance framework must embrace not just one cloud, but all of them. Multi-cloud governance ensures that your processes and outcomes keep pace with your business needs and expectations. It also means that your security systems keep pace with the clouds you've adopted so that any misalignment between environments doesn't harm your organization.



REMEMBER

A single vendor simply can't do everything. In certain instances, a strong partner ecosystem can be highly beneficial. This is certainly true in security. A platform that seamlessly integrates with market-leading security tools will help you keep your environment secure and stay ahead of cybercriminals. The Nutanix partner ecosystem is comprised of more than 300 hardware and software vendors to address all kinds of applications and use cases.

Streamlining infrastructure operations with advanced machine intelligence

Artificial intelligence and machine learning have enabled advanced automation and orchestration of complex processes across the entire IT environment. Next-generation HCI is no exception. You can automate many simple, repetitive storage management tasks and orchestrate more complex tasks.



REMEMBER

Nutanix Prism Pro lets you automate and orchestrate security hardening, application auto-scaling, and other big jobs in your environment. For example, with Prism Pro's proactive remediation capabilities, you can create playbooks for common remediation or troubleshooting steps. Those playbooks can be triggered automatically based on alert policies that you define.

IMPLEMENTING COMPREHENSIVE DISASTER RECOVERY

Every business must be prepared for natural and manmade disasters, such as severe weather, earthquakes, power grid failures, terrorism, and civil disturbances. Of course, there are also more mundane "disasters," like accidentally deleting a production database in the middle of the workday. Your disaster recovery (DR) plan must address it all.

Your DR plan covers much more than "where to run your critical workloads if your datacenter ceases to exist". It must also encompass operational data recovery and the steps necessary to migrate workloads to DR sites and, eventually, back into production.

Your DR plan should consider both your recovery point objectives (RPOs) and recovery time objectives (RTO). RPOs define how much data loss your business is willing to accept. RTOs define how long your business can be down. Your RPO and RTO targets determine certain operational characteristics of your HCI cluster and how it handles data replication. Lower RPO and RTO targets, for example, may require your HCI environment to support synchronous replication. Less stringent RPO and RTO targets may enable you to use less expensive asynchronous and near-synchronous replication.

Taking the On-Ramp to Enterprise Cloud with Next-Generation HCI

An *enterprise cloud* delivers the frictionless agility, simplicity, and fractional consumption of public cloud services while providing control over performance, location of data and services, and choice of platforms.



REMEMBER

Six key components comprise the enterprise cloud:

- » **Unified governance** models are the policy-centric instantiations of the single control plane discussed earlier in this chapter.
- » **Full-stack infrastructure and platform services** deliver turnkey infrastructure for any app at any scale, anywhere, delivered through a combination of on-premises datacenters and public cloud services.
- » **Zero-click operations and artificial intelligence/machine learning** deliver operational simplicity through automation and insights.
- » **Rapid elastic consumption** allows businesses to buy and use only the IT resources they need, and non-disruptively scale when demands grow. It helps embrace an OpEx model within and outside of the datacenter.
- » **Integrated security and governance** covers the entire infrastructure stack across private and public clouds, leveraging automation to maintain a security baseline.
- » **Application-centric mobility** lets businesses place and move applications anywhere, with no infrastructure lock-in.



TIP

To learn more about the enterprise cloud, download a free copy of *Enterprise Cloud for Dummies* at www.nutanix.com/go/what-is-the-enterprise-cloud-for-dummies.

IN THIS CHAPTER

- » Managing workloads on-premises and in the cloud
- » Running your mission-critical applications
- » Addressing remote office and branch office challenges
- » Delivering virtual desktops “as-a-service”
- » Measuring success in terms of time-to-value
- » Reducing cost and latency in the datacenter
- » Supporting big data on a really big scale (tens of petabytes)
- » Transforming storage with flash technology and next-generation HCI

Chapter 3

Supporting Workloads Anytime, Anywhere

Do you know where your workloads are? No, really. Can you say with certainty exactly which servers or environments are hosting which workloads? There was a time when these weren't hard questions to answer. Everyone knew that the enterprise resource planning (ERP) system ran on the server named “Spock” and the customer relationship management (CRM) system ran on the server named “Snoopy.”

Today, as workloads have increasingly been virtualized, they move dynamically across different physical hosts and even different datacenter and cloud environments. For example, autoscaling capabilities enable new instances of an application or workloads

to be spun up and down as demand increases and decreases. Additionally, modern applications no longer run on a single server but instead run as a combination of components and microservices across many different VMs and environments, such as web, application middle tier, and database servers, as well as external Software as a Service (SaaS) components.

Virtualization technology has also made it relatively easy to deploy new workloads in the datacenter or cloud, and this increased velocity has led to virtual machine (VM) sprawl in the datacenter and the cloud. Today, all you know is that the workload exists and it's nearly impossible to keep track of all your resources. Systems and applications are no longer cute, cuddly pets with adorable names. Instead, they've become a virtual flock with too many to count (even if you're an insufferable insomniac) and certainly too many to name (even Little Bo-Peep didn't bother to name her sheep). If you tried to task your IT Operations team with manually keeping track of all these systems and applications, you might just have a mutton-y on your hands!

This change has created new needs and challenges in workload management, which is the subject of this chapter.

Operating Workloads On-Premises and in the Cloud

Workloads today run across many different environments. They may run in an on-premises datacenter or in multiple public, private, or hybrid cloud environments. Next-generation hyperconverged infrastructure (HCI) enables the enterprise cloud, so you don't have to settle on just one location to host your critical workloads. Even better, next-generation HCI can help you manage the chaos that often ensues in the world of multi-cloud by providing centralized management for workloads and components that may reside in various locations.



REMEMBER

The enterprise cloud delivers the frictionless agility, simplicity, and fractional consumption of public cloud services while providing control over performance, location of data and services, and choice of platforms. To learn more about the enterprise cloud, read Chapter 2 or download a free copy of *Enterprise Cloud For Dummies* at www.nutanix.com/go/what-is-the-enterprise-cloud-for-dummies.

Enabling Mission-Critical Workloads

In the early days of HCI, there was concern about whether or not the use of hyperconverged infrastructure would become a hindrance and negatively affect workloads. This concern quickly faded as the technology proved itself and particularly once nodes started being outfitted with all-flash storage. Organizations began deploying mission-critical workloads on HCI, such as electronic medical records (EMR), customer relationship management (CRM), e-commerce, and enterprise resource planning (ERP) systems.



REMEMBER

Organizations are deploying their most critical applications on next-generation HCI solutions today to leverage the robustness and simple scalability of hyperconverged clusters in these solutions.

They're being supported by the vendor, as well. That's the key. Applications like SAP and other ERP tools are often deployed based on very specific requirements. Next-generation HCI is fully supported by most critical applications today and the solution can provide a less expensive and more efficient operating environment, helping organizations save money while realizing better outcomes.

How Next-Generation HCI Solves the ROBO Challenge

As technology pervades every corner of the organization, an interesting phenomenon has occurred. The datacenter is no longer the only place where data exists, and neither is the cloud.

Specifically, remote office and branch office (ROBO) environments are key areas in need of improvement. ROBO environments include branch sales offices for large corporations, doctor's offices and urgent care clinics, restaurant chains and coffee shops, retail outlets and mall kiosks, gas stations, and more.

These locations all need computing power and storage capacity, but typically not as much as the headquarters location. In the past, these ROBO locations often had full stacks of three-tier

infrastructure deployed because that's all that was reasonably available. Of course, three-tier environments have challenges. These issues are multiplied when you deploy infrastructure into remote environments without full IT support.

Next-generation HCI has emerged as a viable solution for these locations. Now, rather than a bulky, expensive deployment, companies can deploy smaller hyperconverged clusters that provide exponentially higher levels of availability and better central management capabilities. When you're dealing with thousands of locations, the savings can be enormous. Additionally, solutions such as AHV, the native Nutanix hypervisor, help companies eliminate additional software license costs.

Making VDI a Reality

Early in its evolution, HCI was the go-to technology to support virtual desktop infrastructure (VDI) deployments. However, VDI was getting a bad rap because of the poor storage choices that were available at the time. As HCI solutions evolved and flash storage was added, many of these VDI performance challenges were handily solved. However, VDI also had a reputation for being overly complex, with all kinds of components to deploy just to get a few desktops running. Now, with next-generation HCI solutions, these infrastructure challenges have been simplified and VDI has once again emerged as a viable enterprise desktop solution.

Next-generation HCI solutions enable a new paradigm for enterprise desktop computing delivered in the cloud: desktop as a service (DaaS). DaaS provides a complete turnkey solution for virtual desktops, greatly simplifying desktop administration within the enterprise.



REMEMBER

Nutanix Frame is a next-generation HCI DaaS solution that delivers the benefits of a virtual desktop environment running on intelligent software and scalable performance-centric hardware. Nutanix Frame is available as a cloud offering or as an on-premises solution.

Decreasing Application Time-to-Value

Business and IT decision makers use a number of methods to measure the success or failure of an IT department. The unfortunate truth is that these metrics are sometimes mutually exclusive, meaning that IT needs to get ultra-creative in forging a path ahead.

One key metric is obviously cost. How much is IT costing the organization? In many places, IT is still considered just a cost center laden with expenses and, sometimes, a “necessary evil” that must be paid for. In these organizations, IT is often discussed in terms of *total cost of ownership (TCO)*, which has a direct focus on the expense side of the business equation.

More modern organizations view IT as an opportunity center. The organizations are still concerned with how much IT costs, but they also understand that it’s an investment. In fact, in such organizations, the *return on investment (ROI)* metric is a key driver for IT initiatives.



REMEMBER

TCO is an estimate of the direct and indirect costs of an investment over the life of the investment, with no attempt to quantify the benefits of the investment. ROI calculates both the cost and the expected benefits of an investment over a specified period, typically three to five years.

Regardless of which path your organization has taken, a third metric is increasingly important: *time-to-value*. This is a measurement for how long it takes for new applications and new initiatives to begin bearing fruit. Organizations that use this metric generally seek to drive technology-led innovation throughout the enterprise. They’re willing to pay for it to get ahead of the competition and get to market faster.

That’s not to say that there’s a blank check sitting on the CIO’s desk. Although such organizations want to get new services deployed quickly, they also realize the need for a return on that investment. For some aspects, the total cost of ownership must be considered.

For these more complex organizations, the ability to deploy applications into a ready-made environment brings positive results to all three of these metrics. Next-generation HCI offers a lower TCO than most other architectures. This means that the payback period is shorter, which can increase your ROI. Because next-generation HCI solutions are relatively simple to manage and scale, deploying new applications is no longer held up by infrastructure provisioning.

Improving Critical Datacenter Metrics

As you dive deeper into the inner workings of the enterprise datacenter, certain technical metrics require your consideration. Each one directly relates to the overall cost of your workload operating environment. Some metrics relate to the physical space itself, while others apply to the systems that operate in that space.

For the purposes of your next-generation HCI plans, you need to watch these three space-centric metrics:

- » **Rack space:** How much rack space is your equipment using?
- » **Power draw:** How much electricity is the equipment in your datacenter consuming?
- » **Cooling load:** How much cooling is needed to ensure that your infrastructure is running at an optimal temperature?

These factors are all related to some degree. In general, the more equipment you have, the more rack space it takes, the more power it draws, and the more cooling is required to keep it functional.

A next-generation HCI solution helps you address all three of these metrics by collapsing the amount of infrastructure you need to operate. No longer are you running separate servers and storage. Now, it all runs on one solution. Likewise, if your old environment was hard drive-centric and you're moving closer to all-flash in your next-generation HCI environment, the savings on power and cooling may be substantial.

Another way that a next-generation HCI environment helps to reduce the amount of gear in your datacenter is through the use of traditional data reduction services, such as deduplication and

compression. By squashing the amount of data that has to be stored, you don't need as much power and cooling.

The nodes themselves are also potential sources of improved datacenter metrics, but this time, the focus goes to workload performance. Thanks to the fact that data is close to applications and, at a minimum, accelerated by flash, if not operating on all-flash nodes, you may see reduced latency.



REMEMBER

Latency is the king of workload performance metrics. Reducing it does good things for your workloads.

Supporting Big Data

Big data is, well, big! How big? Big in this context can range from a few terabytes to several petabytes. Your next-generation HCI solution must be able to grow with you as your big data needs burgeon.



TIP



REMEMBER

Nutanix next-generation HCI can support your enterprise big data needs with solutions that handle tens of petabytes of data.

Big data comes in many forms and requires a variety of storage service to work, from block to file to object storage. Most HCI solutions support running virtual machines (VMs) but only a few, such as Nutanix, also support native file, block, and object storage services.

A next-generation HCI solution breaks out of the traditional limitation and becomes a platform that provides native storage services without forcing you to build a VM construct, such as a Server Message Block (SMB) file server.

Flash and Next-Generation HCI — Savior of the Universe

It was once fashionable to design storage systems around the applications that they would support (and storage architects are, of course, known for their sense of fashion). Actually, designing your storage around applications was required. Hard disk drive

(HDD)-based storage was not nearly as forgiving as flash storage technology and you had to configure data protection mechanisms while keeping application performance requirements in mind.

Flash technology changed all that, but next-generation HCI is truly transforming this design paradigm. Next-generation HCI solutions embrace newer technologies, including NVMe and Intel Optane. Flash technology provides exponentially higher input/output operations per second (IOPS) than HDD technology by several orders of magnitude. In addition, a next-generation HCI solution provides a full array of storage services so you can support just about any combination of workloads. Finally, you can combine HDD, flash, and next-generation HCI software to ensure the right performance, capacity, and cost balance are available for any application or use case.

IN THIS CHAPTER

- » Covering all your enterprise storage needs
- » Enabling modern application development with containers and Kubernetes support
- » Delivering database management as a service
- » Making the case for secondary storage
- » Creating a simple-to-use, repeatable blueprint for application deployments
- » Leveraging artificial intelligence and machine learning for edge computing and the Internet of Things (IoT)

Chapter 4

Enabling Advanced and Modern Services

Next-generation hyperconverged infrastructure (HCI) doesn't stop with providing a platform for virtual machines (VMs). It goes much, much further and provides a native operating environment for a number of important enterprise-grade ancillary services.

In this chapter, you discover the role that next-generation HCI plays in ensuring that you can continue to collapse service silos in your datacenter without compromising the services you offer.

Supporting Multiple Storage Types

All HCI solutions make it possible for you to create storage solutions via deployment of VMs that provide those services. For example, if you need a file server, you can simply build a Windows VM, enable file services, and go on your merry way.

This approach presents some problems, though. You may want something more scalable (for example, leveraging automation) and reliable without having to build a cluster of such VMs.



REMEMBER

This is where a next-generation HCI solution comes to the rescue. Nutanix provides a storage solution for just about every need beyond serving up VMs. The architecture provides native support for file storage, object storage, and block-based storage. Named, respectively, Files, Objects, and Volumes, these services grow with you. As is the case with your VM storage, if you need more capacity for one of these storage services, you just add nodes.

Why is this capability important? You may not want to run every application inside your cluster, but you still want the cluster's storage to be used as an application target. With these services, you're exposing your cluster's storage resources in a native format that enables a broad array of application support, thereby eliminating the need to buy alternative storage solutions that create islands of infrastructure for your different applications.

Bringing Containers into the Enterprise

A container is somewhat analogous to a small apartment in which a mini-application resides, generally supporting a specific task and either operating independently or as a part of a larger distributed application. Kubernetes takes the analogy a bit further: A Kubernetes cluster is like a high-rise apartment complex full of containers. Now we're movin' on up!

A next-generation HCI solution must support containers. This can be done in a couple of ways. The first is to deploy a VM that itself becomes a container host. The second is to use a platform that provides native container orchestration, automation, and management with integrated persistent storage services, like Nutanix with Karbon.

This second approach means that you won't have to deal with the heavy lifting of building the container environment and you'll get the same management and scalability benefits of next-generation HCI that you enjoy with your VM farm.

Many organizations are running open source Kubernetes or Kubernetes-based platform-as-a-service/containers-as-a-service) (PaaS/CaaS) distributions on top of Nutanix, but they are struggling with the operational burden that these services add to their already tight budgets; plus PaaS/CaaS essentially adds another silo of management, infrastructure, and operations.

Organizations need consumer-grade design in the world of containers and Kubernetes. They do not want to invest in dedicated DevOps or site reliability engineering (SRE) teams to keep Kubernetes online, up to date, or integrated with third-party components and tooling.

Nutanix Karbon is a private cloud, turnkey-curated, enterprise-grade Kubernetes service offering that simplifies the provisioning, operations, and lifecycle management of Kubernetes. Karbon makes it simple to deploy a highly available Kubernetes cluster and operate web-scale workloads.

Nutanix Karbon enables enterprises to provide a private-cloud Kubernetes solution with the simplicity and performance of public clouds. It is also part of a complete cloud-native solution from Nutanix including storage (Volumes/Objects/Files), database automation (Era), and enhanced monitoring (Epoch). Leveraging Karbon, developers can enjoy the native Kubernetes experience that is delivered fast while all complexities of infrastructure are abstracted with no additional costs.



REMEMBER

Karbon is included in all Nutanix Acropolis Operating System (AOS) software editions.

Supporting the Database-as-a-Service Era

Databases are the circulatory system of the enterprise and should be treated as such. However, doing databases right can take a lot of time and effort. By doing them right, we mean making sure that they're highly available, that they have the resources they need, and that you can easily support common operations, like

cloning from production to test/dev, and ensuring that they remain protected.

This complexity is one of the reasons behind the rise in interest of database-as-a-service (DBaaS) platforms.

Collapsing such a service into the next-generation HCI environment would be a boon for database administrators.



REMEMBER

Fortunately, that's exactly what's happening today. Really! Nutanix includes in its platform a DBaaS solution called Era. With support for Oracle and PostgreSQL and more on the way, such as Microsoft SQL Server and MySQL, Era enables supported databases to leverage the cluster's snapshot technology for what amounts to a one-click time machine to allow you to recover to practically any point in time. Key benefits of Era include:

- » **Increased business agility and innovation rate:** Replace time-consuming and complex database operations with automated services, allowing resources to focus on business initiatives.
- » **One-click database operations:** Exercise enterprise-grade database management for all different database engines.
- » **Application programming interface (API) first architecture with full operational visibility:** Easily integrate with your preferred self-service tools.

Embracing Secondary Storage

Another hot topic today is the concept of *secondary storage*. As the name implies, secondary storage is anything that isn't primary storage. *Primary storage* includes things like your latency-sensitive mission critical workloads. *Secondary storage* refers to workloads that are still important but may be less sensitive to a little more latency, such as backups, data analytics, and so on.

Secondary storage has also come to mean that some level of data protection is included in the platform. What if you could get all of it — primary and secondary support with data protection — from a single platform?

That's one of the many goals of the Nutanix next-generation HCI vision, which encompasses far more services than primary storage. The point of secondary storage is to enable cloud-like scalability for your applications and imbue the environment with integrated data protection capability.

This unified operating environment offers your organization increased simplicity and faster time to value for your services.



Nutanix Mine brings all the benefits of a next-generation HCI solution to secondary storage. The company has partnered with a number of data protection companies — including Veeam, Veritas, HYCU, Commvault, and Unitrends — to provide comprehensive data protection services for primary and secondary storage needs.

Automating Applications with Calm

You've learned that next-generation HCI enables hybrid cloud. One of the key challenges in hybrid cloud scenarios is managing them both operationally and from a cost perspective. Problems can quickly spiral out of control if you don't put something in place to manage it all.

This is where Nutanix Calm comes in. Nutanix Calm is a multi-cloud application orchestration and management framework that provides application-level orchestration to transform how you deploy and manage IT operations. The point of Calm is to move beyond the VM as the primary entity and toward an application fabric that consists of VMs, containers, and cloud services. A blueprint-based process ensures consistency in ongoing deployments.

Calm provides application automation and lifecycle management natively integrated into the Nutanix Platform. With Calm, applications are defined via simple blueprints that can be easily created using industry standard skills and control all aspects of the application's lifecycle, such as provisioning, scaling, and cleanup. Once created, a blueprint can be easily published to end-users through the Nutanix Marketplace, instantly transforming a complex provisioning ticket into a simple one-click request. Key capabilities and benefits of Calm include:

- » **Improve IT agility and eliminate human errors:** Simplify the setup and management of custom enterprise applications by

incorporating all elements of each app, including relevant VMs, configurations, and related binaries, into an easy-to-use blueprint that is managed by the infrastructure team. By making the deployment and lifecycle management of common applications both automated and easily repeatable, infrastructure teams can eliminate the hours and days currently devoted to routine application management.

- » **Streamline daily operations:** Eliminate IT personnel bottlenecks that slow application deployments and lifecycle management by turning specialized operations into repeatable actions that follow the application, not the infrastructure. Build repeatable environments anywhere, empowering IT generalists to manage nearly all operations.
- » **Automate self-service with centralized control:** Empower different groups in the organization to provision and manage their own applications, giving application owners and developers an attractive alternative to public cloud services. Calm provides powerful, application-centric self-service capabilities with role-based access control. All activities and changes are logged for end-to-end traceability, aiding security teams with key compliance initiatives.
- » **Modernize application development:** Combined with Nutanix Karbon or your choice of certified Kubernetes, Calm provides the tools required to modernize applications without losing control of policy. Additionally, Calm natively integrates with Jenkins to empower continuous integration/continuous delivery (CI/CD) pipelines with automatic infrastructure provisioning or upgrades for all applications.
- » **Unify multi-cloud orchestration:** Calm unifies the management of all your clouds into a single pane of glass, removing the need to jump between portals. Calm automates the provisioning of multi-cloud architectures, scaling both multi-tiered and distributed applications across different cloud environments. With native integration into Xi Beam, Calm even shows the overall utilization and true cost of public cloud consumption at a glance, providing the information required to make deployment decisions with confidence.

Enabling the Internet of Things

No next-generation solution would be complete without support for what has emerged as a force unto itself: the Internet of Things (IoT). *IoT* is an umbrella term for the multitude of connected, smart devices that have distributed computing power far beyond its traditional confines. It may refer to the virtual assistant device in your home, the smart thermostat on your wall, or the security cameras in your office.

IoT, artificial intelligence (AI), and machine learning (ML) technologies often go hand-in-hand. Of course, this isn't always the case, but it's worth discussing.

IoT has serious data needs. For that, you need serious capacity. Many IoT services depend on AI/ML capabilities in order to analyze the mass of data that runs through IoT-centric workflows. There's simply too much data for a human to realistically ingest and derive insights from.



REMEMBER

The AI/ML-centric portions of the workflow require computing resources at the edge locations in which IoT devices often reside. AI/ML can be pretty compute-intensive, so many organizations naturally turn to the cloud to deliver the CPU cycles and storage capacity that's necessary to process these workloads. In these scenarios, *IoT gateways* become key as IoT devices direct their traffic through them, with the cloud being the ultimate analysis destination.

This approach isn't always feasible. Sometimes you have too much data to push to the cloud, which would result in an unacceptable latency period for analysis. In other cases, network latency itself can be a factor. Thus, organizations are seeking to embrace hybrid cloud services that enable some immediate processing at the edge with longer-term processing being pushed to the cloud. For immediate decisions, you allow edge services to do the work. For analysis that may take longer or that you don't need immediately, the workload is sent off to the stratosphere. Figure 4-1 shows how Nutanix Xi IoT enables a hybrid-cloud IoT workflow with analysis capabilities present at both the edge and in the cloud. Xi IoT delivers cloud-based services using next-generation HCI, thus providing Nutanix customers with a similar experience and operating model as their on-premises environment.

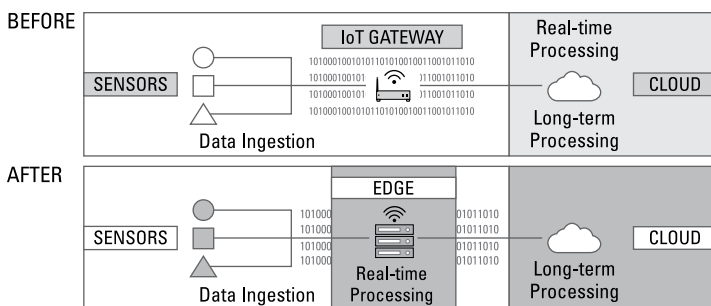


FIGURE 4-1: Before and after Nutanix Xi IoT deployment.

Xi Edge, a part of the Xi IoT platform, operates on bare metal, on Nutanix nodes, or as a virtual machine running the same Nutanix software, thus providing the same experience, whether on-premises or in the cloud. Cloud support includes the Xi Data Cloud, AWS, Azure, Google, and a private cloud environment, making it eminently flexible.

- » Identifying the differences between hardware and software approaches
- » Discovering why the hypervisor isn't what it used to be
- » Maximizing your cloud options

Chapter **5**

Having Freedom to Choose without Compromise

Early hyperconverged infrastructure (HCI) solutions were often prescriptive. You were able to buy hardware appliances that required a somewhat rigid configuration. You may have had some limits with regard to the hypervisor you selected, and public cloud services weren't a consideration because they were completely separate.

Next-generation HCI solutions offer the flexibility and agility that is so important in modern IT. You have a lot of options that you simply didn't have before.

In this chapter, you discover what this flexibility and agility means for your organization.

Choosing Your Model: Software versus Hardware

“You can have it in any color you want, as long as it’s black.” So goes the saying, and variations of it as people joke about how rigid certain buying processes can be. Early on, a lot of HCI solutions were like this — but Henry Ford didn’t invent HCI solutions. Sure, there were some software-based opportunities, but even those had some hardware-centric guidelines that weren’t very forgiving.

Over the years, HCI has become a force unto itself with myriad options at your fingertips. Today, you can deploy next-generation HCI solutions that are hardware- or software-centric.



REMEMBER

The real magic of next-generation HCI happens in the software, which can run on a broad ecosystem of supported hardware options.



TIP

Nutanix next-generation HCI software runs on the best hardware available from the most trusted manufacturers. Customers can choose branded Nutanix appliances, original equipment manufacturer (OEM) appliances from Dell, Lenovo, and IBM, or software-only options with validated bills of materials (BOMs) from Cisco, Dell, HPE, and more. Nutanix has also announced global partnerships with Fujitsu, Inspur, and HPE. HPE is offering two new appliances, based on HPE ProLiant and HPE Apollo servers, that ship with Nutanix software preinstalled. HPE also offers Nutanix Enterprise Cloud software as an on-premises managed service through HPE’s GreenLake program, with a flexible pay-as-you-go licensing model.

The freedom to choose your hardware in a software-centric next-generation HCI also extends to your cluster configuration and server procurement options. Nutanix software allows administrators to create heterogeneous clusters, including mixing CPU generations, hybrid and all-flash storage, as well as storage-heavy and compute-heavy nodes. This allows customers to create clusters made up of nodes tailored to their specific challenges and workload requirements. If processor, memory, or storage consumption grows faster than anticipated, customers can easily add nodes to the cluster to meet those needs. The same applies for performance characteristics, such as adding all-flash storage or higher speed processor nodes, which are more compute dense.



This flexibility obviates the time-consuming and wasteful process of ripping and replacing (“forklift” upgrades) every three to five years, based on best guesses for long-term growth and use cases. Instead, you can plan for near- and mid-term needs and simply optimize as necessary over time by adding nodes that are an exact fit for the environment. With Nutanix you have the freedom to make purchase decisions based on desired business outcomes, rather than upgrade cycles.

Choosing Your Hypervisor

VMware vSphere revolutionized virtualization technology and showed the world what is possible in a software-centric world. Today, like your hardware and software options (discussed in the previous section), you also have hypervisor options, including Nutanix AHV and Microsoft Hyper-V, among others.

Nutanix supports all of the leading hypervisors, including virtualization solutions from VMware, Microsoft, and the Nutanix hypervisor purpose-built for HCI, AHV. No matter which hypervisor you choose, Nutanix Prism makes management and operations a breeze, with seamless upgrades and automated virtual machine (VM) management. Nutanix hypervisor flexibility provides numerous benefits including:

- » **Multi-hypervisor management:** Run a mixed environment, or easily switch hypervisors to meet your changing needs.
- » **Cross-hypervisor disaster recovery (DR):** Run different hypervisors in the datacenter and the edge. For example, run VMware in production and AHV for backup or storage-heavy use cases to reduce licensing costs.
- » **Changed region tracking for backup:** Nutanix uses the same application programming interface (API) for VMware ESXi and AHV. This functionality allows you to use a single backup tool, no matter the hypervisor. The API makes use of native snapshots, which eliminates the need for costly backup additions.
- » **Security first:** Thanks to security configuration baselines and self-healing remediation based on U.S. Department of Defense (DoD) Security Technical Implementation Guides (STIGs), administrators don't have to be security experts; all

configuration is automated and enforced. This design reduces the risk of human error and saves weeks of going through spreadsheets with checklists of manual security hardening tasks.

Choosing Your Cloud

What does the cloud have to do with your next-generation HCI deployment?

The question should be, what *doesn't* it have to do with it! Business now takes place in a hybrid- and multi-cloud world. With this reality in mind, Nutanix designs its products and services to transcend the boundaries of on-premises and cloud environments. Enterprises benefit when they are free to choose the best cloud for their apps and business needs.



TIP

Nutanix has developed an array of next-generation HCI solutions that facilitate the freedom to choose your cloud — from cloud application lifecycle management to cloud monitoring, desktops, databases, and DR as a service. These solutions include:

- » **Calm** is a hybrid-cloud application lifecycle manager that lets you model your applications in easy-to-consume blueprints, deploy them on the clouds of your choice, and manage them throughout their entire lifecycle. A single application blueprint can contain any combination of clouds, and the decision on where to run the application can be made at deployment. Simply redeploy if you change your mind. No more locking into a single cloud vendor; deploy where it makes the most sense to run your application.
- » **Xi Beam** provides data-driven insights to help you determine which cloud makes the most sense for your business in terms of security compliance. Beam ensures security compliance by automating various out-of-the-box and custom audit checks that help to detect and fix any cloud security issues.
- » **Nutanix Frame** is a cloud-native, public-cloud service that delivers any Windows or Linux application or desktop to an end-user's web browser. Frame enables enterprises to

continuously integrate and deliver virtual apps and desktops at any scale, in any region, with the apps and services that end-users consume, all running on your preferred clouds. Frame is elastic, so administrators can scale capacity up and down with one click and automatically power up and power down desktops and apps to accommodate variations in usage.

- » **Nutanix Era** is a software suite that automates and simplifies database management, bringing one-click simplicity and invisible operations to database provisioning and lifecycle management (LCM). Nutanix Era enables database admins to provision, clone, refresh and restore their databases to any point in time.
- » **Xi Clusters** enable a true hybrid cloud architecture with clusters that look virtually the same in the public cloud as in on-premises Nutanix clusters. These clusters run the same Nutanix Acropolis Operating System (AOS) as well as AHV, management interfaces, and APIs. This allows existing IT processes or third-party integrations that work on-premises to continue to work with Xi Clusters in the public cloud. Customers needing to extend Nutanix environments can now leverage the flexibility of public cloud and keep the same familiar Nutanix experience.
- » **Xi Leap** is the Nutanix DR as a service offering, bringing Apple iCloud-like simplicity to the notoriously tedious, complex, expensive, and unpredictable task of disaster recovery. Xi Leap enables Nutanix Enterprise Cloud users to port their environment to the cloud in a single click. What's more, you can test the service at any time, unlike traditional DR scenarios that take weeks or months of planning — and still don't always work. Xi Leap also eliminates the time and expense of managing and scaling a second datacenter.
- » **Nutanix X-Powered** enables consumer choice in yet another way — letting best-of-breed service providers manage your cloud services entirely. Nutanix X-Powered service providers deliver the reliability, security, and performance of Nutanix Enterprise Cloud, but without the delays and upfront costs associated with procuring new infrastructure.

- » Understanding data at rest encryption options
- » Addressing regulatory compliance requirements
- » Discovering how micro-segmentation improves enterprise security

Chapter 6

Securing Next-Generation Hyperconverged Infrastructure

Security has always been important, but today it's a boardroom issue for almost every organization. For those in which it isn't, it should be. Every company's risk management strategy has to include information security as a key component.

The unfortunate reality is that every organization has some level of risk when it comes to enterprise security. Cybercriminals and other malicious actors breach organizations for financial gain, to steal information, or to damage or destroy information, infrastructure, and networks. Your employees can also create risks in your environment. Insider threats include malicious acts, honest errors and mistakes, and a general lack of security awareness (such as good security practices to avoid ransomware and phishing attacks).

In this chapter, you learn about the security and compliance capabilities of next-generation hyperconverged infrastructure (HCI).

Implementing Data at Rest Encryption

Data at rest encryption is an important layer in a defense-in-depth strategy to prevent data from being stolen for financial benefit or gaining system access in the event of unauthorized access to data. It provides an additional countermeasure and necessary layer of protection for data stored on disk. Data at rest encryption is also required for compliance with many data protection regulations. Data at rest encryption offers several key security protections including:

- » Preventing an attacker from simply exfiltrating unprotected data after breaching a network
- » Ensuring that data is protected if an attacker attempts to copy the data to another system
- » Protecting data in the event of physical drive thefts
- » Ensuring that data isn't accessible if it inadvertently leaves the datacenter on failed or replaced drives



TIP

Intel cryptographic instructions combined with the Nutanix next-generation HCI architecture (data locality) and the point in the data path where the data is encrypted makes the Nutanix Federal Information Processing Standards (FIPS) 140-2 validated software-based encryption implementation efficient with no material performance impact. Thus, the only reason to choose self-encrypting drives is if hardware-based tamper detection is required.



TIP

Nutanix implements a data security configuration that uses Acropolis Operating System (AOS) functionality along with the next-generation HCI cluster's local or external key management server (KMS). A symmetric data encryption key (DEK) such as Advanced Encryption Standard (AES) 256 is applied to all data being written to or read from the disk. The key is known only to AOS, so there is no way to access the data directly from the drive. In the case of an external KMS, each node maintains a set of certificates and keys in order to establish a secure connection with the KMS. Nutanix uses open, Key Management Interoperability Protocol (KMIP) standards for interoperability and strong security.

Supporting Regulatory Compliance

Although security and compliance are separate topics, they are somewhat related because most security and privacy regulations and standards are based on security best practices. Some examples of these regulations and standards include:

- » **General Data Protection Regulation (GDPR):** This European Union (EU) regulation requires organizations (regardless of whether or not they are located in the EU) to protect the privacy of EU residents and guarantees certain individual rights, such as the right to have inaccurate data correct and the right to be forgotten (have their data permanently deleted).
- » **Health Insurance Portability and Accountability Act (HIPAA):** This U.S. regulation safeguards protected health information (PHI) that is processed or stored about individuals by any covered entity, such as healthcare organizations and payment providers, among others.
- » **Payment Card Industry Data Security Standard (PCI DSS).** This global industry standard protects the processing, transmission, and storage of payment card (such as credit and debit cards) information.

Keeping up with secure configurations and compliance can be a big task. To help take some of the compliance pressure off, Nutanix publishes custom security baseline documents based on U.S. Department of Defense (DoD) Security Technical Implementation Guides (STIGs). These configuration guides cover the entire infrastructure stack and prescribe steps to secure deployment in the field. Nutanix baselines are based on common National Institute of Standards and Technology (NIST) standards that can be applied to multiple regulatory requirements for government, healthcare, finance, retail, and other industries. To further simplify, these guides are applied in the factory and backed by built-in, automated configuration, compliance audit, and remediation functions to reduce the risk of security configuration drift or falling out of compliance.

Nutanix also follows and complies with several security certifications and standards including validated FIPS 140-2 cryptographic modules, National Security Agency (NSA) Suite B support (to Top Secret), NIST SP800-131A, and others.



TIP

You can learn more about how Nutanix helps to secure your next-generation HCI by downloading the *Security with Nutanix: A Defense in Depth Strategy* e-book, available at www.nutanix.com/viewer?type=pdf&path=/content/dam/nutanix/resources/solution-briefs/sb-security-first-with-nutanix.pdf.



REMEMBER

Nutanix Beam provides continuous cloud security and compliance for multi-cloud (which includes your on-premises Nutanix deployment) environments with configuration audits, compliance reporting, and remediation for vulnerabilities. Beam provides insights into security vulnerabilities in real time so that you can resolve potential threats before they turn into business challenges. With Beam you can audit and maintain security compliance for HIPAA, International Organization for Standardization (ISO), PCI-DSS, Center for Internet Security (CIS), NIST, and Service Organization Control (SOC-2), enforce custom policies and audits or leverage more than 250 built-in security checks based on industry best practices.

Delivering Application-Centric Security with Micro-segmentation

You may have heard that with the advent of cloud computing and the proliferation of mobile devices, the traditional network perimeter has all but disappeared. But that's not entirely correct. More accurately, the perimeter has just gotten a lot more complex and rather than a single perimeter around an entire datacenter, it now consists of hundreds or thousands of perimeters around individual applications and workloads. These “micro” perimeters are constantly moving — within and across the datacenter, and within and across clouds.

Micro-segmentation (sometimes called *east-west firewalling*) creates granular network policies between applications and services. Micro-segmentation is a key part of a modern defense-in-depth strategy against advanced datacenter threats, providing the next layer of defense beyond perimeter firewalls that traditionally protected north-south traffic between the “trusted” corporate network and the “untrusted” Internet.



TIP

Before implementing micro-segmentation policies, it's important to have a clear understanding of the communication flows between applications, VMs, and services to ensure you don't break your applications. A next-generation HCI solution, such as Nutanix Flow and Epoch, provides the tools to discover and visualize these communications.

Micro-segmentation is necessary not only because the traditional network perimeter has become a lot more porous with users communicating from anywhere and on any device, but applications themselves have also become distributed, taking advantage of local and remote data services. Modern microservices-based application architectures enable rapid development of new applications by separating applications into distinct functions and services and deploying them where they make the most sense, whether in an on-premises datacenter or in public or private cloud environments — but these individual components must still communicate securely and efficiently with each other regardless of where they are deployed. Even applications that are fully deployed within a single datacenter or cloud must still communicate securely with other application components in a microservices architecture.

The result is that today, the overwhelming majority of network traffic is east-west — between applications and resources within the datacenter or cloud — rather than north-south, and traditional perimeter firewalls are mostly blind to these traffic patterns and thus largely ineffective. Threat actors recognize this weakness in traditional firewalls and take advantage of it after initially breaching the network, moving laterally within the target environment undetected and unimpeded, establishing a persistent foothold, and escalating their privileges within the environment — eventually gaining access to the valuable data.

Micro-segmentation essentially reduces the security perimeter to a fence around each service, application, or virtual machine (VM). The fence permits only necessary communications between application tiers or other logical boundaries, thus making it difficult for cyber threats to spread from one system to another. Therefore, compromising one tiny perimeter doesn't automatically expose other targets in the environment.

NUTANIX FLOW PROVIDES VISIBILITY AND GRANULAR CONTROL

Nutanix Flow delivers advanced networking and security services, providing visibility into the virtual network, application-centric protection from network threats, and automation of common networking operations.

Fully integrated into Nutanix Enterprise Cloud OS and Nutanix AHV virtualization, Flow allows organizations to deploy software-defined virtual networking without the complexity of installing and managing additional products that have separate management and independent software maintenance requirements.

Key capabilities and benefits of Flow include:

- Application-centric firewall policies for VMs
- Always-on native networking functionality with no additional software or management consoles
- Capability of working with any network topology or architecture
- Application and network visibility
- Automated policy change management tied to VM lifecycle
- Protection against propagation of network security threats
- Potential for expanding functionality via third-party network inspection and policy tools

Making micro-segmentation application-centric further streamlines security operations by enabling the ability to define high-level policies without needing details about the underlying infrastructure or network identifiers. Policy focuses on application tiers or groups and what types of communication are allowed.

This is an important distinction because it separates the policy and groups from more dynamic network identifiers like IP addresses or virtual local area network (VLAN) segments and enables the policy to be applied dynamically with the application or workload, rather than being constrained to a physical or logical construct. This approach significantly reduces the complexity typically

involved in policy management. The responsibility for understanding the infrastructure or network connectivity is removed from the human policy writers and left to the virtualization platform, which always knows the information needed to automatically update the policy accordingly.



TIP

Ideally, policy writers should incorporate application-level security policy without any changes to the existing network configuration, keeping things simple and allowing admins and architects to focus on the business or application requirements, not the network infrastructure. Eliminating the reliance or impact on the existing physical network also eliminates the need to change or rearchitect the physical design. As a result, the time required to implement security policy is dramatically reduced.

Chapter 7

Ten Capabilities and Benefits of Nutanix Next-Generation Hyperconverged Infrastructure

Here are ten important capabilities and benefits in Nutanix next-generation hyperconverged infrastructure (HCI) solutions to help your organization thrive today and in the future:

- » **Consume infrastructure as you need it.** Legacy-based IT infrastructure procurement models stifle innovation and limit business agility. With next-generation HCI, you can adopt the pay-as-you-go consumption model of the public cloud while providing a common foundation upon which to run both legacy and cloud-native apps.

- » **Align IT to your business.** With a software-centric approach to next-generation HCI, Nutanix enables IT to focus less on hardware and more on digital transformation and other strategic initiatives that deliver real business value.
- » **Run Nutanix software-based next-generation HCI solutions on your choice of hardware.** Hardware is important, but software is where the magic happens. Nutanix next-generation HCI software solutions are hardware agnostic, running on vendor hardware such as Dell, Lenovo, Cisco, Fujitsu, Inspur, and HPE, as well as Nutanix.
- » **Deliver virtual desktop infrastructure (VDI) in the cloud.** For those who prefer the ease of delivering their desktops as a service (DaaS), Nutanix offers Frame and Xi Cloud Services. This option provides a simple consumption-based cloud services model built on next-generation HCI.
- » **Enter a new Era in database management.** Databases are no longer limited to a single physical location or infrastructure. With Nutanix Era, you can easily restore your databases to any point on any infrastructure or cloud.
- » **Calm your nerves on your journey to the cloud.** Nutanix Calm is your on-ramp to the multi-cloud era, providing application lifecycle management for hybrid on-premises and cloud environments including VMware vSphere, Nutanix AHV, Amazon Web Services (AWS), Microsoft Azure, Google Cloud Platform (GCP), Kubernetes, and Google Kubernetes Engine (GKE).
- » **Support cloud native workloads.** Kubernetes (sometimes written K8s) is becoming the de facto standard for automation and orchestration of container-based applications. Developers want the instant convenience and scale of cloud deployments and the enterprise wants the control of private cloud. Nutanix Karbon dramatically simplifies Kubernetes provisioning, operations, and lifecycle management without requiring dedicated resources to manage infrastructure.
- » **Make security a pervasive part of the enterprise fabric.** Micro-segmentation, software-based data encryption, and other protective technologies available in Nutanix next-generation HCI solutions help you secure your environment in an ever-evolving threat landscape. The Nutanix Acropolis Operating System (AOS) is hardened by default and Nutanix Flow delivers

application-centric security for your virtual machines running on AHV via visualization, micro-segmentation, and network automation.

- » **Embrace edge computing.** The edge enables key use cases for the Internet of Things (IoT) and real-time performance-intensive applications, among others, that require computing power and storage capacity closer to the end-users. Nutanix IoT, Xi Edge, and appropriately sized next-generation HCI clusters deliver these important capabilities.
- » **Choose wisely.** With your choice of hardware, hypervisor, cloud, and much more, Nutanix provides enterprises with unprecedented flexibility that allows business-centric decisions to be made based on best-of-breed technology rather than limiting choice due to vendor lock-in.



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Tear down silos and elevate your team with industry-leading hyperconverged infrastructure.

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Address evolving business needs with HCI

Next-generation hyperconverged infrastructure (HCI) goes beyond solving the myriad storage challenges in traditional datacenters to form the very core of an enterprise-wide operating platform that spans your on-premises and cloud environments. This book takes you on a journey from the earliest days of HCI through today and into a bountiful and secure future.

Inside...

- Explore HCI's evolution
- Enable mission-critical workloads
- Reduce cost and latency
- Enable the enterprise cloud
- Handle big data on a large scale
- Support containers and Kubernetes
- Secure next-generation HCI

NUTANIX™

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