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THE GORILLA GUIDE TO...®

Hyperconverged Infrastructure Implementation Strategies

Scott D. Lowe

INSIDE THE GUIDE:

- Discover the traits that make hyperconverged infrastructure a must-look for every organization
- Explore use cases in which hyperconvergence helps organizations transform IT
- Assess the positive organizational impact that hyperconvergence can deliver

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THE GORILLA GUIDE TO...

Hyperconverged Infrastructure Implementation Strategies

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ENTERING THE JUNGLE

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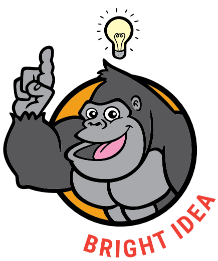

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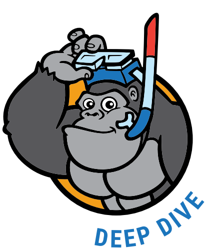

Takes you into the deep, dark depths of a particular topic.

Discusses items of strategic interest to business leaders.

ICONS USED IN THIS BOOK

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Defines a word, phrase, or concept.

KNOWLEDGE CHECK

Tests your knowledge of what you’ve read.

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We want to make sure you see this!

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We’ll help you navigate your knowledge to the right place.

WATCH OUT!

Make sure you read this so you don’t make a critical error!

SECTION 1

Technical Overview

CHAPTER 1

Introduction to Hyperconverged Infrastructure

The world of technology is changing at both a broader and faster pace than ever before. In years past, IT practitioners and decision makers might have had to deal with a few new hardware options and some software upgrades. Today, changes come every day as companies break the data center walls in favor of hybrid cloud, as cloud providers continue to grow, and as software updates deploy silently behind the scenes.

As employees devour technologies such as smartphones, tablets, wearables, and other devices, and as they become more comfortable with solutions such as Slack, Dropbox, and Zoom, their demands on enterprise IT intensify. On top of this, management and other decision makers are also increasing their demands on enterprise IT to provide application environments that have higher levels of availability and easier growth capability, but with the kinds of pay-as-you-grow economics that they see from the cloud. Unfortunately, enterprise IT organizations often don't see much, if any, associated increases in funding to accommodate these demands, particularly as spending increases on other business priorities, such as improved security, analytics, and digital transformation efforts.

These demands have resulted in the need for IT organizations to attempt to mimic NASA's much-heralded "Faster, Better, Cheaper" operational campaign. As the name suggests, NASA made great attempts to build new missions far more quickly than was possible in the past, with greater levels of success, and with costs that were dramatically lower than previous missions. NASA was largely successful in its efforts, but the new missions tended to look very different from the ones in the past. For example, the early missions were big and complicated with a ton of moving parts, while modern missions have been much smaller in scale with far more focused mission deliverables.

The same "Faster, Better, Cheaper" challenge is hitting enterprise IT, although even the hardest-working IT pros don't usually have to make robots rove the surface of an inhospitable planet! Today's IT departments must meet a quickly growing list of business needs while, at the same time, appeasing the decision makers who demand far more positive economic outcomes, either by cutting costs overall or doing more work within the existing budget.

Even as the public cloud continues to gain favor for certain workloads, the real center of workload action remains the on-premises data center. Unfortunately, traditional data center architectures actively work against modern goals, because with increasing complexity comes increased costs—and things have definitely become more complex. Virtualization was a fantastic opportunity for companies, but with virtualization came new challenges, including major issues with storage. With virtualization, enterprise IT moved from physical servers, where storage services could be configured on a per-server basis, to shared storage systems. These shared storage systems, while offering plenty of capacity, have often not been able to keep up in terms of performance, forcing IT departments to take corrective actions that don't always align with good economic practices.

These are just some of the challenges that administrators of legacy data centers need to consider as well:

- **Hardware sprawl.** Data centers are littered with separate infrastructure silos that are all painstakingly cobbled together to form a complete solution. This hardware sprawl results in a data center that's increasingly complex, decreasingly flexible, and expensive to maintain.

- **Policy sprawl.** The more variety of solutions in the data center, the more touch points that exist when it comes to applying consistent policies across all workloads.
- **Scaling Challenges.** Predictability is becoming extremely important. That is, being able to predict ongoing budgetary costs and how well a solution will perform after purchase are important. Legacy infrastructure and its lack of inherent feature-like scaling capability make both predictability metrics very difficult to achieve.
- **Desire for less technical overhead.** Businesses want analysts and employees that can help drive top-line revenue growth. Purely technical staff are often considered expenses that must be minimized. Businesses today are looking for ways to make the IT function easier to manage overall so that they can redeploy technical personnel to more business-facing needs. Legacy data centers are a major hurdle in this transition.
- **A focus on security.** Security has always been important, but never more than it is today. Increasingly a boardroom issue, security spending is accelerating, sometimes at the expense of other areas of IT, a situation that data center architects need to accommodate.

So, with all of this in mind, what are you to do?

Hyperconverged Infrastructure from 30,000 Feet

A number of years ago, a new data center architectural option, dubbed hyperconverged infrastructure, came on the scene and exploded faster than anyone could have imagined. Hyperconvergence is a way to reduce your costs and better align enterprise IT with business needs. At its most basic, hyperconverged infrastructure is the conglomeration of the servers and storage devices that comprise the data center with modern iterations of the technology also swallowing up complex networking components. These systems are wrapped in comprehensive and easy-to-use management tools designed to help shield the administrator from much of the underlying architectural complexity while providing an infrastructure that's self-managing.

Why are storage and compute at the core of hyperconverged infrastructure? Simply put, storage has become an incredible challenge for many companies. It's one of—if not the—most expensive resources in the data center and often requires a highly skilled person or team to keep it running. Moreover, for many companies, it's a single point of failure. When storage fails, swaths of services are negatively impacted. Finally, with the increase in the growth of data volume, legacy storage architectures were beginning to crumble.

Combining storage with compute is in many ways a return to the past, but this time serious brains have been wrapped around it. Before virtualization and before SANs, many companies ran physical servers with direct-attached storage systems, and they tailored these storage systems to meet the unique needs for whatever applications might have been running on the physical servers. The problem with this approach was it created numerous "islands" of storage and compute resources without a centralized coordinating mechanism. Virtualization solved this resource-sharing problem, but introduced its own problems previously described.

Hyperconverged infrastructure distributes the storage resource among the various nodes that comprise a cluster. Built using standard server chasses and hardware, hyperconverged infrastructure nodes and appliances are bound together via Ethernet and a powerful software layer. The software layer often includes what is termed as a virtual storage appliance (VSA) that runs on each cluster node. Each VSA communicates with all of the other VSAs in the cluster over an Ethernet link, thus forming a distributed file system across which VMs (VMs) are run.

If you reread that last paragraph, you'll note that the network plays a critical supporting role in every hyperconverged solution on the market. However, few hyperconverged vendors treat the network as more

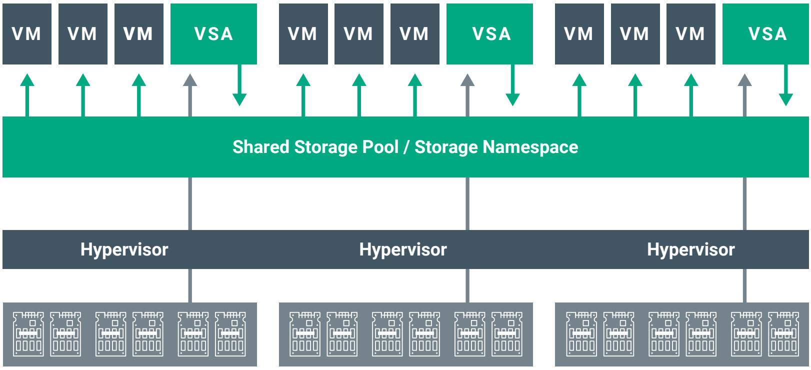


Figure 1-1: An overview of a Virtual Storage Appliance

than a support infrastructure. Today, as organizations scale beyond single racks, overlooking the criticality of the network introduces serious scaling limitations. Later in this book, you'll discover how HPE has solved this challenge through the introduction of the HPE Composable Fabric, a software-defined networking solution that eliminates scaling challenges in hyperconverged infrastructure (and other) scenarios.

The fact that hyperconverged systems leverage standard off-the-shelf hardware is critical. The power behind hyperconverged infrastructure lies in its ability to corral resources—RAM, compute, data storage, and networking—from hardware that doesn't all have to be custom-engineered. This is the basis for hyperconverged infrastructure's ability to scale granularly and the beginnings of cost reduction processes.

Resources to Consolidate

The basic combination of storage, servers, and networking is a good start, but once you look beyond the confines of this baseline definition, hyperconverged infrastructure begins to reveal its true power. The more hardware devices and software systems that can be collapsed into a hyperconverged solution, the easier it becomes to manage the solution and the less expensive it becomes to operate.

Here are some data center elements that can be integrated in a hyperconverged infrastructure.

Deduplication Appliances

In order to achieve the most storage capacity, deduplication technologies are common in today's data center. Dedicated appliances are now available that handle complex and CPU-intensive deduplication tasks, ultimately reducing the amount of data that has to be housed on primary storage.

Deduplication services are also included with storage arrays in many cases. However, deduplication in both cases is not as comprehensive as it could be. As data moves around the organization, data is rehydrated into its original form and may or may not be reduced via deduplication as it moves between services.

SSD Caches/All-Flash Arrays

To address storage performance issues, companies increasingly deploy either solid-state disk (SSD)-based caching systems or full SSD/flash-based storage arrays. However, both solutions have the potential to increase complexity as well as cost. When server-side PCI-e SSD cards are deployed, there also has to be a third-party software layer that allows them to act as a cache, if that's the desire. With all-flash arrays or flash-based stand-alone caching systems, administrators are asked to support new hardware in addition to everything else in the data center.

Backup Software

Data protection in the form of backup and recovery remains a critical service provided by IT and is one that's often not meeting organizational needs. Recovery time objectives (RTO) and recovery point objectives (RPO)—both described in the deep-dive section, "The Ins and Outs of Backup and Recovery"—are both shrinking metrics upon which IT needs to improve.

The basics behind hyperconverged infrastructure should be well understood before proceeding with the remainder of this book. If you're new to hyperconverged infrastructure or are unfamiliar with the basics, please read "Hyperconverged Infrastructure for Dummies," available now for free from www.hpe.com/HCI/fordummies

Using traditional hardware and software solutions to meet this need has been increasingly challenging. As RPO and RTO needs get shorter, costs get higher with traditional solutions.

With the right hyperconverged infrastructure solution, the picture changes a bit. In fact, some baseline solutions include comprehensive backup and recovery capability that can enable extremely short RTO windows, enabling very small RPO metrics—both *very* good characteristics!

Data Replication

Data protection is about far more than just backup and recovery. What happens if the primary data center is lost? This is where replication comes into play. By making copies of data and replicating that data to remote sites, companies can rest assured that critical data won't be lost.

To enable these data replication services in traditional scenarios, companies implement a variety of other data center services. For example, to minimize replication impact on bandwidth, companies deploy WAN-acceleration devices intended to reduce the volume of data traversing the Internet to a secondary site. WAN accelerators are yet another device that needs to be managed, monitored, and maintained.

The Ins & Outs of Backup & Recovery

There are critical recovery metrics—known as recovery time objective (RTO) and recovery point objective (RTO) that must be considered in your data protection plans. You can learn a lot more about these two metrics in **Chapter 5**.

There are acquisition costs to procure these devices; there are operation costs in the form of staff time and training; and there are annual maintenance costs to make sure that these devices remain supported by the vendor.

Up Next

With an understanding of hyperconverged infrastructure and knowledge about many of the resources that can be consolidated into such solutions, let's move on to discuss some specific data center architectural elements and options that comprise a hyperconverged environment.

CHAPTER 2

Architecting the Hyperconverged Data Center

Data centers are dynamic, complex, and sometimes even chaotic. As business needs evolve, so does the data center, with IT staff working hard to ensure that the operating environment is sufficiently robust. Today, the term "data center" is coming to mean something completely new, too, as organizations look for ways to comingle public cloud and on-premises environments to operate their mission-critical workloads.

Hyperconverged infrastructure starts to change the mechanics behind how these efforts are carried out. With regard to hyperconvergence, there are a number of architectural elements that must be considered in order to determine the best path forward. But always remember: One of the primary goals of hyperconvergence is to simplify data center and hybrid cloud infrastructure.

You don't need to worry about buying all kinds of different hardware, because with hyperconvergence the traditional silos of compute and storage resources have been merged into a single hyperconverged appliance. Moreover, the more sophisticated hyperconverged infrastructure solutions converge far more than just servers and storage. These appliances can also include your entire backup-and-recovery process, your deduplication and WAN acceleration appliances, and much more. Your architectural decisions can revolve around higher-order items, such as those described in the following sections.

Decision 1: Server Support

Not all hyperconverged solutions ship in the same kind of packaging. For example, there are appliance-based hyperconverged solutions from companies such as HPE, Nutanix, Scale Computing, and NetApp. And then there are software-only solutions that you install yourself.

With an appliance-based solution, you're buying the full package, and you just need to plug everything in and turn it on. These are really easy to get going since most things are already done for you. Even better, when you combine your hyperconverged solution with a software-defined networking component, such as HPE Composable Infrastructure, things get even more plug-and-play since the network can self-configure based on the kind of network traffic that it sees.

Perhaps the biggest downside to an appliance-based solution is that you generally have to live with whatever constraints the vendor has placed on you. You need to remain within its hardware specifications. That said, today, there's generally more than sufficient configurability so that this is mostly a non-issue.

Decision 2: The Storage Layer

Let's face facts. One of the main reasons people are dissatisfied with their data centers is because their storage solution has failed to keep pace with the needs of the business. It's either too slow to support mission-critical applications or it doesn't have data-efficiency features (deduplication and compression), thus forcing the company to buy terabyte after terabyte of new capacity. Or, the company is falling victim to a data tsunami and can't keep up with the old ways of adding storage all the time.

Many storage devices aren't well-designed when it comes to supporting virtualized workloads, either. Traditional SANs are challenged when attempting to support the wide array of I/O types that are inherent in heavily virtualized environments. At the same time, storage has become more complex, often requiring specialized skill sets to keep things running. For some systems, it's not easy to do the basics, which can include managing LUNs, RAID groups, aggregates, and more. Some storage solutions also impose complex storage requirements, which can further muddy the infrastructure waters.

As companies grow and become more dependent on IT, they also start to have more reliance on data-mobility services. Legacy storage systems don't always do a great job enabling data mobility and often don't even support services like remote replication and cloning or, if they do, it's a paid upgrade service. Without good local and remote cloning and replication capabilities, ancillary needs like data protection take on new challenges, too.

None of these situations are sustainable for the long term, but companies have spent inordinate sums of cash dragging inadequate storage devices into the future.

Hyperconverged infrastructure aims to solve this storage challenge once and for all. At the most basic level, hyperconverged infrastructure unifies the compute and storage layers and effectively eliminates the need for a monolithic storage array and SAN.

How does the storage component actually work if there's no more SAN? Let's unveil the storage secrets you've been dying to know!

Software-Defined Storage Defined

Abstract. Pool. Automate. That's the mantra by which the software-defined movement attains its success. Consider the traditional SAN. It can be a huge and expensive device. Software-defined storage (SDS) works in a vastly different way. With SDS, storage resources are abstracted from the underlying hardware. In essence, physical storage resources are logically separated from the system via a software layer.

Hyperconverged infrastructure systems operate by returning to an IT environment that leverages direct-attached storage running on standard server hardware, but many solutions go far beyond this baseline. In these baseline systems, there are a multitude of hard drives and SSDs installed in each of the x86-based server nodes that comprise the environment.

Installed on each of these nodes is the traditional hypervisor, along with software to create a shared resource pool of compute and storage. Increasingly, hyperconverged vendors are either eliminating disks from their product lineup and moving to flash-only configurations, or they're adding all-flash variations to their existing product portfolios.

What's more is that there are vendors who collapse data protection, cloud gateway technologies, and services such as deduplication, compression, and WAN optimization into their solutions. In essence, hyperconverged infrastructure leverages the concepts behind SDS systems in order to modernize and simplify the data center environment.

With storage hardware fully abstracted into software, it becomes possible to bring policy-based management and APIs to bear in ways that focus efforts on management on the VM rather than the LUN. The VM is really the administrative target of interest, whereas a LUN is just a supporting element that contributes to how the VM functions. By moving administration up to the VM level, policies can be applied more evenly across the infrastructure.

To VSA or Not to VSA?

Much has been written about why virtual storage appliances, or VSAs, (which run in user space) are terrible, why VSAs are awesome, why hypervisor-converged (kernel space) storage management is terrible, and why hypervisor-converged storage management is awesome. In short, should storage-management services run in user space (VSA) or kernel space (kernel-integrated)?

Defining VSA and Kernel-Integrated Management

Before examining the facts behind these opinions, let's take a minute to make sure you understand what constitutes a VSA versus a kernel-integrated storage management system. Bear in mind that both VSAs and kernel-integrated management systems are part of the SDS family of storage systems in which storage resides in the server, not on SANs or separate arrays—at least in general.

A VSA is a VM that runs on a host computer. This VM's purpose is to manage the storage that is local to that host. The VSAs on individual hosts work together to create a shared storage pool and global namespace. This storage is then presented back to the virtual hosts and used to support VMs in the environment. HPE's SimpliVity platform is among a number of offerings from various companies that use a VSA to support the storage element of the solution.

Figure 2-1 provides a conceptual look at how VSAs operate. The key point here is to understand that the VSA is a VM just like any other.

Most hyperconverged systems on the market use this VSA method for handling storage abstraction.

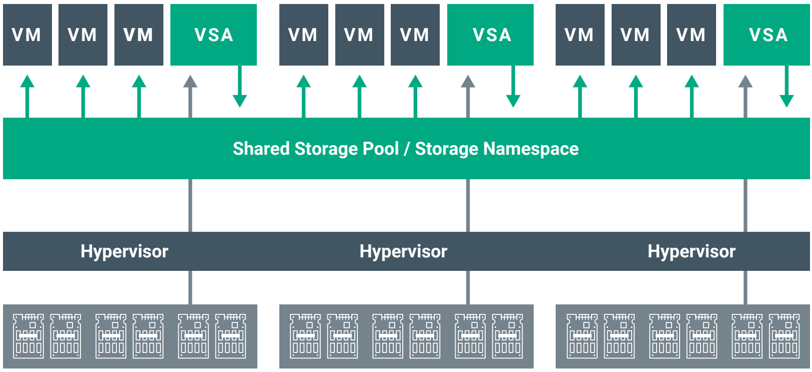


Figure 2-1: This is the general architecture that includes a VSA

However, kernel-integrated storage is another method you should understand. Referred to as either kernel-integrated storage management or hypervisor-converged storage, this non-VSA storage management method operates through the implementation of a kernel-based module that resides in the hypervisor. In other words, instead of a VM handling local storage management, this hypervisor kernel handles the job. The most well-known kernel-integrated hyperconverged infrastructure solutions is VMware VSAN, which uses an operating system driver to handle storage needs.

There are other significant players in this space as well, such as Microsoft with Storage Spaces Direct (S2D). This feature is built right into the Windows Server Datacenter edition. Users can either build their own architecture and manage it or they can partner with a vendor such as HPE if they prefer to have a fully supported S2D experience. Regardless of how it's supported, S2D is a kernel-driven service that requires Windows at the core.

Choosing a Method

So, which method is better? Let's take a look at both options and how they align with needs around hyperconverged infrastructure.

First, recall the discussion around hypervisor choice. If you don't need multi-hypervisor support, then either a VSA or a kernel-integrated kernel module will work equally well. Remember that multi-hypervisor choice is often not a major requirement as long as the intended solution supports the hypervisor you want to use, or plan to use in the future.

As soon as you introduce a need for multi-hypervisor support, your only choice is to work with a VSA. Because a VSA is just another VM running on the host, that VSA can be transitioned to run on any other hypervisor. When it comes to portability, VSA is king. There are far more VSA-based hyperconverged infrastructure solutions available on the market than non-VSA ones.

Hypervisor-integrated systems will lock you into the hypervisor to which the kernel module is tied. For some, that's a big downside. For others, it's not a problem since they don't have any plans or desire to move to a different hypervisor.

All this said, let's talk reality. VMware has spent years tuning the general hypervisor for performance and has told its customers that it's more than sufficient for running even their most performance-sensitive applications, including monster databases on Oracle and SQL Server, Exchange, SAP and SAP HANA. It boils down to this: If it's good enough for those kinds of really I/O-heavy applications, why can't it support storage and hyperconvergence?

Proponents for VSA-based systems say they are designed from the ground up to support storage and hyperconverged infrastructure running a variety of workloads and applications. In fact, some of these appliances are certified to support Microsoft and high-impact SAP apps, without being tied to a single hypervisor. That kind of flexibility can't be overstated.

It's hard to say that one solution is "better" than the other. Instead, they're just different ways to achieve the same goal, which is to abstract storage, pool it, and present it back to the hypervisor as a single shared resource pool. The choice really comes down to other goals you may have for your environment.

The Role of Custom Hardware in a Commodity Infrastructure

The first S in SDS stands for *software*. SDS is very much a software-driven storage architecture. However, this doesn't mean that custom hardware has *no* place in the solution. For software-defined purists, having any custom or proprietary hardware anywhere in the software-defined data center might be considered blasphemous. However, don't forget that we live in a world where not all is black and white. Shades of gray permeate everything we do.

The purists are right to a point. Proprietary hardware that doesn't serve a strategic purpose doesn't belong in a software-defined data center. However, when proprietary hardware provides a value-add that significantly differentiates a solution, it's worth a hard look. The vendor isn't creating that proprietary hardware for no reason.

For example, HPE includes a proprietary hardware card, called an accelerator card, in one of its hyperconverged models to handle much of the heavy lifting when it comes to complex storage operations.

In the modern data center, some storage truths must be observed. The first is that latency is *enemy No. 1.* The more latency that's introduced into the equation, the slower that workloads will operate. HPE SimpliVity's accelerator card is inserted into a commodity server and uses custom-engineered chips to provide ultra-fast write caching services that don't rely on commodity CPUs. Moreover, the accelerator card enables comprehensive data reduction technologies (deduplication and compression) to take place in real time with no performance penalty in order to massively reduce the total amount of data that has to be stored to disk and the I/O that it takes to carry out operations.

Of course, it wouldn't be a complete modern solution if this card was an absolute requirement. To that end, HPE also makes available SimpliVity node options in which the heavy lifting around deduplication and compression are wholly handled by increasingly powerful commodity CPUs. Modern CPUs have incredible horsepower, some of which can be sliced away and used to improve overall data efficiency. HPE's software-optimized stack (read: no physical accelerator card) allows more adaptation of HPE server platforms from high performance computing to edge computing to match customer's use cases.

Regardless of which way you go, remember this: Even when there's some custom hardware, "software-defined" has nothing to do with hardware. "Software-defined" is about abstraction from the underlying hardware, thereby allowing software to present all services to applications.

Decision 3: Data Protection Services

Data protection shouldn't be considered an afterthought in your data center. It should be considered a core service that's central to how IT operates. RTOs and RPOs should be a key discussion point as you're considering hyperconverged infrastructure solutions. Bear in mind that not all hyperconverged products come with the same levels of data protection.

Decision 4: The Management Layer

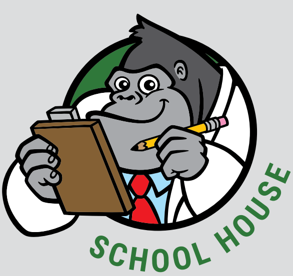
The data center has become an ugly place when it comes to management. There are separate administrative consoles for everything in the environment. The result is that administrators have no consistency in their work and are burdened with inefficiencies. To simplify management in the data center, admins need as few interfaces as possible. Here are the most common options that you need to be aware of when considering a hyperconverged virtual infrastructure:

Virtualization Layer Management

For those using VMware vSphere, vCenter is already in place.

Organizations using Microsoft Hyper-V likely use System Center Virtual Machine Manager (SCVMM).

Dot Your RPOs and Your RTOs



We haven't ignored how important RTOs and RPOs are in this book. In fact, we have a whole chapter on data protection! To learn everything you've ever wanted to know about data protection as it relates to hyperconverged infrastructure, head on over to **Chapter 5**.

Orchestration and Automation Layer Management

Once the hyperconverged infrastructure is running, common tasks must be automated to gain efficiencies. Common orchestration and automation tools are:

- **VMware vRealize Automation (vRA).** Provides automated provisioning through a service catalog. With the ability to deploy across multi-vendor cloud and virtual infrastructures, vRA allows you to provide applications to the business as needed.
- **HPE OneView.** HPE OneView is an integrated management platform that brings together compute, storage, networking, and the public cloud into a singly managed hybrid cloud platform. In a hyperconverged scenario, OneView provides a management and orchestration layer that includes a complete API for automation.
- **Containers.** Containers have become a key player in the infrastructure space as have software management and orchestration layers, including the massively popular Kubernetes. Containers run atop a virtualized environment allow for increased workload flexibility, just like traditional applications.

Vendor-Supplied Management

Many hyperconvergence solutions provide you with a whole new management interface for your virtual infrastructure. With most hyperconverged solutions running vSphere today, this idea of creating a whole new management tool for the virtual infrastructure disregards that fact that you already have one—VMware vCenter.

REST APIs

A Relative State Transition Application Programming Interface (REST API) provides you with the entry point required to integrate multiple management points and automate your data center.

You should ensure that the hyperconvergence solution you choose offers compatibility with the virtualization management, automation, orchestration, and API tools discussed here. Also, ensure that your hyperconvergence solution does whatever is possible to reduce the number of management points and tools that are required for administration and troubleshooting.

Decision 5: The Network

As was mentioned earlier in this book, the network has become a more important consideration than it was in the past. Today, your hyperconverged infrastructure platform choice needs to include an evaluation of what you need in terms of networking. If you're a smaller environment, a run-of-the-mill 10Gb Ethernet network may be just fine. But, as you scale, you need to seriously consider software-defined options, such as HPE Composable Fabric. See **Chapter 3** for more information about software-defined networking and how it intersects with hyperconvergence.

With virtualization forming the core for hyperconverged infrastructure solutions, the question naturally turns to one of hypervisor choice. If there's one thing IT administrators try to avoid, it's a lack of choice.

Hypervisor Support

By its very nature, hyperconverged infrastructure requires using some kind of hypervisor. The hypervisor has become the standard layer on which most new business applications are deployed. Although there are still services deployed on bare metal servers, they're becoming far less common as virtualization assimilates more and bigger workloads and as Kubernetes-powered containerized applications hit the scene.

Organizations demand choice, and this is also true when considering the server virtualization component of the data center.

Just keep in mind a few key facts when choosing hypervisor support:

- First, although variety in choice is highly desired, it's not always required for individual hyperconverged infrastructure solutions. There are options on the market today that each support vSphere, KVM, and Hyper-V. If you absolutely demand to be able to use a particular hypervisor, there is likely a solution waiting for you. However, not every hyperconvergence vendor supports every hypervisor.
- Second, for the hyperconverged infrastructure vendors that do support multiple hypervisors, the customer (that's you!) gets to decide which hypervisor to run on that platform.

In terms of popularity, it's pretty common knowledge that the most popular hypervisor on the market today is VMware's vSphere. With a formidable command of the hypervisor market, vSphere is offered as a primary hypervisor choice on a number of hyperconverged platforms.

Therefore, your decision concerning hypervisor support is really simple: For which hypervisor do you require support?

Up Next

Overall data center architecture includes a number of critical decision points, as described in this chapter. You were briefly introduced to one decision point: hardware acceleration. In the context of hyperconvergence, acceleration has to do with storage capacity and performance – efficiency. There is a third critical resource that was briefly mentioned in this chapter but that deserves more attention and, so, it gets a chapter all to itself. Chapter 3 delves deep into the world of software-defined networking.

CHAPTER 3

Exploring the Intersection of Software-Defined Networking and Hyperconverged Infrastructure

In considering the history of hyperconverged infrastructure, it becomes clear that the foundations of the technology focus squarely on the storage and compute portions of the data center triad, leaving the networking leg as nothing more than a supporting element. The result has been a series of hyperconverged infrastructure deployments that may operate atop networks that were never really designed with the unique needs of hyperconvergence in mind.

How Hyperconvergence Leverages the Network

Much more than other storage technologies, hyperconvergence relies on the network as a fundamental part of its capabilities. Consider this: in any storage system that uses multiple copies of data as a part of the overall data protection scheme, data has to be written to two or more locations. When the storage system is self-contained, as is the case with more traditional SAN and NAS devices, these write operations can take place, sometimes, within the confines of a single chassis or across a dedicated storage fabric.

In contrast, most hyperconverged infrastructure solutions rely on simple Ethernet as the glue that binds the nodes to one another. And, as a part of the data protection algorithm in these solutions, there has to be the ability for the cluster of nodes to withstand the loss of any one node. As such, with every write operation comes a need to write data to multiple nodes, each separated by an Ethernet link.

The Result of Network-Centric Data Protection

Early iterations of hyperconverged infrastructure didn't enable the kinds of scaling opportunities we see from modern products. They were local affairs, keeping traffic within the confines of a single rack, with no need for storage traffic to traverse top-of-rack switches to other racks. Of course, this was severely limiting; so, over time, hyperconvergence vendors worked hard to improve the scaling capabilities of their products.

Traditional networking topologies introduce some significant challenges in terms of hyperconvergence. To start with, distributed hyperconverged infrastructure storage systems are inherently latency-sensitive. This is especially true when considering intra-cluster metadata, - such as heartbeat and state change traffic. Anything that introduces additional latency impacts the overall performance and reliability of the entire system.

Why?

Let's take a step back and look at hyperconvergence from the 100,000-foot view. What is it, really? At its core, hyperconverged infrastructure features a software-defined storage element. Software-defined storage systems typically have the ability to be highly distributed, just like a lot of other kinds of workloads that exist in today's enterprise IT market. Think of file-systems such as Hadoop, vSAN or high-performance computing environments. All these designs rely on a software-defined data management layer and require infrastructures capable of supporting a lot of nodes, with minimal latency between them.

Latency Origination Points

Software defined storage is somewhat unique, though. There are several opportunities to introduce latency into a distributed storage service. There are three specific primary latency triggers that contribute to the total latency experienced by storage traffic in a distributed software-defined storage system.

The first contributor is network congestion. As more and more traffic traverses a given network link, the network experiences an increased level of congestion. At some point, this congestion slows down all network traffic and latency increases, which, for any storage traffic operating on that network, means that storage operations will suffer. Of course, this outcome isn't specific to storage alone, but high storage latency can quickly impact users.

Another type of latency that can impact distributed storage solutions is *hop latency*, which is the latency introduced during packet and traffic processing on networking devices. The more devices there are between nodes, increased hop latency may be experienced.

And, finally, we have the primary contributor to latency in a network-centric storage stack: the storage protocol stack itself. Whenever storage traffic has to be moved across a network, there are various points at which data has to be encapsulated on the sending host and then de-encapsulated on the receiving host. For IP-based Ethernet networks, storage traffic has to first be placed inside an IP packet, which is then itself encapsulated into an Ethernet frame.

A newer approach to moving large amount of data across Ethernet with low latency is RDMA over Converged Ethernet (RoCE) in which remote direct memory access (RDMA) over an Ethernet network is enabled. While emerging standards like RoCE promises to reduce server-to-server latency by streamlining the protocol stack, this approach is still in early stages of adoption.

TCP-offload engines have also attempted to accelerate the processing time in the host protocol stack. While such approaches help accelerate these processes, they add cost. In the end, host-to-host traffic still needs to undergo this transformation to be sent across the network. This adds latency to the overall storage equation.

Traditional Network Designs and Hyperconvergence

All networks have inherent scaling limitations. Both traditional three tier and leaf-and-spine networking topologies rely on one or more layers of routers to overcome this challenge. In addition, most traditional networks were designed primarily to deliver connectivity, not performance. To keep cost under control, cross-network bandwidth typically received minimal attention. As a result, these kinds of fabrics hit a wall at some point where lots of network lanes are reduced to just a few. This often happens where top-of-rack switches are uplinked to other switches. It is not uncommon to see whole racks of 30 to 40 servers sharing only a few uplinks to the data center fabric at large. Blocking ratio of 10:1 is all too common. Such designed-in bottlenecks hurts and effectively discourages rack-to-rack traffic. While it's possible to build non-blocking architectures, it gets expensive and can be complex.

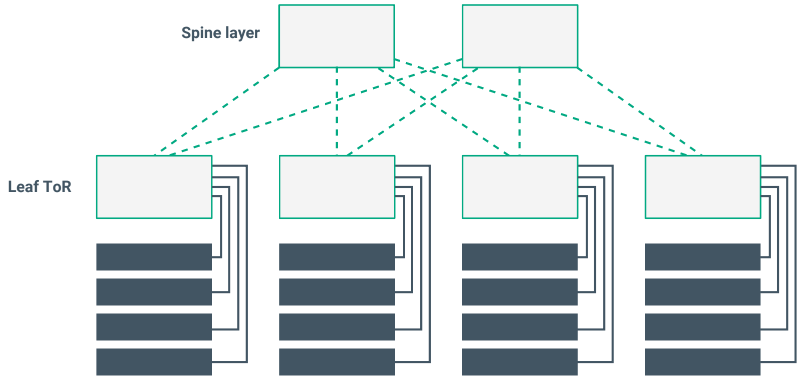


Figure 3-1: Traditional leaf-and-spine fabric

While these types of architectures and hyperconvergence aren't directly related, to the network, a hyperconvergence/software-defined storage system looks just like any other workload. At some point, an unsuitable network design will catch up to it and it will become a limiting factor in terms of continued expansion of the storage cluster.

In essence, hyperconverged solutions are exposing the data center network to new traffic patterns and cross-rack bandwidth demands which forces re-thinking of network design. In fact, many of today's workloads benefit from a new approach to the top-of-rack switches – where hyperconverged servers are connecting as part of an overall multi-rack system strategy. Ideally the top-of-rack switches would form their own intelligent cross-rack system backplane. There needs to be a new network strategy that works for all workloads, including these server-to-server workloads, a design that supports the overall fabric.

Enter Software-Defined Networking

Software-defined networking (SDN) isn't a new technology, but it is constantly and quickly evolving. And, based on some of the articles that have been written about it, you'd be forgiven if you were under the impression that this technology has magical properties that imbue your network with fairy dust!

What, exactly, is SDN? Like so many other technologies that used to rely solely on hardware, networking has made the jump into software. In essence, with an SDN infrastructure, what used to be fused control planes and data planes are torn asunder and kept separate.

With traditional networking devices, both the brains and the brawn exist on the same device. The brain is the control plane, while the brawn – the ability to process networking traffic and pass it along to the next device that the brain directs it to – is the data plane.

There are a couple of problems inherent in this structure:

- **Visibility.** The brains are limited in terms of insight. They can see only what's on their local device, and what certain protocols, such as spanning tree, provide to them. They don't have a comprehensive view of the network.

- **Coordination.** With so many brains across so many devices, there isn't a central authority. Sure, there are tools that can act as a central authority, but they're often bolt-ons that don't always enable a true real-time view of the network.

As more workloads, in terms of both quantity and diversity, hit the network, the rigidity of traditional networking structures has begun to show its weaknesses more clearly. As workloads continued to become more variable, it's clear that the network was having issues keeping up, even with the Herculean efforts of highly skilled administrators tending to it.

It's Not Just Software: It's a Reimagining of the Network

At this point, you might be thinking, "There is still just physical Ethernet under all of this. How does software-defined networking actually make things better?"

Don't fall into the trap of thinking that SDN is the beginning and the end of solving your networking challenges. In reality, the move to an SDN infrastructure should be seen as an opportunity to fundamentally transform how your infrastructure operates. And it's not just a matter of installing new code on a few switches: you'll need to rethink everything, from the cabling plant to the hardware.

The end result will be a fabric with an overarching view of the network and of the workloads operating on that network. The brains, formerly distributed to lots of switches with little external visibility, are now centralized, with a master view of everything. The brawn is still

Figure 3-2: SDN Meshed Topology

distributed. The centralized controller tells individual devices what should happen with traffic based on the brain's detailed understanding of what's happening across the network.

In essence, one of the things that SDN brings to the table is deep insight into the entire environment, allowing the automation of traffic decisions that takes everything into consideration. Better yet, this can happen more quickly than would be possible under the old model.

The traditional layered approach to networking results in bottlenecks that can be difficult to manage around. It's the network reimagined.

The Cabling Plant

Cabling is rarely seen as strategic. But, with the deployment of SDN, it's time for data center architects to rethink the role that cabling plays.

Let's start with the basics. Under traditional networking environments, top-of-rack switches were cabled to uplink switches. Every server in the rack connects to the top-of-rack switch, which then typically has just a few ports connected to the next-higher switch in the pyramid. This creates bottlenecks when a lot of traffic has to exit the rack.

SDN changes the game, as you'll learn shortly.

Scaling in the Software Defined Networking World

Traditional meshed topologies are not new. But they have historically been limited in scale. It is easy to see how: if, for example, a given top-of-rack switch has 8 fabric ports by which to connect out of the rack, a fully connected mesh will be limited to 8+1 switches. If we further set that each switch has 48 ports, the maximum fabric size possible with this particular switch is 9 X 48 = 432 network ports.

For smaller data centers, 400+ ports may be enough. However, for larger data center fabrics, we need to scale larger. Again, this is where a software driven approach to networking unlocks new capabilities. With a software-defined solution such as the HPE Composable Fabric, it's possible to build an *n* dimensional mesh that enables tremendous scalability. If we again use the 8-fabric port switch, we can now use the 8 ports to build a two-dimensional fabric. Here 4 ports are used in a horizontal dimension and 4 ports are used in a vertical dimension. Think of the network topology as a kind of chess board with 4+1 switches in each direction for a total of 25 switches and 25 X 48 = 1,200 ports. We now have retained to any-any properties of a meshed fabric yet crated a fabric that is 170% larger than before.

Continuing with the 8-fabric port example. The largest n-dimensional fabric with 8 fabric ports per switch is a fabric in 4 dimensions: 3 X 3 X 3 X 3 = 81 switches and 81 X 48 = 3,888 ports. 9 times larger than the traditional single dimensional mesh.

Even larger fabrics can be build using switches with more fabric ports. With the HPE Composable Fabric, data center network scalability is determined by:

a. The number of fabric ports on each switch, and

b. The number of meshed dimensions selected.

Meshes Lead to Messes? Not with Software-Defined Networking

Imagine, if you will, a traditional environment. What happens when you try to use multiple links? Either you use some protocol that enables link aggregation, or you run into a mess from spanning tree protocol. Remember: Spanning Tree Protocol was developed as a way to prevent network loops from bringing down entire swaths of infrastructure courtesy of the unregulated network broadcast traffic that is generated by such loops.

Simply put, routing method drives network layout (topology). While the Spanning Tree Protocol works well in hierarchical networks, it completely undermines fully meshed topologies. Yet, a meshed network is exactly what we want when traffic flows from machine to machine. That's where SDN comes in. With the right solution, a top-of-rack switch can be connected directly to other top-of-rack switches – forming a fully connected mesh, allowing everyone to talk to everyone at the same time. Furthermore, each-top-of-rack switch can now contribute part of its ports and bandwidth to the resilience and overall throughput of the network. If a given path is disconnected, there are many path alternatives to route around the failing link.

Once a mesh has been created, the next step is to bring it under the auspices of a controller that can manage and monitor potentially thousands of nodes simultaneously. This controller needs to have the brains to dynamically identify the kinds of workloads operating on that mesh, and to automatically reconfigure nodes to provide the best possible support for those workloads. This all has to be automatic and real-time. If a human has to get involved, it won't scale.

In terms of the network, the software-defined storage system is just another workload that operates on a cluster. The network controller needs to identify this workload so that it can automate configuration and segment traffic as needed.

Solving Latency

While SDN effectively pools the bandwidth available in each switch, the simple introduction of software doesn't eliminate latency. There will still be congestion latency. There will still be hop latency. There will still be latency imposed by the storage stack.

But let's put latency into some perspective in the context of HPE's Composable Fabric technology. Congestion latency points to some kind of a bandwidth constraint. With a full mesh, that shouldn't be a routine occurrence; since the fabric is controlling all switches as a single pool of resources. If the addition of new workloads creates a need for more bandwidth, you can add more switches to the mesh. The bandwidth of each additional switch adds to the total bandwidth budget of the overall fabric. Finally, if the node bandwidth is too low, you may elect to upgrade the speed of the top-of-rack switches. 25GbE is becoming more common on servers these days, with high-performance servers using 100GbE.

As with a traditional switch, there will still be some hop latency; the switches in an SDN scenario still need to process packets. But that processing time is minimal: with HPE's Composable Fabric, hop latency can be as low as 0.5 *micro*seconds.

And, SDN provides more pathways for your workloads, because as you add more ports to the mesh, you also add more potential pathways. Even if they have to traverse a bunch of switches, with each hop imposing additional latency of 0.5 microseconds per switch, it will take a lot of switches for hop latency to have a noticeable impact on total latency.

SDN and Hyperconverged Infrastructure

What does all of this SDN goodness have to do with hyperconverged infrastructure? First, as mentioned earlier in the chapter, keep in mind that hyperconvergence is *highly* network dependent since hyperconverged infrastructure workloads depends on unrestricted server-to-server data flows. A poor network infrastructure will have noticeably negative outcomes. A well-designed network will have good outcomes, but a well-designed software-defined network can deliver fantastic outcomes.

HPE Composable Fabric provides an architecture that's self-managing and can adapt as the underlying mix of workloads drives new demands. By watching the kinds of workloads that operate on the fabric and automatically tuning the network to prioritize, for example, latency sensitive workloads such as HPE SimpliVity cluster traffic, the network controller makes sure that the network is adjusted to support low latency and at the same time provide high bandwidth for high throughput workloads.

On the ongoing operational front, the intelligent networking fabric can also automate VLAN configuration after automatically identifying the workloads running on the network. This eases administration and ensures that human error is kept to a minimum.

The end result is a highly scalable environment that provides the performance necessary for even the most demanding workloads. Even as your workloads scale beyond the rack, a well-designed SDN underpinning will help ensure that your hyperconverged infrastructure traffic doesn't suffer due to legacy constraints.

Up Next

Software defined networking has emerged as a critical player in hyperconvergence, as described in this chapter. While SDN needs to be a more engrained component of the modern data center, compute and storage are still often top of mind. Chapter 4 goes into some details around how you can address key pain points in these realms.

CHAPTER 4

Addressing Data Center Pain Points

As much as IT pros hate to be told, "We have to do more with less," it's doubtful that this directive will die in the near future. The unfortunate truth is that IT has to continue to do more with either no increase or with decreases in overall resources. This comes at the same time that increasing attention is being paid to other technology-centric needs, including increasing security and undertaking digital transformation initiatives.

That means that organizations need to reconsider how they operate underlying infrastructure to make sure that it's cost effective and can allow staff time to work on these other needs. In this chapter, you'll learn about how hyperconverged infrastructure can be leveraged to help address these needs.

The Relationship Between Performance & VM Density

Return on investment. Total cost of ownership. These are phrases used to describe the economic impact of technology investments—or expenses—depending on your perspective. Regardless of the perspective, though, businesses want to squeeze as much return as possible out of their technology investments while spending as little as reasonably possible on those investments.

You might be wondering what this quick economic discussion has to do with workload performance in the data center. There's actually a direct link between these two topics and it revolves around overall VM density.

VM density refers to the number of VMs that you can cram onto a single host. The more VMs that you can fit onto a host, the fewer hosts you need to buy. Obviously, fewer hosts means having to spend less money on hardware, but the potential savings go far beyond that measure.

When you have fewer hosts, you also spend less on licensing. For example, you don't need to buy hypervisor licenses for hosts that don't exist!

The savings don't stop there. Fewer hosts means less electricity is needed to operate the data center environment. Fewer hosts means there's less cooling needed in the data center environment. Fewer hosts means that you free up rack space in the data center environment.

However, these benefits cannot come at the expense of workload performance. When workloads perform poorly, they actively cost the company money, such as lost efficiency and customer dissatisfaction.

How do you maximize VM density without impacting workload performance? First of all, it's a balance that you need to find, but when you're initially specifying hardware for a new environment, you won't necessarily know how your workloads will function in that new environment, so things can be tough to predict. Instead, you need to look at the inputs, or the resources atop which the new environment is built. Storage is one of these key resources.

Storage Performance in a Hyperconverged Infrastructure

In a hyperconverged infrastructure environment, one of the primary resources that must be considered is storage, and not just from a capacity perspective. Remember that storage and compute are combined in hyperconvergence, so that becomes a factor that's not present in more traditional environments. In a traditional environment, 100 percent of the available CPU and memory resources are dedicated to serving the needs of running VMs. In a hyperconverged infrastructure environment, some of those resources must be diverted to support the needs of the storage management function, usually in the form of a VSA. This is one of the core trade-offs to consider when adopting a hyperconverged infrastructure.

Data Deduplication Explained

Consider this scenario: Your organization is running a virtual desktop environment with hundreds of identical workstations all stored on an expensive storage array purchased specifically to support this initiative. That means you're running hundreds of copies of Windows, Office, ERP software, and any other tools that users require.

Let's say that each workstation image consumes 25GB of disk space. With just 200 such workstations, these images alone would consume 5TB of capacity.

With deduplication, you can store just one copy of these individual VMs and then allow the storage array to place pointers to the rest. Each time the deduplication engine comes across a piece of data that's already stored somewhere in the environment, rather than write that full copy of data all over again, the system instead saves a small pointer in the data copy's place, thus freeing up the blocks that would've otherwise been occupied.

In the figure "Deduplication vs. No Deduplication," the graphic on the left shows what happens without deduplication. The graphic on the right shows deduplication in action. In this example, there are four copies of the blue block and two copies of the green block stored on this array. Deduplication enables just one block to be written for each block, thus freeing up those other four blocks.

Now, let's expand this example to a real-world environment. Imagine the deduplication possibilities present in a VDI scenario: With hundreds of identical or close-to-identical desktop images, deduplication has the potential to significantly reduce the capacity needed to store all of those VMs.

Deduplication works by creating a data fingerprint for each object that's written to the storage array. As new data is written to the array, additional data copies beyond the first are saved as tiny pointers. If a completely new data item is written—one that the array hasn't seen before—the full copy of the data is stored.

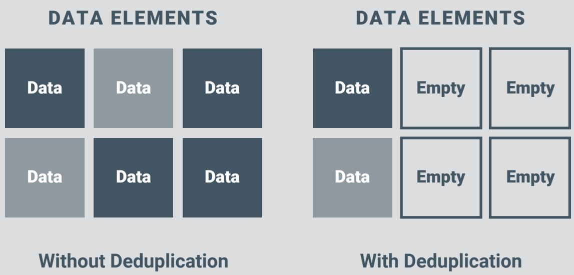
Different vendors handle deduplication in different ways. In fact, there are two primary deduplication techniques that deserve discussion: inline deduplication and post-process deduplication.

Inline Deduplication

Inline deduplication takes place at the moment in which data is written to the storage device. While the data is in transit, the deduplication engine fingerprints the data on the fly. As you might expect, this deduplication process does create some overhead.

First, the system has to constantly fingerprint incoming data and then quickly identify whether that new fingerprint already matches something in the system. If it does, a pointer to the existing fingerprint is written. If it does not, the block is saved as is. This process introduces the need to have processors that can keep up with what might be a tremendous workload. Further, there's the possibility that latency could be introduced into the storage I/O stream due to this process.

Deduplication vs. No Deduplication



A few years ago, this might have been a showstopper since some storage controllers may not have been able to keep up with the workload need. Today, though, processors have evolved far beyond what they were just a few years ago. These kinds of workloads don't have the same negative performance impact that they might've once had. In fact, inline deduplication is a cornerstone feature for most of the new storage devices released in the past few years and, while it may introduce some overhead, it often provides far more benefits than costs. With a hardware-accelerated or software-optimized hyperconverged infrastructure, inline deduplication is not only the norm, it's a key cornerstone for the value that's derived from the infrastructure.

Post-Process Deduplication

As mentioned, inline deduplication imposes the potential for some processing overhead and potential latency. The problem with some deduplication engines is that they have to run constantly, which means that the system needs to be adequately configured with constant deduplication in mind.

Making matters worse, it can be difficult to predict exactly how much processing power will be needed to achieve the deduplication goal. As such, it's not always possible to perfectly plan overhead requirements.

This is where post-process deduplication comes into play. Whereas inline deduplication processes deduplication entries as the data flows through the storage controllers, post-process deduplication happens on a regular schedule, perhaps overnight. With post-process deduplication, all data is written in its full form—copies and all—on that regular schedule. The system then fingerprints all new data and removes multiple copies, replacing them with pointers to the original copy of the data.

Post-process deduplication enables organizations to utilize this data reduction service without having to worry about the constant processing overhead involved with inline deduplication. This process can take a significant amount of time and overhead, especially if you have large amounts of data, which is why many organizations schedule dedupe (deduplication) to take place during off hours.

The biggest downside to post-process deduplication is the fact that all data is stored fully hydrated—a technical term that means that the data hasn't been deduplicated—and, as such, requires all of the space that non-deduplicated data needs. It's only after the scheduled process that the data is shrunk. For those using post-process dedupe, bear in mind that, at least temporarily, you'll need to plan on having extra capacity. There are a number of hyperconverged infrastructure systems that use post-process deduplication while others don't do deduplication at all. Lack of full inline deduplication increases costs and reduces efficiency.

Hardware Acceleration and Software Optimization to the Rescue

Hardware-accelerated and software-optimized hyperconverged infrastructure solutions completely solve the overhead challenges inherent in those systems. All deduplication tasks are delegated to the accelerator card or the software-defined accelerator, thereby negating the need for the system to consume processor resources that are also needed by the VMs.

Tiering and Deduplication

In order to match storage performance needs with storage solutions, many companies turn to what are known as tiered storage solutions. They run, for example, hard disk-based arrays for archival data and they run flash systems for performance needs and they manage these resources separately. This also means that deduplication is handled separately per tier. Each time dedupe is duplicated, there are additional CPU resources that must be brought to bear and there are multiple copies of deduplicated data. Neither is efficient. Hyperconverged systems that include comprehensive inline deduplication services carry with them incredibly efficient outcomes.

This is where hardware acceleration can be a boon when it's selected. Most hyperconverged infrastructure systems rely on the commodity hardware to carry out all functions. With a system that uses hardware acceleration, more Intel CPU horsepower can be directed at running VMs while the acceleration hardware handles processor-intensive data reduction operations, such as deduplication and compression.

Don't underestimate the benefits of data reduction! These services have far more impact on the environment than might be obvious at first glance and the benefits go far beyond simple capacity gains, although capacity efficiency is important.

There are several metrics that benefit when dedicated and specialized hardware is brought to bear.

Capacity

"Data Deduplication Explained" discusses generalized capacity benefits of deduplication, but let's now consider this in the world of hyperconverged infrastructure. In order to do this, you need to consider your organization's holistic data needs:

- **Primary storage.** This is the storage that's user- or application-facing. It's where your users store their stuff, where email servers store your messages, and where your ERP's database is housed. It's the lifeblood for your day-to-day business operations.

- **Backup.** An important pillar of the storage environment revolves around storage needs related to backup. As the primary storage environment grows, more storage has to be added to the backup environment, too.

- **Disaster recovery.** For companies that have disaster recovery systems in place in which data is replicated to secondary data centers, there's continued need to grow disaster recovery-focused storage systems.

When people think about storage, they often focus just on primary storage, especially as users and applications demand more capacity. But when you look at the storage environment from the top down, storage growth happens across all of these storage tiers, not just the primary storage environment. In fact, these secondary storage needs are growing faster than any other segment.

In other words, your capacity needs are growing far faster than it might appear. Hardware acceleration, when applied to all of the storage domains in aggregate, can have a tremendous impact on capacity. By treating all of these individual domains as one, and deduplicating across all of them, you can achieve pretty big capacity savings.

But deduplication, as mentioned before, can be CPU-intensive. By leveraging hardware acceleration, you can deduplicate all of this without taking CPU resources away from running workloads. By infusing the entire storage environment with global deduplication capabilities via hardware or software-optimized acceleration, you can get capacity benefits that were only the stuff of dreams just a few years ago. Hyperconvergence with great deduplication technology can attain great results while also simplifying the overall management needs in the data center.

IOPS

Imagine a world in which you don't actually have to write 75 percent of the data that's injected into a system. Very often, we see solutions screaming "one million IOPS!" when they should be screaming "we get stuff done!"

What does this mean? IOPS shouldn't be the sole direct measure of performance. More doesn't mean better. IOPS is a reflection of how hard your system is working. If you can make your system do more with less, then you don't need crazy IOPS metrics to begin with. You get the job done more efficiently, without impacting performance of your workloads/applications.

ACCELERATION USING THE CPU

Although the HPE SimpliVity hardware accelerator card is an engineering feat, there are software options that perform similar functions. The accelerator card does ensure that 100 percent of the available CPU is dedicated to VMs, but as you look at the market and see processors with dozens of cores, it's clear that some of those cores can easily be carved off to support data reduction needs. To this end, recent software-optimized HPE SimpliVity appliances instead leverage these modern processor behemoths in place of the hardware accelerator.

That world becomes possible when acceleration is used so that all workloads benefit from inline deduplication, not just some workloads.

The more that data can be deduplicated, the fewer write operations that have to take place. For example, a deduplication ratio of 5-to-1 means that there would only be one actual write-to-storage operation that takes place for every five attempted write operations.

Hardware and software-optimized acceleration allow this comprehensive data reduction process to take place in a way that doesn't divert workload CPU resources. As a result, you continue to enjoy the IOPS benefits without having to give up workload density.

Latency

Latency is the enemy of data center performance. By offloading intensive tasks to a custom-developed component that specifically handles these kinds of tasks, latency can be reduced to a point where it doesn't affect application performance.

Application Performance

At the end of the day, all that matters is application performance. That's the primary need in the data center environment and, while it can be difficult to measure, you'll know very quickly if you've failed to hit this metric. The phones will start to ring off the hook. Hardware and software-optimized acceleration help you to keep this metric in the green.

Linear Scalability

Businesses grow all the time. The data center has to grow along with it. Scaling "up" has been one of the primary accepted ways to grow, but it carries some risks. Remember, in the world of storage, scaling up occurs when you add additional capacity without also adding more CPU and networking capacity at the same time. The problem here is that

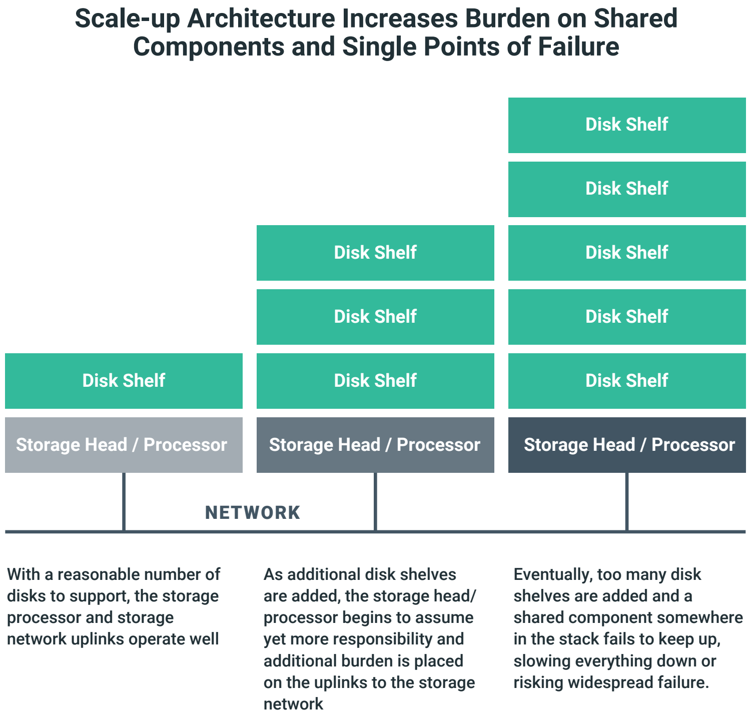


Figure 4-1: A scale-up environment relies on shared components.

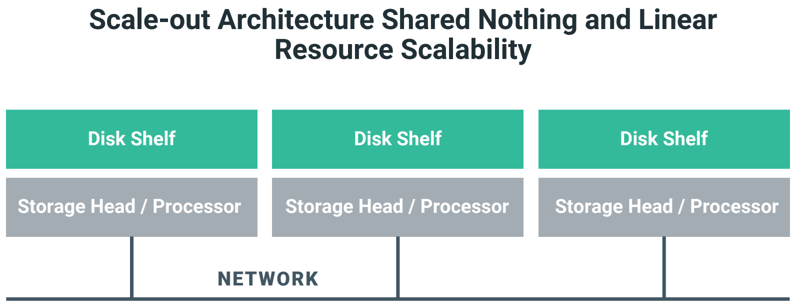


Figure 4-2: A scale out environment has nodes that can individually stand-alone

you run the risk of eventually overwhelming the shared resources that exist. **Figure 4-1** shows an example of a scale-up environment.

Scale-out has become a more popular option because it expands all resources at the same time. With hyperconverged infrastructure, the scaling method is referred to as linear scalability. Each node has all of the resources it needs—CPU, RAM, and storage—in order to stand alone. **Figure 4-2** gives you a look at this kind of scalability.

For solutions that use them, accelerators are a critical part of the scaling capabilities as they offload intensive functionality that can be workload-impacting. This increases density, but more importantly, by freeing up resources, it adds more predictability to the overall performance of applications, even while maintaining high levels of density.

Up Next

The items discussed in this chapter are critically important to ensuring that the data center adequately (maybe even excellently!) supports business needs, but these metrics are just the very tip of the iceberg.

Under the waterline are other requirements that can't be ignored. In the next chapter, we'll discuss one really important requirement that's often quite challenging: data protection.

CHAPTER 5

Ensuring Availability, Data Protection and Disaster Recovery

Even the smallest of small businesses today depend on their IT resources being available on a 24/7 basis. Even short periods of downtime can wreak havoc, impact the bottom line, and mean having to cancel going out to lunch. Maintaining an agreed-upon level of infrastructure availability is critically important. On top of that, outages or other events resulting in loss of data can be a death knell for the business. Many businesses that suffer major data loss fail to recover in the long-term and eventually make their way down the drain. Data protection is one of IT's core services. Unfortunately, it's also a hard service to provide at times, or at least, it was. There are now some hyperconverged infrastructure solutions that are uniquely positioned to solve, once and for all, the challenges across the entire data protection spectrum.

The Data Protection and Disaster Recovery Spectrum

Let's talk a bit about data protection as a whole. When you really look at it, data protection is a spectrum of features and services. If you assume that data protection means "ensuring that data is available when it's needed," the spectrum also includes high availability for individual workloads. **Figure 5-1** provides you with a look at this spectrum.

The Ins & Outs of Backup & Recovery

There are two primary metrics to consider when it comes to disaster recovery.

Recovery Point Objective (RPO)

If you're using a nightly backup system, you're implicitly adhering to a 24-hour RPO. You're basically saying that losing up to 24 hours worth of data is acceptable to the business. RPO is the metric that defines how much data your organization is willing to lose in the event of a failure that has the potential to result in data loss. To reduce RPO, you need to back data up more often.

Recovery Time Objective (RTO)

RPO is critically important as it defines just how much data you're willing to lose. Once you've suffered a data loss, the critical metric shifts. Now, you're more interested in how long it takes you to recover from that failure. How long is your organization willing to be without data while you work to recover it from backup systems? This metric is often used to support such statements as, "For every minute we're down, the company loses $X."

The RTO is the formal name for this metric and is one that companies will go to great lengths to minimize. As is the case with RPO, the closer to zero that you attempt to get to RTO—that is, the less time that you're willing to be down—the more it costs to support.

To achieve very low RTO values, companies will often implement multi-pronged solutions, such as disaster recovery sites, fault tolerant VMs, clustered systems, and more.

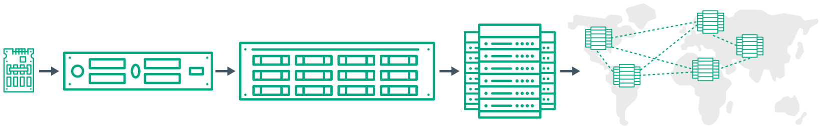


Figure 5-1: The Data Protection Spectrum

RAID

Yes, RAID is a part of your availability strategy, but it's also a big part of your data protection strategy. IT pros have been using RAID for decades. For the most part, it has proven to be very reliable and has enabled companies to deploy servers without much fear of negative consequences in the event of a hard drive or two failing. Over the years, companies have changed their default RAID levels as the business needs have changed, but the fact is that RAID remains a key component in even the most modern arrays.

The RAID level you choose is really important, but you *shouldn't have to worry about it!* The solution should do it for you. That said, don't forget that it's pretty well-known that today's really large storage devices have made traditional RAID systems really tough to support. When drives fail in a traditional RAID array, it can take hours or even days to fully rebuild that drive. Don't forget this as you read on; we'll be back to this shortly.

RAID is also leveraged in some hyperconverged infrastructure systems; however, with these systems, administrators are shielded from some of the complexity and configuration options that they used to work with on stand-alone storage arrays. Bear in mind that one of the tenets of hyperconverged infrastructure is simplicity. As such, you don't have to go through a lot of effort to manage RAID in a hyperconverged system. It's simply leveraged behind the scenes by the system itself. In **Figure 5-2**, you get a look at how RAID protects data.

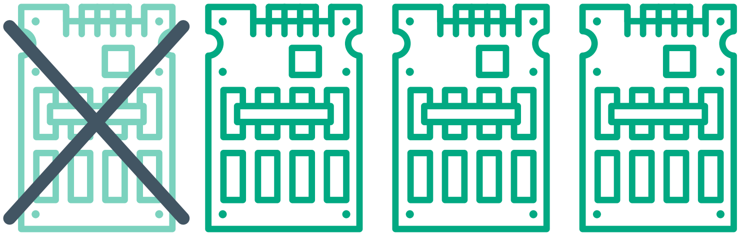


Figure 5-2: Key Takeaway: On the data protection spectrum, RAID helps you survive the loss of a drive or two

Replication/RAIN/Disaster Recovery

RAID means you can lose a drive and still continue to operate, but what happens if you happen to lose an entire node in a hyperconverged infrastructure cluster? That's where replication jumps in to save the day. Many hyperconverged infrastructure solutions on the market leverage replication as a method for ensuring ongoing availability and data protection in the event that something takes down a node, such as a hardware failure or an administrator accidentally pulling the wrong power cord.

This is possible because replication means "making multiple copies of data and storing them on different nodes in the cluster."

Therefore, if a node is wiped off the face of the earth, there are one or more copies of that data stored on other cluster nodes.

In some hyperconverged infrastructure solutions, like those shown in **Figure 5-3**, you can configure what's known as the replication factor (RF). The replication factor is just a fancy way of telling the system how many copies of your data you'd like to have. For example, if you specify a Replication Factor of 3 (RF3), there will be three copies of your data created and stored across disparate nodes. You'll sometimes see replication-based availability mechanisms referred to as RAIN, which stands for Redundant Arrays of Independent Nodes.

Two Kinds of Replication

There are two different kinds of replication to keep in mind. One is called local and the other is called remote. Local replication generally serves to maintain availability in the event of a hardware failure. Data is replicated to other nodes in the cluster in the same data center. Remote replication is leveraged in more robust disaster recovery scenarios and enables organizations to withstand the loss of an entire site.

Besides helping you to make sure that your services remain available, replication goes way beyond just allowing you to withstand the loss of a node, too. When replication is taken beyond the data center to other sites, you suddenly gain disaster recovery capability, too. In fact, in some hyperconverged systems that leverage inline deduplication across primary and secondary storage tiers, that's exactly what happens. After deduplication, data is replicated to other nodes and to other data centers, forming the basis for incredibly efficient availability and disaster recovery.

How About Both: RAID and RAIN Combined

Let's go a little deeper into the RAID/RAIN discussion with an eye on hyperconverged infrastructure solutions that provide both. First, there are some downsides to just RAIN-based replication (Replication Factor 2 or RF2). There are solutions on the market that provide RF2. Systems based on RF2 will lose data if any two nodes or disks in a cluster fail, or if even just one node should fail while any other node is down for maintenance.

To make things a bit more resilient, you could bump up to RF3, but this replication factor then requires a minimum of five nodes at each site

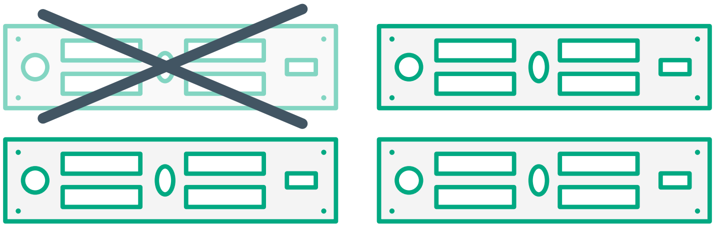


Figure 5-3: Lost a node? Can't find it? Don't worry! Replication will save the day!

that uses RF3 and imposes an additional 50 percent penalty on capacity. With RF3, you can also start to think about using erasure coding, but this requires RF3 and carries with it a lot of CPU overhead due to the way that erasure coding works. This may not be suitable when trying to support high-performance applications.

How about combining RAID and RAIN into a single solution? Maybe you combine the use of local RAID 6 on individual nodes so that any node can tolerate double disk failures and keep VMs up and running. With each individual node very well protected, the likelihood of losing an entire node is reduced. From there, you apply RAIN so that, in the event that a complete node is lost, you can tolerate that, too. The strategic combination of RAID and RAIN enables tolerance against a broad set of failure scenarios.

What Is Erasure Coding?

Erasure coding is usually specified in an N+M format: 10+6, a common choice, means that data and erasure codes are spread over 16 (N+M) drives, and that any 10 of those can recover data. That means any six drives can fail. If the drives are on different appliances, the protection includes appliance failures, so six appliance boxes could go down without stopping operations.

Courtesy: www.networkcomputing.com/storage/raid-vs-erasure-coding/a/d-id/1297229

Backup and Recovery

Despite your best efforts, there will probably come a day when you need to recover data lost from production. Data losses can happen for a variety of reasons:

- **Human error.** People make mistakes. Users accidentally delete files. Administrators accidently delete VMs. IT pros can sometimes accidentally pull the wrong disk from a storage system or unplug the wrong server's power cord.
- **Hardware failure.** When hardware fails, sometimes it fails spectacularly. In fact, hardware failure may not even be the result of failed IT hardware. You may end up in a situation, for example, in which the data center cooling systems fail and the server automatically shuts down as the temperature rises. This could be considered a server hardware failure because of the outcome (the server going down), when in fact the server is actually doing exactly what it's supposed to do in this case.
- **Disasters.** Hurricanes, tornados, floods, a new "Terminator" movie. Disasters come in all kinds of forms and can result in data loss.

Disaster Recovery

Disaster recovery takes backup one step further than the basics. Whereas backup and recovery are terms that generally refer to backing up data and, when something happens, recovering that data, disaster recovery instead focuses on recovery beyond just the data.

Disaster recovery demands that you think about the eventual needs by starting at the end and working backward. For example, if your data center is hit by an errant meteor (and assuming that this meteor hasn't also caused the extinction of the human race), recovering your data alone will be insufficient. You won't have anything onto which to recover your data if your data center is obliterated.

The HPE SimpliVity Story on Protecting Production Data and Availability

Being a hyperconvergence platform, HPE SimpliVity first provides the compute and storage infrastructure for customers' production applications. As data is ingested from the hypervisor, we stage the VM data into DRAM on the HPE SimpliVity Accelerator Card (or software-optimized accelerator) across two of our nodes within a single data center. With data now protected across multiple nodes, in addition to super-capacitor and flash storage protecting the DRAM on each HPE SimpliVity Accelerator Card, we acknowledge a successful write back to the VM and process the data for deduplication, compression and optimization to permanent storage on both nodes. Once this process is complete, every VM in an HPE SimpliVity data center can survive the loss of at least two disks in every node, in a data center, *and* the loss of a full hyperconverged node.

Before we get too fatalistic, let's understand what the word disaster really means in the context of the data center. It's actually kind of an unfortunate term since it immediately brings to mind extinction-level events, but this is not always the case for disaster recovery.

There are really two kinds of disasters on which you need to focus:

- **Micro-level disasters.** These are the kinds of events that are relatively common, such as losing a server or portion of a data center. In general, you can quickly recover in the same data center and keep on processing. Often, recovery from these kinds of disasters can be achieved through backup and recovery tools. With that said, these events will probably still result in downtime.

- **Macro-level disasters.** These are the kind of life-altering events that keep IT pros awake at night and include things like fires, acts of {insert deity here}, or rampaging hippos.

Recovery from these disasters will mean much more than just restoring data.

Thinking about the disaster recovery process with the end in mind requires that you think about what it would take to have everything back up and running—hardware, software, and data—before disaster strikes.

Yes, your existing backup and recovery tools probably play a big role in your disaster recovery plan, but that's only the very beginning of the process.

Disaster recovery plans also need to include, at a bare minimum:

- **Alternate physical locations.** If your primary site is gone, you need to have other locations at which your people can work.
- **Secondary data centers.** In these locations, or in the cloud, you need to have data centers that can handle the designated workloads from the original site. This includes a space for the hardware, the hardware itself, and all of the software necessary to run the workloads.

Business Continuity

Since disaster recovery is kind of a loaded term, a lot of people prefer to think about the disaster recovery process as "business continuity" instead. However, that's not all that accurate. Business continuity is about all the aspects to a business continuing after a disaster. For example, where are the tellers going to report after the fire? How are the phone lines going to be routed? Disaster recovery is an IT plan that's a part of business continuity.

- **Ongoing replication.** In some way, the data from your primary site needs to make its way to your secondary site. This is a process that needs to happen as often as possible in order to achieve desirable RTOs and RPOs. In an ideal world, you would have systems in place that can replicate data in minutes after it has been handled in the primary data center. The right hyperconverged infrastructure solution can help you achieve these time goals.

- **Post-disaster recovery processes.** Getting a VM back up and running is just the very first step in a disaster recovery process. RTO is a measure of more than just the restoration of the VM. From there, processes need to kick off that include all the steps required to get the application. and data available to the end user. These processes include IP address changes, DNS updates, re-establishment of communication paths between parts of an n-tier application stack and other non-infrastructure items.

HPE SimpliVity's Answer to Full-Spectrum Disaster Recovery

HPE SimpliVity alone makes it simple for you to achieve the first part of disaster recovery, which is making sure that VMs are always available, even if a data center is lost.

Along with their 1-click SimpliVity RapidDR solution, HPE has focused on providing integration into other tools that can help automate and orchestrate all of the remaining steps of the disaster recovery process, including pre-built packages of HPE SimpliVity functionality within VMware's vRealize Automation and Cisco's UCS Director, and supporting partners in the development of tools on top of HPE SimpliVity APIs like VM2020's EZ-DR.

The Data Virtualization Platform and Disaster Recovery

To protect data at specific instances of time, HPE designed backup and restoration operations directly into the DNA of the HPE SimpliVity Data Virtualization Platform, enabled by the ability to dedupe, compress, and optimize all the VM data. This results in backups and restores that can be taken in seconds, which can help reduce RPOs and RTOs, while consuming almost no IOPS off the HDDs.

When protecting data across datacenters, HPE SimpliVity maintains awareness of data deduplication across the different sites. If a VM is configured to backup to a remote data center, the receiving data center determines which unique blocks need to be transported across the WAN and the sending data center only sends those unique blocks. This drastically reduces the WAN bandwidth necessary between sites, increasing the frequency of backups to remote sites and eliminating IOPS by reducing the amount of data that needs to be read from and written to the HDDs.

Data Reduction in the World of Data Protection

We're going to be talking a lot about data reduction—deduplication and compression—in this book. They're a huge part of the hyperconverged infrastructure value proposition and, when done right, can help IT address problems far more comprehensively than when it's done piecemeal.

When it comes to data protection, data reduction can be really important, especially if that data reduction survives across different time periods—production, backup, and disaster recovery. If that data can stay reduced and deduplicated, some very cool possibilities emerge. The sidebar, "**The Data Virtualization Platform and Disaster Recovery**," highlights one such solution.

Fault Tolerance

Availability is very much a direct result of the kinds of fault tolerance features built into the infrastructure as a whole. Data center administrators have traditionally taken a lot of steps to achieve availability, with each step intended to reduce the risk of a fault in various areas of the infrastructure. These can include:

- **Using RAID.** As previously mentioned, RAID allows you to experience drive failures within a hyperconverged node and keep operating.
- **Redundant power supplies.** Extra power supplies are, indeed, a part of your availability strategy, because they allow you to experience a fault with your power system and still keep servers operating.
- **Multiple network adapters.** Even network devices can fail, and when they do, communications between servers and users and between servers and other servers can be lost. Unless you've deployed multiple switches into your environment and multiple network adapters into your servers, you can't survive a network fault. Network redundancy helps you make your environment resilient to network-related outages. A software-defined network with automation and workload intent-based principles provides even more protection, as the intelligence recognizes faults and automatically adjusts network paths.
- **Virtualization layer.** The virtualization layer includes its own fault-tolerance mechanisms, some of which are transparent, and others that require a quick reboot. For example, VMware's High Availability (HA) service continuously monitors all of your

vSphere hosts. If one fails, workloads are automatically restarted on another node. There is some downtime, but it's minimal. In addition to HA, VMware makes available a fault-tolerance feature. With FT, you actually run multiple VMs. One is the production system and the second is a live shadow VM that springs into action in the event that the production system becomes unavailable. However, with all that said, there are some limitations inherent in hypervisor-based fault tolerance technology, described in the sidebar, "Fault Tolerance Improvements in vSphere 6+." This is why some hyperconverged infrastructure vendors eschew hypervisor-based fault-tolerance mechanisms in favor of building their own solutions.

End Results: High Availability, Architectural Resiliency, Data Protection, and Disaster Recovery

No one wants downtime. It's expensive and stressful and can even be career-impacting. Most organizations would be thrilled if IT could *guarantee* that there would be no more downtime ever again. Of course, there's no way to absolutely guarantee that availability will always be 100 percent, but organizations do strive to hit 99 percent to 99.999 percent (and even higher) availability as much as possible.

Simplified Storage Systems

Bear in mind that RAID, and storage in general, becomes far simpler to manage in a hyperconverged infrastructure scenario. There's no more SAN and, in most cases, RAID configuration is an "under the hood" element that you don't need to worry about. This is one less component that you have to worry about in your data center.

High availability is really the result of a combination of capabilities in an environment. In order to enable a highly available application environment, you need to have individual nodes that can continue to work even if certain hardware components fail and you need to have a cluster that can continue to operate even if one of the member nodes bites it.

Hyperconverged infrastructure helps you to achieve your availability and data protection goals in a number of different ways. First, the linear scale-out nature of hyperconverged infrastructure (in other words, as you add nodes, you add all resources, including compute, storage, and RAM), means that you can withstand the loss of a node because data is replicated across multiple nodes with RAIN. Plus, for some hyperconverged solutions, internal use of RAID means that you can withstand the loss of a drive or two in a single node. With the combination of

Fault Tolerance Improvements in vSphere 6+

Frankly, vSphere Fault Tolerance used to be all but useless, except for the smallest VMs. Here's an excerpt from VMware's documentation explaining the limitations of vSphere Fault Tolerance: "Only VMs with a single vCPU are compatible with Fault Tolerance." This limitation was one of the many items that held back vSphere Fault Tolerance from being truly usable across the board.

vSphere 6 increased Fault Tolerance capabilities to VMs with up to four vCPUs. This is still a significant limitation when you consider that many VMs are deployed with eight vCPUs or more, particularly for large workloads. And, only machines with 64GB or less of RAM were supported by Fault Tolerance in vSphere 6.0 and 6.5.

Fortunately, VMware keeps moving ahead. vSphere 6.7 further increases the vCPU limit for Fault Tolerance to eight vCPUs and on the RAM front, VMs with up to 128GB of RAM are supported.

RAIN+RAID providing the most comprehensive disaster recovery capabilities, you can withstand the loss of an entire data center and keep on operating with little to no loss of data.

As you research hyperconverged infrastructure solutions, it's important to make sure that you ask a lot of questions about how vendors provide availability and data protection in their products. The answers to these questions will make or break your purchase.

Up Next

It's clear that data protection and high availability are key components in any data center today. The cloud has become another way that companies can improve their availability and data protection systems. Of course, cloud can do a lot more as well, which is why it's the topic of our next chapter.

CHAPTER 6

Hyperconverged Infrastructure in a Hybrid Cloud World

This chapter will help you understand the ways by which you can leverage cloud services as part of your hyperconverged infrastructure solutions. It will also help you better understand the private cloud and how that fits with hyperconvergence. Can a hyperconverged solution deliver some of the things that organizational leadership has come to expect from the cloud? Can public and private cloud deployments co-exist in harmony?

Why Is Cloud So Desirable?

You'll learn more about what defines cloud a little later in this chapter. Before getting into the various definitions, though, let's discuss the inherent cloud traits that make this destination a popular and desirable choice for service deployment.

The Economic Model

Everything in business eventually comes down to money. Decision makers are constantly on the lookout for ways to reduce costs while also boosting efficiency and outcomes. This is often a seemingly impossible task described as "doing more with less." IT was supposed to be an enabler, but for many companies, it has become a money pit—an expense center to be minimized. Obviously, when leveraged properly, IT can be an incredible enabling function, but even in these cases, no one wants to spend more than they have to.

When you buy your own data center hardware and software, you incur pretty significant capital costs. This initial cash outlay, necessary to procure a solution, can be pretty high and can result in the need to cut corners or even delay upgrades if there's not enough cash available or if management won't make sufficient cash available.

When you decide to start consuming resources from the public cloud, there's no initial cash outlay necessary. You don't incur capital expenses. Sure, you might have to pay a bit in the way of startup costs, but you don't have to buy hardware and software. You simply rent space on someone else's servers and storage.

Business decision makers *love* this shift. They don't need to worry about huge capital expenditures, and they know that they're paying for what they use. They're not paying for extra hardware that may never end up actually being leveraged to help solve business needs.

Scale

Your business isn't a static entity. It grows. It changes over time. At some point, that may mean needing to scale the data center environment. When you build your own data center, you have to do all the work yourself. Sometimes, you can scale in increments that make financial sense, while other times you have to add more than you might like due to predefined requirements from your vendors. It's an inexact science.

When you use the public cloud, you don't have to worry about inherent scaling limits or increments. Remember, you pay for what you use. As your usage grows, so does your bill, but you don't generally need to manually add new resources to your account. It can happen automatically.

Scalability granularity often isn't a problem with the public cloud, either. You grow as you need to in the increments that you need. There's no practical limit to how far you can grow as long as the cloud provider still has resources.

Geographic Diversity and Disaster Recovery

Building multiple data centers can be an expensive undertaking, but it's one that's often executed as companies seek ways to protect their data and ensure continuity of their business in the event of a disaster striking the primary data center. The separate data centers are generally geographically diverse so that a single natural disaster can't take out both sites at the same time.

Public cloud providers almost always have native systems that can quickly enable geographic diversity for applications that are already running on their systems. Enabling geographic diversity is often as simple as clicking a mouse button and, most likely, paying some additional money to the cloud provider.

The Public Cloud

The cloud is everywhere. For many, the term itself has become synonymous with "Internet" or is just another way to describe what used to be called "hosted services." However, there are a number of traits that make a public cloud a public cloud.

First, in general, public cloud systems are comprised of multi-tenant environments operated by a service provider with the hardware and software located in the provider's data center. As the saying goes, it's someone else's computer. In these environments, the customer may not always even be aware in which provider data center the services reside, nor does the customer have to be aware in some cases (although it's good practice to know where your data lives). The beauty of these systems is that workloads can move around as necessary to maintain SLAs.

Cloud service providers generally build their systems with the assumption that hardware will ultimately fail, which means the you, as the customer, can avoid the need to buy expensive failover and availability systems on your own since the provider's already doing it.

The Faces of the Public Cloud

Here's a brief look at the different kinds of public cloud services that are available on the market.

Software-as-a-Service (SaaS)

From a customer perspective, SaaS is the simplest kind of cloud service to consume as it's basically an application all wrapped up and ready to go. Common SaaS applications include Salesforce and Office 365.

With SaaS applications, the provider controls everything and provides to the customer an application layer interface that only controls very specific configuration items. Because all of the infrastructure and the fact that most of the software is hidden from the you as the customer, you don't need to worry about any underlying services except those that may extend the service, such as integrating Office 365 with your on-premises Active Directory environment.

Platform-as-a-Service (PaaS)

Sometimes, you don't need or want a complete application. In many cases, you just need a place to install your own applications but you don't want to have to worry at all about the underlying infrastructure or virtualization layers. This is where PaaS comes into play.

PaaS provides you with infrastructure and an application development platform that gives you the ability to automate and deploy applications including your own databases, tools, and services. As a customer, you simply manage the application and data layers.

Infrastructure-as-a-Service (IaaS)

In other cases, you need a bit more control, but you still may not want to have to directly manage the virtualization, storage, and networking layers. However, you need the ability to deploy your own operating systems inside vendor-provided VMs. Plus, you want to have the ability to manage operating systems, security, databases, and applications.

For some, IaaS makes the most sense since the provider offers the network, storage, compute resources, and virtualization technology while you manage everything else.

For scale, the cloud provider can provide grid-like scalability so that you don't need to worry about how to grow when the time comes.

For public cloud, there are a number of pros and cons to consider. On the plus side, cloud will:

- Enable immediate implementation
- Carry low to no initial deployment costs
- Provide a consumption-based utility cost model

However, there are definitely some downsides to cloud as well, which include:

- Provide more cost-effective scale than would be feasible in a private data center
- Potentially unpredictable ongoing usage charges
- Concerns around data location; many don't want data stored in U.S.-based data centers due to concerns around the NSA and PATRIOT Act and GDPR; this issue is now referred to as ensuring an understanding of *data sovereignty*
- Charges across every aspect of the environment, from data storage to data transfer and more
- No control over underlying infrastructure
- Care needs to be taken to avoid lock-in

On-Premises Reality

Even though public cloud has a number of desirable traits, there are some harsh realities with which CIOs and IT pros need to contend:

- **Security.** For some, particularly those in highly regulated or highly secure environments, the idea of moving to a multi-tenant public cloud is simply not feasible, although cloud providers have added, and continue to enhance, versions of their services to meet specific compliance requirements.
- **Bandwidth.** Many areas of the world remain underserved when it comes to bandwidth, and some companies can't get sufficient bandwidth or link redundancy with sufficiently low latency to make cloud a feasible option at scale.
- **Cost.** There may come a point at which cloud may become more expensive than simply building your own environment. This is an increasingly common scenario. For example, unused instances, reserved compute, and instances that are turned off all lead to unexpected costs and stranded capacity. A survey performed by RightScale estimates that *up to 35%* of public cloud spend is wasted due to these issues.
- **Comfort level to meet service levels.** Let's face it, in spite of everything that public cloud has to offer, it's hard to trust having all of your apps and data live offsite. Most IT organizations opt to keep some business-critical data on-premises to meet business service level agreements (SLAs).

These challenges are reasons that many organizations are turning to private cloud environments.

Private Clouds

The term private cloud is often, well, clouded in confusion as people try to apply the term to a broad swath of data center architectures. So, let's try to clear up some of the confusion.

First and foremost, a private cloud environment generally resides in a single tenant environment that is built out in an on-premises data center, but it can sometimes consist of a single tenant environment in a public data center. For the purposes of this chapter, we'll focus on the on-premises use case.

Private cloud environments are characterized by heavy virtualization, which fully abstracts the applications from underlying hardware components. Virtualization is absolutely key to these kinds of environments. Some companies go so far as to offer internal SLAs to internal clients in a cloud-like manner. The key phrase there is "internal clients"—that's the customer in a private cloud environment. For such environments, being able to provide service-level guarantees may mean that multiple geographically dispersed data centers need to be built in order to replicate this feature of public cloud providers.

Heavy use of virtualization coupled with comprehensive automation, orchestration, and intelligent reporting tools enables an additional benefit of private cloud: self-service. Moving to more of a self-service model has several benefits:

- Users get their needs serviced faster
- IT is forced to build or deploy automation tools to enable
- self-service functionality, thereby streamlining the administrative experience
- Reporting and analytics gives ability to charge-back and show-back usage as well as optimize the infrastructure with predictive analytics and monitoring to avoid stranded capacity.

As mentioned before, many companies want to keep their data center assets close at hand and in their full control, but they want to be able to gain some cloud-like attributes, hence the overall interest in private cloud. As is the case with public cloud, there are a number of pros and cons that need to be considered when building a private cloud.

In the pros column, private cloud:

- Provides an opportunity to shift workloads between servers to best manage spikes in utilization in a more automated fashion
- Enables the ability to deploy new workloads on a common infrastructure. Again, this comes courtesy of the virtualization layer
- Provides full control of the entire environment, from hardware to storage to software in a way that enables operational efficiency. In other words, routine tasks are automated and repeatable
- Allows customers to customize the environment since they own everything
- Provides additional levels of security and compliance due to the single tenant nature of the infrastructure. Private cloud-type environments are often the default due to security concerns

As with everything, not all is a perfect picture. Private clouds do have a number of drawbacks, including:

- Requiring customers to build, buy, and manage hardware. This is often something that many companies want to reduce or eliminate
- They don't always result in operational efficiency gains
- Not really providing what's considered a cloud-computing economic model. You still have to buy and maintain everything
- Potentially carrying very high acquisition costs

In short, private clouds are intended to have some of the architectural characteristics of public clouds while offering internal clients cloud-like economic outcomes when chargeback processes are implemented.

Even if the central IT department providing the service doesn't really use "the cloud," as internal clients are able to provision and consume resources on demand—at least to a reasonable point—there's the beginning of a private cloud taking shape.

Hybrid Cloud & Multi-Cloud

Increasingly, people are choosing both cloud options—public and private—to meet their needs and are even adopting multiple public cloud offerings. In these hybrid and multi-cloud scenarios, the company builds its own on-premises private cloud infrastructure to meet local application needs and also leverage one or more public clouds where reasonable and possible. In this way, the company gets to pick and choose which services run where and can also move between them at will.

The Intersection of Cloud and Hyperconverged Infrastructure

If you're wondering what all of this talk about cloud has to do with hyperconverged infrastructure, wonder no more! Depending on the hyperconverged infrastructure solution you're considering, there are varying degrees of association between the hyperconverged infrastructure product and both public and private clouds.

Economics

Everything you've read so far leads to money. The potential to completely transform the data center funding model is one of the key outcomes when you consider hyperconverged infrastructure. With easier administration comes lower staffing costs. With the use of commodity hardware comes lower acquisition costs. With the ability to scale linearly in bite-size chunks, companies can get the beginnings of a consumption-based data center equipment acquisition model that enables closer pay-as-you-go growth than traditional data center architectural models allow. As your environment needs to grow and as users demand new services, you can easily grow by adding new hyperconverged systems.

Scale

Agility implies some level of predictability in how workloads will function. Public cloud provides this capability. For those wishing to deploy a private cloud environment, these needs can be met by leveraging hyperconvergence's inherent ability to scale linearly. In other words, you scale all resources simultaneously, including compute, storage, and networking in small increments to large scale. In this way, you avoid potential resource constraint issues that can come from trying to manually adjust individual resources and you begin to achieve some of the economic benefits that have made public cloud a desirable option.

Scaling the data center shouldn't result in scaling the complexity. In order to attain the full breadth of economic benefits that go with cloud, you have to make sure that the environment is very easy to manage or, at the very least, that management is efficient. This means that you need to automate what can be automated and try to reduce the number of consoles that it takes to get things done.

With hyperconverged infrastructure, management efficiency—even at scale—is a core feature of the solution. You're able to manage all of the elements included in the product from a single console; to apply a breadth of consolidated policies to VMs; and leverage robust APIs for orchestration and automation.

Geographic Diversity and Disaster Recovery

Also on the economics front, the value of resiliency and disaster recovery cannot be overstated. One of the benefits of the cloud is the geographic diversity that can be achieved to protect against natural disasters. With a hyperconverged infrastructure solution that has resiliency and data replication as a part of the core offering, multisite redundancy capability is baked in as part of the solution.

For those that have opted to build hybrid clouds, some hyperconverged infrastructure solutions can leverage that public cloud deployment as a replication target. In other words, rather than going to the expense of building out a second physical site, the public cloud can be used to achieve data protection goals.

Hyperconvergence and the Private Cloud

Building a traditional private cloud can be hard work. It takes a lot of effort to get all of the pieces aligned. Hyperconverged infrastructure makes it possible to deploy private clouds in a fraction of the time it would normally take. Everything is built into the individual appliances, including centralized management, data efficiency, replication, and the ability to scale in incremental units. These are core needs in building an agile private cloud environment.

Up Next

You've now completed your introductory journey into the technical world of hyperconverged infrastructure. In the next section of this book, you'll learn about a number of ways that you can begin using this knowledge in order to solve some of your most challenging business problems.

SECTION 2

Use Cases

Virtual Desktop Infrastructure

For years, IT pros have been trying their best to improve what has become a chaotic desktop management environment and to reduce costs for providing desktop computers. One of the original use cases for hyperconverged infrastructure was virtual desktop infrastructure (VDI), a use case that's still strong today.

VDI is an interesting solution. Like many trends in IT, VDI has gone through the Gartner Inc. "Hype Cycle" (**Figure 7-1**). It went through both a period of sky-high expectations and also hit rock bottom as people became increasingly disillusioned with the technology. Today, however, it's reaching the topend of the Slope of Enlightenment and entering the Plateau of Productivity.

How did we get to where we are?

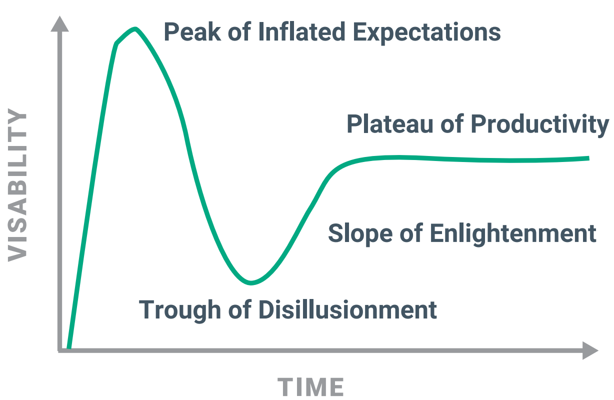


Figure 7-1: The Gartner Inc. Hype Cycle (courtesy of Wikipedia)

VDI Through the Years

Long before x86-based virtualization became the norm, IT departments searched for ways to simplify and streamline desktop computing. Microsoft and Citrix led the way in this space and, for a time, their products were ubiquitous. People deployed thin clients based on specialized editions of Windows Server and had an adequate experience. Unfortunately, their experience was one that was mostly useful where terminals, not full desktop capabilities, were needed. And, really, who wants an "adequate" experience when an awesome one is possible?

Then came along server virtualization. Server virtualization resulted in the ability to transform the business and IT—lowering costs while increasing productivity and efficiency along the way. With server virtualization, data center administrators could almost completely replicate their physical servers inside software with little to no loss of functionality.

At some point, someone somewhere had the bright idea to attempt to apply the same thinking to desktops in order to close the user-experience gap and make terminal-based desktops more like their PC brethren. Things didn't work out quite so well. IT pros quickly discovered that their path to VDI success would be littered with very different challenges than those faced on the road to server virtualization.

VDI Workload Differentiators

Although servers and desktops are both computers, how they're used is very different. These differences have driven many of the challenges that doomed early VDI projects. Just because virtual desktops look like virtual servers, it doesn't mean they act like them. Whereas server-based workloads will have their own performance peaks and valleys, they're nothing compared to what happens in the world of the virtual desktop.

Types of Virtual Desktops

There are two different kinds of virtual desktops that you can use in a VDI environment: persistent and non-persistent.

Persistent Desktops

Persistent desktops are the type that closely resemble desktop computers in the physical world. There is a 1-to-1 relationship between a virtual desktop and a user. In other words, a user has his or her own virtual desktop that no one else uses. This model is the most seamless from a user perspective since users have become used to having their own space. Persistent desktops require you to have sufficient storage for desktop customizations.

Non-Persistent Desktops

Think of a college computer lab: rows of computers available for any student, and students can go to different computers every day. The students really don't care which computer they use each day as long as one is available, and they don't need to maintain user-specific settings. This is known as a non-persistent desktop. User settings aren't maintained between sessions. Each time a user logs in, it's as if they have logged in for the first time.

Linear Usage Patterns

In VDI environments, usage patterns directly follow user actions. When users log in or boot their virtual desktops in the morning, each virtual desktop undergoes significant storage I/O operations. Contrast this to a traditional PC, where you've probably seen it take minutes for computers to fully boot and log in. This is because a lot of information has to be read from disk and placed into memory on a traditional PC. There are also copious write operations taking place, including writing all kinds of information to logs, including any exceptions that may take place at boot time.

Now, multiply all of this I/O by the number of users logging into their virtual desktops at the same time. In the world of the traditional desktop, each user has his or her own storage device (the local hard drive) to handle these I/O operations. In a VDI environment, the virtual desktops all share common storage systems, often a SAN or NAS device shared among the various hosts that house the virtual desktops. The amount of I/O that starts to hit storage can be in the hundreds, thousands, or even tens of thousands of IOPS. This can quickly overwhelm storage.

The Failure and Resurgence of Storage

This was the problem in the early days of VDI. Then-current disk-based storage systems simply could not keep up with demands and quickly succumbed under the IOPS-based assault that came their way. This catapulted VDI directly to the Gartner Hype Cycle's Trough of Disillusionment as people quickly discovered that there would be no return on their VDI investment because they had to buy shelves and shelves of disks to keep up with I/O demands. In technical terms, getting appropriate performance characteristics wasn't cheap at all.

Shortly thereafter, flash storage started its journey into the enterprise. With the ability to eat IOPS faster than anything previously on the market, flash has become a go-to technology for virtual desktops. For quite some time, flash carried its own baggage on the VDI journey. First, some of the flash-based solutions added complexity to storage, and second, all flash systems tended to be expensive, although, in recent years, the price of flash storage has plummeted as the technology gains traction and economies of scale come into play.

Second-Class Citizenship for Data Protection

Protecting VDI environments was also a challenge. The nature of VDI didn't always mean that it would enjoy the same kinds of data protection services as server workloads, even though desktop computing really is a critical service. Between WAN bandwidth and backup storage needs, fully protecting the desktop environment wasn't always feasible.

It's All About That Scale

Scaling VDI was, again, a far different chore than scaling server-centric workloads. Whereas server workloads were scaled based on individual resource need, VDI-based workloads scaled far more linearly, requiring RAM, compute, and storage to scale simultaneously.

The User Experience Trumps All

Finally, let's talk about the user experience. In a perfect VDI world, you have persistent virtual desktops in which users' settings and experience are maintained between sessions. This is the scenario that most closely mimics the real desktop experience, and people like it. With legacy infrastructure, getting the performance and capacity needed to support persistent desktops can be a real challenge.

Many gave up on VDI, thinking that they would never be able to enjoy their dreams of an efficient desktop environment. But then something interesting happened. Hyperconverged infrastructure hit the market.

Hyperconvergence and VDI Scaling and Performance

As mentioned earlier in this chapter, VDI became one of the original primary use cases for the introduction of hyperconverged infrastructure into a company. It's not hard to see where hyperconvergence solved just about all of the challenges—real and perceived—around VDI.

First, let's talk about the ability for hyperconverged infrastructure to scale. You learned earlier that hyperconvergence natively enables linear resource scalability, which is also necessary for VDI environments to be able to keep pace with growth. As you add virtual desktops, you need to assign both CPU cores and RAM to those systems along with sufficient storage for the operating system, applications, and user files.

Performance is one of the big challenges in VDI, particularly as it relates to storage. With today's hyperconverged infrastructure systems, you're likely getting an all-flash system, although there are products on the market that combine flash and spinning disk in a hybrid storage configuration.

Further, with hyperconverged systems that have deduplication and compression features at the storage layer, you get even more benefits. Virtual desktops are all very similar, so they're very easily reduced at the storage layer. With reduction, you're able to store more VMs on the storage that exists in your hyperconverged infrastructure, which saves you a lot on disk costs. Deduplication and compression are the key technologies that enable the use of persistent desktops in a VDI environment. Deduplication also massively reduced the I/O footprint for VDI systems. Being able to efficiently cache deduplicated desktop systems can virtually eliminate the various storms—boot storms and login storms—that can negatively impact performance otherwise.

Let's not forget about data protection and availability. In a traditional desktop environment, fully protecting workstations can be a tough task and, in the event that a workstation happens to fail, a user could be without a computer for an extended period of time. In a VDI environment, if a user's endpoint fails, it can be very quickly replaced with another endpoint—the user simply reestablishes a connection to the persistent desktop.

But data protection in VDI goes way beyond just making it easy to get users back up and running. In fact, it comes down to being able to fully recover the desktop computing environment just like any other mission-critical enterprise application. In a hyperconverged infrastructure environment with comprehensive data protection capabilities, even VDI-based desktop systems enjoy backup and replication for users' persistent desktops. In other words, even if you suffer a complete loss of your primary data center, your users can pick right up where they left off thanks to the fact that their desktops were replicated to a secondary site. Everything will be there—their customizations, email, and all of their documents.

Up Next

With easy scalability, excellent performance capabilities, and great data protection features, hyperconverged infrastructure has become a natural choice for VDI environments. Up next, let’s go a little deeper into how this architecture can help you address remote office and branch office scenarios.

CHAPTER 8

Supporting Edge Computing

The modern computing era has created a need for some new terminology. For example, in a previous iteration of this book, this chapter was titled "Remote Office & Branch Office (ROBO)" and this will still be the primary focus of this chapter. However, additional non-cloud and non-data center locales have forced the creation of a new term. That term, Edge Computing, typically encompasses ROBO environments, but can also include autonomous vehicles, cargo ships, and anywhere else that isn't the cloud or your centralized data center.

With the view of hyperconvergence that we're discussing, our primary focus for edge computing will be ROBO, and for good reason. ROBO IT demands can create some pretty tough situations for IT pros to conquer. Perhaps the most significant problem is one of scale. Many edge environments have the need to grow very large, but need to do so by remaining very small in each location. Consider a fictional company that has 500 locations. This is a big company, so the overall aggregate technology needs of the organization are significant. At the same time, though, each branch location in this company supports 20 employees and is also a sales outlet. The individual sizing needs of each branch are relatively modest.

Traditional ROBO Challenges

At first look, it might seem like a simple solution. Throw a couple of servers into each location and call it a day. Unfortunately, it's not that easy. There's a lot more to the scenario than meets the eye.

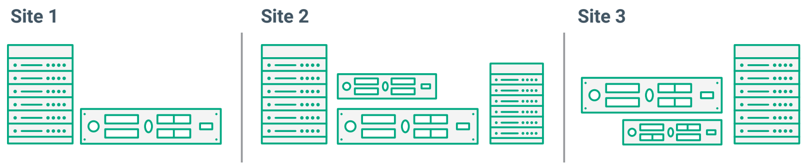


Figure 8-1: Chaos is the norm in many ROBO environments

First and foremost, just a couple of servers may not meet the needs of the branch office. Each branch is probably sized a little differently, so some may be able to operate with just a couple of servers while others may need more substantial capabilities. You'll probably want two or more servers just so you can have some level of availability. If one server fails, the other one can pick up the load. Getting high availability with just two servers, while solvable, isn't always straightforward.

At the same time, you have to keep an eye on performance to make sure that poorly performing local applications don't negatively impact the branch's business. You can't forget about data protection, either. If this was a single-site company, data protection would be relatively easy; you just back data up to a tape, disk, a second location, or the cloud. But if you have many sites and some have slow Internet links, it can be tough to protect data in a way that makes sense. You don't want to have local IT staff that needs to change tapes or watch backup appliances. You also don't want to have non-technical people trying to do this as a part of their jobs. It doesn't always work out well.

Plus, there's ongoing support. Stuff happens. You need to be able to keep every site operational. However, with each site you add, each with its own unique needs, the overall complexity level can become overwhelming. As complexity increases, efficiency decreases, and it becomes more difficult to correct problems that might occur. **Figure 8-1** provides a demonstrative overview of today's data center. In many ROBOs, centralized IT delivers services to the remote sites from a centralized location over a WAN. By centralizing IT, the company eliminates the cost of skilled IT staff on site at remote sites and reduces the risk to business continuity since IT handles data protection.

However, the major drawbacks are often poor application performance, scattered management, and difficulty correcting issues that arise in remote sites.

To summarize the challenges faced in ROBO environments:

- There's a need for a lot of decentralized systems to support individual branch offices and edge needs, and there's often lack of a cohesive management platform
- Bandwidth to edge locations can often be limited and may not be reliable. Most edge locations lack the full breadth of data center services (high-performance storage, WAN accelerators, and so on) enjoyed by headquarters and by single-site companies
- Data generated at edge locations needs first-class citizen protection, but often can't get it using legacy tools
- There is often a mashup of different hardware platforms at edge locations and, even in consistent environments, there may be more hardware than is necessary, just to maintain availability
- Hardware at edge locations might run the refresh-cycle gamut from aging devices to brand new components. Some sites have just a server or two where others have a full cluster with a SAN. It can be a logistical nightmare to maintain minimal hardware at such locations and somehow centrally manage solutions
- There's a lack of technical personnel at most edge locations and companies don't want to have to hire dedicated technical staff for each one

Without some kind of change, the dystopian future for the ROBO and edge locations will be so challenging that even Captain Marvel would call it quits and hang up her suit.

Transforming ROBO and Edge Operations with Hyperconverged Infrastructure

ROBO and edge operations are areas in which the right hyperconverged infrastructure solution has the potential to completely transform the environment and how those environments are managed. The overall results can be lower costs, improved efficiency, and better overall disaster recovery capabilities.

So what does it take to achieve this ROBO/edge utopia and how does hyperconverged infrastructure fit into the equation?

Keeping IT Simple

Hyperconverged infrastructure brings simplicity to chaotic IT organizations and nothing says "chaotic" like dozens of different sites running disparate hardware managed as individual entities. By moving to a common hyperconverged infrastructure platform, you instantly gain centralized administrative capabilities that encompass every site. Moreover, when it comes to hardware support, every site becomes a mirror of the others, thereby streamlining your support efforts. Such an architecture eliminates the need for dedicated technical staff at each branch.

The need to keep management simple cannot be overstated. Companies are no longer willing to scale IT staff at the same rate that they add sites and services, but they expect consistent performance. To solve this seeming paradox of intentions, IT has to look at the ROBO and edge situation much more discerningly and deploy solutions that overcome their unique challenges. They need to choose solutions that unify management across all ROBO and edge sites in a way that makes them appear as if they're a single entity even while they support a dispersed organization.

Less Hardware

Some sites need very little hardware while others need more. Some sites traditionally needed dedicated storage while others didn't.

It's chaos. With the right hyperconverged infrastructure solution, you can have sites that operate on just one or two appliance-based nodes without having to compromise on storage capacity and performance. You simply deploy the two nodes, and they form their own cluster that imbues the branch with highly efficient storage capabilities that include comprehensive data deduplication and reduction. For larger sites, you simply add more nodes. No SAN is needed and all of the hardware across all of the sites is common, easy-to-support, and provides enterprise-level capabilities, even in a single-node or two-node cluster.

The data reduction features available in some hyperconverged infrastructure solutions mean that you don't need to constantly add storage. With reduction, you get to cram more data into the same amount of overall capacity at the branch site. Reduction also has other benefits. Read on.

Comprehensive Data Protection

Data generated or managed at edge locations needs to be treated just like data generated at HQ. In many cases, the data originating from such locations is even more important because it's the information that's created as the result of sales, sensors, or other production efforts.

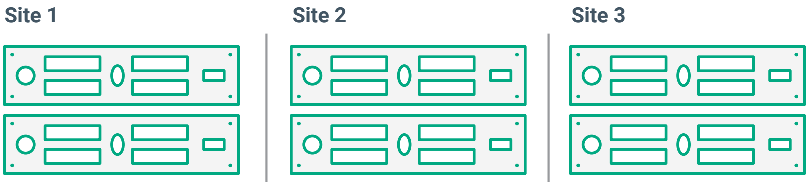


Figure 8-2: Hyperconverged infrastructure tames the ROBO chaos

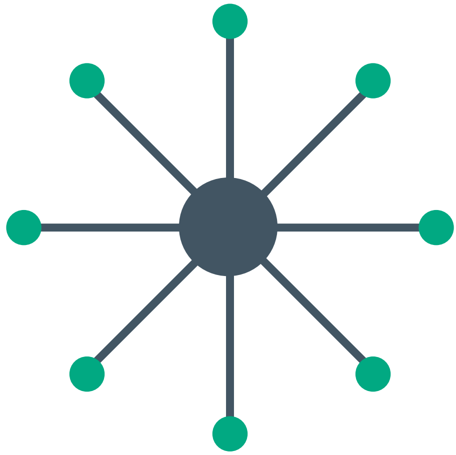


Figure 8-3: A look at a hub and spoke ROBO model

With a hyperconverged infrastructure solution that has the ability to fully compress and deduplicate data and that can work with data in its reduced form, you can get data protection capabilities that allow you to replicate edge-generated data to other edge sites or to HQ even over slow WAN connections. Better yet, you don't need WAN accelerators to accomplish this feat. With the right solution, reduced data is transferred over the wire and, even then, only the blocks that don't already exist at the target site are transferred, resulting in an incredibly efficient process. This kind of data protection infrastructure also eliminates the need for on-site staff to perform tasks such as changing tapes and increases the potential for successful recovery in the event of a disaster. In **Figure 8-2**, you see a nice, neat, and streamlined infrastructure.

Deployment Options

As you're deploying ROBO solutions using hyperconverged infrastructure, you need to take a look at how you want your ROBO sites configured. There are two typical models available:

- **Hub and spoke** (**Figure 8-3**). With this architecture, there's a centralized hub in the center and each remote site is at the end of a spoke. With this model, the various remote sites will generally talk to the hub spoke, but not often with each other. Backups and other data transfer operations will generally flow from the end of one of the spokes back to the hub.

- **Mesh** (**Figure 8-4**). In a mesh environment, all of the sites can talk directly to the other sites in the mesh. Under this model, it's possible to have individual sites back up to each other and the organization can, theoretically, operate without a centralized hub, although one of the nodes often acts in this capacity.

As you're deploying hyperconvergence throughout your organization, it's important to ensure that the intended solution can easily support whichever deployment model you use, even if it happens to be a combination of the two. Most importantly, regardless of which model you use, you should be able to centrally manage everything and have the ability to implement data protection in whatever way makes the most sense for you. Finally, adding new sites—scaling the environment—should be a basic feature of the solution and not a complicated afterthought.

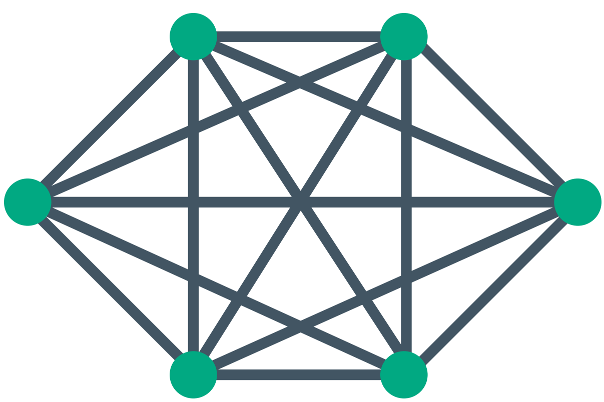


Figure 8-4: A look at a mesh-based ROBO model

Up Next

Edge environments can be considered as "applications" that require some specialized attention. This is a perfect use case for hyperconvergence. However, there are some actual applications that have special resource needs as well. In the next chapter, you'll learn about these applications and how hyperconvergence helps.

CHAPTER 9

Tier 1/Dedicated Application Support

Not every company needs to tear down their entire data center and replace everything with shiny new hyperconverged infrastructure appliances. The chances are pretty good that you can't really do that even if you wanted to. However, you may have a single application that's challenging you and needs to be tamed. Or, perhaps you have a new application that you need to deploy, and you can't deploy it on your existing data center infrastructure.

For you, hyperconverged infrastructure still might be just the answer. In fact, even if you have only a single application, you might still be able to leverage hyperconvergence.

Enterprise Application Needs & Challenges

Not all enterprise applications are created equal. Every application has a unique performance profile, and each requires a varying amount of resources to be dedicated to that application. In Chapter 7, you learned about the popular enterprise application VDI and discovered that it has very different resource needs than general server virtualization.

Many traditional data center architectures aren't equipped to handle applications that don't fit a mainstream operational envelope. That is, these traditional data centers are equipped to operate a broad swath of mainstream applications, but don't always have the capability to support applications with very unique resource needs. The kinds of applications that fit into this category will vary dramatically from company to company. For some, the entire centralized IT function consists of just a file server, so even something as common as an Exchange system would place undue stress on the traditional environment. For others, the traditional environment handily supports Exchange, but SQL Server or Splunk would be a step too far.

Every application has some kind of an I/O profile. This I/O profile dictates how the application will perform in various situations and under what kind of load. On top of that, every organization uses their systems a bit differently, so I/O profiles won't always match between organizations. As you deploy new applications, it might be time to leverage hyperconverged infrastructure.

A lot of people worry about virtualizing some of their resource-hungry applications for fear that they won't perform well. This is why, even to this day, many companies still deploy physical SQL Server, Exchange, and SharePoint clusters. While physical deployment isn't "wrong," the benefits of virtualization are well-known and include better overall hardware utilization and better data protection capabilities.

Hyperconvergence and Dedicated Applications

The right hyperconverged infrastructure solution can help you to virtualize even the largest of your Tier 1 mission-critical applications while also ensuring that you have sufficient resources to operate these workloads. Plus, don't forget the major role hardware acceleration plays in some hyperconverged systems.

Modern hyperconverged infrastructure solutions offload deduplication operations either to a dedicated accelerator card that sits right inside the server or to a powerful software stack that takes advantages of the fact that Intel keeps adding processing cores to its CPUs. Some of the cores are carved out to enable deduplication without imposing a significant performance impact.

Elements of the Microsoft stack, including SQL Server and SharePoint, can be safely virtualized and significantly accelerated by moving to hyperconvergence. The same holds true for Oracle. Other I/O-hungry applications are growing in popularity, too. Splunk and Hadoop are two emerging applications that carry with them pretty significant I/O requirements. Splunk is a logging tool that subjects to abusive write-intensive workloads, while Hadoop is a big data analytics tool that requires a whole lot of both read and write I/O capability. Both need a lot of storage capacity, too, which is where deduplication features come into play.

Even better, as you need to grow, you just grow. Scalability is a core part of the infrastructure. When you grow, you can add more storage capacity, more storage performance, more CPU, and more RAM as needed, so you don't need to worry about encountering a resource constraint somewhere along the line. That said, one common misperception about hyperconverged infrastructure is that you are absolutely required to scale all resources at exactly the same rate. This is simply not true. For example, with HPE SimpliVity, you can add compute-only nodes that don't have any storage. It's not a one-size-fits-all conversation. Even in these cases, scaling is simple.

Moreover, for whichever applications you choose to include in your hyperconverged infrastructure, depending on the hyperconverged infrastructure solution you select, you can gain comprehensive data protection capabilities that will help you more quickly recover in the event of a disaster or another incident. In addition, you can also inherit the ability to manage the hyperconverged environment from a single administrative console.

Finally, if you're thinking "private cloud" with regard to your data center, you have to virtualize your Tier 1 applications in order to bring them into the centralized, API-driven management fold. A private cloud is a VM-centric construct that requires high levels of virtualization to imbue the environment with the agility and flexibility needed to get things done.

Up Next

Just when you thought that you had everything solved by virtualizing and moving all of your Tier 1 applications to hyperconvergence, now comes along a directive to consolidate your disparate data centers.

That, dear reader, is the topic of Chapter 10.

CHAPTER 10

Data Center Consolidation

Mergers and acquisitions. Cost cutting. New business initiatives. "We're moving to the cloud!" There are all kinds of reasons why companies make the decision to consolidate data centers. Maybe your company undergoes explosive, barely controlled growth or they may decide to stop, take a pause, and reconsider how IT does business in their organization. Or maybe your company decides to buy out another company, and you suddenly inherit a whole series of data centers that you're not prepared to handle.

Want to know a secret? It will be up to you to figure it out. Furthermore, you'll probably be asked to do it with the same budget you already have.

Here's the thing, though. Data center consolidation isn't always just about reducing the number of data centers from a big number to a smaller number. Sometimes, it's about reducing the amount of stuff strewn about the data centers that you already have.

Today's IT organizations generally buy and integrate numerous point solutions from a plethora of vendors, each with its own training courses, licensing, refresh cycles, and mode of operation. These point products are the result of years of planning and investments to support business applications.

We hear the same story time and time again. Does this sound familiar? You virtualized a decade ago and naturally a data protection strategy project came directly after that. The SharePoint implementation project for your marketing organization took eons to complete and required purchasing a new SAN. It feels like you just bought that SAN yesterday, but you blinked, three years flew by, and it's time to refresh ... again.

The decision to buy all of these products made sense at the time, but today data center complexity can feel overwhelming and discourage innovation.

All of this has really cooked up several challenges for IT organizations, including:

- Time overhead spent on operational tasks
- Mobility and management of VMs
- Budget constraints
- Breaching service-level agreements (SLAs)
- Operational efficiency
- Application performance

The list goes on and on. Complexity is one of the biggest issues holding back IT, and the business, today. It's also a key inhibitor to your company's digital transformation efforts, which rely on a simple approach to technology.

Ask yourself these questions to determine where you might have pain points:

- As data growth explodes, can you continue to operate the same way you always have?
- Are your legacy technologies designed for virtualized environments?
- Are you spending more time on maintenance, upgrades, deployments, provisioning, and management tasks instead of building more valuable innovation for the business?
- Do you have the necessary expertise to manage each of these products separately?

- Are your applications and programs delayed by siloed teams and backlogged requests?
- Are you struggling to meet your SLAs with the business?
- Are you missing data protection objectives like RPOs and RTOs?
- Can you point directly to technical complexity as a major factor holding back your digital transformation needs?

Review your answers carefully. You may find that you're the perfect candidate for hyperconverged infrastructure.

Consolidation with Hyperconvergence

In every chapter of this book so far, you've learned about how hyperconverged infrastructure solutions can reduce the variety of hardware and software you have to manage in the data center. Every time you eliminate a class of hardware or software in your data centers, you're on your way to answering "Yes" to all of the questions outlined in the previous section.

That's the ideal scenario.

At the most basic level, hyperconverged infrastructure consolidates storage and compute, enabling you to eliminate the monolithic SAN environment. From there, some hyperconverged infrastructure vendors make things pretty interesting. For example, Nutanix and HPE both provide something in the way of data reduction via deduplication and compression. HPE SimpliVity, however, takes this to the extreme through the use of their accelerator components, which form the basis for what they call their HPE SimpliVity Data Virtualization Platform.

By enabling global inline deduplication and compression with a solution like HPE SimpliVity, you suddenly need less overall capacity, which means you need less overall hardware. With constant data reduction, you no longer need:

- WAN accelerators to reduce data over the wide area network because data stays reduced
- Separate backup software to protect the data in your environment
- Separate deduplication appliances
- Separate SD arrays

Instead, you can massively reduce the amount of hardware and software that you're operating, maintaining, getting trained on, and, maybe even struggling with. With less stuff to manage and worry about, you can better focus on the business and on improving SLAs, RTOs, and RPOs. You get to focus on the business rather than on the technology.

If you're in a situation in which you need to reduce the number of data centers you're managing, hyperconverged infrastructure can help you there, too. How? For the same reasons that we just discussed. Rather than just taking all of the hardware from the various sites and combining it all into one supersite, you can rethink the whole model. In addition to cutting down physical locations, you can also minimize complexity.

Up Next

Data center consolidation is important, but you still need a place to run applications and perform testing and development. Testing and development environments are often short-changed in the world of IT. In the next chapter, you'll learn why that's not a good situation. Plus, you'll learn how hyperconverged infrastructure can help you to improve your operations—from testing to production.

CHAPTER 11

Test & Development Environments

It's pretty clear that production environments enjoy premier status in most data centers. Production gets the fastest storage, the biggest servers, and all of the supporting services that make the application magic happen. Meanwhile, the poor test and development (test/dev) environment doesn't get all that much attention.

Let's take a look at what the test/dev environment supports. Test/dev consists of important activities, which include:

- Testing new application versions as they're released in order to determine potential impact on production
- Creating new custom software to serve the needs of the business
- Having a place to perform unit testing and load testing for new software being created by developers

In fact, in some organizations, even the developers' development machines are virtualized, and they work against virtualized instances of production software to ensure that their efforts will translate well into production.

The State of Test/Dev Environments

In many companies, test/dev environments are often given leftovers and hand-me-downs. For example, production servers that have been decommissioned might be moved to the test lab or to a development lab. These servers are configured just like they were three to five years ago when they were originally purchased, and they generally don't have warranty support. Further, they use hardware that's one or two generations removed from current products.

The same goes for your storage systems that support the test/dev environment. Storage might consist of the old SAN that was removed from production. Or it might include a cheap array of disks, which provides reasonable capacity but is lacking performance.

At first, this may seem like a reasonable thing to do. After all, test/dev is a lower priority than production, right? Well, there are a few reasons why test/dev is more important than you might think:

- **Time is money.** That's the old adage. By using older, slower equipment in test/dev, you waste staff time that could be better spent doing other things.
- **Development efficiency.** Your developers are likely among your higher-paid staff. The more you short-change their work environment, the slower they work and the less efficient they become. This leads to slower overall development time and increases time to market for new features, products, and services.
- **Work stoppage.** Not having a warranty equates to having non-existent or slow service, if and when equipment fails. Failure in test/dev means that a critical piece of your environment is no longer available.

The Impact on Production

In most organizations, it's good to make sure that the test/dev environment resembles the production environment, especially when it comes to developing software and pushing it from test/dev to production.

When there's massive variance between test/dev or when test/dev isn't sufficient, bad things can happen, including:

- **Perplexing performance.** An inability to truly determine how well an application will perform in production means that you can't quickly resolve performance-related problems. When hardware between production and test/dev isn't close, applications will probably run very differently. This means you can't easily predict how well applications will operate.

- **Elevated expenses.** Some say that having underpowered hardware in test/dev actually makes sense since it means that, if an application performs well there, it's guaranteed to work well in the more robust production environment. In essence, they're saying that overbuilding production makes sense. That means that you're buying resources you may not need.

- **Insidious inefficiency.** The fact is that having two complete sets of hardware doesn't always make sense, even when it's necessary.

- **Dubious data defense.** Many people don't do data protection in test/dev since it's not as critical as production. For those that do a lot of internal development, they often do take steps to protect code, but not always to the level that they do in production and they may leave test/dev more vulnerable than they would like.

Hyperconverged Infrastructure in Test/Dev Environments

Once again, the right hyperconverged infrastructure solution has the potential to address all of the challenges identified in the previous section. Further, with the right solution, you can also add test/dev capabilities to companies that may not have had it in the past.

There are a couple of ways you can stand up a test/dev environment using a hyperconverged infrastructure solution:

- Build a separate environment
- Add an additional node or two to production
- Use hyperconverged infrastructure for test/dev only

Each of these methods has its own benefits. Building a complete environment that mirrors production makes it possible to truly see how well applications will perform in the production environment and also provides plenty of capacity to allow development to take place.

Figure 11-1 gives you a look at how such an environment might be structured.

Further, this method makes it possible to use each hyperconverged environment as a replication target for the other. You can protect production by replicating it to test/dev and vice versa. When you stand up the environment like this, you can also take advantage of any global deduplication capabilities offered by your hyperconverged infrastructure platform.

This is a key factor in containing costs. In essence, you can deduplicate the entire environment and, since test/dev mimics production, the capacity savings can be huge.

If you don't need a complete replica of production, you can also opt to simply add an additional node to your existing production hyperconverged infrastructure environment. As is the case with building a completely separate test/dev environment, you'll still enjoy the incredible capacity savings that come with global deduplication. This benefit is

When There Is No Test/Dev

There are companies that don't have any test/dev environment. They don't have the budget, the personnel, or the space to stand up a complete test environment, so they operate by directly updating production before performing complete testing. This is a relatively high-risk activity that can be disastrous if a mistake is made. We recommend having at least some kind of testing capability to make sure that updates to production don't result in downtime.

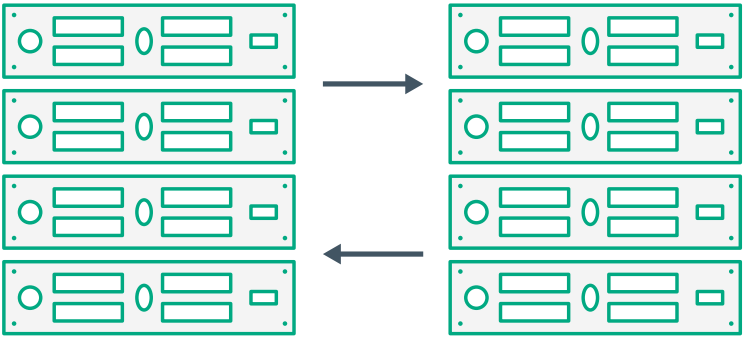


Figure 11-1: Building out two environments to support separate test/dev and production scenarios

also for the same reason—the test/dev workloads mimic production, so even though there are a lot of identical blocks floating around the workloads, each of those only has to be stored one time.

When it comes to disaster recovery, you have a few options as well. With a separate environment scenario, you already know that you can do disaster recovery between the two environments via replication.

With a hyperconverged infrastructure solution that deduplicates across the entire environment, you'll save a whole lot of storage capacity.

Also, if you choose to simply add nodes to production to handle test/dev needs, you can still replicate everything from production to a secondary site if you have one. Regardless, you'll still be able to

withstand the loss of a node in the cluster while maintaining operational production and test/dev capabilities.

There's also a third potential use case: using hyperconverged infrastructure for test/dev only. It's entirely possible that you already have a well-running production machine and you don't want to move it to hyperconverged infrastructure. There's no reason that you can't consider using the architecture for test/dev only. This will ease the administrative burden in test/dev and avoid the need to get too deep into the technical weeds for that environment. Things will just work. You won't need to buy a separate SAN and you'll get great performance for this critical infrastructure arena. Further, since you'll probably have a lot of different copies of the similar VMs in test/dev, you'll be able to get great benefit from any data reduction services that may exist in the hyperconverged infrastructure solution.

With hyperconverged infrastructure, you won't have to maintain the IT skills around the dev/test SAN and other needs and will be able to focus the development budget on application development. There are also some other benefits that can be had by using hyperconverged infrastructure in test/dev:

- Allows you to keep pace with business needs by quickly turning around incremental tasks in a production-like environment
- Ability to clone production environments and integration environments in minutes
- Having a well-defined process that includes ways to push changes to production, including creating backup of the original environment to have ability to roll back
- Developers and businesses would like to adopt a SaaS model for test/dev and are looking for cloud-like elasticity and ease of getting environments established

Up Next

It's clear that test and development environments can be significant assets, but they're only useful if they're leveraged in a way that supports the needs of the business. In the next chapter, we'll talk about what happens when IT goes rogue ... or at least appears to do so. Alignment between IT and the business is the topic of Chapter 12

CHAPTER 12

Aligning Architecture & Priorities

Perhaps one of the most enduring meta-conversations about IT in past decades has been focused on how well IT serves the needs of the business. Often referred to as "IT/business alignment" this conversation generally used to indicate when IT failed to meet the needs of the business. In a perfect world, there wouldn't have to be this conversation because IT would never be considered as off-track or "rogue." Unfortunately, that isn't reality. IT often struggles to maintain a focus on the business, a problem often exacerbated by the infrastructure solutions that have been adopted.

In fact, this whole idea of alignment is one that hyperconverged infrastructure has the potential to address head-on. No, it won't fix every alignment problem in every organization, but it can begin the process.

The State of Hyperconverged Infrastructure

In various research efforts undertaken by ActualTech Media, we uncovered a pretty significant misalignment between IT priorities and the potential hyperconverged infrastructure benefits.

Data centers are among the costliest physical assets owned and operated by organizations. The cost isn't just in the equipment that's deployed, but also in the sheer effort that it takes to manage that equipment, keep it running, and keep it maintained year after year. To make matters worse, many companies have deployed Band-Aid-like

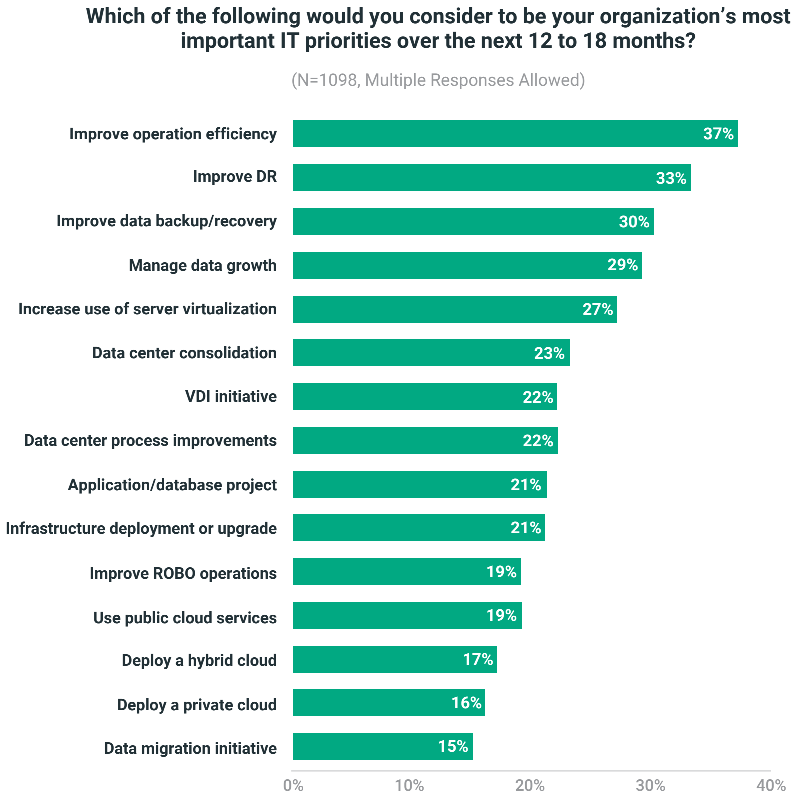


Figure 12-1: Primary drivers for interest in hyperconverged infrastructure

solutions to patch over problems introduced as the data center grows more complex or is challenged to meet emerging business needs.

Let's start with the items considered priorities by respondents. In **Figure 12-1**, you'll see that improving data protection, improving operational efficiency, and implementing VDI are the top-three items on respondents' radars. Remember, these responses don't consider the role of hyperconverged infrastructure; these are simply overall IT priorities.

Now, let's look at respondents' primary driver for considering hyperconverged infrastructure, the results of which are shown in **Figure 12-2**. See if you can tell exactly where the results of each question diverge from one another. Notice anything interesting?

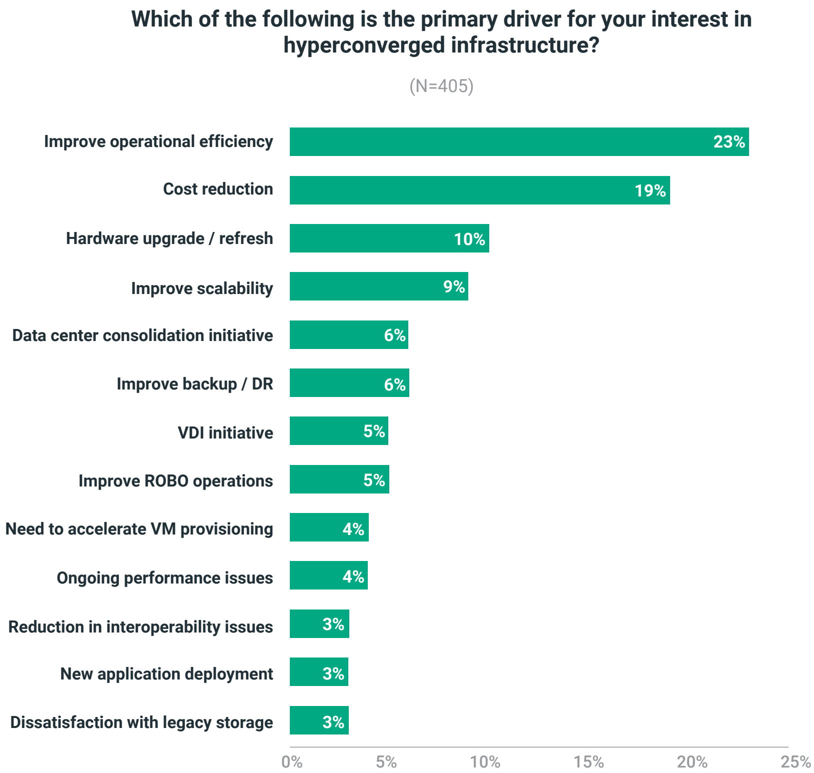


Figure 12-2: Primary driver for interest in hyperconverged infrastructure

Improving operational efficiency is near the top of both lists, as we'll discuss later in this chapter. What's a bit more interesting is where we see divergence, particularly as it pertains to data protection. There's a vast gulf between the importance of data protection on the overall IT priorities list and what people look for in hyperconverged infrastructure.

Data Protection

Improving data backup and disaster recovery emerged as the single most important overall need for the IT organization from this research. In comparing key drivers for hyperconverged infrastructure against larger IT initiatives, it was surprising to see that data protection ranked seventh on the list despite the fact that it was identified as the highest

From work performed by IDC, it's clear that data protection continues to rise in importance. Learn more about this, including why IDC finds traditional backup/recovery software to be insufficient for today's workloads, by reviewing the paper that HPE has made available on the topic: https://www.hpe.com/us/en/resources/integrated-systems/hyperconverged-data-protection.html.

IT priority to address. This may be due to the fact that enterprises aren't equating modernizing the architecture with hyperconverged infrastructure with modernizing data protection; they continue to view hyperconverged solutions as simple conglomerations of servers and storage. Because, to many people, "hyperconverged" simply means exactly that, it may not be so far-fetched that they don't consider data protection a key part of the hyperconverged package. Many hyperconverged infrastructure solutions include backup, recovery, disaster recovery, and business continuity capabilities.

This book devotes an entire chapter to this topic, so we won't reiterate all of that here, except to say that those who have significant backup, recovery, and disaster-recovery needs would do well to carefully study the hyperconverged infrastructure market and understand what's possible in this realm. With the right solution, there are some impressive data protection capabilities available.

Operational Efficiency

The VM is the center of the universe when it comes to applications in most modern data centers. Most new workloads are deployed in VMs. However, consider the state of centralized policy in the data center. For data centers that have equipment from a wide variety of vendors, or that have a lot of "point solutions" (such as WAN accelerators and replication tools), there could be a number of touch points when it comes to policies.

These various touch points don't always align very well with one another, particularly when there are different vendors in the mix. For example, while it may be possible to define some policies at the hypervisor layer, it's often difficult to apply storage policies that have any awareness of VM boundaries. There are myriad other devices in the data center that can suffer from the same problem.

Since the VM is the center of the data center universe, why not implement a system that focuses directly on these constructs? Hyperconverged infrastructure solutions provide this opportunity to varying degrees, depending on the vendor. Rather than go to three different places to define storage, backup, and replication policies, some hyperconverged infrastructure systems enable these policies to be attached to the VM.

Policy application is just one aspect of operational efficiency. There are many more, including:

- **Shielding complexity from the administrator.** Even IT pros shouldn't be subjected to complexity in the infrastructure when it can be avoided. Hyperconverged infrastructure helps make this happen. Availability mechanisms, such as RAID configurations and management, are often hidden from view and are simply a part of the environment. Software-defined networking takes this infrastructure simplification one step further, further automating and masking complexity from the VM admin with intuitive management GUIs.

- **Use-case improvements.** Ensuring that new applications and use cases, such as edge and VDI deployments, can be supported without adding complexity and introducing inefficiency into operations, is critically important to help IT maintain alignment with business needs. When deploying these kinds of applications introduces inefficiency, IT and business alignment will suffer.

- **Overall alignment enhancement.** As has been mentioned, efficiency and simplicity can help IT better achieve alignment with the business.

You’ll have noticed that cost reduction is also very high on the list for survey respondents. We believe that cost reduction and operational efficiency go hand in hand with one another for many people. However, we also understand that hyperconvergence has the potential to dramatically improve how the IT budget is constructed. You’ll learn much more about the economics behind hyperconvergence in **Chapter 14**.

Up Next

Alignment is about more than just technology. It’s also about people and hyperconvergence can—and will—have some impact on you. Don’t let hyperconvergence worry you with regard to what it means for your job. In the next chapter, we’ll tackle that issue.

SECTION 3

Organizational Considerations

CHAPTER 13

The New Role of the IT Pro in a Simplified Data Center

Every technology paradigm shift is fraught with anxiety as each one introduces uncertainty into what people want to be a stable equation. Hyperconverged infrastructure brings to the market a solution that is truly revolutionary. With such change comes concern around what this means for careers.

Simply put, hyperconvergence is a career opportunity for IT pros, even for those with specialized storage knowledge. While the change may give some the jitters, you should look at these feelings as growing pains. For admins looking to broaden their skills, there's big opportunity for job growth when you embrace new technologies.

But that doesn't mean modernization is *always* desirable. There can be perfectly valid reasons to delay adoption of new technologies.

In research conducted by ActualTech Media, IT pros identified a number of reasons why they're reluctant to move forward with hyperconverged infrastructure initiatives (**Figure 13-1**). In spite of the benefits it can bring, not everyone is enamored with the potential for hyperconverged infrastructure, for reasons that range from cost to resiliency concerns about this "new" architecture.

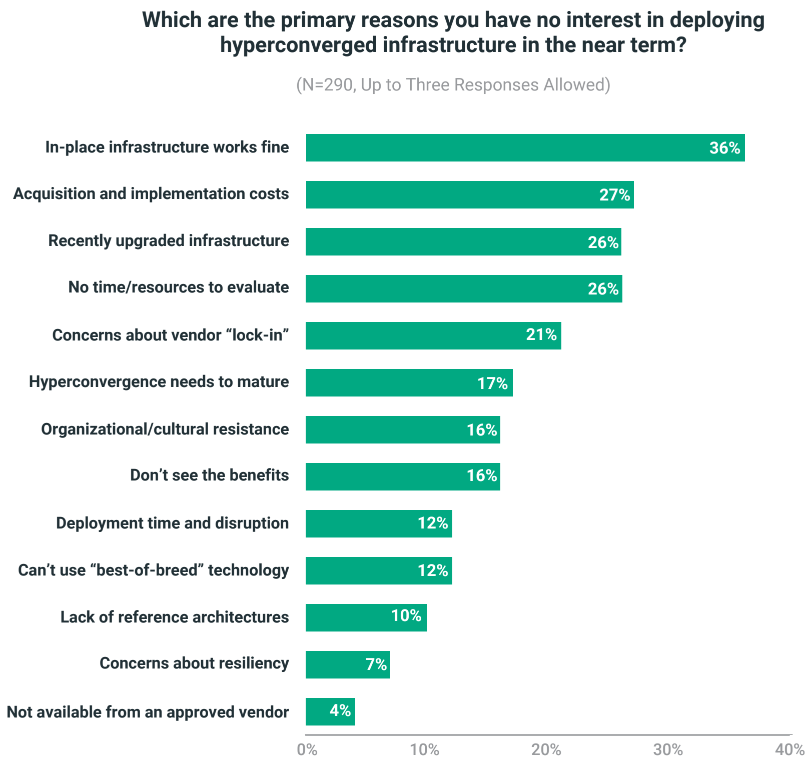


Figure 13-1: Primary reasons for not deploying hyperconverged infrastructure

However, the top reasons why people aren't yet looking at the technology have nothing to do with the technology itself, but rather have to do with the business cycle:

- **Current solution works just fine.** The adage, "If it's not broke, why fix it?" holds true for many. However, that won't always be the case. Business priorities change on a dime, and understanding the significant benefits that may come from modernizing the data center with hyperconverged infrastructure solutions will be useful for the future.
- **Recently upgraded infrastructure.** This is a valid reason for businesses that have upgraded the entire infrastructure in the past 6 months. For everyone else, it should be a minor consideration.

Infrastructure components are constantly being refreshed - that's a fact of business. Most hyperconverged infrastructure solutions do not require forklift upgrades. Different solutions offer varying degrees of integration opportunities but most can integrate into the existing environment at some level. In fact, the technology is designed for modular growth.

- **No current IT or business need.** Some people truly have no present infrastructure needs and are focusing their efforts in other areas. These folks can be considered as part of the "current solution works just fine" category. If your IT organization falls into this category, you might want to start looking for opportunities to introduce hyperconvergence at some point, to ease your infrastructure into the future. If new applications are being deployed or there's a specific use case (such as VDI or edge), there may be an opportunity to introduce hyperconverged infrastructure into the environment. Many businesses start with a pilot program and expand it from there.

In this chapter, we're going to tackle some of the more serious issues that people have brought up with regard to hyperconvergence.

The IT Staffing Challenge

It should not come as a surprise that most companies want to limit the number of IT staff that they hire, at least in certain areas. Infrastructure is almost always one of those areas, because it's directly associated with the expense side of the ledger.

As a result, many companies aren't willing to scale their infrastructure staff at the same rate that they scale the infrastructure itself.

At that point, the IT staff is forced to take on more and more responsibility while working with dwindling resources. This is the very definition of that loathed phrase, "Doing more with less."

This situation is one of the very reasons why people consider hyperconverged infrastructure. By massively reducing the variety of hardware and software that needs to be managed and maintained, the same number of IT pros can manage an increasing number of appliances while providing all of the necessary services.

Hyperconverged Infrastructure and Your Job

Job security is a huge concern for many IT pros, particularly storage experts. While server, storage and networking specialists all need to familiarize themselves with hyperconverged infrastructure when it's introduced, storage pros may feel more threatened, especially if their current job involves spending a whole lot of time on relatively mundane tasks.

New, simple, more efficient systems may appear threatening, but there are different ways to think about this. The IT organization's goal is to ensure that services are still provided, and while the environment is changing, it rarely changes overnight. Transforming from legacy infrastructure to hyperconvergence may at first mean a single hyperconverged cluster is deployed, instead of a new SAN.

The evolution of the infrastructure is an opportunity for the storage team to take the lead in choosing the right hyperconverged infrastructure solution—one that has the storage characteristics the organization needs. From there, if you're a storage pro, it will mean expanding beyond the storage realm into the world of servers and the hypervisor.

It's not just storage people that need to adapt, though. We are headed toward a world of IT versatilists, where you are the "director" of your world, and software and hardware handle the tedious, complex, repetitive tasks behind the scenes. Where an IT admin used to focus on servers or storage, now you'll be able to broaden your skillset and help with networking, too, and get a better grasp on software-defined services and systems. IT admins who are more efficient (thanks to new efficient systems) can work on less mindless tasks and participate in more innovative projects that can contribute to the bottom line.

Solution Maturity

There's no question that we are headed into a more software-defined future. The overall packaging of hyperconverged infrastructure—that is, packing everything into appliances and stacking them together—isn't revolutionary, but the software that makes it all work truly is. Be an agent for change.

There's a simple way to ensure that your intended solution can meet your needs: Test the heck out of it.

Every hyperconverged infrastructure vendor on the planet will allow you to do proof-of-concept testing of their solution.

Your job is very clear. Test it. Put it through its paces and decide for yourself if the solution will meet your needs. Use real-world tests, not synthetic benchmarking tools to perform testing. After all, you won't be running synthetic tests in production; you'll be running real applications.

Eliminating the Modern Refresh Cycle

The data center refresh cycle is out of control and is way too tied to capital budget dollars. Many organizations tackle individual resources separately. For example, they replace storage in Year 1 and then every four years thereafter. They replace a few servers each year. They replace supporting equipment, such as WAN accelerators and SSD caches, every three years. This mish-mash of replacement cycles creates confusion and doesn't always result in an equal distribution of budget dollars.

What if you could implement a real rolling refresh process and simply add new appliances as new business needs dictate? And, as a reasonable replacement cycle emerges, you simply remove an appliance a year and cycle in a new one. **Figure 13-2** gives you a look at once such scenario.

The figure also demonstrates how you scale this environment. As you need to add new appliances, you just add new appliances. As shown in

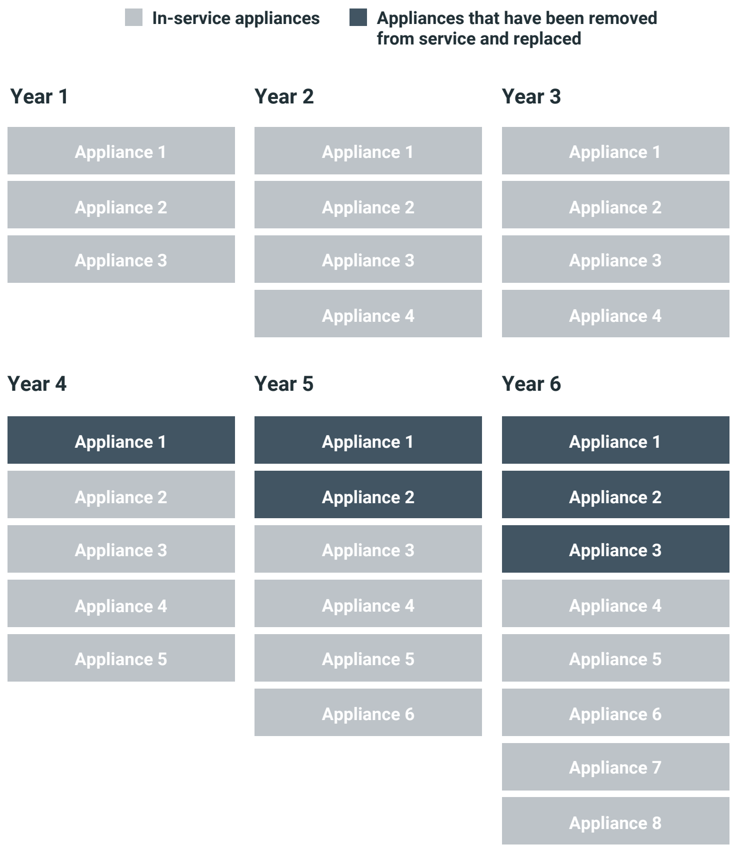


Figure 13-2: The hyperconvergence refresh process

Figure 13-2, you start with three appliances in Year 1 and scale to four appliances in Year 2 and Year 3. In Year 4, you maintain four appliances but begin to cycle in new appliances. The entire process consists of racking and stacking new appliances as well as removing old ones.

This is a pretty new way to handle every infrastructure element. You no longer have to juggle storage, servers, and other supporting systems, including WAN accelerators, backup storage, and the other myriad appliances that litter the data center.

Obviously, though, you can't just tear everything out of the data center today and replace it all with hyperconverged infrastructure. Like most things, you need to be able to phase in hyperconvergence as it is possible from a budgetary and logistical perspective.

There are a few ways you can do this:

- **Introductory project.** If you have a new need, such as VDI, test/dev, or a ROBO modernization initiative, you can introduce hyperconvergence by implementing your new project on hyperconverged infrastructure. From there, on your natural replacement cycles, begin to migrate your other workloads to the new environment. Eventually, you'll have fully phased out your traditional storage and server environment.
- **Pilot project.** If you have a workload that could use a boost in performance or efficiency, or a remote site that might benefit from modernization, use that as a model. A pilot is a great way to introduce the team to hyperconverged technology, and to learn about its capabilities.
- **Make coexistence a priority feature.** Some hyperconverged infrastructure solutions enable peaceful coexistence with legacy infrastructure. For example, you're able to use existing vSphere hosts with the storage in the hyperconverged cluster. Coexistence with legacy infrastructure isn't possible with all hyperconverged solutions, so choose carefully. Some solutions require you to implement hyperconvergence as a standalone silo of infrastructure.

The Rise of the Versatilist

The IT "generalist" used to be considered a lesser role than those that required deeper subject matter expertise in a resource silo. The saying used to be "jack of all trades but master of none." Whether this was actually the case or not is open to debate, but the fact is that in today's world, a versatile generalist is exactly what the business needs in order to grow. It's also a great set of skills to have for IT pros.

As business requires increasing levels of nimbleness, silo-based solutions are eschewed in favor of ones that are more flexible and fit better into the overall equation. These kinds of solutions require knowledge of a broad range of technical concepts as well as of the business. The technical side of the equation isn't one that requires deep expertise, but rather understands how, at a high level, the pieces all fit together.

This high level thinking is in strong demand today and it's an incredible opportunity for IT pros to reshape their careers.

Up Next

Understanding how to overcome inertia in order to make the right changes in your data center is really important. Also important are the economics behind the intended solution. That's the topic of our next and final chapter.

CHAPTER 14

Hyperconvergence Economics: The Impact on the IT Budget

Hyperconverged infrastructure has the potential to transform more than just the data center. By unlocking staff time and other resources, hyperconvergence can help your organization transform IT from a "keeping the lights on" cost center to a top-line revenue driver.

Focus on the Business, Not the Tech

We talked in Chapter 12 about the need for alignment between IT and the business. When the technology becomes too complex for IT to fully manage, or constantly requires the addition of new IT staff and skills, the focus shifts from the business to the infrastructure. In other words, people focus on building the infrastructure itself instead of enhancing what the infrastructure can do for the business. That can lead to a long-term problem and is one of the primary reasons that you'll start seeing misalignment.

The goal for most organizations must be to reduce the amount of "technical overhead." Just like other areas of the business, you reduce overhead to lower costs. You can do the same thing in IT with its own version of overhead. Reduction activities include simplifying administration, improving utilization of existing assets, and limiting the staff time spent on the care of feeding the existing infrastructure.

The result is often reduced budgetary needs, and it can also mean that the company is better able to seize new business opportunities as they arise. That alone can have a dramatic positive impact on an organization's finances and the perception of IT's value to the business.

Where Do the Savings Emerge?

This next question revolves around the actual source of savings. As you evaluate hyperconverged infrastructure solutions for yourself, these are some of the areas in which you'll need to focus to properly calculate cost and expense differential between your traditional environment and the hyperconverged environment.

- **No need to separate workloads.** By having the ability to consolidate workload silos into fewer or even just one silo, you can more easily increase overall utilization of what you're running. This harkens back to the early days of server virtualization, which carried increased utilization as a key driver for adoption.
- **Coexistence with existing systems.** Although this isn't possible for all hyperconverged infrastructure solutions, the savings can be significant for those that can, in fact, coexist with existing infrastructure. In this scenario, you can more easily continue to use some existing systems (generally, existing vSphere hosts) in conjunction with the new hyperconverged environment.
- **Reduction in electrical and cooling.** If you eliminate a bunch of servers, a slew of hard drives, and the accompanying infrastructure (such as WAN accelerators and SSD caches) from your data center, you will massively reduce your electrical and cooling costs. Less equipment translates to less power. Fewer moving parts means less generated heat, which leads to lower cooling costs. Whether or not you're a fan of the Green New Deal, it's easy to agree that reducing electrical costs, and therefore emissions, is a laudable goal.

OpEx vs. CapEx

There are two kinds of expenses that you need to keep in mind when you consider data center economics:

Operational expenditures (OpEx)—OpEx generally aligns with the total cost of ownership (TCO) of a solution minus the initial costs. These are the ongoing expenses incurred when administering and maintaining what you've already purchased.

Capital expenditures (CapEx)—These align pretty closely with the initial cost of a solution and are often considered the one-time costs associated with a purchase.

- **Don't discount these potential savings.** They can be significant and are direct reductions on the operational side of the budget.
- **Reduced maintenance contracts.** You probably have annual maintenance contracts on everything in your data center. What would be the impact if you had fewer such contracts because you no longer required those hardware or software components in your data center? The likely outcome is that you'd be saving money in the operational budget. As has been stated throughout this book, hyperconverged infrastructure has the potential to transform IT operations, including the operational budget.
- **Get those digital transformation efforts off the ground.** Less "tech" to manage means that the same or even fewer staff can manage it. There are fewer discrete skill sets needed in a hyperconverged infrastructure, meaning you can begin to redirect efforts toward goals that are more directly business-facing.
- **Training.** Top-down management (workload) vs. bottom-up (component) means less training will be required. Consider an

iPhone. The iPhone handily replaces several distinct devices. But with the iPhone, there's only one interface to learn vs. the component-level management of a GPS, music player, camera, video recorder, timepiece, and so on.

- **Operational and capital expense improvements.** You've seen a number of ways that the operational budget can be improved, but hyperconverged infrastructure can also have a dramatic impact on capital budgets. A lower cost of acquisition is just the beginning. As was mentioned previously in this book, you can implement a "rolling upgrade" paradigm. This can even out many of the spikes and valleys inherent in many capital budgets and enable easier scaling, which doesn't rely on predetermined financial schedules.

Initial Investment Analysis

The initial investment in a solution is often one of the only financial elements considered by many organizations. That's because it's really important. They need to know how much a solution is going to cost right now. However, there are a ton of flaws inherent in this myopic model. First, you don't get a good feel for what the TCO will be for the solution. Forrester recently revealed that hyperconverged infrastructure can deliver a 192% ROI and a payback period as short as 7 months.[1]

Furthermore, many traditional procurement models aren't even looking at what the business needs today. Instead, because of the way that most organizations have established budgets, they're buying the solutions that they need three or even five years from today. In other words, you're buying resources you'll have to grow into, not what you actually need immediately.

Let's examine this in more detail. In the **Figure 14-1**, you'll see two lines. The flat line is the purchased resource capacity at the inception of the

[1] https://www.hpe.com/us/en/resources/integrated-systems/simplivity-economic-impact.html

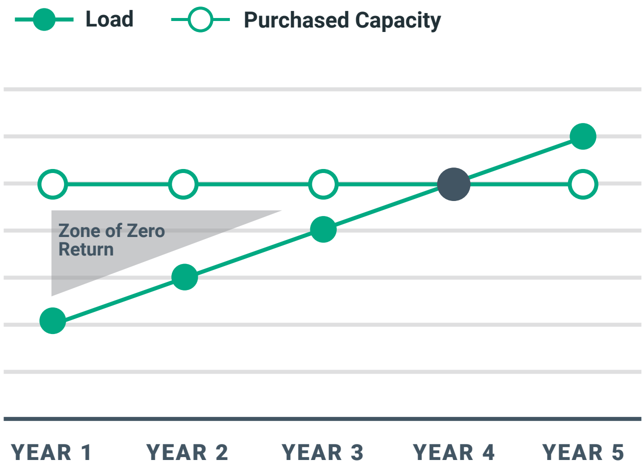


Figure 14-1: Load vs. purchased capacity in a traditional data center infrastructure

current replacement cycle. The sloping line is the actual resource need in the data center. The shaded area is a zero ROI zone.

For the first few years of this solution, there's massive waste in resource and budget. IT has to buy this way today because many data center solutions don't easily lend themselves to incremental scale. Instead, IT staff have to attempt to project the data center's needs for the next three to five years, and they won't always get it right. This is not a knock on IT pros; after all, stock market gurus often fail to predict markets, too. It's just the way things are based on the tools we have today.

Hyperconverged infrastructure solutions can help you break out of this cycle and more closely match data center resources with current business needs. By enabling granular and simple scaling, you can buy what you need today and, as the business grows, just add more nodes.

Besides being technically simple, this also enables you to rethink the budgeting process. By not having to buy for needs that might be in place three to five years from now, you can focus on improving what the business needs today.

Your Financial Evaluation Criteria

As you consider implementation of hyperconverged infrastructure, **Figure 14-2** shows a simple worksheet you can use to help determine which solution makes the most financial sense—a traditional approach or a hyperconverged infrastructure.

1T = One-time
OG = Ongoing

	Traditional		Hyperconverged		Difference	
	1T	**OG**	**1T**	**OG**	**1T**	**OG**
Server						
Hypervisor						
Storage/SAN						
Backup/Recovery Tools						
Disaster Recovery Tools						
WAN Accelerator						
SSD Cache						
Deduplication Appliance						
Power & Cooling						
Dedicated Staffing						
Other						
Totals				**Savings**		

Figure 14-2: Traditional vs. hyperconverged infrastructure worksheet

That's a Wrap!

You've now been introduced to hyperconverged infrastructure, its use cases, plus the organizational and financial considerations for the technology. You've made it through the jungle of hyperconverged infrastructure and can move on to more harmonious locales. We hope your journey here has helped you better understand this important topic.