Test & Development Environment Using the Yottabyte Enterprise Starter Kit

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"Scale your datacenter-in-a-box, including networking, automation, orchestration and analytics, as well as compute and storage, with Intel based yCenter YottaBlox."

Audience and Purpose

This document is intended for enterprise internal IT teams, and systems integrators supplying enterprises. More specifically, the target audience is organizations seeking to build their own private cloud infrastructure while ensuring that this infrastructure can eventually be expanded to encompass multiple sites and/or expand to become a true service provider-backed hybrid cloud.

This document outlines the implementation of a basic single site private cloud using the Yottabyte enterprise starter kit, which runs on YottaBlox appliances using servers powered by Intel technologies and powered by yCenter software. Intel-based server designs, processors, SSDs, converged network adapters and Intel software libraries provide the best possible experience for yCenter-based clouds.

The contents of this paper should significantly reduce the learning curve for building and operating your first cloud computing infrastructure. This will significantly simplify the creation, operation, duplication, backup and ongoing maintenance of test and development environments.

yCenter includes storage, compute, networking, automation, orchestration and analytics. Traditionally, these would each be a platform unto themselves; with yCenter these are all base features incorporated into a single platform.

yCenter's datacenter convergence model allows for a simplified, "building-block" approach to the creation of a high-performance virtual datacenter environment. This can help create a competitive advantage for your organization by reducing the time it takes to create and implement a fully enterprise ready cloud solution.

Because the creation and operation of a cloud requires integration and customization to existing IT infrastructure and business requirements, it is not expected that this paper can be used "as-is." For example, adaptation to an existing network and identification of management requirements are out of scope for this paper. Therefore, it is expected that readers of this paper will make significant adjustments to the design to meet specific requirements. This paper is assumed to be a starting point for that implementation.

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Executive Summary

The Yottabyte Enterprise Starter Kit is the perfect way to stand up a fully dynamic test and development environment. Entire environments can be created, backed up, duplicated or retired with the push of a button. The Yottabyte Enterprise Starter Kit provides a simple means for enterprises to test and prove out the benefits of multi-tenant cloud solutions without requiring a massive training or time commitment.

Traditional hyperconvergence marries storage and compute capacity into a single server or cluster of servers, while leaving the customer to figure out hypervisor licensing, networking, automation, orchestration and analytics. yCenter incorporates all of these elements into a single offering, changing the field of play to convergence at a datacenter level.

yCenter is hybrid by design; it was created with the goal in mind of moving workloads between different datacenters. As such, yCenter is designed to be a multi-tenant solution, with each "tenant" of the datacenter able to control their own virtual datacenter, but isolated from the others. These tenants can be individual departments within an enterprise or multiple companies sharing infrastructure (as is common in public cloud solutions).

Where traditional hyperconverged solutions simply offer a marginally more efficient and economical means to create virtualization clusters, yCenter natively integrates the features and functionality necessary to enable true hybrid cloud computing. These features include the ability to do anything from individual virtual machines to entire virtual environments (including storage, networking, automation and orchestration) between clusters.

These clusters can be owned by your business (as in a private cloud) or hosted (as in a public cloud). The ability to easily and effortless move between them is what makes yCenter hybrid by design. This functionality is perfect for test and development solutions, as entire copies of test and development virtual environments can be cloned to a public yCenter provider and spun up there should local resources prove temporarily inadequate.

Software defined networking allows geographically disparate datacenters to be bridged transparently, making moving workloads between a customer's on-premises cloud to a service provider's public cloud nearly effortless. Data tiering enables customers and service providers to use multiple types of storage as they see fit, and also allows data to be archived to cloud storage in an automated fashion.

The advantage to software defined everything in the modern datacenter is the ability to choose between many hardware vendors without disrupting operations. After a great deal of testing, Yottabyte chose Intel-based server designs and other Intel technologies as the basis for YottaBlox appliances. Software needs hardware upon which to run, and the hardware acceleration Intel technologies provide proved to be the best choice.

yCenter is all about ease of use, while still providing a broad array of enterprise class features. The end goal is to make managing and maintaining infrastructure as painless as possible. Whether that infrastructure is local to the customer's datacenter, or in the cloud.

Introduction

Traditional storage architectures scale poorly and are economically inefficient. Traditional storage requires high recurring capital investments (often called forklift upgrades) and comes with high operating expenses. To combat this, storage within the modern datacenter is being reengineered. Hyperconverged Infrastructure (HCI) is rapidly becoming the new mainstream approach.

In order to support the rapid expansion of infrastructure associated with hyperscale services, it is no longer efficient to relegate servers to dedicated roles, which is the usage profile for which traditional storage had been engineered. A clustered architecture running both compute and storage workloads on the same nodes allows compute and storage to then be scaled together. This allows for scaling on an as-needed basis while maintaining resiliency and high availability. HCI is the realization of this goal.

Early HCI systems were proprietary, with each hyperscale provider creating and maintaining their own. Building on this initial research, commercial HCI solutions entered the market. Today, IT organizations of any size can enjoy the same advantages of scalability and low incremental growth costs enjoyed by hyperscale providers by leveraging open source technologies and solutions based on open standards.

HCI uses industry-standard x86 hardware platforms. Local storage that consists of both traditional magnetic storage as well as SSDs are bound together across all servers in a cluster to create a single high speed hybrid storage pool. The integration of the HCI software stack into the underlying hypervisor allows for data redundancy, resiliency to failure, and the provisioning of the full range of enterprise class storage features.

Taking full advantage of HCI, however, requires more than just the marriage of storage and compute. Networks have to evolve. Datacenters are already having to adapt to a change in data flows from the traditional client-server (or north-south) model to the more modern server-server (or east-west) predominance. By decentralizing and distributing the storage layer, HCI amplifies this trend.

Once networking is brought into HCI, we move beyond the traditional industry usage of the term "hyperconverged". Whatever the original meaning, hyperconverged has come to mean almost exclusively storage + compute married into a single appliance. Clearly, this misses a key datacenter function.

Datacenter convergence is the next logical step. Storage, compute, networking, automation, orchestration and analytics are all provided as a single entity. With a hybrid-by-design approach that enables cross-datacenter manageability and workload movement, datacenter converged solutions are bringing the full promise of the cloud realized by the world's hyperscale providers to everyone.

While implementation of datacenter convergence requires adaptation, the benefits of a hyperconverged infrastructure are many. HCI enables faster deployments, simplified and rapid capacity expansion, as well as automated deployment of most infrastructure components.

HCI also reduces hypervisor vendor lock in by eliminating long design and implementation phases. Some HCI providers, like Yottabyte, which provide both appliances and installable software also free businesses from hardware lock-in.

Don't like your current HCI vendor? Select a new one. Open core HCI solutions reduce expensive hypervisor licensing and provide ease of migration between solutions by using open VM formats.

So long as you can move VMs from one cluster to another, you are not bound to any vendor.

Yottabyte developed the Yottabyte enterprise starter kit, which serves as an example of Yottabyte's range of available YottaBlox. The Yottabyte Enterprise Starter Kit is powered by Intel® Xeon® E5-2600 v3 processors, which are a significant advancement over the previous generation CPUs. These CPUs provide far greater performance with lower power requirements, improving efficiency.

The Yottabyte Enterprise Starter Kit also employs Intel® Solid State Drives Data Center Family, and 10Gb Intel® Converged Network Adapters to provide the fastest possible HCI solution while still maintaining an affordable price point.

The v3 generation of Intel's Xeon® E5-2600 family and associated software libraries enable Yottabyte to provide enterprise class features, such as cluster-wide erasure coding, that would have been impractical and inefficient even one generation prior.

Combined, Yottabyte and Intel's technologies allow the building of a range of YottaBlox HCI appliances. These appliances can be mixed and matched to enable the simple creation of a cloud infrastructure as well as the ability to grow that infrastructure as needed, without expensive overcapacity.

Product Overview

The Yottabyte Enterprise Starter Kit is based on Yottabyte's yCenter and hosted on Intel® Xeon® E5-2600 v3 processor based appliances. The Yottabyte Enterprise Starter Kit aggregates and virtualizes storage, compute, and networking resources to create a virtual datacenter independent from the underlying hardware.

Offering yCenter as an appliance via the Yottabyte Enterprise Starter Kit provides IT organizations of all sizes with a turnkey infrastructure solution for high-performance test and development environments, while lowering cost and complexity when compared to traditional infrastructure architectures.

yCenter creates a true virtual datacenter environment, called the "Virtual Environment", that incorporates storage, compute and networking. Intel SSDs, processors and converged network adapters allow yCenter to take advantage of many forms of hardware acceleration. This tight integration between software and hardware provides high performance without traditional high rack space, power and cooling requirements.

Typical "hyperconverged" solutions

consist of only storage and compute married in an easily consumable appliance, while networking is left as an exercise for the customer. As a true datacenter converged solution, yCenter handles storage, compute, networking, automation, orchestration and analytics, bypassing the need for multiple disparate solutions.

Centralized System Management

A private cloud, such as that made available by the Yottabyte Enterprise Starter Kit, wouldn't be worth much if it was a pain to manage! yCenter provides a single management platform for the storage, networking and compute components of your virtual environment. It also serves as a single point of management for all of your workloads: those in your cloud, and those in the clouds of your service providers.

The full scope of datacenter deployment and administration is performed via a single interface designed for use by an IT generalist that is 100% mobile-friendly. Not only does this lower administration costs, but the easy-to-use interface reduces downtime due to migration and recovery efforts.

Entire virtual environments (which can contain hundreds of VMs) can be dupli-

cated (cloned) or backed up (snapshotted) with only a few clicks. Thanks to yCenter's Yottabyte File System (YBFS) this takes only seconds. Test and development environments have a greater need for this level of flexibility than any other use case, and yCenter's centralized management makes it simple.

Hypervisor Included

Most hyperconverged vendors leave licensing the underlying hypervisor as an exercise for the customer. yCenter is built on top of the proven KVM hypervisor, which does not carry licensing requirements, reducing expenses. This not only helps to avoid hidden costs, but can provide long term TCO benefits as hybrid solutions involving moving some workloads to public providers are implemented.

Optimized Compute Tiers

All workloads were not made equal, and when you are ready to grow beyond a single Yottabyte enterprise starter kit, this becomes an important consideration. yCenter supports multiple compute tiers to meet the needs of individual workloads, from high core-count, low-GHz CPUs to low core-count, high GHz CPUs, and everything in between.
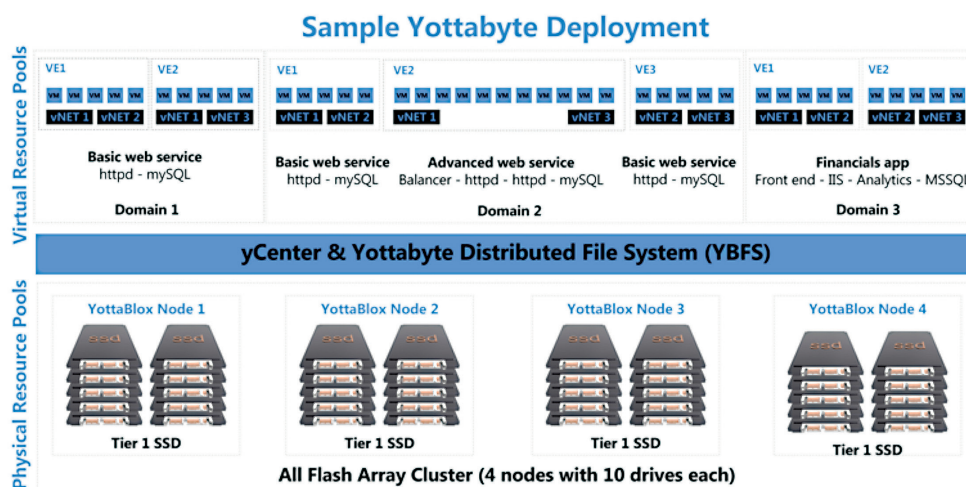

Figure 1 – Sample Yottabyte Deployment

Different CPU generations are supported, and feature availability can be altered across the datacenter to accommodate the capabilities of the hardware available. Customers can start small with an Intel® Atom® based server to run a minor local workload, while relying on service providers to provide the real horsepower. Conversely, customers can buy the highest performance Xeon-based servers to run performance hungry workloads on premises or any combination that may be desired.

Virtual Networking

Most hyperconverged offerings are storage + compute. Yottabyte includes storage and compute integration alongside integration with a L2/L3 software defined virtual networking stack. yCenter includes full-featured virtual networking capabilities that allow you to quickly configure and reconfigure VLANs to meet business demand.

Each virtual network includes DNS and DHCP services, Network Address Translation (NAT) and a firewall. This allows individual VLANs to be fully isolated from the rest of your network, or configured to allow external access. yCenter can also connect geographically disparate locations using native layer 2 extensibility, ensuring security without a VPN.

These are critical features for meeting the ever growing ease of use demands of the modern datacenter.

Native Data Management

Yottabyte File System (YBFS) is a highly scalable, distributed file system that provides data efficiency and management features such as metadata-based zero-cloning, minimum-sized snapshots, deduplication, compression and encryption.

The storage core of the yCenter is yStor, Yottabyte's software-defined storage virtual SAN. yStor connects virtually any type and size of server or disk into a unified storage fabric, from consumer grade SATA drives to enterprise-class SSD devices. yStor will automatically allocate workloads to those devices, based on your configuration, to meet your specified QoS settings.

YBFS and yStor combine to offer the full suite of enterprise data management services. yCenter allows you to secure your data with encryption, minimize the data footprint with deduplication, protect your data with regular clones and snapshots, and move copies offsite or to a public cloud provider to ensure disaster recovery needs are met.

There's no need for multiple data management products from multiple vendors, nor is there a "death by SKUs" approach to nickel-and-diming each feature. Yottabyte provides all of the enterprise data management features required out of the box so that you can stop worrying
about how to use your infrastructure and get on with actually using it.

Test Bed Blueprint

We all have to walk before we can run. Before a company can set about deploying a cloud, a pilot project to prove the technologies has to occur. The Yottabyte Enterprise Starter Kit was designed to meet two different, but related needs.

The Yottabyte Enterprise Starter Kit is ideal for companies looking to prove out the concept of multitenant private cloud environments. It is also the "starter block" for larger deployments. One can cascade into the other: as the pilot proves out, it can be moved into production as the first block in the new company cloud.

The Yottabyte Enterprise Starter Kit consists of four servers and two switches. The servers provide all non-networking services, including compute and storage hardware as well as virtualization, administration, orchestration and automation software.

The servers in question are Yottabyte H1116i YottaBlox. These are Intel-based server designs and feature Intel® Xeon® E5-2600 v3 processors, Intel Data Center Family SSDs, and Intel converged network adapters. Intel® Xeon® E5 processors are key, as the AVX instructions on Intel CPUs provide key acceleration capabilities to the erasure coding software used by yCenter.

H116i YottaBlox (per node)	
RAM	256 GIB
Network	1 Quad Port Intel® I350-A4 GbE I/O Module AXX4P1GBPWLIOM 1 Quad Port Intel® X710 DA4 SFP+ DA Copper PCI-E x 8 10GbE
CPU	Intel® Xeon® E5-2680 v3
SSD	Intel® Data Center S3710 800 GB

Intel SSDs and network adapters were chosen because they have earned their position as the industry standard for enterprise hardware. The proven reliability and high endurance of Intel SSDs made them a natural fit. The wide selection of hardware acceleration options were why the Intel network adapters were the best choice.

Each server in an H1116i YottaBlox contains 256GiB of RAM, 4x 1 Gigabit and 4x 10 Gigabit Intel® Converged Network Adapters. The CPUs used in this reference architecture are Intel® Xeon® E5-2680 v3, while the SSDs are Intel® Data Center S3710 800GB models.

Storage performance has traditionally limited the density and capability of VMs in virtualized environments, preventing infrastructure administrators from realizing the full capabilities of the server nodes they deploy. This specific configuration has been chosen because it meets the workload balance needs of the majority of polled customers.

In other words, while Yottabyte can and does ship with lower end components, choosing components in upper price points makes for a cluster that doesn't have its performance potential sharply limited by storage performance. The cluster as a whole is better balanced to allow for high VM density than nodes built based on lower bound "sweet spot" component prices.

Yottabyte Enterprise Starter Kit uses the "4x4" erasure code model (ability to sustain 4 drive failures or the loss of one whole node) for capacity and data resiliency. As the starter kit uses 4 nodes, 50% of the total drive capacity is available for use. The Yottabyte Enterprise Starter Kit can tolerate up to 4 drive failures across the cluster, or the failure of two entire server nodes.

Cluster networking is provided by two Yottabyte N1148-10G top of rack SDN switches. These switches are true SDN switches, allowing all network functions to be virtualized and controlled by the yCenter software.

The Yottabyte Enterprise Starter Kit is shipped as a single SKU, with all software pre-installed, including the Yottabyte yCenter. yCenter is built on a custom distribution of Linux maintained by Yottabyte that is based on Debian. It deviates from upstream only by 14 packages, some configuration elements and the deep integration of yCenter into KVM. Many of yCenter's enhancements to KVM - notably storage and networking - are integrated as kernel modules on top of what is provided by the base distribution.

		4 Drive Failures, Initial Chassis Required		
YottaBlox Node Failures		**4+4 Drive Model: 50% Drive Capacity**	**8+4 Drive Model: 66% Drive Capacity**	**16+4 Drive Model: 80% Drive Capacity**
	1	2 nodes	3 nodes	5 nodes
	2	4 nodes	6 nodes	10 nodes
	4	8 nodes	12 nodes	20 nodes

Figure 3 – Yottabyte Erasure Code Reliability Chart

Note: Suffer no data loss even if the bolded number of nodes fail in an "n" node sized cluster, or alternatively the loss of any four drives across the cluster.

Technical Review

Being an appliance-based solution, the implementation of the Yottabyte Enterprise Starter Kit is simple. Unbox the hardware, mount on a server rack, connect the power and networking cables and then start up.

Connecting the Yottabyte Enterprise Starter Kit to power and networking is simple. Each server in the kit has two power supplies. We recommend connecting each server to a separate uninterruptible power supply to ensure maximum availability through power outage events. Each switch should also be connected to an uninterruptible power supply.

All servers should be connected to both switches, with 2x 1Gb and 2x 10Gb network adapters connected between each server and each switch. The two switches should be connected to one another. This design allows for redundancy in case of switch failure, or power interruption to a switch.

Once your Yottabyte Enterprise Starter Kit is racked, plugged in and powered on, the first thing the administrator will want to do is go to the yCenter administration page. This will be located at http://[yCenter IP Address], where [yCenter IP address] is the IP address that yCenter obtained from your network's DHCP server.
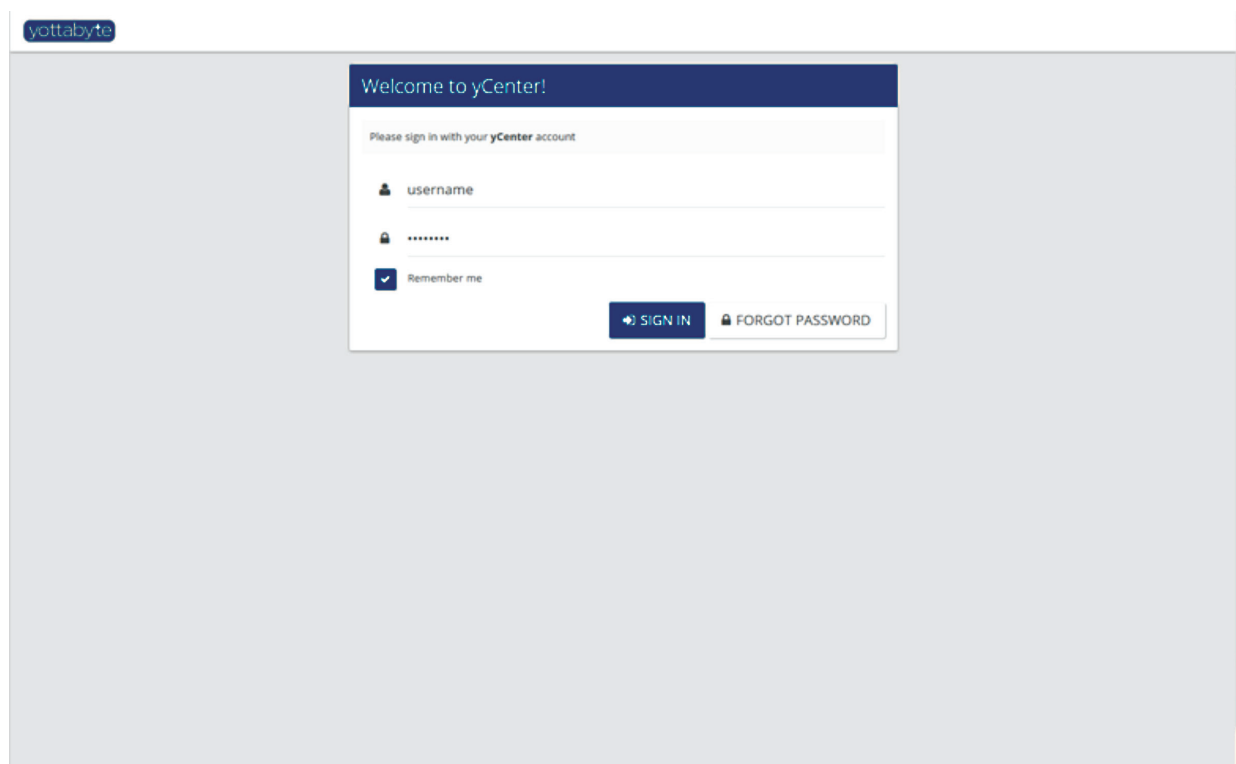

Figure 4 – Yottabyte welcome screen

Complete the initial configuration information screen by filling out your company information and clicking submit. From here configuration of yCenter to suit the needs of the individual enterprise environment can begin.

The first step is to create a yCenter domain. During the creation of a yCenter domain, physical resource pools are sliced into virtual resource pools. These virtual resource pools are assigned to a domain, which acts as a virtual datacenter. Domains can be assigned to individual departments, tenant companies or so forth.

As enterprise needs grow beyond what can be provided by a single Yottabyte Enterprise Starter Kit, virtual resource pools from multiple sites can be assigned to domains, allowing workloads to span sites. This can also be used for disaster recovery scenarios and hybrid cloud computing.

Resource pools can be designed to allow for tiering. A typical enterprise class configuration would be an SSD storage tier dedicated to write intensive (tier 1) workloads, a second SSD storage tier dedicated to read-optimized (tier 2) workloads, and then an archival tier of magnetic storage for backup, archive, snapshotting, etc.

The Yottabyte Enterprise Starter Kit does not come with magnetic storage, so that tier would be omitted in this specific configuration. For the purposes of proving out the technology we feel that an all-flash solution offers the best experience.

All flash is the highest performance solution and ensures that there is adequate disk I/O to support the powerful Xeon E5-2680 v3 CPUs each node is using. While tiering is useful in production, where backups, archiving and snapshotting can take advantage of "deep and cheap" bulk magnetic storage, we have found that for test environments and smaller production deployments all-flash works best.
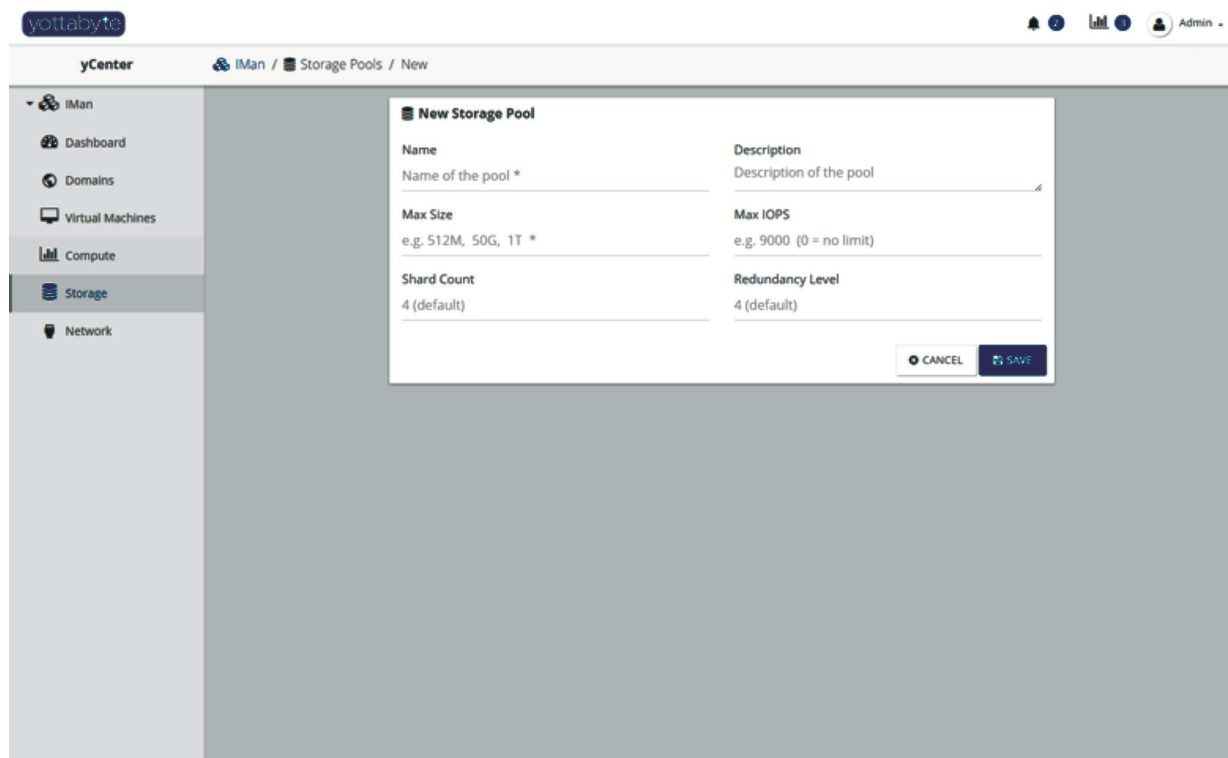

Figure 5 – Yottabyte interface for storage pool configuration
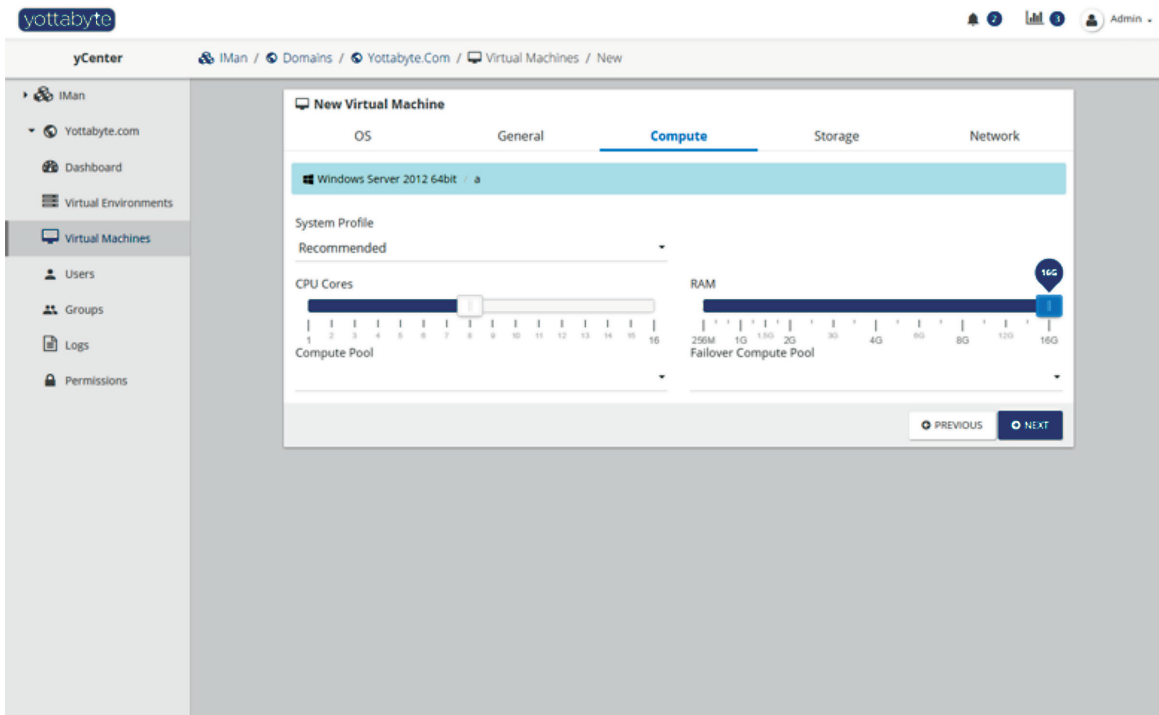
Figure 6 – Yottabyte datacenter configuration dialog - compute

When creating storage pools, RAM and CPU cores are always coupled, at a ratio determined by the yCenter administrator during the creation of the virtual environment.
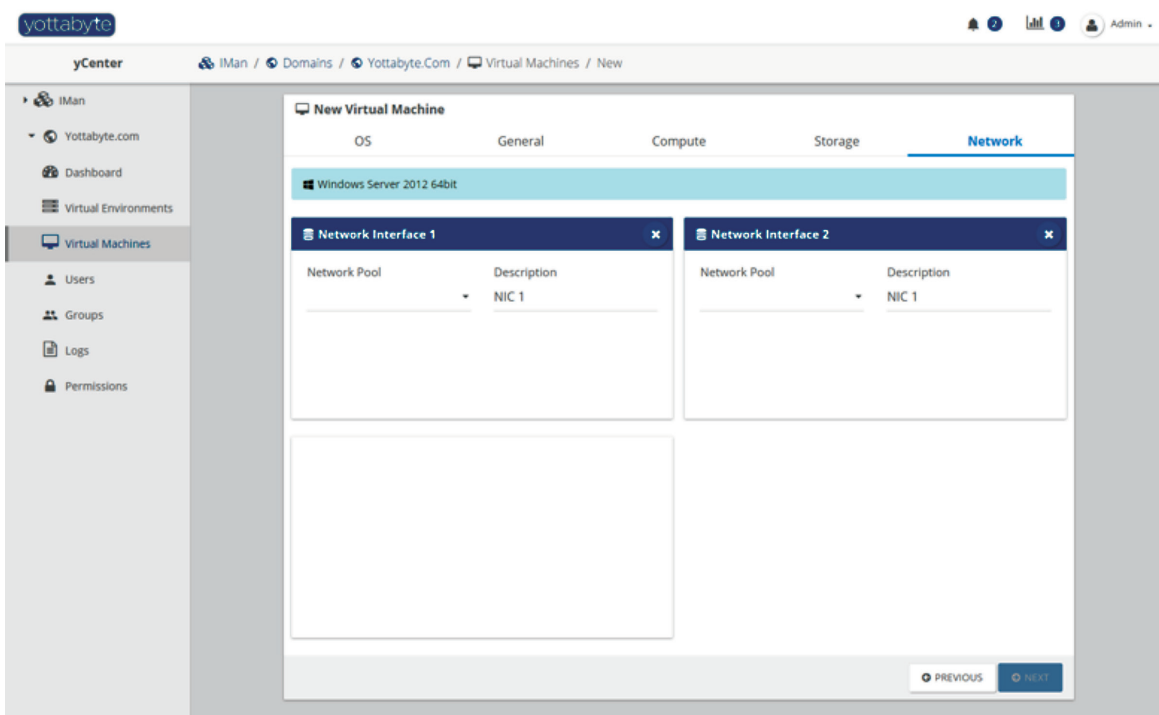

Figure 7 – Yottabyte datacenter configuration dialog – networking

Domain creation includes the creation of virtual networks and assignation of network duty to these virtual networks. Networks can be flagged as public, private or bridged.
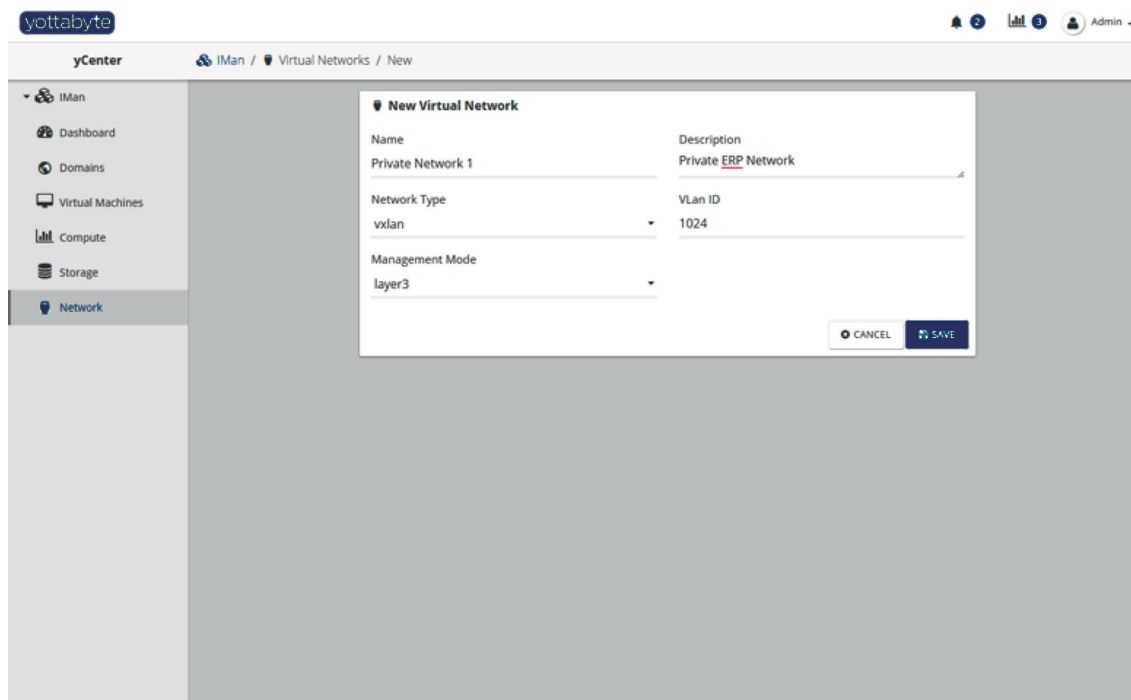

Figure 8– Yottabyte datacenter domain assignments

Once virtual networks have been assigned and created, they can be assigned to domains. Virtual networks manifest themselves as "virtual wires", and networking for a domain is handled by virtue of giving a domain access to that network.
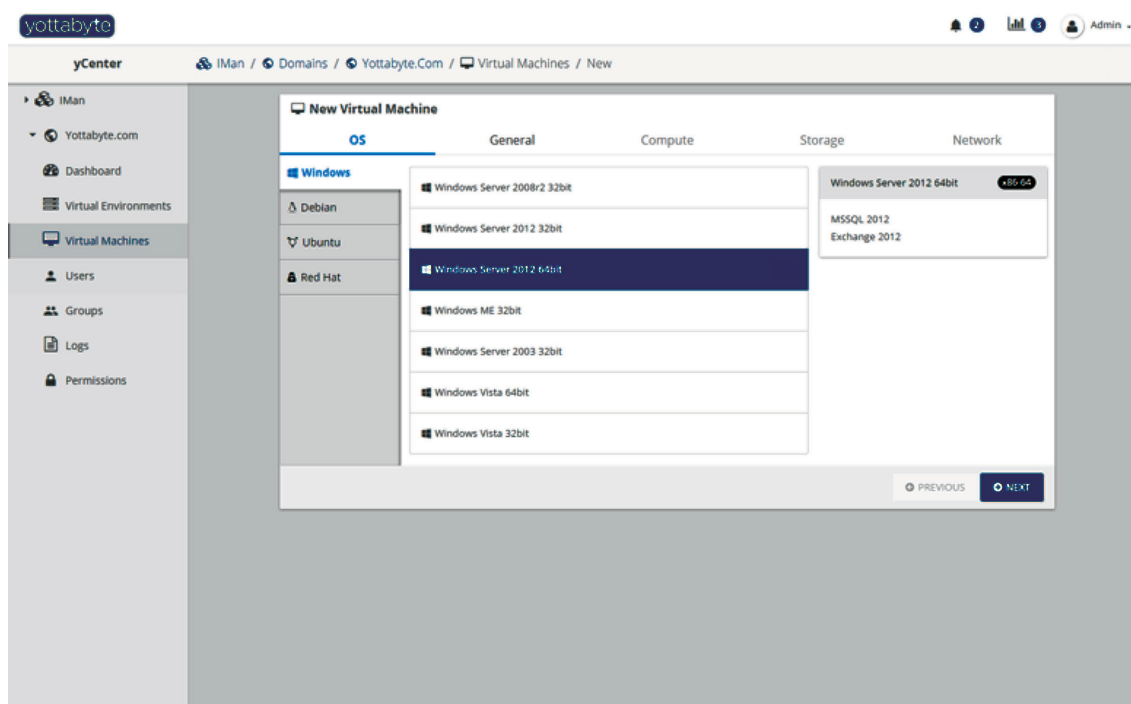

Figure 9 – Yottabyte virtual machine dialog

Once domain creation is complete, VMs can be created or imported as needed. Congratulations, your Yottabyte Enterprise Starter Kit is configured.

To give an understanding of the performance that can be expected from the Yottabyte Enterprise Starter Kit, here are some baseline benchmark results. Virtual Desktop Infrastructure (VDI) bootstorm tests were performed with Windows 2012 R2 VMs configured with 2 vCPUs, 2GiB of RAM and 50GiB of disk space. VDI bootstorm tests were chosen for two reasons. The first is that they are strongly storage dependent; if your storage is weak, it will show in a VDI bootstorm. The second reason they were chosen is VDI bootstorm tests are a commonly used by HCI appliance vendors, allowing for easy cross comparison.

To understand a bit about how the tests were run, we'll define some parameters. VMs were considered "started" when they had logged in and opened task manager. Initial attempts at running VDI tests booted VMs sequentially. Our testing showed that sequentially start-ing Windows VMs using a Yottabyte Enterprise Starter Kit at a delay of one second between starts resulted in VMs starting so quickly there wasn't much overlap in I/Os. This didn't make a very good test.

VM Bootstorm			
VMs	**50**	**100**	**200**
Boot Time	16.7s	24.2s	73.6s
Read	4.87 GiB/s	12.1 GiB/s	11.3 GiB/s
Write	33.2 MiB/s	136 MiB/s	223 MiB/s
Read Ops	242527	601052	508581
Write Ops	2866	10764	15526

Figure 10 – YottaBlox bootstorm performance results

The second testing round tried to take into account the fact that yCenter has distributed storage. We divided the VM list into 4 (as there were 4 VMs) and booted 4 VMs at a time, one VM per node. This caused much more stress on the systems, but also showed how much more it was able to handle.

Starting up 50 VMs simultaneously required a total of 16.7 seconds to get to the point that the last VM was able to log in. Sample vSAN traffic across the cluster during the bootstorm saw a maximum of 4.87GiB/sec of read traffic and 33.2MiB/sec of write traffic. The bootstorm peaked at 24,2527 read ops and 2,866 write ops.

Starting up 100 VMs simultaneously required a total of 24.2 seconds to get to the point that the last VM was able to log in. Sample vSAN traffic across the cluster during the bootstorm saw a maximum of 12.1GiB/sec of read traffic and 136MiB/sec of write traffic. The bootstorm peaked at 601,052 read ops and 10,764 write ops.

Starting up 200 VMs simultaneously required a total of 73.6 seconds to get to the point that the last VM was able to log in. Sample vSAN traffic across the cluster during the bootstorm saw a maximum of 11.3GiB/sec of read traffic and 223MiB/sec of write traffic. The bootstorm peaked at 508,581 read ops and 15,526 write ops.

This last test shows that vSAN speeds are affected by extreme CPU utilization. While yCenter's CPU utilization is low enough to allow for even high end workloads, delivering extreme IOPS drives up the CPU requirements. This is the expected behavior of all hyperconverged infrastructures. Only when the CPU demands of the workloads and the IOPS demands of the workloads are at their peak is contention seen.
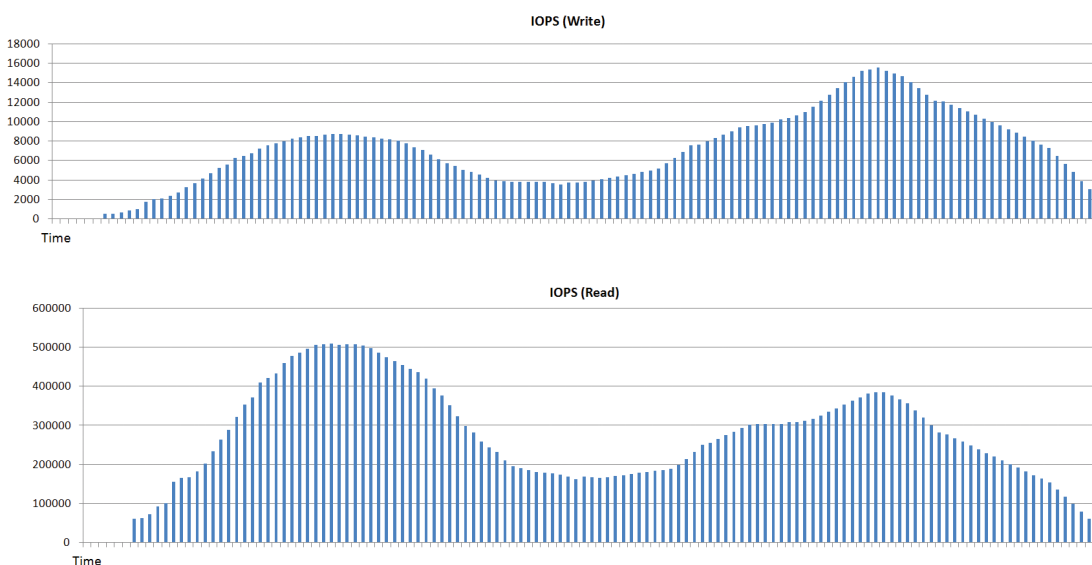

Figure 11 – IOPS across 73 second boot storm for 200 VMs

Things to Consider

No matter how much effort goes into the design of hardware, software or services, there is a certain amount of knowledge required to choose the right mix of IT products to support any given business. While Yottabyte is devoted to ease of use, there remain some elements of IT and business knowledge that are beyond the scope of this document.

The most important of such considerations are the cross-cluster, cross-site and hybrid cloud extensibility of yCenter. In the context of the test and development requirements discussed in this document, these capabilities can be very important.

Once the initial pilot testing phase has been completed, the Yottabyte Enterprise Starter Kit is also the perfect initial building block for any number of different possible solutions. These include hyperscale private clouds, multi-site private clouds or service-provider backed hybrid clouds.

A typical expansion example might include adding a second Yottabyte Enterprise Starter Kit in another site so as to enable off-site backup of test and development environments. One might also stand up a production yCenter infrastructure so that copies of entire test and development environments could be pushed to production clusters once proven to be known good. This can speed time to production significantly when compared to pushing individual VMs or application configurations.

Scalability

Yottabyte's yCenter allows for truly massive scalability. While this document covers the Yottabyte Enterprise Starter Kit - a 4 server, 2 switch design - yCenter can scale to thousands of servers and dozens of switches spread throughout sites across the world.

Designing for that level of scalability includes elements that Yottabyte can only partially address.

Similarly, while Yottabyte is a capable product, some business requirements will be beyond Yottabyte's technical capabilities. One example of this would be real-time fault tolerance for workloads, especially over geographically disparate distances.

Businesses purchasing a Yottabyte Enterprise Starter Kit as a pilot project with an eye to dramatic or edge scalability should contact Yottabyte directly to arrange for a consultation.

Networking

The interconnection of the Yottabyte Enterprise Starter Kit with other networks is a topic with potentially unlimited scope. The details of this interconnection will vary with the details of each organization's internal networking.

Assignation of public networks requires either assigning a port on each switch to your public facing network and configuring VLANs for that port appropriately, or interconnecting with your existing VLAN infrastructure, neither of which are covered by this document.

Similarly, interconnection between your existing network infrastructure and the Yottabyte Enterprise Starter Kit may require VLAN assignation and understanding of advanced network architecture (depending on extant network designs) that are not covered by this document.

Similarly, designing networking for scales beyond that of the 4 server, 2 switch Yottabyte Enterprise Starter Kit can require different models of switches or advanced considerations such as trunking. It is recommended that enterprises with questions about network interconnection or scale contact Yottabyte directly for consultation.

Storage

Yottabyte can theoretically work with any storage media that can be presented to the hypervisor. This can range from traditional magnetic disks to SSDs to tape or even storage located on different sites. Yottabyte has the ability to replicate, tier storage and migrate workloads between tiers.

This can make storage designs complex, especially as enterprises scale their solutions. The Yottabyte Enterprise Starter Kit only ships with Intel SSDs. This is because the starter kit is designed to be a simple design that showcases the speed and ease of use of yCenter. There is, however, nothing preventing an enterprise looking to add additional tiers of storage from simply adding additional nodes to the cluster with different types of storage media loaded.

It is also perfectly possible to add nodes that are designed strictly as storage nodes, and where there is no intention of running active workloads. This is typically seen where there is a need for the bulk addition of slow magnetic storage to serve as an archival tier backing the primary storage of SSD-equipped YottaBlox.

In theory, any combination of compute, storage and networking is possible. yCenter enables complex or simple networks all with a single, central, easy to use management interface. Companies grow organically. Business and technology needs change over time. Yottabyte recognizes this, and is why this flexibility exists within yCenter.

The flip side of that particular coin is that it is entirely possible to design yourself into a nasty corner, with storage, compute and networking completely unbalanced. To this end, Yottabyte encourages customers to consult with Yottabyte when planning expansion of existing infrastructures.

Conclusion

The Yottabyte Enterprise Starter Kit enables enterprises to prove the viability of private clouds and to take their first steps towards the creation of one. It is the perfect opportunity to get the corporate toes wet, gain experience with tomorrow's technologies and ready the enterprise for the next generation of simplified, scale-out, hybrid cloud infrastructure.

Hyperconverged Infrastructure systems (HCI) have been available for a few years. But HCI systems only offer compute + storage in a single appliance. The Yottabyte Enterprise Starter Kit adds software defined networking, orchestration and automation to the traditional compute + storage HCI offering to create a whole new category in infrastructure ease of use: datacenter convergence.

Yottabyte's choice of standard servers based on Intel processors, SSDs and network adapters have allowed for a dramatic reduction in price to customers compared to traditional proprietary offerings. The use of Intel hardware and software libraries have allowed Yottabyte to offer efficiency and ease of use that simply weren't possible even a year ago.

The Yottabyte Enterprise Starter Kit removes the complexity so that you can prove the value of cloud computing without having to worry about setting it up in the first place. When you're ready to build your own cloud beyond the pilot, the simplicity of the Yottabyte Enterprise Starter Kit makes it a strong building block for new cloud deployments. Stop spending time creating and maintaining test and development environments and get on with the business of actually running your business.

"Start or expand your private cloud infrastructure today so that it can be multi-site and/or service provider backed hybrid cloud tomorrow."
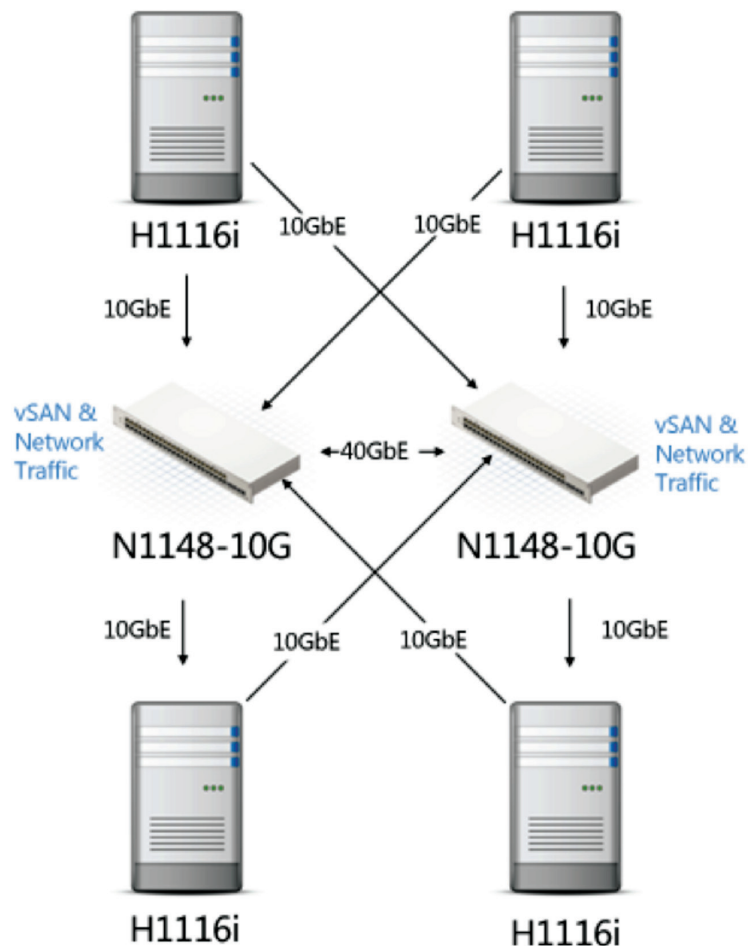

Figure 12 – recommended general purpose configuration

Glossary/Appendix/Additional Information

Nomenclature of units – varyingly, GB, GiB and Gb are used throughout this document. These are used in order to provide precision.

> **G (giga)** is an SI prefix representing 10003 or 1000000000.
>
> **Gi (gibi)** is a binary prefix representing 10243 or 1073741824.
>
> **b** is a standard suffix for **bits**.
>
> **B** is a standard suffix for **bytes** (one byte is 8 bits).

Gb (gigabits) is typically used to measure network   throughput.

GB (gigabytes) is typically used by manufacturers to measure hard disk and SSD capacity.

GiB (gibibytes) is typically used to measure RAM capacity, or by operating systems to measure hard disk and SSD capacity.

For more information on binary prefix visit https://en.wikipedia.org/wiki/Binary_prefix

KVM: Kernel-based Virtual Machine, virtualization solution which turns the Linux kernel into a hypervisor

Erasure Code: Erasure coding (EC) is a method of data protection in which data is broken into fragments, expanded and encoded with redundant data pieces, and stored across a set of different locations, such as disks, storage nodes or geographic locations

VDI: Virtual desktop infrastructure (VDI) is the practice of hosting a desktop operating system within a virtual machine (VM) running on a centralized server. VDI is a variation on the client/server computing model, sometimes referred to as server-based computing.

Hypervisor: A hypervisor or virtual machine monitor (VMM) is a piece of computer software, firmware or hardware that creates and runs virtual machines. A computer on which a hypervisor is running one or more virtual machines is defined as a host machine. Each virtual machine is called a guest machine.

Deduplication: In computing, data deduplication is a specialized data compression technique for eliminating duplicate copies of repeating data. Related and somewhat synonymous terms are intelligent (data) compression and single-instance (data) storage.

Scale-Out Architecture: Scale-out storage architecture uses a number of storage nodes -- consisting of multiple low-cost computer servers and storage components -- that are configured to create a storage pool or are configured to increase computing power to exceed a traditional storage array.

Endnotes

yCenter uses commodity industry standard servers and switches to deliver storage, compute and networking resources. Instead of buying expensive proprietary SANs, blades, fibre channel and proprietary networking equipment, Yottabyte enables flexibility and scalability on whichever equipment the customer is most comfortable with.

Service providers can build out rack upon rack of Open Compute nodes, and install yCenter on top, if that is the route they prefer. Meanwhile enterprises don't have to alter their preferred vendor relationships with Dell, HP, Supermicro, et. al. Those preferring an appliance-based solution can choose Yottabyte's verified Intel server-based appliances (such as the Yottabyte Enterprise Starter Kit discussed in this document) and not worry about equipment selection or prototyping.

Disclaimers