

Hyper-Convergence: Revolutionizing The Data Center

*1.Sampada Vivek Sathe, 2. Pushpendu Manna
1,2.Associate Developer, SAP LABS INDIA PVT LTD, Bangalore*

Abstract: *Hyper Converged Infrastructure (HCI) solutions are built from the ground up to host a virtualized datacenter. Hyperconvergence adds abstraction and automation to the IT framework. It consists of a preconfigured package of software and hardware in a single system which ensures simplified management. The compute, storage, and networking components cannot be separated. The software-defined elements are virtually implemented and there is a seamless integration into the hypervisor environment. Thus, organizations can easily expand the capacity of their IT framework by deploying additional modules. For IT companies, beginning projects on modernized data centers, Hyperconvergence provides the dexterity of public cloud infrastructure without giving up control on hardware of their own premises.*

Index Terms—*HCI(Hyper-converged Infrastructure), SDDC(Software Defined Data Center), SDN(Software Defined Network)VM(Virtual Machine), SAN(Software Area Network), WAN(Wireless Area Network), VDI(Virtual Desktop Infrastructure), ROI(Return of Investment), IOPS(Input Output Operations per Second)*

I. INTRODUCTION

Hyperconvergence is an IT framework that combines storage, computing and networking into a single, isolated system. This, reduces data center complexity and increases scalability. Hyperconverged platforms include a hypervisor which provides virtualized computing, software-defined storage, and virtualized networking. They run on standard, off-the-shelf servers. Clustering of multiple nodes can be done to create pools of shared compute and storage resources, designed for convenient consumption. The use of commodity hardware, supported by a single vendor, provides an infrastructure that's flexible and simpler to manage than traditional enterprise storage infrastructure.

HCI uses a software-centric architecture to tightly integrate compute, storage, networking and virtualization resources into a single offering, from a single vendor which ends the frustrating cycle of over-buying storage capacity only to find it outdated soon after. This unity helps reduce manufacturer finger pointing when troubleshooting and other challenges analogous with virtualizing datacenters.

A major benefit of hyperconvergence is that it allows businesses to grow their environments seamlessly and scale out as needed – even one node at a time. CPU, memory, disk, flash and other such latest technologies can be added to existing storage nodes. The higher workload densities, increased capacity and updated capabilities and features help optimize the investment in the original nodes which both enhances the ROI and helps in reducing the risk of over-buying. These software-redefined improvements make HCI significantly uncommon and finer to proprietary SANs.

This paper aims to understand the importance of hyper convergence infrastructure in today's world of constant change and upgradation in IT. It sheds light on evolution of data center and its role in reducing overall costs and maintenance challenges. The architectural requirements and benefits are also explained to stress on the need for organizations to shift to hyperconverged infrastructure.

II. BACKGROUND

Enterprises around the world still struggle with the gigantic challenges associated with the increasing complexity of their IT environments and the mounting growth of data. IT ecosystems place expendable, excessive demands on IT resources and skills, which create gaps that can be difficult to overcome with the growth of businesses and IT deployments. It thus becomes a larger and more complicated challenge to support the growing data center operations. Without technology that directly addresses simplified operations and data center agility, IT teams will continue to struggle to accommodate emerging and immediate workload requirements across business units that in turn, result in increased IT costs and complexity. The first phase of data center consolidation is virtualization as it promises to deliver a more cost-effective and less complex alternative to traditional infrastructure technologies. However, with the deeper perfusion of virtualization into IT ecosystems, IT organizations discovered that it can result in more complex and costly environments. The demand for more storage capacity creates storage silos that also present management challenges. This has annexed the storage complexity culminating in a difficult-to-manage VM sprawl. Thus, IT organizations today face higher hardware and software costs. It also causes a strain on IT resources as they strive to provide adequate support and management for virtualization and storage environments. Technology trends such as big data, analytics, cloud and Internet of Things (IoT) are currently trending in the market and their increased traction further compounds virtualization and storage hurdles.

Virtualization stands out as one of the true infrastructure revolutions in the past 20 years. Hyperconvergence is a favorable solution for burgeoning the data center infrastructure which brings speed, efficiency and reduces the overall cost, of on premise hardware.

III. EVOLUTION OF CONVERGENCE

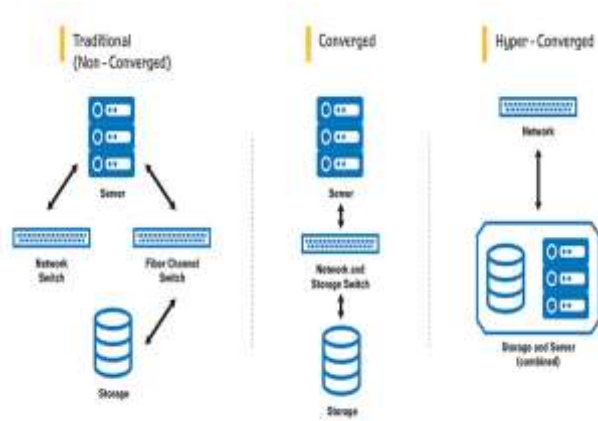


Figure 1: Traditional vs Converged vs Hyper-Converged

A. Integrated System

The earliest infrastructure convergence solutions are simply conglomerations of existing hardware and software. They have complete network, compute, storage, and virtualization capabilities, with little to no actual innovation in product features to be leveraged. The solutions offered by major original equipment manufacturers tend to lock customers into their technology stacks. The most important benefit of integrated systems is that customers gain a single point of contact for their infrastructure, from purchase to end of life. Also, these systems are always tested and are fully racked and cabled, and ready to go to customer sites. On the downside, when more power is needed, a big chunk of infrastructure needs to be bought which results in a big step size. Also, these products usually don't tackle the serious challenges faced by many organizations.

B. Converged Infrastructure

The converged infrastructure products effectively eliminate the need for dedicated storage area network (SAN)-based storage by combining the server and storage components in a single appliance. These systems provide a localized isolated resource pool solution. They provide simplified management and faster time to deployment. The storage layer is effectively virtualized and runs in the virtualization platform. Overall acquisition cost is lower, and management of the server and storage resources is simplified. The overall resource utilization with these systems, is higher than with a legacy island-based infrastructure.

However, converged infrastructure has some limitations like, the systems include just the server and storage resource components. In addition, the fundamental data management challenges have not been solved. It simply migrates the functionality of a traditional storage array into the virtualization platform. They are less flexible than some organizations require, since the resource ratios (such as CPU: storage: network) are fixed. A converged infrastructure appliance's storage from

existing legacy systems cannot be used and users are forced to create a separate resource island.

For these reasons, converged infrastructure systems don't coherently address performance and data problems in the legacy infrastructure.

C. Hyperconverged Infrastructure

Hyperconverged infrastructure, is the logical next step in the evolution of infrastructure convergence. Hyperconvergence consolidates all required functionality into a single infrastructure stack running on an efficient, elastic pool of x86 resources and thus, delivers simplification and savings. The data management is radically simplified by completely reinventing the underlying data architecture. Hyperconverged infrastructure provides SDDC at the technological level. It also includes a single shared resource pool thus, carrying forward the benefits of convergence. Hyperconvergence makes some legacy services obsolete by going beyond servers and storage and bringing many services into the convergence fold like, data protection products (backup, replication), deduplication appliances, wide-area network (WAN) optimization appliances, solid-state drive (SSD) arrays, SSD cache arrays, public cloud gateways, replication appliances or software.

Hyperconvergence, thus takes convergence to the next level in the data center and provides a wide array of benefits to both IT and business.

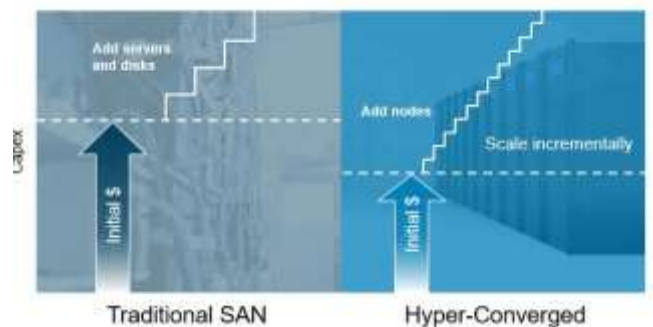


Figure 2: Implementation cost in Traditional SAN vs Hyper-Converged

IV. ARCHITECTURE OF HCI

Hyper convergence harnesses several key technology trends to deliver modern infrastructure with more performance and simplicity for less total cost. Hyperconvergence architecture comprises of several key components:

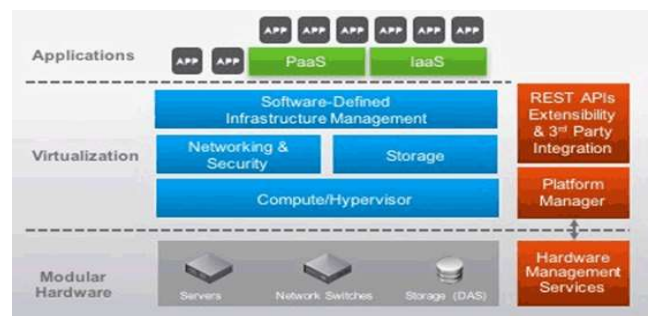


Figure 3: HCI Architecture

A. High-density flash technology

High-density flash and nonvolatile memory technologies can accelerate storage performance and reduce read- and- write latency. To fully realize the potential performance gains of these new memory technologies, the *network hop* where data passes through bridges, routers, or gateways must be eliminated. The hyper- converged approach, is to bring data much closer to the CPUs which is achieved with a big boost from flash technologies. HCI adoption is on the rise since the cost of flash devices is decreasing thus, making the price per IOPs more attractive.

B. Server Technology

With the advancement of multicore CPU technology, industry-standard x86 servers are getting more powerful. The servers have become so powerful that they can handle the workload requirement of high performance storage of enterprise environments. Also, with the software centric architecture of HCI, processing platforms can be easily updated to take the advantages of the improved processing power of the new processors.

The cost of x86 hardware, including flash memory is very low as compared to storage arrays. Hence HCI delivers significant cost saving in terms of deploying siloed servers, storage networking and external storage solutions.

C. Hypervisor

The hypervisor is the foundation for expanding on the benefits of server virtualization to cover storage, networking, and unified management. It enables a clear path to HCI and ultimately the SDDC without requiring forklift changes to current infrastructure and expertise.

A hypervisor provides abstraction and isolates operating systems and applications from the underlying host machine hardware. It operates one or more virtual machines as guests such that multiple guest VMs share the system’s physical compute resources, such as processor cycles, memory space, network bandwidth and so on. This, thus vastly improves the utilization of the underlying hardware by decoupling the piece of hardware from the software layer.

In an HCI solution, the hypervisor forms the foundation and plays a key role in ensuring data availability, storage efficiency, application performance, and flexible scalability.

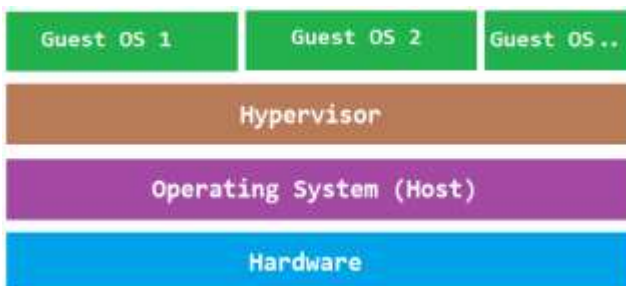


Figure 4: Virtualization in HCI

D. Storage

Storage and storage networking can be collapsed into a server and virtualized. The tight integration between storage and storage networking provided by HCI solutions eliminates the need for a separate virtual storage appliance deployed on each server, which leads to lower resource utilization and lower VM densities. Thus, operations, costs, and overall physical footprint is streamlined.

Hyper converged infrastructure provides software pools server attached storage. This thus leads to create high performance, resilient, shared storage that’s optimized for VMs. IT infrastructure can grow affordably without the need for large capital investments since the right storage solution can lower operational expenditures (OpEx) by streamlining routine tasks, enabling better and more predictable performance.

E. Management Platform

HCI solutions provide an easy to use interface to manage the virtualized infrastructure (compute, storage, and storage networking) to manage or monitor the different layers. A unified platform helps manage the entire stack and seamlessly integrates all workflows. The already known x86 infrastructure can be easily leveraged using Intel Architecture based servers.

Thus, no new hardware needs to be learnt, no new purchasing process, and no new support model is required to navigate making HCI adoption quite easy.

V. BENEFITS OF HCI

HCI has strong benefits across enterprise IT like, consolidating data centers, building private cloud environments, supporting virtual desktop infrastructure (VDI) deployments, serving as backup and disaster recovery platforms, enabling test and development environments, and supporting Big Data analytics. In each of these use cases, HCI provides an ideal solution as compared to the traditional data centers or even converged infrastructure.

A. Data Center Consolidation

In legacy data center model, organizations have multiple data centers at different geographical locations. These multiple data centers occupy expensive infrastructure and require costly cooling and power hardware. In addition, organizations generally buy and integrate solutions from different vendors and hence require different management tools and expertise for operating different data centers. The increased availability of high speed networking has allowed organizations to consolidate data centers to reduce cost and management task and instead build more valuable innovation for the business.

Organizations seeking to consolidate data centers can take the advantage of hyperconverged infrastructure which provides computing and storage capacity in a single hardware. Thus, it takes less space and reduces cooling

and power requirements. HCI provides simple deployment and management solution which makes it easier to deploy different IT applications and manage data center with fewer human resources. HCI also provides deduplication and compression solutions to reduce the overall hardware required to store data.

B. Cost Effective Private Cloud

Organizations are slowly moving from on premise data center to cloud computing to leverage the advantages which comes with it. Cloud computing reduces the start-up cost by eliminating the need to buy hardware and software separately. It provides great flexibility and scalability to deploy and scale applications and automates operational activities. While public cloud provides immediate implementation, low initial deployment cost and consumption based utility model, private cloud provides greater control on the underlying infrastructure and additional levels of security and compliance. Hence, many organizations are choosing both cloud options depending on the requirements of the application.

HCI architecture supports software-defined storage services that delivers the cloud's flexibility and scalability within an organization's own data center. This enables organization to build cost effective private cloud platform. HCI can scale linearly by scaling all the resources including compute, storage and networking simultaneously. HCI also provides powerful management and automation tool to manage and automate the resource utilization and storage requirement of the application as the business needs fluctuate.

C. Virtual Desktop Infrastructure

Virtual Desktop Infrastructure is a virtualized technology enabling access to a virtualized desktop which is hosted on a centralized server in a data center. Individuals can use computers, thin client or even mobile devices to connect to the virtual desktop. It provides many benefits:

- VDI has significant security benefits since the data resides in the data centers and not in personal laptop.
- It enables organizations to pool expensive software licenses that may be shared among VDI users.
- VDI provides consistent end-user experience and reduces cost associated with managing the end-user devices.

In traditional data centers, implementing VDI can be expensive since the OS, applications, data and settings for every user must be stored in data center. Capacity needs and cost required to meet them increases exponentially. Several HCI vendors produce custom-made appliances to simplify VDI rollout. HCI infrastructure products which bundles storage, servers, networking and virtualization software have emerged to reduce the cost associated with VDI.

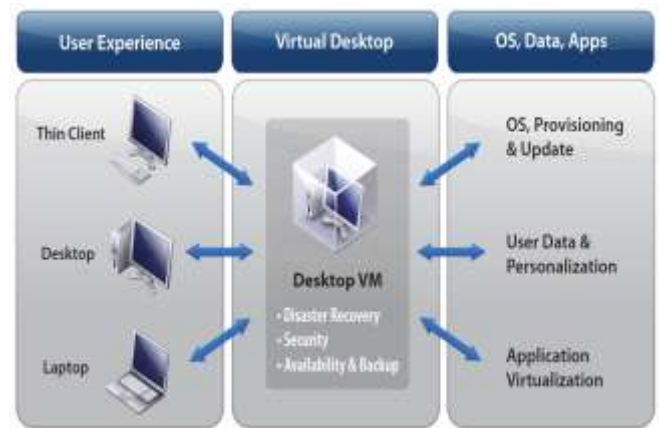


Figure 5: Virtual Desktop Infrastructure

D. Data Protection

Every organization understands the importance of data protection and recovery. It is one of IT's core services. Every organization depends on its data to provide goods and services, manage ongoing operations and analyze performance. Without this information, operations would be crippled, in best case, and possibly shut down. For this reason, organizations should emphasize more on data protection, backups and disaster recovery strategies. In traditional data centers, it is very difficult to design a robust data protection strategy because of the complexity of the data center. Cost of designing and implementing such data protection strategy is also high.

HCI eliminates the complexity in data protection and reduces the cost of operation. Rather than acquiring, installing and maintaining separate data protection technology, HCI solutions provide integrated data protection, back-up and disaster recovery capabilities. When it comes to data protection, data reduction and compression are important. HCI leverages the deduplication technology to reduce the data to be retained by the organization thus, reducing the cost of maintaining back-ups.

E. Testing and Development

Whether an organization develops its own application or uses commercial application, testing the application before going in production phase is crucial to success. Developers must test the application in less-than-ideal replica of the production space since there is no robust environment for testing. This makes it incredible difficult to maintain high quality standards and avoid serious outages.

HCI makes it possible to have robust test environment at reduced cost and without any complexity. HCI enables organization to create an ideal replica of the production environment, create a test instance and then eliminate the virtual machine used for testing once it is complete. This allows organization to maintain high quality standards of the product.

F. Big Data Analytics

As the data keeps on growing at an alarming rate, it is important for modern businesses to use Big Data analytics to achieve valuable insights from their data. With traditional data centers, organizations need new technology infrastructure design to cater to the computational and storage needs of Big Data. The specialized architecture of Big Data relies upon distributing data across multiple nodes and rapidly perform analysis on that data.

HCI eliminates the need for separate infrastructure complexities to support sophisticated data analytics tools, hence simplifying and accelerating their deployment. HCI's virtualization and container technology makes it faster, easier and cost-effective to deploy Big Data applications.

VI. SUMMARY

There is a need for data centers that can both handle the load generated by the rise of Big Data, the consumerization of technology and the explosion of network-enabled devices and respond dynamically to changing demands. The demand for IT resources is also on the rise which, puts data center operators under a consuming pressure to deliver. Ordering of appropriate equipment, careful architectural design, substantial planning and lead time was required a few years ago, to reconfigure the existing data centers. With HCI, data centers are flexible and scalable, allowing for rapid reconfiguration at a cost-effective price.

From the organization's perspective, hyperconverged infrastructure makes financial sense. The core building blocks of compute, storage and networking can be purchased in modular units and the advantage of hyperconvergence software can be taken to reallocate those resources as needed. Essentially, HCI technology makes the software-defined data center a practical reality by bringing the scalability and simplicity of the cloud to enterprise data centers without requiring siloed technical expertise to configure and manage different layers of the technology stack.

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