The Journey Toward the Software-Defined Data Center

SDDCs have the potential to help enterprises radically shift the way infrastructure has been architected, deployed and managed.

Executive Summary

The term SDDC, or software-defined data center, was coined in 2012 by VMware's former chief technology officer (CTO), Dr. Steve Herrod. At first, it seems bizarre to define a data center in terms of software, rather than hardware infrastructure, that programmatically turns on and off devices, or shrinks and expands computing resource consumption as business requirements dictate.

While this sounds futuristic, this evolution of IT infrastructure and architecture represents a complete paradigm shift from today's standard operating procedures for architecting and provisioning IT services.

This white paper briefly touches upon potential future state scenarios and discusses the implications for today's legacy infrastructure, management tools, automation levers and data center facilities. How this future state will emerge is still open to debate (for more insight, please read our white paper "Creating Elastic Digital Architectures"); but what is clear is enterprises that tread toward adopting SDDC must be cognizant of its potential impact, evaluate possible risks and benefits and take baby steps forward.

Data Center Characteristics and the Evolution of Infrastructure Architecture

Core infrastructure components in the enterprise data center such as compute, storage and network are the foundation upon which business applications are built (see Figure 1). Traditionally, enterprise data centers are designed to last forever and meet visible business objectives, meaning that their underlying components are sized and built for a projected workload. They are also sized and built using application volumetric modeling and nonfunctional requirements such as performance, availability, scalability and security.

Most organizations have a mix of physical compute, legacy infrastructure and virtualized compute nodes supporting business applications, with storage and network interconnected. Organizations have legacy systems, or mainframes, that support core business logic in many cases, and these legacy servers bring with them their own challenges with respect to monitoring and management.

This has led organizations to create a plethora of individual, stand-alone systems, or tools, to

Standard Data Center Attributes

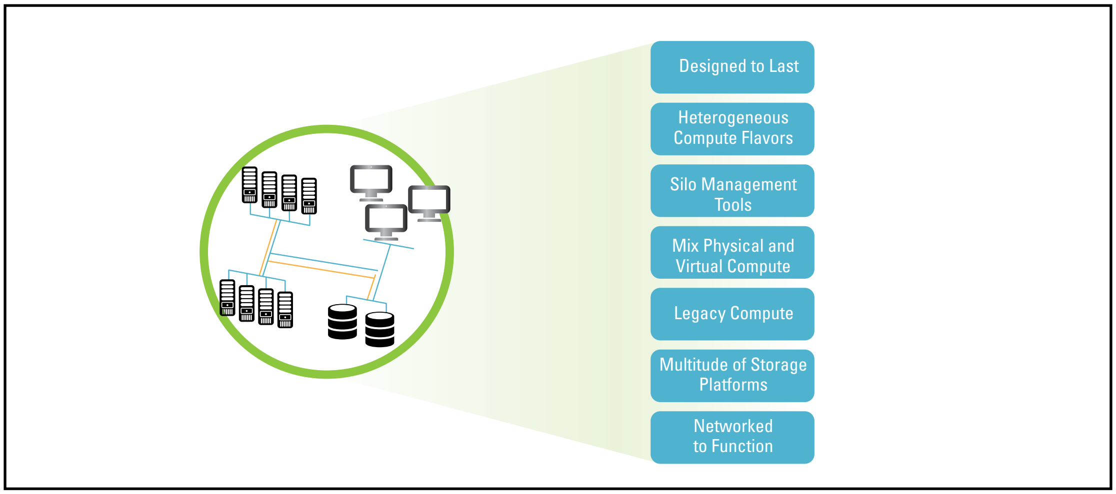

Figure 1

perform monitoring and management functions across server farms. Moreover, many use a separate set of tools for managing network and storage performance. This results in enterprise data centers that lack a single, unified view of resource availability across infrastructure, to the application and database layers.

The infrastructure is designed and provisioned considering the specific volumetric for supporting the business applications and considering the peak load transaction in jobs per second, availability and scalability requirements. When volumetric and projected growth do not manifest as envisaged, this method of sizing infrastructure compute and storage could lead to either undersizing or oversizing the footprint. Often, having such islands of infrastructure compute and storage leads to underutilization of resources. This has a cascading effect on investment and the effort expended toward energy consumption, management overheads, software licenses and data center costs.

The shortcomings of this model led many enterprises to the next wave of infrastructure design — utilizing shared infrastructure services and virtualized compute to increase efficiency in resource utilization and ensure that infrastructure is designed and fit for the purpose, and not over-engineered. Figure 2 depicts how a shared infrastructure delivery design is leveraged, considering guidelines such as grouping of applications with similar workload and grouping of line-of-business applications, with virtualized compute resources. In this model, applications reap the benefit of virtualization, with hypervisors enabled to programmatically allocate and deallocate compute resources for applications. The bare metal hardware controlled by the hypervisor software can be further partitioned and guest operating systems with logically separate instances can be instantiated, resulting in increased utilization.

This model has its advantages in terms of how resources are efficiently utilized in ideal application workloads. However, when one or more application workloads begin to consume more resources than expected, scenarios could arise where several guest operating systems are short of compute resources, thereby impacting business application service level agreements.

While this approach brought holistic capacity management, monitoring and tools capabilities, it also provided evidence that infrastructure compute and server resources were truly benefiting from improved resource utilization and automation. This was brought about, to a certain extent, by programmatically controlling the resources provided to guest instances. However, new thinking about solutions was still needed to meet the challenges of dynamic workloads of run-the-business applications and compute-intensive enterprise applications.

With the emergence of the cloud, the new age "mantra" and infrastructure as a service (IaaS) as a delivery model (as illustrated in Figure 3), the challenges of processing demands from dynamic workloads is being addressed. Designing high-availability clusters and scalable solutions can be architected based on nonfunctional requirements.

IT Infrastructure: Shared Resource Model

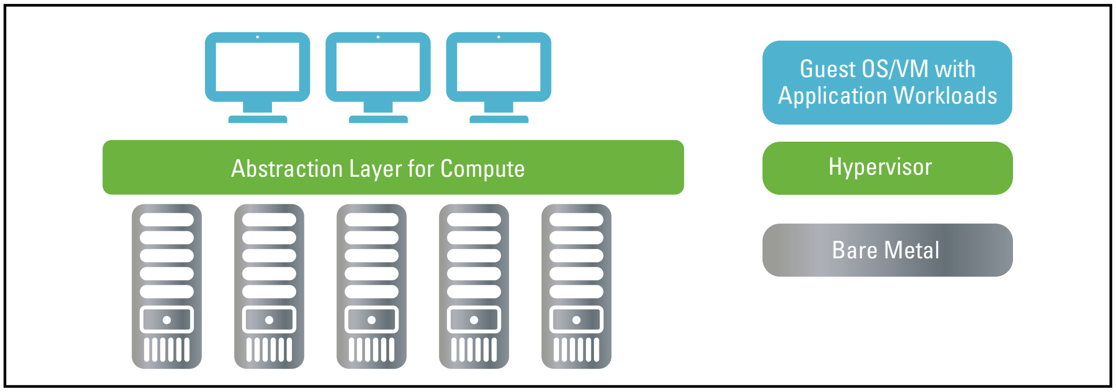

Figure 2

Since it is elastic by nature, the cloud delivery model enables resources to expand or shrink based on consumption. An abstraction software layer, known as hypervisor, virtualizes processing resources from the bare metal, thereby enabling compute, memory and hard disks to accommodate flexing demand.

Software-defined server virtualization is able to efficiently and dynamically allocate shared-pooled resources to balance workloads, thereby meeting application requirements. Through automation, self-service, orchestration and metering ability, the success of enterprise server virtualization has prompted IT organizations to extend this capability across the data center, with software controlling the hardware. What follows are the steps that key industry sectors must take and ways enterprises can approach and overcome the perceived challenges that will emerge.

Software-defined server virtualization has thus become mainstream. Our experience reveals that numerous organizations have implemented or are in the process of implementing technologies to help them get there. With this model, we can say that compute bottleneck at the server hardware layer is more or less eliminated. However, unless planned and executed, this hardware resource constraint shifts to the storage I/O and network I/O. This, in turn, brings an equally challenging problem of ensuring the abstraction at the storage and network layers is tightly coupled with the server abstraction layer.

In the next sections, we examine if this is permissible and how the industry is helping to perpetuate software-defined infrastructure and programmatically-controlled hardware to create more elastic IT resources.

Dynamic Infrastructure Compute Schema

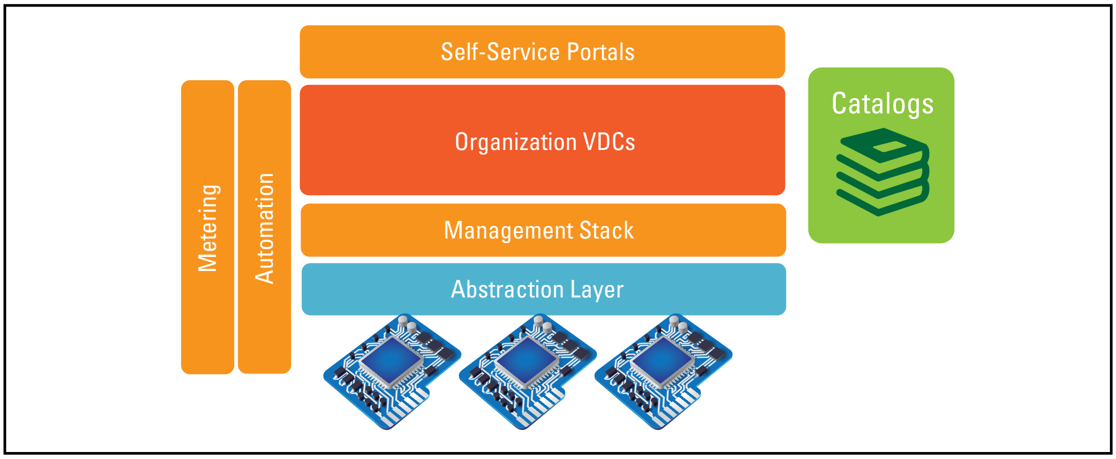

Figure 3

The Solution: A Vision of Future State Data Centers

The software-defined data center can be defined as using software to control the bare metal (or hardware), with an ability to turn services on and off, thereby shrinking or expanding resources to meet a defined level of service assurance. The mechanisms to achieve this lie in the ability to abstract the hardware layer and provide compute services as virtual resources to the applications seeking them through the following options:

- Server virtualization.
- Storage virtualization or software-defined storage.
- Network virtualization or software-defined networking.

As discussed in the previous section, server virtualization enabled via hypervisor as the abstraction layer has reached mainstream adoption. There is ongoing R&D to bring storage and network devices to equivalent maturity. A multitude of niche products already exist in this area; moreover, numerous acquisitions by large original equipment manufacturers (OEMs) are adding SDDC capabilities to their hardware products. However, the vendor community lacks a comprehensive framework to allow organizations to deploy and minimize the risk of being early SDDC adopters. In addition, available solutions still lack the ability to demonstrate how existing infrastructure or legacy infrastructure could be leveraged and converged with SDDC infrastructure.

The future state of the data center encompasses hardware infrastructure designed and programmatically controlled by software across server, storage and network.

One promising development is the OpenDayLight Project where a set of companies have defined a common goal of establishing an open-source framework for software-defined networking (SDN).

Across server, storage and network, regardless of their maturity, organizations can now quickly draw the mapping on abstraction layers for their hardware devices. Figure 4 documents with an asterisk (*) that technologies are emerging around SDN.

As with other virtual technologies, network virtualization provides an abstraction layer on various physical network devices, thereby retaining the network's physical properties, such as packet forwarding and trustworthy packet routing, but enabling logical isolation and device independence. Some experts define network virtualization as a network that can be instantiated, operated and removed without physical network asset interaction by the network administrator. Software-defined networking can be leveraged to enable virtualized networks, thereby decoupling the data and the network hardware.

With storage virtualization, physical storage devices are pooled and used as virtual resources. The future state of the data center encompasses hardware infrastructure designed and programmatically controlled by software across server, storage and network. The converged infrastructure within this future state must have an ability to integrate with existing legacy systems in the data center. Power and cooling solutions, for instance, need the intelligence to switch on and off based on consumption. An all-encompassing dashboard is also required to indicate the health of various components within the SDDC. Hardware management and monitoring, coupled with software, needs intelligence to automate tasks and self-heal/self-learn problems.

Conceptual View of the Solution

SDDCs are an extension to the cloud delivery model of infrastructure as a service (IaaS), and basic tenets of cloud delivery model will exist as foundational building blocks. Additional integration layers between legacy hardware, data center facilities and an all-encompassing monitoring and management stack are among the other key tenets to this solution.

SDN Emerges

HW Tier	Abstraction Layer
Server	Hypervisor
Storage	LUN/Volumes/Virtual Disks
Network	Evolving* (VMware NSX) is one such, OpenFlow protocol

Figure 4

Today's Data Center Infrastructure Architecture: A Conceptual View

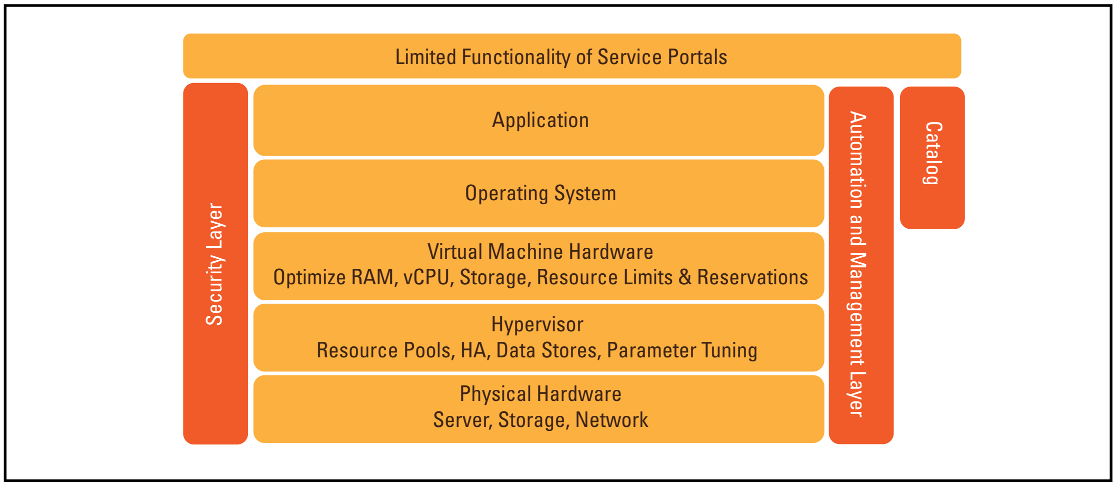

Figure 5

Figure 5 depicts a conceptual view of today's infrastructure architecture in a traditional data center. The surrounding data center components such as data center facilities and legacy infrastructure would exist in the estate, as individual components in the data center. Figure 6 illustrates the infrastructure architecture surrounding SDDC, where software programmatically controls, and is deployed to meet, enterprise business applications for dynamic workloads.

SDDC blocks need to be holistic for integration across physical, legacy and data center facilities. This requires third-party vendors with plug-ins to provide the interfaces.

- **Physical hardware and legacy infrastructure:** This constitutes the bare metal hardware and data centers that can be virtualized across physical or legacy systems. The ability of these to be involved and controlled via software, programmatically, will be based on the evolution of technology or business needs, depending on the abstraction of server, storage, network components and legacy integration requirements. OEMs and converged infrastructure vendors are key players since they design, fabricate and integrate to make this happen.
- **Management layer:** This consists of an integrated suite of management and monitoring

Infrastructure Surrounding SDDC: A Conceptual View

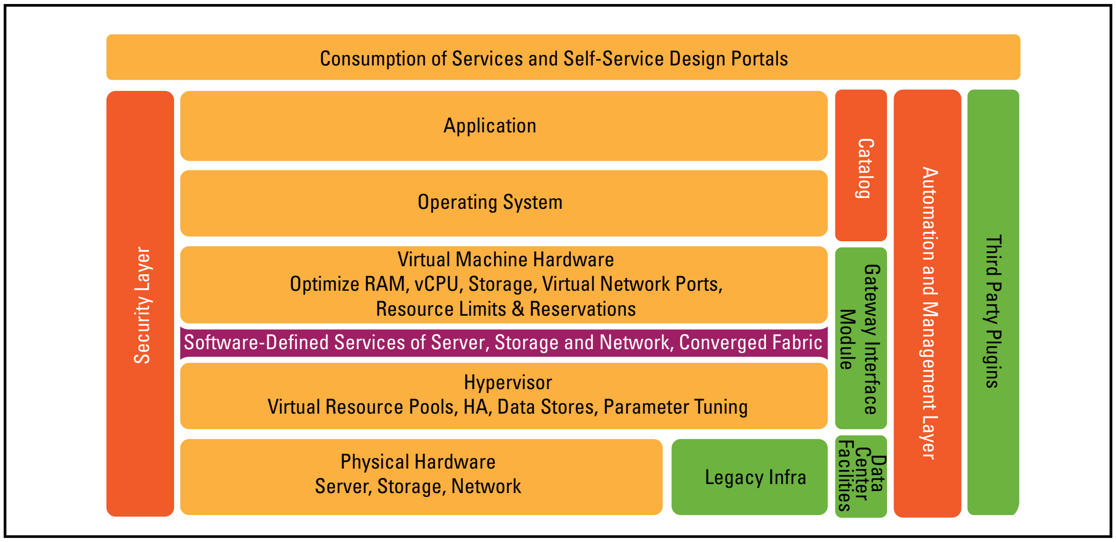

Figure 6

solutions for the data center estate, comprising operations and performance engineering capabilities.

- **Gateway interface module:** For SDDCs to be mainstream, they must be integrated with existing data center components. This gateway module will comprise multi-vendor OEM plug-ins connecting with the existing data center footprint. OEM partners and service system integrators need to drive this.
- **Data center facilities:** Considering that there is an increase in dynamic resource shifts, enhanced power and cooling components are needed to drive control and provision requirements that meet the scale and demands of the data center effectively. Plug-ins and application programming interfaces (APIs) must also be scaled up and tightly coupled with the converged infrastructure.
- **Consumption and service design:** The ability to consume hardware, controlled via software, will materialize through a customized service partner's portal, as well as OEM players' integrated solutions.

As we see from these key tenets of the infrastructure architecture, a very strong integration across multi-vendor components is required. With minimal common standard reference framework and guidelines, SDDC reference architecture will continue to evolve in the next five to 10 years. Figure 7 shows a logical depiction of SDDC to visually explain the challenges we foresee in mainstream adoption.

Future SDDC: A Logical View

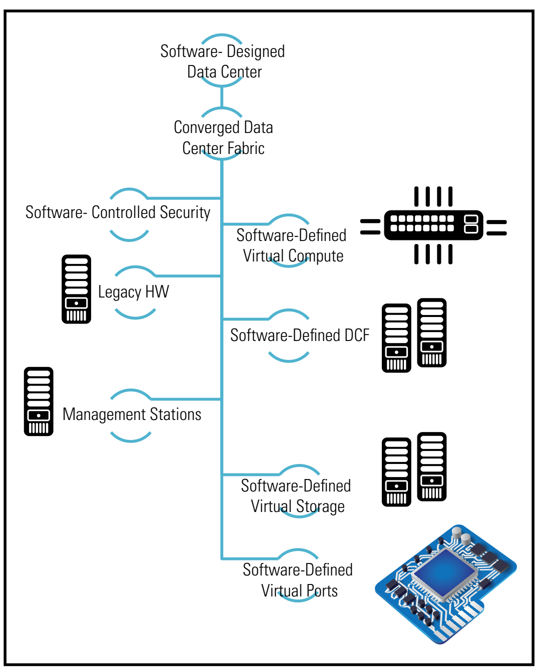

Figure 7

Power and Cooling

As noted above, power and cooling play an important role in making the SDDC vision real. Moreover, a common standard approved reference architecture is needed to convert vision into reality. Given the current state of enterprise architecture, a unified fabric including power, cooling, SAN fabric, IP for LAN and storage block level data through fiber is still more of a vision than a reality.

For a data center, the facilities play an important role in ensuring that the SLAs are aligned and met. Given the mix of data center categories in use (such as tier 1, 2, 3 or 4, with tier 4 data centers built for maximum resiliency and uptime), data center providers must develop integrated and adaptable power and cooling solutions in line with the infrastructure capacity planned and provisioned.

With the software-defined abstraction layer, theoretically numerous virtual machines can be deployed. However, VM sprawl can be disastrous given that there can be only finite amount of power and cooling. To bring these SDDCs in to the mainstream, the data center must optimize power usage. Therefore, providers must redefine key integration touch points of the data center, and build management systems, infrastructure management and monitoring systems.

The potential of software-defined power can be reached if the industry reaches a consensus on a solution with reference architecture and common standards. This will help to provide power to data centers based on demand consumption, rather than planning and provisioning the power and cooling requirements based on preexisting knowledge of peak systems usage.

Management and Monitoring

SDDC will result in the entire data center infrastructure being controlled via software, programmatically turning on and off devices and controlling the behavior of individual systems. Consider mission-critical applications that leverage such an infrastructure and in the event of an incident requiring troubleshooting, the holistic view is of utmost importance; i.e., proper management and monitoring of the data center footprint, along with the ability to quickly identify, diagnose, correlate, isolate and resolve issues. The existing management and monitoring stack for the siloed components will not be effective and responsive enough to be able to help diagnose issues pertaining to the foundational elements of the stack, and can result in excessive lead times for problem resolution. The change will be driven by software that will work at an enormous speed to keep track of individual siloed components.

Management of the stack will be from the abstraction layer within the server, storage, network and fabric. Given the future vision, this will mean commoditizing infrastructure across server, storage and network components and implementing a centralized software module to determine the functionality and features deployed for the bare metal.

Since the SDDC will have bare metal with intelligent software abstracting the hardware and presenting services to applications, the management and monitoring ecosystem needs to be comprehensive multi-vendor, cohesive and integrated. The instrumentation for all the pieces can be collected, grouped, investigated and reported. Figure 8 depicts the holistic management and monitoring stack required as basic building blocks.

The horizontal layers are briefly discussed below.

- **Bare metal:** This is the physical hardware, comprising servers, storage, network and unified fabric — all connected to present the solution to the upper layers.
- **Abstraction layer:** This is the intelligent piece of software, providing the individual logical containers with compute, memory, storage and network, and adhering to overall SLA objectives.
- **Infrastructure and application operations:** These layers comprise APIs and plug-ins that can interface with enterprise monitoring and management software to undertake the operations and performance tuning for infrastructure and applications.
- **Cloud metering and portals:** This is the consumption method and charge-back for the services consumed; this will also be tightly coupled to the overall monitoring and management stack. Given that in SDDC programmatically controlling the response of hardware can change very fast and be tightly coupled with end user action, determining bottlenecks, such as response time across the layers, is of paramount importance.

The vertical pillars of the stack include:

- **Security layer:** This is the end-to-end solution controlling the access and identity of the data (a necessity, given that consumption of resources is programmatically controlled) and to align with the confidentiality, integrity and availability (CIA) of the security triad. This is not merely to be controlled at the guest host or at a logical volume for storage, but rather covers the entire integrated architecture deployed.

SDDC Management Stack Blocks

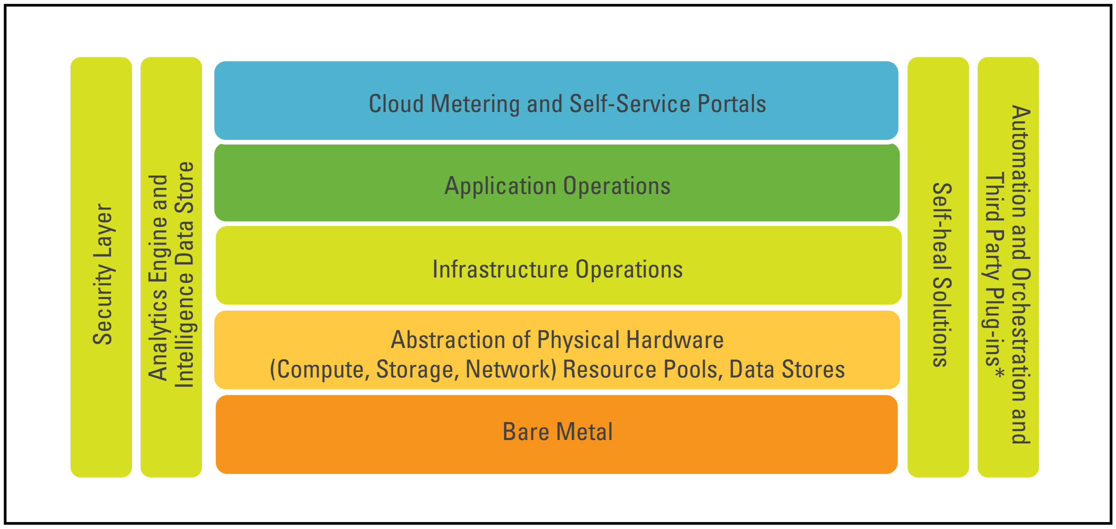

Figure 8

- **Self-heal solutions:** In an SDDC, automation services wherever possible will identify, diagnose, correlate and isolate incidents, and resolve them.
- **Orchestration and third-party plug-ins:** Workflow through orchestration tools and plug-in/APIs with third-party products is needed to control data center resource consumption in an SDDC. The management and monitoring stack will therefore need to be interleaved through these APIs to apply intelligence and predict the behavior of the systems.
- **Analytics engine and data store:** With programmatically controlled infrastructure architecture, there will be huge amounts of audit, log and change management data generated as resource consumption changes. This data surge will require a database with an ability to cull relevant information feeding various systems for information retrieval and reporting. Analytics and intelligence to correlate events, along with a comprehensive data store capability, will be in high demand in such scenarios.

Adoption Path

Depending on the infrastructure's maturity, the enterprise needs to draw up a roadmap to leverage the benefits of SDDC. While SDDC itself is evolving, enterprises must take a proactive view and consider a data center designed for the future, designed for change and nimble enough to adapt to ever-changing technology levers.

Figure 9 depicts the data center maturity curve needed for organizations to take initial steps toward SDDC.

The "inception" to "functioning data center" stage essentially depicts the level of virtualization adopted in the enterprise. The "functioning data center" state to "performing data center" state depicts improvements in virtualization maturity coupled with active automation, self-service portals and converged infrastructure. "Envisaged SDDC" represents the future goal of a data center integrated with legacy infrastructure and aligned with complete automated operations connected to unified fabric. While we know that a true software-defined data center does not exist currently, the steps taken will serve as a business differentiator for enterprises and bring about flexibility and fungibility across IT functions comprising architecture and operations. Enterprises implementing greenfield data center builds are often the prime candidates to leverage the SDDC concept by aligning to the principles of virtualization in their infrastructure footprints.

SDDC Adoption Roadmap

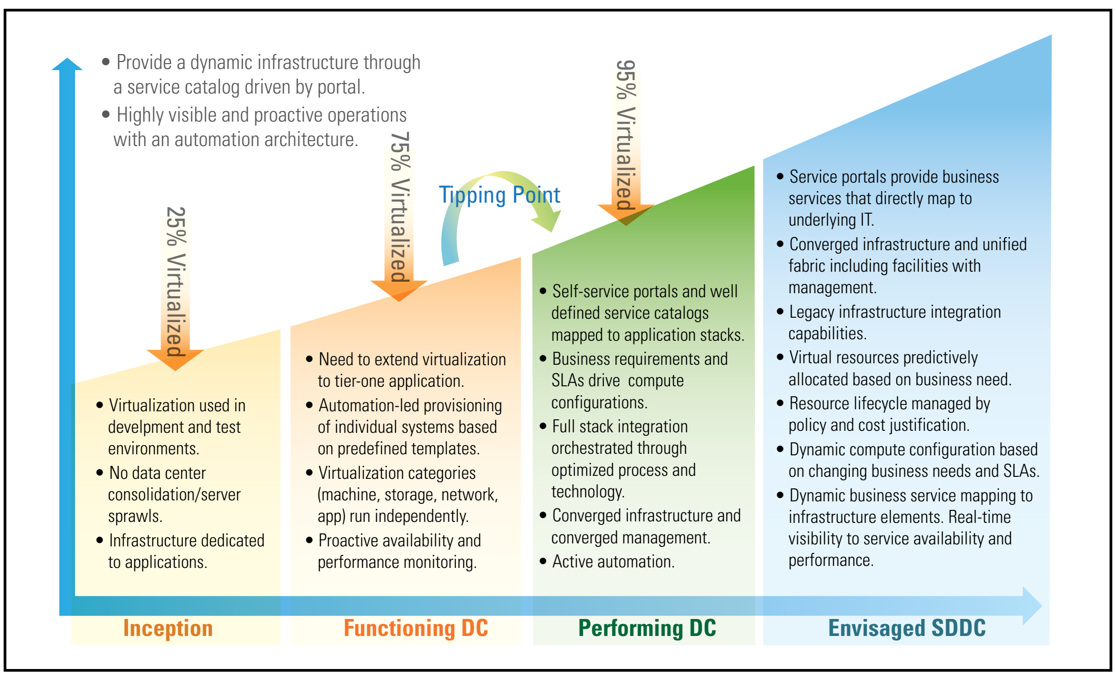

Figure 9

Steps to Move Toward SDDC

To move forward, enterprises need to embrace the following:

- Overcome the resistance to change and have a sustained vision for SDDC, since it could be a long journey for organizations to take.
- Get formal training on the concept.
- Undertake an exercise to refine and validate functionality, licensing policies and support from OEM partners for business applications and commercial off the shelf (COTS) products to be used.
- Create an impact assessment and implementation plan to align SDDC with server build architects, network and security architects and storage architects.
- Onboard and evaluate a data center facilities operator for converged infrastructure implementation.
- Hire an IT security officer to revisit standards and adhere to common objective and security-based goals for the organization.
- Test, undertake a pilot and roll out.

Challenges

To translate the SDDC vision into reality and mainstream adoption, the industry has to overcome several challenges, including:

- Given that an enterprise data center will have different infrastructure maturity standards, the SDDC stack must have a mechanism to identify legacy infrastructure and physical infrastructure and be intuitive enough to have a programmatically controlled environment to integrate such SDDC nuances.
- A common open standards-based framework for software defined networking (SDN) and software defined storage (SDS) to leverage and implement SDDC and interoperability among OEM partners.
- Converged infrastructure and products from OEM vendors could potentially have a vendor lock-in.
- All-inclusive management and monitoring tools to encompass compute, storage, network and facilities, as well as building management systems and a tightly-coupled automation and orchestration solution.

Apart from this, enterprises have to overcome inherent inertia and maintain a sustained SDDC vision.

Benefits

Enterprises will have to wait to see what benefits accrue to SDDC as an end-state solution or vision, similar to early-stage adopters of private cloud services. However, SDDC offers further efficiency and effectiveness in the way IT meets business demands. Considering the hypothetical state of software-defined network implementation, the organization can initially benefit from the virtual port of a device to be programmatically controlled to function as a router or firewall or a load balancer. This will eliminate the need for physical devices for each IT function, thereby enabling enterprises to leverage an optimized infrastructure footprint. Having said this, hardware cannot be eliminated in an SDDC; hardware restrictions (in terms of bandwidth capability for throughput) and storage IOPS capabilities will be governed by the physical hardware deployed. Similarly, with software-defined storage virtualized data can be separated from the physical location of the user to ensure efficient handling of data retrieval and updates. Other benefits include:

- A single view of skills required to administer the entire IT footprint, rather than managing and administering individual, siloed IT components. Fungible skills in the IT environment will be the way forward.
- Achieve standardization across processes and systems and increase utilization of resources provisioned within a data center.
- Transform enterprises to be more fungible and agile to meet business demands in a challenging and dynamic business environment.
- Enable enterprises to provide and build just-in-time environments rather than an infrastructure procurement process for each and every business application.
- Enable enterprises to potentially achieve self-service versus multiple handoffs/touch points within the IT team for resolving issues or for specific request fulfillments with regard to provisioning or capacity enhancements.
- Enable integration and holistic cross-pollination of IT systems.

The Vendor Space

Given SDDC's status as a potential future state, leading vendors are working to ensure their products remain relevant and in concert with this fast-evolving marketplace. As a result, mergers and acquisitions is one route for vendors to either complement or add value to existing products and services. Some recent M&As include:

- VMware's acquisition of Nicira gives VMware the capability for network virtualization via an engine that decouples the physical network from the virtual network. The physical network still has the properties to route packets and align to routing protocols whereas the virtual network maintains policies and accesses lists and services.
- Cisco's acquisition of Cloupia moves Cisco toward a unified and converged infrastructure and management platform.
- Oracle's acquisition of Xsigo enhanced Oracle's capabilities for network virtualization and software-defined networking stacks.
- Brocade's acquisition of Vyatta extends its reach into SDN, providing the ability to deliver software-based network OS with firewall, routing and VPN capabilities for cloud services delivery.
- EMC's acquisition of Syncplicity and development of ViPR for software-defined storage for storage virtualization and self-service provisioning; ViPR's controller can support broad and varying storage technologies for integration with APIs for onboarding disparate storage systems.

Looking Forward

SDDCs have the potential to help enterprises radically shift the way infrastructure has been architected, deployed and managed. As discussed above, the proposition for enterprises is to move from a workload-defined architecture considering volumetric and growth while sizing and architecting infrastructure, to a software-defined infrastructure architecture wherein dynamic workloads can be defined, provisioned and managed. The challenges discussed in this paper are critical, and OEMs and vendors will need to address this holistically rather than only look at discrete virtualized resources to maximize adoption of the future goal of building an SDDC.

If and when this paradigm shift to SDDCs is fully embraced and propelled to the mainstream, it will revolutionize the service marketplace, as OEM partners, system integrators, data center providers, managed service partners and implementers will reorient their efforts toward subscription-based enterprise services. We believe that there will be a plethora of tools and accelerators enabling this vision.

It now remains to be seen how the industry moves forward with SDDC thinking and develops products designed to maximize its adoption. There are a few early movers thus far, such as VMware and Cisco. However, with mergers and acquisitions, the large players referenced above can quickly enter the race to help realize this future vision.

Appendix

Forrester's definition of an SDDC: "An SDDC is an integrated abstraction layer that defines a complete data center by means of a layer of software that presents the resources of the data center as pools of virtual and physical resources, and allows them to be composed into arbitrary user-defined services."

IDC defines SDDC as "a loosely coupled set of software components that seek to virtualize and federate data center-wide hardware resources such as storage, compute and network resources and eventually virtualize facilities-centric resources as well. The goal for a software-defined data center is to tie together these various disparate resources in the data center and make the data center available in the form of an integrated service..."

References

- http://www.forrester.com/The+SoftwareDefined+Data+Center+Is+The+Future+Of+Infrastructure+Architecture/fulltext/-/E-RES81941.
- http://www.virtualizationpractice.com/software-defined-data-center-analytics-21481/.
- http://www.tintri.com.
- http://www.forbes.com/sites/danwoods/2013/04/10/why-software-defined-data-centers-cost-much-more-without-optimized-power-and-cooling/.

- http://www.infoworld.com/print/199930.
- http://www.data centerknowledge.com/archives/2013/05/07/emc-unveils-vipr-software-defined-storage-platform/.
- http://www.computerweekly.com/feature/Software-defined-datacentres-demystified.
- http://www.informationweek.com/cloud-computing/infrastructure/interop-cloud-experts-debate-sdns-future/240154473.
- http://blog.shi.com/2013/01/03/making-sense-of-the-software-defined-data-center/.
- http://www.virtualizationpractice.com/building-a-management-stack-for-your-software-defined-data-center-20676/.
- http://www.virtualizationpractice.com/sddc-application-performance-management-21497/.
- http://www.tintri.com/blog/2013/05/emergence-software-defined-data-center.
- http://www.tintri.com/vision.
- http://www.tintri.com/blog/2013/05/crossing-storage-chasm.
- http://www.tintri.com/blog/2013/05/virtualization-exposes-shortcomings-legacy-storage.
- http://www.tintri.com/blog/2013/05/vm-aware-storage-to-the-rescue.
- http://ronriffe.wordpress.com/2013/05/08/how-do-you-define-software-defined-storage/.
- http://www.techrepublic.com/blog/networking/the-evolution-of-the-data-center-abstraction-layers-stp-and-trill/5784.
- http://searchvmware.techtarget.com/feature/Applying-cloud-VMware-virtual-networking-concepts-to-your-data-center.
- http://www.powerassure.com.
- http://www.vmware.com.
- http://blog.scottlowe.org/2013/04/30/on-network-virtualization-and-sdn/.

About the Author

Sandeep Raghuraman is a Principal Architect within Cognizant's IT Infrastructure Services Business Unit. In this role, he helps clients recognize tangible business benefits by implementing transformational IT initiatives. With 15 years of experience in various IT functions, from operations and consulting through architecting solutions, Sandeep's areas of expertise include infrastructure consulting and IT strategy. He holds a post-graduate diploma in business management and a bachelor's degree in engineering from Mumbai University. He can be reached at Sandeep.Raghuraman@cognizant.com.

About Cognizant

Cognizant (NASDAQ: CTSH) is a leading provider of information technology, consulting, and business process outsourcing services, dedicated to helping the world's leading companies build stronger businesses. Headquartered in Teaneck, New Jersey (U.S.), Cognizant combines a passion for client satisfaction, technology innovation, deep industry and business process expertise, and a global, collaborative workforce that embodies the future of work. With over 50 delivery centers worldwide and approximately 164,300 employees as of June 30, 2013, Cognizant is a member of the NASDAQ-100, the S&P 500, the Forbes Global 2000, and the Fortune 500 and is ranked among the top performing and fastest growing companies in the world. Visit us online at www.cognizant.com or follow us on Twitter: Cognizant.

Cognizant

World Headquarters
500 Frank W. Burr Blvd.
Teaneck, NJ 07666 USA
Phone: +1 201 801 0233
Fax: +1 201 801 0243
Toll Free: +1 888 937 3277
Email: inquiry@cognizant.com

European Headquarters
1 Kingdom Street
Paddington Central
London W2 6BD
Phone: +44 (0) 20 7297 7600
Fax: +44 (0) 20 7121 0102
Email: infouk@cognizant.com

India Operations Headquarters
#5/535, Old Mahabalipuram Road
Okkiyam Pettai, Thoraipakkam
Chennai, 600 096 India
Phone: +91 (0) 44 4209 6000
Fax: +91 (0) 44 4209 6060
Email: inquiryindia@cognizant.com