OCZ enterprise

Flash Delivery in the Software-Defined Data Center

OCZ VXL Software Addresses the SDDC Vision of the Future with Software-Defined Flash Delivery

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1 Introduction*

Over the last decade, the enterprise data center has been transformed into a more dynamic and efficient platform to meet the changing needs of business applications due primarily to the advent of server virtualization. This technology has enabled multiple virtual server loads to run concurrently on a single physical host increasing server CPU and memory resource utilization while simplifying the deployment, high availability (HA) and maintenance of the server loads as well. This virtualized approach of partitioning server resources has radically changed data center economics for the better delivering lower server capital expenditures (CAPEX), operating expenses (OPEX) and total cost of ownership (TCO). Market research firms estimate that over 50% of all data center applications today run on virtual machines (VMs) as virtualization is now an indispensable software component of the corporate IT infrastructure.

While server virtualization delivers impressive data center productivity gains for enterprise servers, the rapid expansion of virtual deployments has impacted storage and network facilities causing performance bottlenecks and sharp increases in IT administration and infrastructure investments. Many legacy physical storage systems are designed for static allocations and are difficult to manage from an IT perspective in a dynamic data center. For today's software defined data center (SDDC) to achieve its full potential, dynamic networking and storage capabilities beyond server virtualization that improve IT asset utilization and operational efficiencies are required.

In the legacy server virtualization model, a business-critical application typically required weeks to deploy, not because of VM provisioning, but rather that the other resources needed by the application, such as storage, networking and security, are physical resources (not virtual ones) that typically require a great deal of IT time to provision. With this imbalance of virtual compute and physical storage and networking resources, the full potential of server virtualization cannot be realized.

OCZ's proven VXL Cache and Virtualization Software in conjunction with its flash-based Z-Drive R4 PCI Express (PCIe) SSD delivers a complete virtual performance system that accelerates VM applications...

Hence, the software-defined data center vision takes what virtualization software has achieved for servers and delivers virtualized capabilities to the entire set of resources required by the application so they can be automatically and quickly deployed with little to no human involvement. Achieving this vision requires an automated infrastructure so that applications can be operational in minutes, shortening time-to-value, while dramatically reducing IT costs and the time expended to application provisioning and deployment.

To realize the SDDC vision, storage hardware and software architectures must be adapted so that storage can be provisioned and responsive to the dynamically changing requirements of the software-defined data center. As a result, enterprise flash is positioned as a key enabler for these new storage architectures and with the right combination of hardware and software, enables efficient, cost-effective and high-performance storage services delivery.

The purpose of this white paper is to introduce the key requirements for the SDDC vision and to present how OCZ delivers and manages flash in this platform as a dynamic, connected and simple-to-manage component providing all of the benefits of flash without compromise. OCZ's proven VXL Cache and Virtualization Software in conjunction with its flash-based Z-Drive R4 PCI Express (PCIe) SSD delivers a complete virtual performance system that accelerates VM applications enabling flash resources to be dynamically deployed exactly to the needs of VMs.
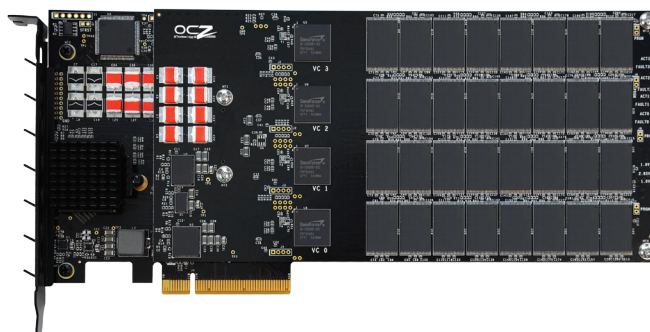
Z-Drive R4 PCIe SSD

2 The SDDC Model*

The software-defined data center is an industry-wide vision and transformative enterprise platform that fundamentally changes how organizations deliver IT services so that users and IT operations are both benefitted. Business users get faster deployment and more reliable access to the applications and data they need while IT departments reduce operating and capital costs, and with simplified operations, have more time to devote to enterprise innovation. The

Hard drive-based SANs simply cannot keep up with server workload demands and are not suited to enable the SDDC vision of the future.

process requires IT staff to evaluate and assess how to best manage and utilize all data center resources whether they are virtual or physical.

In support of the SDDC vision, physical resources such as Compute, storage, networking and security, are deployed automatically from resource pools speeding application roll-out time. By pooling and intelligently assigning application resources based on need, the SDDC maximizes use of its physical resources enabling allocations to be reassigned quickly when market requirements change. This extends the value of the resource investment while reducing IT intervention to address routine tasks.
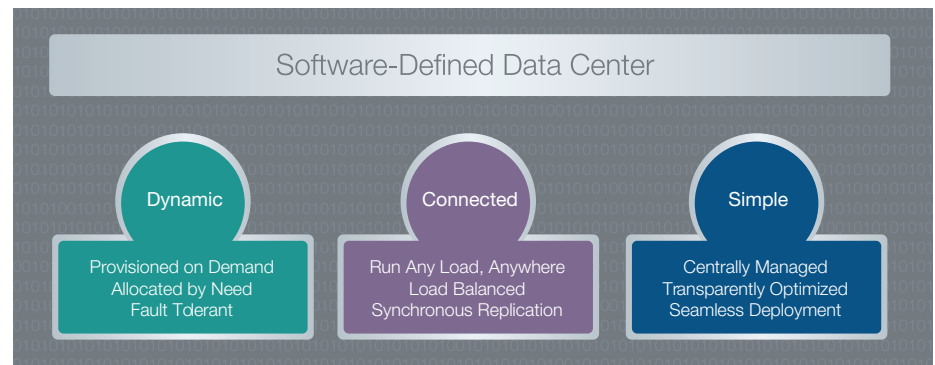

Figure 1: In order for the Software-Defined Data Center to be effective, it must be Dynamic, Connected and Simple

There are three key areas of the SDDC vision that need to be addressed in order for this transformative platform to be effective, as outlined in Figure 1. The SDDC must be **dynamic** and enable provisioning on demand, allocation by need and be fault tolerant. It must also be **connected** so that loads are balanced and can be run anywhere, at any time, while supporting continuous business-critical data access through synchronous data replication and high availability (HA). It must also be **simple** to install and centrally managed with policies optimized for key applications.

3 Hard Disk Limitations

When server virtualization was traditionally added to an IT environment, all application data was typically placed in an external repository such as a storage area network (SAN) to retain the ability of dynamically running any application load from any data center server. While servers can handle millions of input/output operations per second (IOPS), a traditional hard disk drive (HDD) can only deliver between a hundred to three hundred IOPS performance. This performance disparity between servers and hard drives has been and continues to be quite evident so as more virtual servers are added to the data center, hard drive-based SANs simply cannot keep up with server workload demands
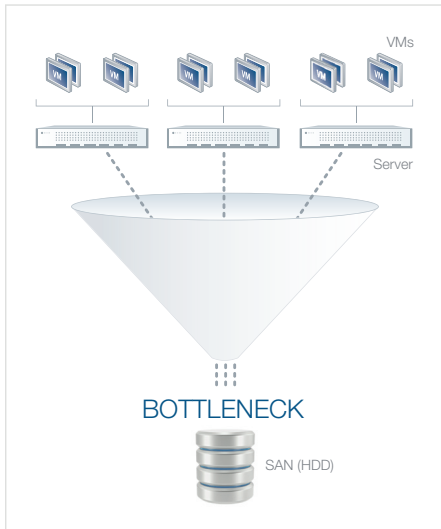
Figure 2: Concurrently running multiple virtual machines (VMs) in a virtualized environment will cause heavy randomization of data access towards the SAN resulting in performance bottlenecks.

and are not suited to enable the SDDC vision of the future. HDD storage has become an inhibitor of virtualization as depicted in Figure 2.

In contrast to HDD storage, flash memory technology, having no moving parts, provides significantly higher IOPS performance, is capable of powering 10 times the application loads of hard drives, and with no mechanical or physical limitations, seamlessly handles random data loads. The result is lower total cost of ownership (TCO) (reduced power and cooling consumption, maintenance and service costs, and installation costs) making it a superior enabler of virtualization and a perfect fit for the SDDC vision.

4 Dynamic Software-Defined Flash Delivery

This section outlines the **dynamic** requirements of the SDDC vision and how OCZ VXL Software supports these requirements through software-defined flash delivery (SDFD).

SDDC Requirements	OCZ Software-Defined Flash Delivery
Dynamic	**Dynamic**
Provisioned on Demand Allocated by Need Fault Tolerant	Flash Virtualization Dynamic Cache Allocation Flash Fault Tolerance (FT)

A dynamic SDDC environment enables its virtual and physical resources to be provisioned on demand. One way to achieve on-demand provisioning is through **flash virtualization**. As one of the first enterprise solid-state solutions providers to achieve successful flash virtualization through its VXL Caching and Virtualization Software and flash-based Z-Drive R4 PCIe SSDs, OCZ efficiently distributes randomized data between all available flash memory cells locally on-host while delivering a complete virtual performance system that accelerates VM applications. VXL Software creates a flash virtualization layer on top of the VMware ESXi hypervisor that enables IT managers to dynamically deploy flash resources exactly to the needs of VMs enabling SDDC provisioning on demand.

To allocate application data by need as part of the SDDC vision, OCZ VXL Software also features **dynamic cache allocation**, as outlined in Figure 3, whereby the flash cache is dynamically pre-loaded with application data in advance of demanding jobs to accommodate specific business-critical workloads that need to run at scheduled times. VXL Software addresses this requirement through a unique 'business-rule' pre-warming cache engine that adapts the flash cache to the workload cycle in the data center. This enables IT managers to automatically pre-warm the cache to assure that relevant data
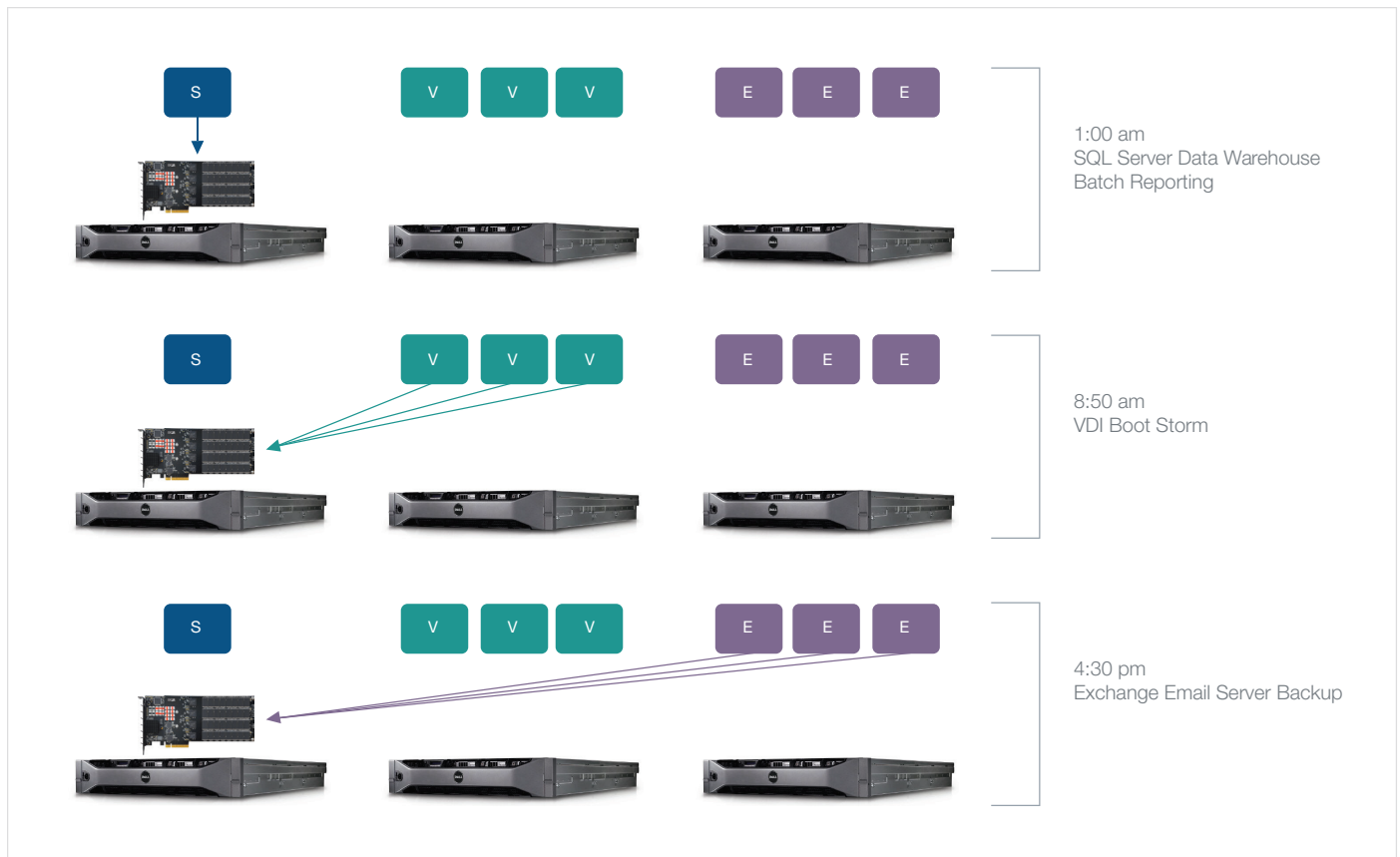
Figure 3 represents OCZ's dynamic cache allocation using an innovative 'business-rule' pre-warm cache engine that adapts the flash cache to the workload cycle in the data center.

resides in it in time for use by the application. For example, Virtual Desktop Infrastructure (VDI) boot data would be fully loaded in cache in the morning hours prior to users arriving to work while a data warehousing job would be fully loaded in cache late in the evening so that the flash resources are utilized to their full potential in the SDDC model.

Fault Tolerance (FT) is yet another important requirement of the dynamic SDDC environment being one of the most demanding virtualized services for continuous, non-interrupted availability of application data during planned or unplanned server downtime. To achieve successful FT, two live identical copies of a VM (mapped down to the last bit) are deployed so that one copy can be an immediate backup for the other. Synchronous mirroring between hosts and high availability are used to assure no downtime or data loss during failures. Though both VMs have identical flash volumes, one is live while the other is replicated data that creates a **flash fault tolerant environment** as the two VMs continue to run in parallel so that commands and new data written by one server are synchronously replicated to the other. If a server failure occurs, VXL Software automatically switches over to alternate flash copies on other servers enabling operations to continue from the exact point when the downed server stopped as if no problem occurred, supporting a fault tolerant SDDC.

5 Connected Software-Defined Flash Delivery

VXL Software does not require agents for communication between VMs and supported SSDs because it resides on the VMware hypervisor enabling data to be shared from any server or VM no matter where the user accesses the network.

This section outlines the **connected** requirements of the SDDC vision and how OCZ VXL Software supports these requirements through software-defined flash delivery.

SDDC Requirements	OCZ Software-Defined Flash Delivery
Connected	**Connected**
Run Any Load, Anywhere Load Balanced Synchronous Replication	Network-Exposed Flash vMotion without Cache Loss Flash Storage Mirroring

The connected SDDC environment enables any application workload to be run any time and from any system point of entry. OCZ VXL Software supports the connected SDDC vision by enabling intelligent and efficient on-demand distribution of SSD flash resources between all connected VMs so that the Z-Drive R4 PCI SSD can be virtualized as a highly available **network-exposed flash** resource to be shared amongst any VM in the cluster regardless of location making sure that no VM inefficiently occupies flash when it can be better used elsewhere in the environment. The flash cache is optimally used at all times regardless of how many VMs are running concurrently and even though the flash cache resource is located in one server, it can be shared across multiple servers to support the SDDC connected vision.

A connected SDDC environment also requires balanced application workloads to provide maximized and consistent server and storage utilization, which in turn, enables users to get more work done in the same amount of time and get access to application data much faster than hard drives. Through full support for **vMotion**, OCZ VXL Software enables transparent and dynamic VM migration from one server to another, without data loss as it treats cached data as a virtualized storage entity that can be continually accessed between VMware ESXi servers whenever VMs are migrated. As VMs migrate from the local ESXi host to a remote host, VXL Software identifies the VMs that are remotely serviced and transfers the local flash connectivity to remote connectivity to support dynamic VM load balancing while eliminating the drastic performance drops that occur due to the loss of cached data.

Synchronous data replication is also a requirement of the connected SDDC environment so in the event of a planned or unplanned system stoppage, a live copy of data will always be available to users so they can continue working as if no downtime occurred. To achieve successful data replication, OCZ VXL Software and connected Z-Drive R4 PCIe SSDs produce two live and identical

copies of a VM's data (mapped down to the last bit) so that one copy is an immediate alternate. As outlined in Figure 4, OCZ synchronous data replication enables mirroring between Z-Drives and between SAN storage systems whereby one cache services both mirroring sets.

6 Simple Software-Defined Flash Delivery

This section outlines the requirements for **simple** manageability of the SDDC vision and how OCZ VXL Software supports these requirements through software-defined flash delivery.

SDDC Requirements	OCZ Software-Defined Flash Delivery
Simple	**Simple**
Centrally Managed Transparently Optimized Seamless Deployment	StoragePro Flash Manager Application-Optimized Caching Seamless Flash Deployment

A simple-to-manage SDDC environment requires central management and monitoring of all flash resources so that IT managers are afforded specific storage and drive details on performance, reliability and operations to identify potential system and/or storage problems in advance and to quickly execute proactive solutions. This level of remote host and SSD management provides the system information and manageability that IT professionals need to perform firmware updates, BIOS updates, Secure/Erase operations, system reboots, remote access configurations to the host, and additional mission-critical actions that maximize data center return on investment (ROI) and associated enterprise flash resources.

Through its **StoragePro XL flash management system**, OCZ centrally monitors and manages OCZ enterprise drives connected to network servers, storage arrays or appliances. It's a network-accessible management system that provides IT managers with a cross-platform view of their enterprise flash resources for unified management and monitoring, and simplifies network administration by enabling connection to multiple host systems across the network. The user-friendly StoragePro XL provides the following key capabilities:

- A structured view of host and SSD activity throughout the data center
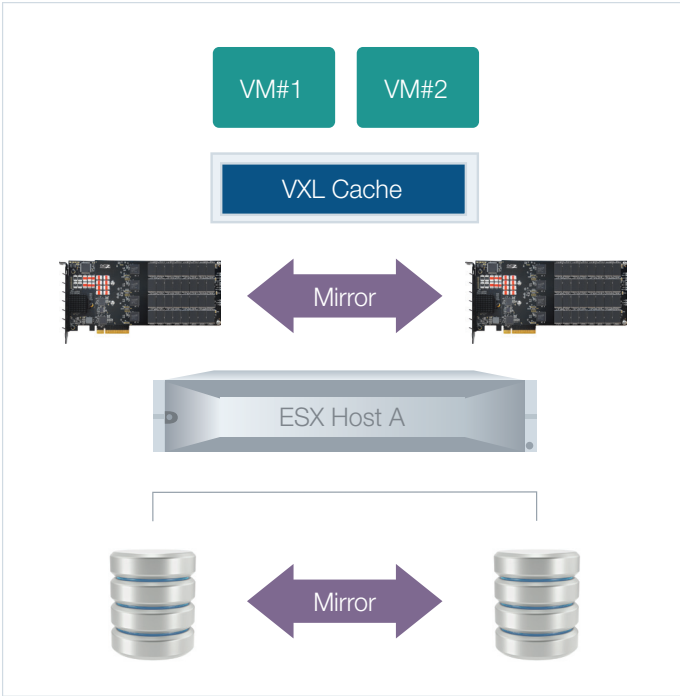

Figure 4: VXL Software enables synchronous data replication (mirroring) between Z-Drive R4 PCIe SSDs and between SAN storage systems using one cache to service both.

StoragePro XL is a network-accessible management system that provides IT managers with a cross-platform view of their enterprise flash resources for unified management and monitoring.

- Critical alert displays and warnings from hosts and connected SSDs
- Simpler and easier SSD installation, allocation, management and maintenance
- The ability to centrally perform fast, routine SSD maintenance runs and host system checks

The simple SDDC vision also requires optimization of SSD tools and capabilities that should be transparent to end-users. In this regard, OCZ VXL Software's advanced policy-based algorithms enable IT administrators to simply select from a set of **optimized application-specific caching policies** so that knowledgeable selections can be made on what data to store in SSD cache. The VXL caching algorithms take into account specific needs of each VM and their priorities based on the application policy as each policy combines data collected from a storage access heat map using application storage access DNA. This policy-based engine capability removes the need for IT managers to manually optimize flash usage to their particular loads as they can simply select from the set of pre-optimized policies.

VXL Software combines the policy selection engine with 'read-ahead, read-around' algorithms that keep the data in the cache relevant at all times. The accessed heat map data is then combined with the sequential read detections and other I/O parameters to determine the best cache data selection taking into account the requests from the collection of connected VMs. The result is flash delivered application-optimized caching policies that meet the SDDC simple vision of the future.
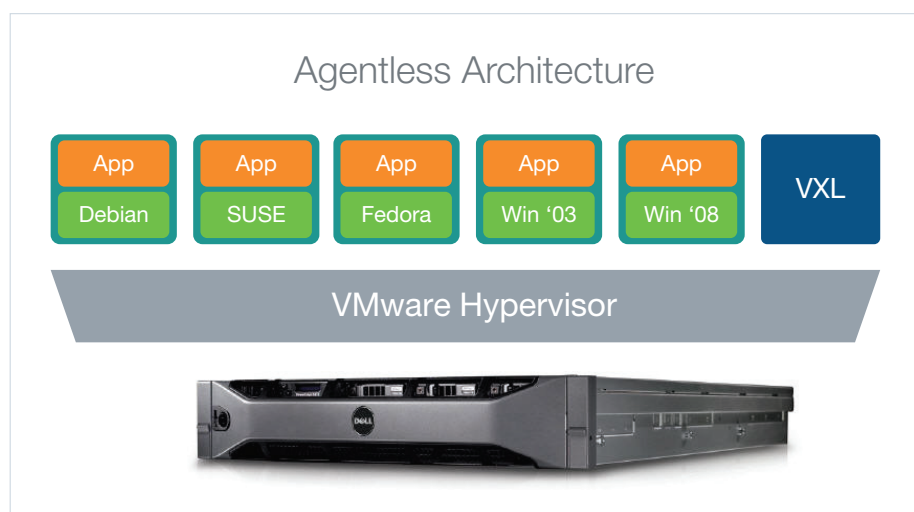

Figure 5: VXL Software provides an agentless architecture that supports any Linux, Windows or guest hypervisor OS

The last of the requirements for the simple SDDC environment calls for **seamless, ubiquitous flash deployment** enabling flash resources to be addressed, connected and easily managed as one highly-available network

OCZ delivers virtualized capabilities to the physical resources required by the application so they can be automatically and quickly deployed with little to no human involvement.

resource. OCZ VXL Software does not require agents or special drivers for caching VM data on the Z-Drive PCIe cards because it communicates directly with the virtualization hypervisor as outlined in Figure 5.

This enables IT staff to scale its Z-Drive R4 PCIe SSD flash requirements based on demand and purchase only as much SSD flash as is required eliminating over-provisioned storage capacity. This 'no agents' approach dramatically simplifies the deployment, management and maintenance of flash storage especially when there are hundreds or thousands of VMs in the virtualized environment that once again supports the connected SDDC vision of the furture.

7 Conclusion

The software-defined data center is a logical extension of server virtualization, and similar to the way that virtualization dramatically maximizes computing power, the SDDC vision of the future should do the same for all of the resources needed by an application (Compute, storage, networking and security). In order for this transformative platform to be effective, it must be dynamic, connected and simple so when storage hardware and software architectures become SDDC-compliant, application resources can be provisioned and respond quickly to the changing market requirements. Enterprise flash is positioned as the key enabler for these new architectures, and with the right combination of hardware and software, efficient, cost-effective and high-performance flash delivery in the SDDC can be enabled.

Combining storage virtualization with PCIe flash caching, OCZ developed a hardware/software SDDC solution that takes advantage of the power of flash without losing any of the benefits associated with virtualization. It treats flash as just another virtual resource and creates a central virtual appliance that works with the VMware ESXi hypervisor to dynamically distribute flash according to need, inside and outside of the physical server, increasing the number of VMs that can run on the host infrastructure by a factor of ten. As such, OCZ delivers virtualized capabilities to the physical resources required by the application so they can be automatically and quickly deployed with little to no human involvement.

In summary, the key benefits of OCZ's VXL Software/Z-Drive R4 PCIe SSD software-defined flash delivery solution include:

- **Faster Time to Value** – provision resources in minutes so that key applications are up and running quickly

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- **Reduce TCO** – cut capital spends (CAPEX), reduce on-going maintenance and operating expenses (OPEX) and devote less time to routine tasks
- **IT Innovation** – with less time spent on routine resource provisioning, IT staff can focus on more strategic initiatives that drive innovation and a key expectation of corporate IT departments today.

*PLEASE NOTE: The Introduction and SDDC Model sections include references from VMware's Business Brief entitled, "Delivering on the Promise of the Software-Defined Data Center"