Defining Software Defined Storage

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Defining Software Defined Storage (SDS) version 2

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Overview

Ever since the 1990s, when the technology vendors recognized that the financial markets valued software higher than hardware, the IT vendors have been on a quest to defined themselves as software companies.

To that end, vendors evolved their storage systems to being more software heavy. In fact, Neuralytix believes that *all* contemporary storage systems are *software-based*. But the term *software-based* does not, in any way define a storage system as being *software-defined*.

By 2010, this frenzy reached a blatant and overt peak, when vendors started to identify their solutions as being "software-defined". These monikers started with Software-Defined Networking (SDN), and quickly followed with the Software-Defined Data Center (SDDC). Before long, the storage industry joined in and introduced the *Software-Defined Storage (SDS)* nomenclature.

In this Neurapective™, Neuralytix will look at leading storage systems vendors and the impact of the Software-Defined Storage (SDS) moniker. We will proffer a singular definition of SDS, and provide an analysis of its implications and ramification on the storage systems industry.

We are singling out the storage systems market since the greatest variations in definitions and approaches are present in this space. We do not disregard that companies including Symantec, RedHat (through its Gluster acquisition), and various open-source movements such as Open Stack, have already made significant in-roads in creating a software-defined storage abstraction layer.

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Introduction

Neuralytix decided to release this second version of this document based on input from our initial document. The only edits have been made in the Appendix. There has been no change in our position, or our opinions.

Most storage vendors, both large and small, have offered their own interpretation of what Software-Defined Storage (SDS) means. Neuralytix has reached out to the leading storage system vendors in an attempt to find common ground among them in order to derive a common singular definition of SDS.

We specifically picked storage systems vendors as it is within these ranks that variations in definition and approaches seem to be greatest.

A quick history

In the beginning, storage was considered a peripheral to computers. As the capabilities of CPUs improved and the cost of processing decreased, users were able to store more and more information and generate an exponentially greater amount of value from data and information.

During this time, the prominence of data storage within an IT infrastructure grew. The problem today, is that the cost of storage can often be the overwhelming majority of the cost of any infrastructure deployment.

Creating an architecture in which data can be interchanged, processed, reused and protected over a long period can often be cost prohibitive. Additionally, the combination of corporate and regulatory compliance, and the tendency for most enterprises to retain multiples copies, generations and formats of a single data object is exponentially adding to the cost of storage.

To combat this, over time, users have had two choices: either leverage a third party abstraction layer, such as Symantec's Veritas File System (an early software-only SDS

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solution); or purchase storage from a single vendor. These choices have pros and cons to each. But with the rising number of lower cost, next generation, start-up storage systems vendors coming into the market, users ultimately wanted choice to take advantage of advances in the areas of scalability, flexibility, interoperability, data-interchangeability, while weighing these attributes against cost effectiveness, and risk.

Software-Defined Storage (SDS) is ultimately a means to an end. It is not a technology or a specific product.

Defining Storage-Defined Storage (SDS)

Neuralytix defines Software-Defined Storage (SDS) as:

> *A set of technologies that present a unified set of storage services across a federation of heterogeneous servers and storage capacity.*

We will discuss in more detail how we arrived at this definition later in the paper. However, a major reason for writing this paper is that the storage systems industry does not seem to adhere to any specific definition of what SDS encompasses.

To this end, Neuralytix invited the following leading storage systems vendors to participate in this paper:

- Dell
- EMC
- Hewlett-Packard (HP)
- Hitachi Data Systems (HDS)
- IBM
- Oracle
- NetApp

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Neuralytix selected these storage systems vendors because the combined market share of these vendors make up a vast majority (over 70% of the entire storage systems market), and depending on the year, can approach nearly three-quarters of the storage systems market. As such, these vendors have the greatest opportunity to make a major impact on the market.

Each vendor was offered the opportunity to present:

- Its definition of SDS;
- Which of its product portfolio best represents its approach to SDS along with its licensing strategy; and
- Why their approach was superior to its competitors.

In some cases, Neuralytix followed up with an interview to gain further clarity to each vendor's response.

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The long-windedness of each of the responses received[1] from the participating vendors is a strong indicator that vendors are trying very hard to be "inclusive" of all forms of SDS. However, in doing so, vendors leave users with a distinct lack of clarity and confusion.

Some vendors approached it with a specific set of its own set of products (such as EMC). Others were less definitive about their specific offerings, instead, deferring to naming partnerships and referencing open source solutions that couple with their traditional storage systems products (Dell and HDS).

The vast spectrum of answers leads a number of questions to be asked:

- Is SDS revolutionary or evolutionary?
- Is SDS an appliance or just software?

[1] Extracts from vendor responses are included in the Appendix

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- What/Who manages SDS – the application or an administrator?
- Is SDS a homogeneous or heterogeneous solution?
- Is SDS a uni- or multi-vendor solution?
- Is SDS a solution or a concept?
- Where does SDS "exist" – in a storage system, in the hypervisor, or in the network?

The criteria for Software-Defined Storage

Neuralytix believes that a definition for SDS should be succinct. In deriving an official definition, we looked at the criteria around which SDS should be expressed:

- It must integrate a heterogeneous storage network architecture, including a heterogeneous federation of storage systems into a single "virtual" storage array;
- It must support a federation of heterogeneous servers;
- It must offer a unified automation, orchestration, provisioning, monitoring and management capabilities; and
- It must virtualize all underlying storage systems and storage networking to a common abstraction layer.

Distinguishing Software-*Defined* Storage, and Software-*Driven* Storage

From the very first file servers, we have had software-***driven*** storage. Storage solutions that are essentially just-a-bunch-of-disks (JBOD) driven by a storage-centric operating system/environment.

This is nothing new. Sun created NFS to "appliantize" this approach. NetApp seized on the opportunity, and as such, has had software-driven storage from the beginning. As soon as the storage industry stopped "siliconizing" storage features and functions, it became software-driven storage.

Obviously, both software-driven and software-defined storage both leverage software. The types of storage services offered distinguish between the two. Software-driven storage is

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simply a single storage system that relies on software to run and deliver storage. On the other hand, SDS extends this to support multiple storage systems.

Control or data path

Neuralytix believes that software-*driven* storage has the distinction of operating along the data path. While software-*defined* storage has the distinction of operating on the control path.[2]

The data path is the "path" or typically the network connection through which the actual data travels and is read or written. While traditional storage systems combined both control and data paths into one network connection, SDS solutions can separate the two.

The control path on the other hand, can be considered an "out-of-band" management of the data. This "path" helps to direct data traffic between the physical storage system and a specific (set of) host(s). These functions include whether data would be replicated, whether data should be delivered within the context of a specific protocol, etc.

As many storage systems today offer functions along the control *and* data paths. So the distinction between the two terms must extend beyond operating functions.

SDS is a set of technologies

SDS is a set of technologies, not just one technology. This means that it includes both hardware and software. Neuralytix already observes that vendors are offering a diverse combination of hardware and software. These combinations help vendors to differentiate themselves from each other, while allowing them to optimize their solution towards specific application workloads.

[2] SDS can from time to time extend to the data path, but this is more opportunistic than absolute. Some storage systems managed by SDS may lack the features expected by SDS, and as such the SDS software should be able to compensate. An example of this is if the underlying storage system does not have file capabilities.

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The software would include a universal control point that is accessed through some form of API (eg. REST). This provides universality for automation, orchestration, provisioning, monitoring and management. Through this API, administrators will no longer need to learn about every storage system in a particular environment, but instead manage all of them from a common interface.

Another benefit of an API is the ability to collect data than can be processed and analyzed (for example using Big Data) to generate improved automation through machine learning.

The heterogeneity of SDS is critical to its distinction from software-*driven* storage. As mentioned, most contemporary storage systems architectures are in large software-*driven*. However, software-*driven* storage systems are distinct from SDS systems in that they are not able to support media from multiple vendors. Therefore, software-*driven* storage is a homogeneous solution. This includes most SAN and NAS systems available today.

SDS, on the other hand, must natively support heterogeneous block storage. Therefore, storage systems such as EMC's VPLEX, HDS' VSP, IBM's SVC and NetApp's V-Series would qualify under this attribute.

As a minimum, the set of storage services offered by SDS must include:

- Automation;
- Provisioning;
- Orchestration;
- Monitoring; and
- Management.

SDS vendors may support a set of individual disk drives, JBOD or a simple array of disks. Depending on the propensity and vision of the vendor, the storage media subsystem may include RAID functionality (to offload the RAID calculations to a dedicated microprocessor

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or ASIC), or it may leverage techniques such as replication, mirroring or erasure coding to provide fault tolerance.

SDS will also provide distinction from traditional storage systems in that it should integrate off-premise capacity. Neuralytix believes that by 2016, all SDS will be able to integrate and manage both on-premise and in-cloud capacity as a unified data storage architecture.

SDS software may, or may not, provide file-to-block or object-to-file, or object-to-block translations. Instead, the SDS may leverage the native capabilities of the underlying storage systems to provide these functions.

SDS software may, or may not, duplicate features or functions of the underlying storage systems. Neuralytix believes that this duplication is necessary given that SDS is evolutionary and not revolutionary. By duplicating some functions, it allows the user to derive the benefits of a common, unified set of storage services, and giving customers choice.

SDS can be instantiated in many ways. It can be software at the server level (eg. EMC's ViPR), or it can be an appliance (eg. HDS' VSP, IBM's SVC and NetApp's V-Series).

Licensing

Upfront Investment

Licensing of SDS varies widely. There are open source solutions that have no upfront costs (eg. OpenStack) for the software. There are proprietary solutions from vendors such as Symantec.

Many vendors have also taken a capacity based licensing schema (such as EMC's ViPR and HDS' VSP).

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Finally, companies such as NetApp have taken a "once-and-done" appliance approach where the only upfront investment is the appliance itself.

Operating Expenses

Neuralytix also asserts a very specific requirement for SDS. There must be a single service contract for the entire SDS solution.

This specifically and explicitly excludes multi-vendor solutions that require multiple service contracts for the solution. An example of such would be Dell's partnership with Nexenta, whereupon, to support the solution, a user would have separate service contracts with Dell and Nexenta respectively.

The reasoning behind this specificity is that the industry is moving towards a highly converged approach to solutions. Product bundling is not particularly evolutionary nor revolutionary.

Neuralytix also believes that given the complexity of SDS solutions and the high number of interdependencies, there must be a "one-throat-to-choke" approach to support.

Conclusion

Therefore, what does all this mean in the context of IT today? The answer is as complex as the technologies that SDS encompasses. SDS is a reflection of the converged nature of IT. Historically and traditionally, IT markets have generally been defined by discreet technologies – for example, storage systems, printers, servers, desktops, laptops, etc. This was relevant 20 years ago.

Today, end-users do not evaluate or acquire technologies in discreet units. No one buys a server, without considering the operating system, the applications, the networking options, the hypervisor, etc.

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What SDS represents, and what SDS defines is the contemporary, and by extension the only relevant way storage should be considered today. In addition to the storage system (think hardware), end-users need to think about the five key attributes of SDS:

- Automation;
- Orchestration;
- Provisioning;
- Monitoring; and
- Management.

Recommendation to Vendors

Vendors need to consider ways of delivering storage solutions that are capable of helping end-users to protect current investments, evolve to contemporary and next generation technologies, while providing a singular storage interface (i.e. APIs).

This does not mean that storage vendors and storage solutions become commoditized. In fact, it means the opposite. Those vendors that take a lead on delivering on an inclusive solution strategy will be the winners, while the rest will be left behind.

Recommendation to End-Users

SDS is not just another term. SDS is not necessarily new technologies. However, SDS does extend the capabilities. It allows end-users to focus on the *information* and not the infrastructure.

SDS will improve the economics for end-users. Users will benefit from generating new value from existing data as a result.

Neuralytix believes that all end-users should evaluate and begin to implement a SDS strategy during 2014; otherwise, their competitiveness could be adversely effected.

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Appendix - The Vendors

Each vendor was asked the following questions:

- What is your company's official definition of software defined storage;
- What is your company's primary product SDS offering and licensing strategy; and
- Why do you think your company's approach is the best.

Dell

In its response, Dell explains that

> *SDS abstracts software functionality from the hardware. This allows utilization of commodity hardware rather than dedicated platforms. The customer will benefit from configuration flexibility and lower cost. Data becomes far more mobile as it is abstracted from specific storage platforms, rather than locked in to a specific solution. This mobility decreases costs through ease of installation, improve scalability and increased performance.*

Dell believes that SDS would result in

> *"better performance, simplifying the management, and/or reducing initial entry and recurring costs. These are key customer attributes for those markets looking to optimize their application mobility at the lowest CAPEX/OPEX."*

Dell went on to state that "*SDS creates a new way to address traditional storage challenges that were previously constrained due to software/hardware lock-in. The exact implementation will depend on business objectives desired."*

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In terms of its primary product and licensing strategy, Dell stated that their "*technology includes both internally developed IP combined with a well planned acquisition strategy that augments internal engineering*." To this end, Dell cited its acquisitions of Ocarina, RNA, Compellent, and EqualLogic. It suggested that combination of these acquisitions, which it terms as its "*in-house portfolio*", is augmented with key partners such as Nexenta to create an SDS solution.

Dell also shared that

> *"[It] has multiple developments and partnerships already in place that position the company well for a transition to SDS. These efforts are targeted towards customers of varying sizes, since the desired benefits of SDS vary by customer size.*
>
> *For large-scale deployments, Dell has existing partnerships with Nexenta and Inktank for large webscale open source deployments fulfilling the cost sensitive/webscale needs. Compellent will utilize orchestration engines through a restful API and multi-tenancy features providing benefits to mid-range, private cloud deployments. Dell offers unique capabilities as an integrated vendor of servers, storage and networking. This includes long standing partnerships with best of breed vendors such as VMware and Microsoft. This is a unique opportunity for Dell, while pure play storage cannot match this end-to-end integration.*
>
> *Dell has other developments in flight to take further advantage of SDS. These include Fluid Cache (placing data next to compute), Federation (Intelligent tiering and data movement within arrays and across locations), restful APIs, deep integration into orchestration frameworks of OpenStack, VMware, Microsoft and Dell ASM, and OpenSource Initiatives and Solutions."*

Neuralytix believes that Dell's aggressive partnering strategy will allow them to level the playing field with its competitors. In Dell's response to why its approach is the best, Dell

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talks about its portfolio as "*the groundwork for [SDS] today*". Neuralytix vehemently agrees with this statement.

However, Neuralytix believes that in addition to its current partnering strategy, Dell needs to take an assertive approach to own technologies in its portfolio; otherwise, Dell will continue to be seen purely as a supplier of infrastructure components rather than complete converged infrastructure solutions.

EMC

EMC provided a very comprehensive definition of SDS:

> *Software-defined storage transforms existing heterogeneous physical storage into a simple, extensible, and open virtual storage platform that preserves the capabilities of underlying physical storage arrays. It abstracts physical storage, pools aggregated capacity, and automates and centralizes management across heterogeneous storage, including commodity storage, in a scale-out architecture. It includes storage services for provisioning, orchestration, change management, monitoring, reporting, and quality of service, and the ability to do new operations on data in-place via value-add data services.*
>
> *Software-defined storage provides a central point of access to management functions, translating requests into specific calls to the underlying storage, while offering storage services to multiple users or tenants, with different access roles through a single common portal. This approach standardizes operations, reduces complexities, and improves an organizations efficiency and agility in deliver storage when and where needed.*

Unsurprisingly, EMC's go-to SDS solution is ViPR. It describes ViPR as:

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> *ViPR is a lightweight, software-only solution that transforms storage into a simple, extensible, and open platform. ViPR centralizes and automates storage provisioning, streamlines management, and maximizes resource utilization across heterogeneous storage environments. With ViPR, the control plane, where you manage storage, is decoupled from the data plane where you store your data. This intelligence enables ViPR to retain the underlying capabilities of file and block arrays and offer higher-level data services, such as object.*

Equally expected is EMC's reasoning on why it believes ViPR's approach is the best for the industry.

> *ViPR is architected to address the common storage challenges faced by IT and employs cloud technologies such as Representational State Transfer (REST) APIs for access and the Cassandra database for performance and scale. It provides a single control point to centralize management, operates in the control plane or control path to preserve and leverage existing storage infrastructure, and provides a platform for enabling new global data services that provide the ability to deliver new combinations of data types (i.e. block, file, and object), protocols, and more.*

Hewlett-Packard (HP)

HP, in its formal response, said that it agrees with Neuralytix competitor, IDC's, description that SDS is "any storage software stack that can be installed on any commodity resources (x86 hardware, hypervisors, or cloud) and/or off-the-shelf computing hardware and used to offer a full suite of storage services and federation between the underlying persistent data placement resources to enable data mobility of its tenants between these resources."

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However, during its interview with Neuralytix, HP recognized the deficiency and vagueness of this description, and that it is not a definition, but a description of one use case.

HP cited the HP StoreVirtual VSA and HP StoreOnce VSA as HP Storage's primary product lines for SDS. Licensing is capacity based on 3 to 5 year increments with services included.

When asked why it believed HP's solution to be superior, it offered three reasons:

> - *Storage is a risk-averse market, and HP removes that risk since it has been shipping software-defined storage in the form of VSAs since 2007 – building a solid install base of over 175,000 licenses;*
> - *The code is mature and feature rich. Compared to other large vendors, HP leads the way in this area of innovation. Compared to smaller vendors, HP leads the way in the richness of features and proven reliability and availability in every license;*
> - *HP provides converged systems of servers, storage and networking to SMB and Enterprise customers with end-to-end support from one reliable vendor.*

Hitachi Data Systems (HDS)

Like Dell, HDS did not offer a formal definition. It also declined to name a specific product; instead, it suggests that SDS characteristics are found among many of its offerings:

> *Software is integral to delivering the extreme flexibility needed for a diverse set of application workloads. Over time, the workload mix has changed. Transactional workloads now share the IT landscape with content serving, archiving, and mobility and analytics applications. The data mix has changed along with the workloads, to a*

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roughly 80/20 split between unstructured and structured data. Hitachi sees the trend toward software defined as a response to these changes and as a method for addressing variable service requirements. Hitachi has and continues to innovate with software to maximize our platforms to deliver the right service levels at the right time for a diverse set of applications.

Software Defined Data Center (SDDC) is an evolving method for delivering variable services as opposed to a fixed set of speeds and feeds. It abstracts and pools infrastructure resources, automates tedious, error prone tasks and programs typical services through a software layer. SDDC extends these to applications and users across and beyond the data center, taking agility and elasticity to new levels. Software Defined Storage controls and delivers flexible data services and storage capacity for all data types to an SDDC.

Hitachi solutions feature abstraction and pooling enabled by our leading storage virtualization software, as well as abstraction of file systems through our object-based content platform. Automation is incorporated throughout our portfolio, through features such as auto-tiering and thin provisioning, automated file migration, auto-throttling for file deduplication, automated encryption for regulatory compliance and auto-discovery of data center devices. Hitachi solutions are programmable through policies and scripts and extensible through integration with standards.

VSP, HUS VM, Hitachi Content Platform (HCP) and Hitachi Data Ingestor (HDI) together with Hitachi Command Suite form the core of Hitachi's software defined storage. Ever versatile, HCP and HDI can run on Hitachi hardware or in a VM as a software only solution.

In 2002, Hitachi pioneered storage virtualization and continues to lead with VSP and HUS VM. HCP aggregates many file systems, make efficient use of underlying media and delivers rich content through a cloud interface. These platforms manage and

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> *extend data services to heterogeneous storage for all data types, delivering choice, business agility and economic advantage to Hitachi customers.*
>
> *The software within these platforms maximizes the value of the performance, resilience and scalability of the hardware on which they run. The Hitachi Unified Compute Platform extends these capabilities to a software defined data center through the orchestrated management of server, storage and network.*

IBM

IBM provided a very comprehensive response to our questions. IBM uses a term called Software-Defined Environment (SDE). In its response, IBM said SDE "is the full system of infrastructure required to meet the workload objectives of a cloud computing deployment. It uses a resource abstraction layer to make compute, network, and storage facilities appear as needed by the workloads. Software Defined Storage (SDS) is a component of SDE where orchestration software, operating through a control plane, configures a storage environment to match the needs of the workloads."

It continues by giving a more specific description of SDS:

> *"Software Defined Storage (SDS) plays an important role in IBM's vision for Software Defined Environments. SDS optimizes the SDE environment by:*
>
> - *Tighter coordination between application and storage/network;*
>
> - *Exposing storage capabilities for the software to dynamically provision storage with the most suitable characteristics*
>
> - *Introducing new operations between software and storage to let storage better adapt to the needs of software*

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- *Integrating storage functions to the software to leverage higher-level knowledge*

- *Control planes separated from the hardware to the software layer. Unified Control Planes allow rich resource abstractions to assemble purpose fit systems.*

- *Programmable infrastructures allow for dynamic optimization to respond to business requirements.*

IBM's vision for SDS within an SDE environment is to:

- *Abstract and virtualize storage capabilities – independent of [hardware] and protocols*

- *Provide a standard interface to enable applications to manage/leverage the storage capabilities to achieve higher efficiency*

- *Create a platform to enable fully integrating compute/storage capability for storage-centric solutions*

IBM's portfolio of SDS solutions were:

- IBM Storwize Family (in which it referenced that the family is built on its 10 year heritage with the SAN Volume Controller (SVC));
- Unified management on IBM Storwize V7000 Unified;
- Highly scalable global file storage with IBM GPFS storage software;
- Integrated support for storage environments; and

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- IBM SmartCloud Virtual Storage Center storage hypervisor that expects to have an OpenStack Cinder API by the end of 2013.

When asked about why it believes its solution and focus to be superior, IBM responded:

> *IBM's Smarter Storage initiative, which was chartered over a decade ago (at that time it was called Optimized Storage), stated the goal of reducing the barrier complexity poses to progress by developing self-managing characteristics of routine storage tasks and abstracting/hiding complexity from operators and users. Our vision for software-defined storage dates back to that original thought and is just as inherent today in every storage product we develop.*
>
> *IBM's approach is uniquely differentiated because we can support an evolutionary approach that leans towards standards and inclusiveness. IBM understands that moving to a software-defined environment is a journey for customers and we have offerings to help them during each step along the way without requiring them to throw over their install base and operations.*
>
> *As an end-to-end IT solutions provider, IBM is also able to [integrate seamlessly] our software-defined storage offering, as well as those from other providers, with software-defined compute and networking offerings to optimize software-defined data centers. We are committed to open and inclusive software-defined solutions as evidenced by our partnership with the OpenStack initiative. We are not only supporting the OpenStack initiative, but we are one of the top contributors.*
>
> *Finally, IBM provides worldwide, end-to-end service and support capabilities that differentiate us from other vendors.*

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NetApp

NetApp also responded with reference to the larger consideration of the Software Defined Data Center (SDDC). One thing that NetApp did reference explicitly and astutely, which others did not, is the concept of Software-Defined Security.

Like other vendors, NetApp did not have a specific definition for SDS. Instead, it describes the concepts around SDS as follows:

> *Clustered Data ONTAP Delivers Foundation for Software-defined Storage.*
>
> *Solving this problem requires an IT infrastructure built for agility, one capable of instantly delivering new services, projects, and capacity while keeping costs down. That's the promise of the software-defined data center (SDDC). This emerging architecture and set of technologies are designed to increase IT agility and speed delivery of services to application owners and development teams. The SDDC model represents the next logical extension of virtualization and cloud approaches. It features three core tenets:*
>
> - *Resources are defined in software.*
> - *Provisioning is based on policy/service levels*
> - *Technology runs on a broad range of hardware platforms.*
>
> *Software-defined storage (SDS) is one of the four SDDC components, as well as software-defined compute, network, and security.*
>
> *NetApp views SDS as a positive development for customers who've embraced virtualization and cloud solutions. The SDS approach provides benefits across the organization, including:*

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- *Autonomy for application owners:*
  - *Instantly deploy new applications and services*
  - *Dynamically respond to shifts in demand*
- *Responsiveness for IT teams*
  - *Provision based on priority and service level*
  - *Automate using policy-based security and delegation*
- *Flexibility for purchase decision makers*
  - *Deploy on platform of choice*
  - *Extend capabilities of existing assets*

Not surprisingly, NetApp's SDS solution is Clustered Data ONTAP.

In terms of advantages, NetApp noted that Clustered Data ONTAP provides its customers with a number of advantages over other providers:

> ***Provision based on service levels**: NetApp is the only storage provider that supports this capability today across both SAN and NAS using virtualized storage services. At the heart of this is our Storage Virtual Machine technology, which enables data access and services to be separated from the underlying hardware. This abstraction allows*

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for storage resources to be assigned and reassigned based on the needs of the application over the course of its lifecycle.

***Deploy on platform of choice**: Hardware diversity is in our nature, and clustered Data ONTAP can operate on a broad range of multivendor hardware. Deploying clustered Data ONTAP on the NetApp unified and optimized FAS platform, whether solely as storage or as part of a FlexPod integrated stack, delivers continuous data access, proven efficiency, and seamless scalability. Data ONTAP also runs on third-party storage arrays through our V-Series product. Data ONTAP Edge provides SDS functionality for commodity disks in servers deployed at branch locations. Customers can consume Data ONTAP in the cloud through NetApp Private Storage for Amazon Web Services.*

***Deliver services without compromise**: To satisfy their users, application owners and development teams need to be more responsive to change. They need a solution that drives storage services closer to the application and provides greater workflow automation. Clustered Data ONTAP excels in these two areas with programmable APIs and deep technical integrations with leading offerings from Cisco, Microsoft, VMware, SAP, Oracle, OpenStack, Citrix, Red Hat, and more.*

Oracle

Oracle declined our offer to be included in this report. Oracle's market share in the storage systems market has been steadily declining, and not only represents a small single digit percentage of the overall storage systems market.

About Neuralytix™

Neuralytix™ is a bespoke strategy consultancy that is focused on *Driving Business Value with Technology*™. Our philosophy aims to *bridge the gap between the boardroom and the computer room*™ by helping stakeholders better understand the business value of technology.

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