Open Source Storage Is Disrupting the Enterprise Market

Trevor Pott & James Green

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- How proprietary and cloud storage falls short

- Why open source is a better development model for storage systems

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Compliments of iXsystems

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The Advantages of Open Enterprise Storage

Virtually every organization in the world relies on computers, making data more valuable today than ever before. Preventing data loss is thus a paramount concern, and storage system reliability is a must-have for organizations of all sizes. Today, open source software is the key to making resilient, enterprise-grade storage affordable for all.

Any storage system today must offer a dizzying array of features and capabilities. Some features, such as silent corruption detection, data efficiency, and write cache resilience in the face of power outages, have traditionally been restricted to proprietary storage solutions targeting the largest enterprises. Open enterprise storage is changing this industry dynamic by dramatically lowering the cost of true enterprise-grade storage.

The cost of storage impacts organizations in a number of ways, some more subtle than others. Large

enterprises are often more agile because their IT is more capable. They can afford to pay for the full suite of features offered by traditional storage vendors, meaning that they can unlock all the capabilities of the products they use, while smaller competitors often struggle to work around those same vendors' artificially-imposed limitations.

Making enterprise storage features affordable by all is disruptive. It's disruptive not only to the storage industry, but to any industry where larger competitors are able to be more agile because they can afford more capable IT.

Artificial Limitations

Consider a non-storage example in the form of VMware's vSphere virtualization platform. In the 6.x line, vSphere Standard licenses do not allow virtual machines (VMs) to be migrated between vCenters or across high-latency, long-distance connections. These capabilities require the significantly costlier Enterprise Plus license.

The result is that vSphere Enterprise Plus license holders have more options for load-balancing their workloads, as well as performing maintenance and

migration activities. Organizations using Enterprise Plus can evacuate clusters – or even entire data centers – for planned maintenance, or as part of a data center refresh.

Natural disasters are a great example of where having this capability can make a demonstrable difference. Some events – such as hurricanes – we can see coming. Ahead of such an event, an Enterprise Plus customer could migrate all their workloads from their primary data center to a secondary site out of the path of the hurricane with a single script, and without interrupting any of the workloads in question. Zero downtime.

In contrast, vSphere Standard customers have to rely on solutions that either require downtime or which could cause potential data loss during the failover. vSphere Standard and vSphere Enterprise Plus are identical, in terms of the product installed by the customer. Only the license is different. This is a classic example of the artificial limitation of a product.

A Decade of Disruption

The storage world is no different: artificial limitations are frequently placed on storage solutions, especially those aimed at enterprises. This practice, combined with high initial capital costs and exorbitant support costs designed to force a 3-year refresh cadence, ultimately led to the storage wars.

For the past decade, the storage wars have seen a parade of storage startups aiming to displace the traditional storage vendors with new approaches to storage such as software-defined storage (SDS) and hyper-converged infrastructure (HCI). Open source storage solutions benefited from the storage wars. Their capabilities and maturity advanced quickly as many new vendors devoted resources to their advancement.

Features that had previously only been available at a premium, such as snapshots and replication, eventually became standard items; at least in a limited fashion. Some proprietary enterprise storage solutions still charge a premium to allow snapshots or replications to occur frequently, still gate access to automation APIs, or otherwise create friction for customers using a lower-cost license.

Open enterprise storage, however, dispenses with the coin-operated feature approach. These storage solutions ship with a full suite of features, and have no artificial capacity limits. This means that organizations can deploy storage solutions with the same set of features across their entire data center.

Open enterprise storage ensures that there is no guessing about which storage solutions offer which functionality. Neither manual workload placement nor convoluted migration strategies are required to work around licensing restrictions. Open enterprise storage offers organizations the flexibility, agility, and security to take full control over both the architecture and the destiny of their data centers.

Open source software enables open enterprise storage, and makes all of the above possible without sacrificing features or compromising resiliency. Open source software is also what allows open enterprise storage to be offered at prices that don't break the bank, while at the same time providing vendors the revenue required to keep their products up to date.

The Best of Both Worlds

During the 1990s, enterprises grew accustomed to buying proprietary systems from large vendors. Several of these vendors spent a portion of their marketing budget for decades spreading Fear, Uncertainty, and Doubt (FUD) about open source software solutions. The past two decades, however, have proven that there's no reason open source should be intimidating.

In the 2000s, emerging tech titans such as Google, Amazon, and Facebook built empires using open source solutions. These companies – and thousands of others – have used open source software to accelerate their growth and become capital efficient.

Arguably, these organizations wouldn't even be able to exist without open source. The costs of client access licenses for Facebook's 2 billion-plus users alone, if Facebook were using Oracle databases, would be unworkable.

With the pioneering work completed on an increasing list of core open source technologies, the 2010s became

the decade during which open source solutions were commercialized for general consumption. Today open source software can be used by all organizations, regardless of size, without requiring specialists.

Enterprise open source vendors, such as iXsystems, unite the many advantages of open source with the traditional strengths of proprietary enterprise vendors. The result is an emerging category of enterprise-grade solutions without the friction traditionally associated with proprietary vendors.

The major advantages of proprietary systems over open source systems have traditionally been viewed as having more complete documentation and more robust support. The advantages of open source solutions over their proprietary competitors have traditionally been flexibility, cost control, open standards, and interoperability.

Open source software offers a great deal of value, and sits at the core of many proprietary IT solutions, including several of the proprietary storage vendors. Different vendors incorporate different open source projects into their products, and each incorporates different amounts of proprietary code, but make

no mistake: open source software is the hidden workhorse of much of today's IT.

Making Open Source Enterprise-Grade

Enterprise buyers demand reliable, capable products from vendors offering responsive, experienced support. All modern IT solutions are a combination of different sub-projects; as a result, the process of turning those sub-projects into a holistic solution that will be accepted by enterprise buyers looks much the same, regardless of the amount of open source software included in the end solution.

The first step in making open source enterprise-grade is curation. There are hundreds of thousands – if not millions – of individual open source projects. Many of these are merely hobby projects; however, there are a number of exceptionally well-regarded, well-documented and meticulously-maintained projects used by millions of organizations around the world.

iXsystems has selected a number of enterprise-grade open source solutions such as FreeBSD, OpenZFS, and Samba. These solutions are then combined into FreeNAS, an open source project headed by iXsystems. FreeNAS serves as the foundation of TrueNAS, but

there is a world of difference between a do-it-yourself FreeNAS solution and a TrueNAS storage array.

▶ Getting to Enterprise-Grade

Enterprise-grade models are engineered with a number of hardware capabilities rare in consumer or midrange storage solutions. These capabilities have a cumulative effect on the reliability and resiliency of a storage system.

Enterprise-grade TrueNAS models include dual upgradable controllers, managed disk cabinets, NVDIMMs, and a non-transparent bridge fast enough to keep the NVDIMMs in sync for use with the write log.

Dual controllers allow one controller to fail – or be updated – without loss of storage availability. The upgradability of these controllers extends the life of the storage solution, allowing it to be scaled up to meet increased demand without disruption to running workloads. Managed disk cabinets allow for the easy addition or replacement of disks, again without impact to running workloads.

Non-enterprise storage solutions may incorporate one or more of these hardware capabilities. The combination of all of these hardware capabilities, however, creates a clear distinction between a true enterprise-grade storage solution and storage solutions providing a lesser class of resiliency.

Transforming the open source FreeNAS into the enterprise-grade TrueNAS takes more than a rebranding. iXsystems engages in rigorous testing of their custom hardware and software combinations under both laboratory and real-world conditions to ensure that no unexpected incompatibilities endanger an organization's data.

As with all enterprise-grade solutions, this testing and validation has to be much more than simply proving that the software will compile, execute, and meet basic functionality requirements. Automated testing – including regression testing – is continuous. New code branches are subjected to a series of trials that test for all primary use cases, as well as an ever-expanding list of edge cases.

Hardware is also subjected to stringent testing. For example, in selecting hardware for the current generation of TrueNAS storage arrays, iXsystems exposed NVDIMM and motherboard vendors to 15 different tests. Only one motherboard and two NVDIMM vendors passed all tests.

In addition to rigorous testing, iXsystems incorporates enterprise-grade technologies into TrueNAS systems that are impractical to incorporate into consumer-

grade storage. One example is the inclusion of NVDIMMs to increase storage performance.

▶ What is an NVDIMM?

Non-Volatile Dynamic Inline Memory Modules (NVDIMMs) are Random Access Memory (RAM) modules designed to make a computer's main system memory non-volatile. Traditionally, RAM is volatile, which means that when a computer is powered off, any data stored in RAM is lost.

An NVDIMM combines a standard RAM DIMM with an equal amount of non-volatile flash memory and either a battery or a supercapacitor. In the event of a power failure, the NVDIMM writes the contents of the DIMM to flash so that this data isn't lost. When the system is powered back on, the data is read from flash back into RAM, allowing the system to resume from its previous state.

NVDIMMs need not be an all-or-nothing use case, as NVDIMMs can be used for only part of the solution's RAM compliment. TrueNAS storage arrays, for example, only use NVDIMMs to guarantee the safety of the Separate Log (SLOG) contents in order to allow SLOG writes to safely proceed at RAM speeds. This approach allows iXsystems to minimize the cost of TrueNAS storage arrays while still enabling maximum performance.

The inclusion of NVDIMMs in a storage solution is one of many technologies that, when combined, are considered to represent a hard separation between

even the highest-end consumer-grade storage systems and true enterprise storage. NVDIMMs are much more expensive than standard memory modules, but provide an added level of resiliency that enterprises cannot do without.

TrueNAS brings system design to the table, which includes high availability for all critical hardware components. Dual-controller designs are the proven bedrock of enterprise-class storage solutions, and an option that consumer-grade storage solutions typically don't offer.

iXsystems supplements all of the above with thorough documentation, REST APIs, a rapid patch and bug-fix schedule, as well as white-glove enterprise support. iXsystems support staff engage in lifelong learning, continually increasing their skills base, and receive regular training on upcoming versions of TrueNAS so that they're ready to solve whatever problems may arise.

These are the steps all enterprise-grade vendors must take, regardless of the software used in their solutions. A storage solution based on open source software, however, has a number of advantages over its proprietary brethren.

The Open Source Advantage

Open source software delivers a number of advantages, beginning with the technologies TrueNAS uses. OpenZFS, for example, allows TrueNAS to incorporate a self-healing file system.

OpenZFS uses checksumming and background scrubbing to identify instances of "silent corruption." Silent corruption is where one copy of a data block has become corrupt. OpenZFS is able to compare all copies of a data block against that block's checksum and repair the corrupt block.

Self-healing is an example of an advanced storage technology that's lacking even from enterprise-targeted solutions from well-known proprietary vendors. Thanks to open source software, iXsystems is able to incorporate this functionality into TrueNAS, despite being a fraction of the size of the well-known proprietary vendors.

This is one of the primary advantages of open source: vendors pool their resources. Each enterprise-grade open source vendor devotes some developers to working on the upstream open source projects upon which their products rely; as a result, all vendors benefit.

▶ Introduction to OpenZFS

OpenZFS is an open source file system based on the ZFS file system designed by Sun Microsystems to overcome the limitations of general purpose file systems. The OpenZFS project has attracted investment from numerous companies across the storage industry and is widely considered to be among the most important open source projects.

Designed for long-term data storage, OpenZFS incorporates numerous features, including several features devoted to caching for performance purposes. The file system is self-healing, uses hierarchical checksumming, includes advanced snapshotting, and incorporates background data integrity checking.

OpenZFS has the ability to store thousands of snapshots, incorporates the concept of file immutability, and supports snapshot-based replication. These features enable advanced data protection capabilities, such as ransomware mitigation, and low-latency cloud backups.

Proprietary vendors have to build functionality in-house. This may give them access to new functionality sooner than their competitors, but they must maintain a significantly larger staff to accomplish this. The result is significantly more expensive products.

The secret weapon of enterprise-grade open source vendors is the communities created around the

numerous open source solutions that make up an enterprise-grade open source product. Consider for example TrueNAS' open source sibling, FreeNAS.

The FreeNAS project is, for all practical purposes, an enormous beta test community; one filled with enthusiastic participants from organizations of all sizes. FreeNAS is used in a wide variety of different environments, and uses versions of various open source components that are newer, and less widely tested.

Like many enterprise-grade open source projects, TrueNAS undergoes fewer iterations than the more adventurous FreeNAS. TrueNAS also uses open source project branches designed for long-term stability, and backports security patches as required.

But it's hard to overstate the benefits from the bug reports, telemetry data, and experiences from the more than 400,000 FreeNAS and TrueNAS deployments. They provide empirical data on when a new feature in FreeNAS is sufficiently mature for inclusion in TrueNAS. FreeNAS feedback also helps iXsystems refine their internal TrueNAS testing approaches, leading to a more stable and resilient end product.

The open source model allows vendors to work together to lower costs for everyone. Taken as a whole, the community of vendors, customers, and developers who work on the numerous projects that make up the complete TrueNAS solution create the world's largest quality assurance testing team.

The advantages of open source are difficult to beat, and they've helped to build TrueNAS into a storage solution certified by a growing number of major enterprise vendors, including Citrix, VMware, and Veeam.

Real-World Reliability

iXsystems has confidence in the quality of both FreeNAS and TrueNAS. Like many storage vendors, iXsystems uses both products internally. These solutions are used for file sharing, VM and application hosting, local backup, and remote replication.

TrueNAS is not just exposed for internal usage. Because it's based on FreeNAS, the world's largest open source SDS operating system, its more than 10 million downloads and nearly 400,000 users ensure that TrueNAS has the world's largest QA organization.

Open Source Enabled Technology Innovation

Heterogeneity is the new normal for IT. Today's organizations have workloads located on-premises, in colocation facilities, in service provider clouds, and in the major public clouds. A unified data platform is quickly becoming a requirement, and not only for enterprises.

Unified data platforms combine block, file, and object storage options with cloud storage interoperability. A full suite of enterprise data services must be combined with resiliency and reliability. Data loss is unacceptable, even as the number of ways data is consumed, and the regularity with which it's moved, continues to increase.

TrueNAS offers numerous ways to consume storage, as well as a full suite of enterprise data services.

Storage Integration

The three basic storage types are block, file, and object. Block storage appears to an operating system or hypervisor as though it is a physically attached disk, and needs to be formatted with a file system to be usable. TrueNAS supports both iSCSI and Fibre Channel block storage.

Most applications and operating systems store data using files. This is done either by installing a file system onto block storage, or by consuming network storage using Network Attached Storage (NAS) protocols. TrueNAS supports the SMB and NFS protocols, which are popularly used for Windows and Unix file sharing, respectively.

Object storage is a simplified storage protocol when compared to file storage. It is predominantly used for large-scale web-server storage. TrueNAS supports the Amazon Simple Storage Service (S3) object storage API.

TrueNAS also integrates with a number of cloud and local solutions, including both virtualization solutions and private clouds based on OpenStack, VMware ESXi, Citrix XenServer, QEMU/KVM, and Hyper-V. TrueNAS

also integrates with public cloud providers such as Amazon S3, Microsoft Azure, BackBlaze B2, and Google Cloud, offering fully-integrated Backup-as-a-Service (BaaS).

Data Efficiency

TrueNAS includes data efficiency technologies, including compression, thin provisioning, and deduplication. Data efficiency allows organizations to store more data on their storage, thus lowering costs. Because of this – and because many proprietary vendors still charge separately to enable it – data efficiency is often the first capability asked about by potential customers.

iXsystems understands how critical data efficiency is, and as a result has developed TrueNAS Adaptive Compression (TAC). TAC uses a compression algorithm so efficient that it not only results in significant storage savings, it also boosts overall storage performance.

This is accomplished by intelligently adjusting the compression ratio. Before data blocks are stored, they're analyzed to determine whether or not they can be compressed without wasting system resources.

▶ What is NVMe, and Why Is it Important?

Non-Volatile Memory express (NVMe) is a logical device interface specification for accessing non-volatile storage which is directly attached to the PCI express (PCIe) system bus. Unlike NVDIMMs, which are designed to make traditionally volatile system RAM non-volatile, NVMe is an interface for talking to storage that is designed to be non-volatile, such as hard disks or SSDs.

NVMe is significantly faster than predecessor interfaces such as AHCI, SATA, and SAS; this is the case even when using media whose characteristics are identical except for the attachment interface. In many cases, latency is up to 80% lower, with an average of 20msec for NVMe vs. 100msec for SAS.

NVMe achieves these higher speeds in two ways. First is the way NVMe allows for direct attachment of devices to the PCIe bus without requiring an intermediary storage controller. In addition, NVMe allows for a higher number of IO commands to be exchanged with storage media than predecessor interfaces allowed.

NVMe is used almost exclusively to talk to SSDs. Classic magnetic hard drives are incapable of the performance required to challenge older interfaces, such as SATA or SAS. Modern SSDs, however, are capable of outperforming those interfaces, which is why the NVMe interface was created.

If the data is reasonably compressible, a compression ratio is chosen based on the initial analysis. If the data is not deemed to be compressible, it's stored uncompressed.

The end result is a storage solution that automatically finds the right balance between maximum data efficiency and maximum performance, without requiring any tuning or domain-specific expertise. Data efficiency capabilities are included with all TrueNAS storage solutions.

Performance Boosts

TrueNAS includes a number of performance-enhancing technologies. Some technologies offer performance enhancements to all TrueNAS models, while others apply only to those models utilizing hybrid storage.

NVDIMMs are a performance technology that applies to all but the entry-level TrueNAS models. The contents of ordinary DIMMs are lost during a power failure, meaning that storage systems cannot use traditional RAM for write caching. This is a problem, because the use of RAM for write caching has significant performance benefits.

Because NVDIMMs don't lose their data, even during a power outage, they allow RAM to be used for write caching. Short bursts of writes – which make up the majority of writes in enterprise environments – are absorbed by the Separate Log (SLOG), which occupies the NVDIMM–protected portion of the storage array's RAM. Because TrueNAS uses NVDIMMs, these writes can be acknowledged immediately, offering the lowest possible latency. These writes are then written to capacity storage as quickly as possible.

The use of NVMe flash drives also allows for a significant performance boost to high–end TrueNAS models. The NVMe interface standard allows for greater parallelism in storage media access, meaning that fewer system resources need to be devoted to RAM–based disk caches due to interface saturation. This allows more cache space to be devoted to absorbing incoming writes, providing a more consistent experience to all consuming workloads.

TrueNAS systems can use NVMe drives in two modes. The first configuration uses NVMe drives as a read cache to accelerate overall system performance, and is common on hybrid TrueNAS models with a lower number of NVMe drives.

TrueNAS systems can also use NVMe drives as a separate primary storage pool. In this configuration, a hybrid TrueNAS storage array presents two storage pools: an NVMe-based performance pool and a disk-based capacity pool.

Only the most extreme use cases require all-flash storage to meet all storage requests at flash latency. Many vendors market all-flash storage arrays as the solution to all performance problems. Unfortunately, all-flash storage arrays are expensive.

For those organizations pushing their storage to the limit, iXsystems does offer TrueNAS all-flash models. However, because of the numerous performance enhancements TrueNAS offers, hybrid TrueNAS arrays have proven to be a cost-efficient solution that meets most organizations' storage needs.

Improving the Economics of Storage

The Total Cost of Ownership (TCO) of any piece of IT infrastructure can be difficult to determine. TCO is defined by a combination of acquisition costs and operating costs.

Storage acquisition costs have two components: 1) The up-front capital expenditure (CapEX) of the equipment, and 2) Installation, testing, and migration costs. Migration costs in particular can be tricky, because they may involve taking workloads down to migrate them.

Migration costs can increase significantly if one or more of the storage solutions in question hinders data migration in any way. While migration of primary working data is often reasonably straightforward, migration of snapshots, backups, and other ancillary data can be a pain point. It's encountered more frequently as these data services become more heavily relied upon.

Open enterprise storage adheres to open standards and allows data migration without hindrance, lowering TCO by reducing hidden storage acquisition costs. Unfortunately, not all advertised storage TCO reduction is so straightforward.

Case Study: How a Major Cybersecurity Service Provider Saved 70% Over AWS

Take cloud storage, for example. It can be appealing because it requires zero or near-zero CapEx: upload your data to the cloud, and pay for what you use. On the face of it, this is a very attractive model. This model recently attracted a major CyberSecurity Service Provider (CSSP) to the cloud.

Unfortunately, the CSSP in question discovered that the price to be paid for this lack of CapEx was increased Operating Expenditure (OpEx). This increased OpEx was seen both in the ongoing cost for cloud storage on a monthly basis, and in the cost of pulling data down from the cloud.

The CSSP's IT team was tasked with reducing their AWS costs by 50%, without compromising performance, usability, or fault-tolerance. The global IT footprint

consisted of thousands of VMs, including large Cassandra, Hadoop, and Splunk clusters. The organization was scaling rapidly, making cost control a top priority; the AWS bills had already reached $1 million per month.

As part of their cost control efforts, the CSSP returned much of their IT operations to three data centers under their control, creating a hybrid cloud solution with only 20% of workloads located in the public cloud. While some workloads were permanently resident in the public cloud, the CSSP aimed to use the public cloud predominantly for burst capacity, meeting their needs when their private data centers had reached capacity.

The CSSP used a combination of TrueNAS Storage, iXsystems servers, VMware ESXi, and VMware vRealize to achieve this goal. The end result was a 70% cost savings when compared to AWS.

Adopting Open Source Storage

If it's possible to realize significant TCO savings by bringing workloads and storage back in-house from the cloud, one might wonder at the popularity of the public cloud. There are two different answers, depending on whom you ask within an organization.

Public cloud computing is attractive in part because of the phenomenon known as shadow IT. Shadow IT is where individuals (or entire business units) within an organization bypass that organization's internal IT department, using the public cloud instead. This is typically done because internal IT is seen as slow and hostile, often earning the nickname "the department of no." Shadow IT costs (and security concerns) can – and usually do – quickly get out of hand.

Another reason public cloud computing is engaged is that its costs are often compared to those from traditional proprietary enterprise vendors only. In that narrow case, public cloud solutions can often offer a TCO that's cost-competitive with IT solutions from those vendors.

The initial acquisition costs of a proprietary enterprise solution may not be much different from an open enterprise solution, but the OpEx costs will often be comparatively punitive. These costs can be obvious – such as the cost of yearly maintenance fees – or they can be hidden, such as the cost of data migration at end of life.

▶ Composability

A composable workload is a workload in which the data and configuration have been separated from the application and execution environment. Fully composable workloads have their complete execution environment defined in code.

This allows for the application storage to be detached, the workload destroyed, and the application storage re-attached to an identical execution environment in moments. Composable workloads are ideal for use as burstable workloads, because they can be created and destroyed as needed; only the application storage and configuration must be preserved.

Claims of dramatic TCO reductions from moving workloads into the cloud have always hinged on the adoption of a great deal of IT automation, starting with the years-long effort to make workloads composable. Despite this, the costs have recently

been close enough to those of proprietary enterprise systems to drive sustained and impressive growth of public cloud providers.

That the previously discussed CSSP managed to achieve a 70% reduction in costs when compared to AWS demonstrates not only the continued value of on-premises storage, but also the gulf in TCO between proprietary enterprise storage solutions and open enterprise storage solutions. The open enterprise storage approach of removing all artificial limitations provides a consistent, predictable environment in which IT teams can operate.

Little wonder then why so many cloud pilgrims become cloud refuges once they get a dose of reality in the cloud. Join the open enterprise storage revolution with TrueNAS, and take back control of your storage.

A Wide Array of Options

iXsystems' TrueNAS M Series product line is the standard-bearer of open enterprise storage. A truly enterprise-grade solution, the M series brings the performance and reliability of NVMe flash storage and NVDIMM non-volatile memory to the award-winning TrueNAS arrays. Both the hybrid and all-

flash TrueNAS M Series models include the Intel Xeon Scalable Family of Processors, and support top-of-the-line networking options, including 100 gigabit Ethernet and 32Gb Fibre Channel.

A popular example of iXsystems' true enterprise-grade storage solutions is the TrueNAS M50. The TrueNAS M50 supports up to four active 100GbE ports, 3TB of RAM, 32GB of NVDIMM write cache, up to 15TB of NVMe flash read cache, and up to 10.4PB of raw capacity. TrueNAS arrays include up to 24/7, global, next-business-day support, putting IT at ease.

The TrueNAS M50 is only one model in iXsystems' comprehensive storage portfolio. For more information, and to find the TrueNAS model that will meet your needs, visit www.ixsystems.com/TrueNAS or follow iXsystems on Twitter @iXsystems, and LinkedIn at www.linkedin.com/company/iXsystems.