Inside Track
Executive Brief

FREEFORM DYNAMICS

Storage and Data Center Evolution

The role of NVMe and NVMe-oF

in association with

Western Digital®

Introduction

It is entirely valid to argue that it is storage evolution that has produced the greatest leaps forward in data center technology in recent years. Until a decade ago, storage was sometimes referred to as "snorage", since things rarely changed by much. Capacity of disks grew slowly and access times to data were hard to improve without expending huge sums of money. But then came solid-state storage, better known to many simply as Flash.

The move from spinning disks and disk arrays to solid-state drives (SSDs) and all-Flash arrays (AFAs) greatly increased the performance of storage, and hence the performance of the applications that depend on it. Other valuable, but sometimes overlooked, benefits delivered by AFA platforms included a significant reduction in space and power consumption.

Alongside these advances in storage - and often closely dependent on them - there have of course been many other developments in data center technology. One example is the fast-maturing world of converged infrastructure and HCI, now being deployed to support the creation of private clouds. All these developments were essential as data center designers strove to keep up with rapidly changing business demands and user expectations.

But AFAs and SSDs still relied on storage protocols that were designed to accommodate the limitations of spinning disks. Adoption was simple and the technology reached the market quickly, but performance wasn't as good as it could be.

This was the spur for the development of NVMe (Non-Volatile Memory Express) and NVMe-oF (Non-Volatile Memory Express over Fabrics). This paper provides an overview of the roles that we expect NVMe and NVMe-oF to have in the evolution of data centers and of their ability to deliver modern IT services in times of rapid business change.

Why storage is important in the data center

There is no question now that almost every business depends on IT in order to be able to function effectively and efficiently in its day to day operations. But until recently it was the case that the importance of storage to the delivery of service quality was, with few exceptions, underappreciated. That changed as cost-effective server performance became almost universally achievable and the visible bottleneck shifted to storage.

Spinning disks had inherent performance limitations that were difficult to mitigate and impossible to overcome without significant investment, investment that was unaffordable except to a small number of truly mission-critical applications and business services. The arrival of AFAs onto the data center scene changed things dramatically. So much so that they have rapidly become an established part of the IT infrastructure.

But a recent survey conducted by Freeform Dynamics shows that while most organizations are happy with their storage platforms, between a third and a half of organizations consider their existing environment to be at best adequate and at worst not very good at all (Figure 1).

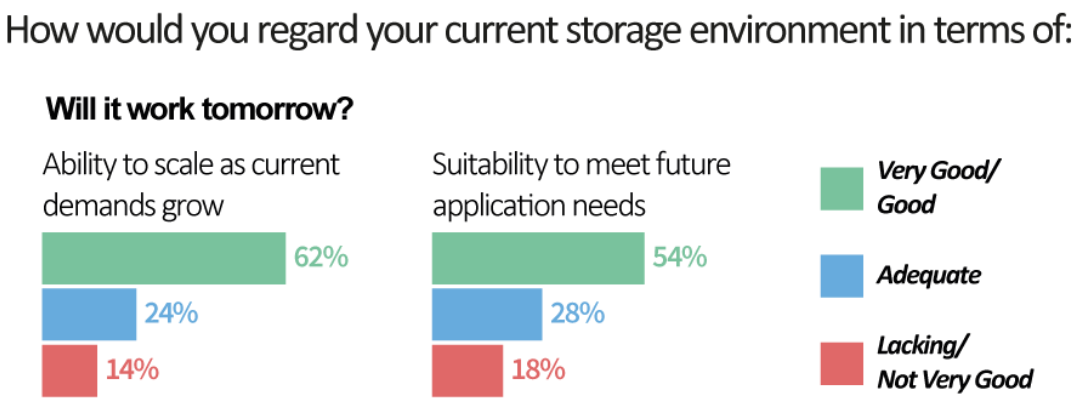

Figure 1

This illustrates that many data center professionals need to decide how they are going to improve their storage platforms. This will clearly involve AFAs being deployed to support an expanding range of workloads, beyond the most performance-sensitive platforms to include many, if not all, business applications.

A key enabler of storage performance

While AFAs are increasingly accepted as able to support diverse workloads, until recently most of those on the market have utilized existing SAS and SATA protocols to connect the processing units to the underlying storage.

This was a good start but the reliance on protocols first developed two or more decades ago has meant that the full performance benefits available from solid-state storage could not be achieved. This is where NVMe-oF and NVMe enter the picture.

The characteristics required

For any new storage technology to be accepted as ready for mainstream business use, it must possess certain characteristics. After all, "Data" is now often cited as one of the most valuable assets an organization has. These essential properties include:

- **Availability and resilience baked in:** While NVMe as a protocol makes sure that data hits the storage as intended, the storage platform itself needs to provide additional data protection services long taken for granted in enterprise storage. But it now must also include fast recovery and simple remote synchronization. NVMe-oF supports clustering over long distances to make it more straightforward to build for resilience, while still providing QoS and enabling geographical data management control.

- **Capacity / Scalability:** Business demands fast access to greater volumes of data, and NVMe has been designed to accommodate this requirement through its ability to process multiple streams of data in parallel, and via the broad interconnectivity at the core of NVMe-oF as a protocol. NVMe-oF utilizes clustering to enable large data sets to be supported.
- **Performance:** Business users want fast access to data and for systems to respond quickly. NVMe was designed to be as lightweight as possible to ensure that the storage hardware achieves its full performance. But just as importantly, it is designed to enable performance consistency, even as workload demands vary.

Future-proofing storage

Almost every IT infrastructure project wants to be certain that it can cater not just for the needs of today, but also those that may be thrown up tomorrow. The NVMe and NVMe-oF protocols were created to work effectively not just with the storage technologies available today, but also to work well with those under development. It is expected that the protocols will form the foundation for data platforms for the foreseeable future. And NVMe is already well on the way to being accepted as 'just part of the furniture' in the data center of the future (Figure 2).

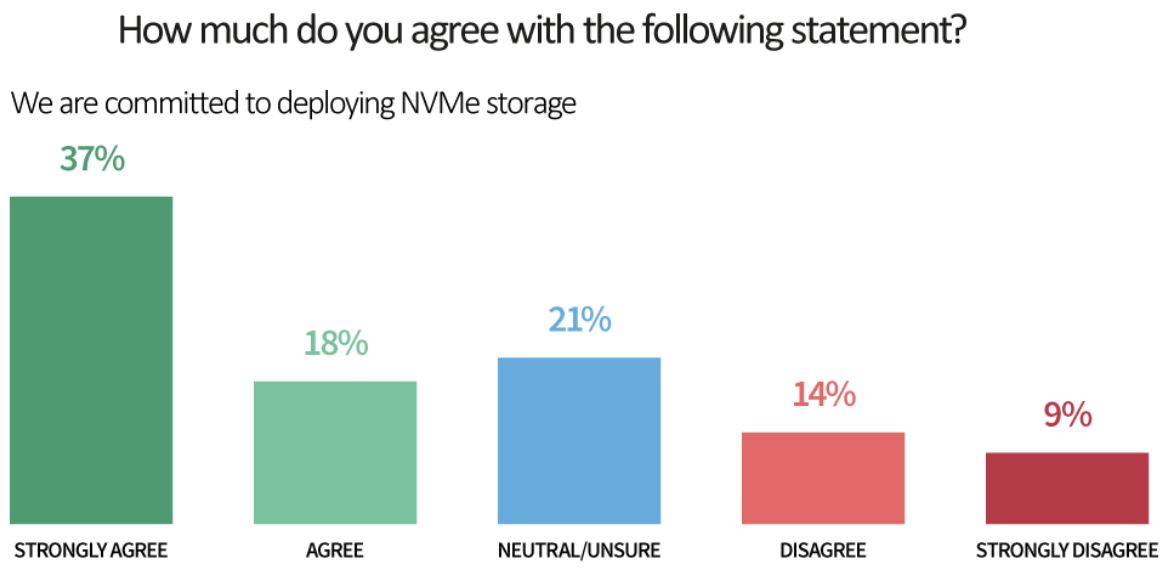

Figure 2

The end-to-end value of NVMe

Implementing NVMe systems clearly delivers advantages to the IT Infrastructure, but because NVMe elements can be adopted piecemeal, it is easy to overlook that, as we have written previously, the full value of NVMe is only obtained when it is implemented end-to-end.

Certainly, the fact that the NVMe protocol has been designed to be as lightweight and efficient as possible is important in itself. But the full range of benefits that NVMe enables can only be achieved when every element in the processing chain, from the compute engines in the processors through the bus interfaces to the storage, all support NVMe natively.

While NVMe has generated much press coverage, and awareness amongst IT professionals is high, the same cannot be said about NVMe-oF and its potential (Figure 3).

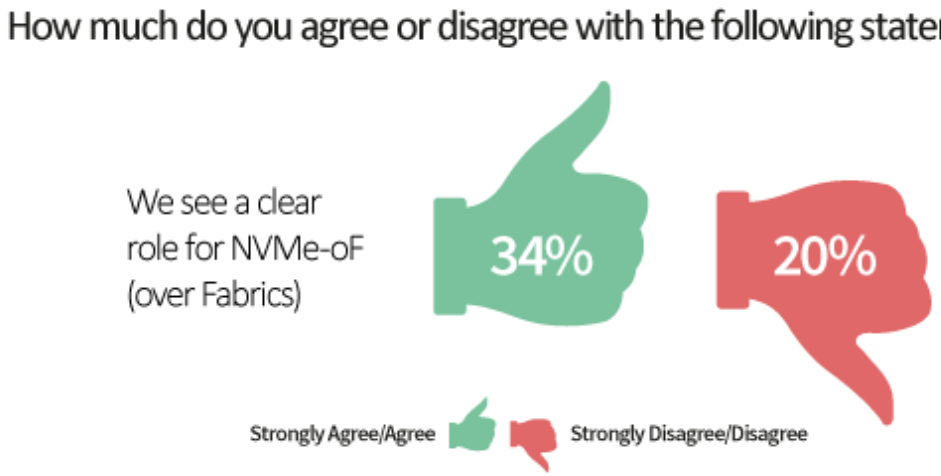

Figure 3

NVMe-oF is the part of the protocol stack that allows NVMe storage to be used across a number of low-latency network connectors, such as InfiniBand, Fiber Channel and Ethernet. This brings additional benefits to systems, in particular it makes it possible for data held within NVMe systems to be accessed remotely.

One obvious benefit this creates is that compute systems can easily be built that can access very large volumes of low latency data. This is something which in the past has been both technologically complex and expensive to achieve.

But NVMe-oF also makes it possible for systems to be built where the storage platforms are geographically dispersed, without the requirement to use additional networking protocols or tools. This opens up the opportunity for geographically dispersed data to be more broadly deployed supporting more workloads than has been economical in the past.

In fact, NVMe is just a component of NVMe-oF. By itself, NVMe is certainly a useful technology at the storage platform level. But it holds the promise of becoming a game-changer only as part of the broader NVMe-oF protocol. We must remember, however, that the entire networking infrastructure needs to be able to handle such demanding workloads, especially if NVMe-oF is to be exploited across sites and over long distances.

In summary

The importance of storage to the success of business has never before been so clear. In the past, storage was almost invisible, something that only concerned a few specialists until it went wrong or performance slowed. Today storage is not only important, it is widely recognized as important, even by non-IT specialists. Business users want fast access to ever-expanding amounts of data that they can manipulate speedily and use to make operational business decisions. Storage is today a front line resource. It has even attracted the attention of finance and procurement professionals who want to know why the business is spending so much money on it.

It is therefore fortunate that NVMe and NVMe-oF have reached maturity at such a time. IT infrastructures need to change to become more flexible, changing more quickly to meet rapidly evolving business requirements, while also supporting escalating demands for speed. It is clear that the NVMe and NVMe-oF protocols will form the basis upon which data center systems will run for the foreseeable future, even as storage embraces new technologies such as non-volatile memory.

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