

DELL TECHNOLOGIES DELIVERS CONSISTENT HYBRID CLOUD ENABLING UNIQUE ENTERPRISE FLEXIBILITY

EMPOWERS IT WITH CONSISTENT CLOUD MANAGEMENT ACROSS CLOUD INFRASTRUCTURE PLATFORMS

EXECUTIVE SUMMARY

Enterprises may choose from many cloud computing platform options and often find themselves using multiple clouds, both public and private. Use of multiple cloud platforms with a common management plane is a great strategy to deliver the flexibility application teams need. As teams develop and operate applications with varied availability, cost and performance requirements, they benefit from choice in capabilities between public cloud(s) and private cloud(s), i.e. hybrid cloud¹.

The challenge of operating in disparate cloud environments is that it easily fragments into separate tool sets for each cloud platform, particularly in the extreme between public clouds. This results in islands of disjointed cloud use and makes it difficult for IT to achieve consistency in management aspects of policy enforcement, security, compliance, cost management and maintaining service levels. Developers see limited application and data portability and attempt to jam every application, regardless of fit, into the cloud island with which they are most comfortable. In this case, the organization is allowing technology limitations to dictate its cloud strategy instead of benefiting from a true, consistent hybrid cloud experience.

For a decade, this has been a challenging issue to solve. Multiple cloud software platforms have been designed for use across public and private clouds. OpenStack, for example, saw private cloud adoption but no high scale public cloud availability. More recent hybrid options from public cloud providers are limited to the providers' specific private cloud infrastructure configurations. Only Dell Technologies Cloud offers a consistent hybrid cloud platform experience via VMware Cloud Foundation across multiple cloud environments spanning private infrastructure and the top public clouds of Amazon Web Services (AWS), Microsoft Azure and Google Cloud Platform.

Dell Technologies Cloud pairs VMware Cloud Foundation's consistent hybrid cloud experience with uniquely integrated Dell EMC infrastructure options to form a comprehensive cloud solution. Dell EMC infrastructure options include Dell Technologies Cloud Platform, VxRail hyper-converged infrastructure (HCI) with integrated management with Cloud Foundation, and Dell Technologies Cloud Validated Designs – including PowerOne converged infrastructure (CI) – for best of breed storage,

¹ Use of multiple public clouds is commonly also referred to as “multi-cloud” and when used with private cloud(s) is sometimes termed “hybrid multi-cloud.” For simplicity, this paper references all these combinations as “hybrid cloud.”

compute and networking. Combining these with Dell Technologies' public cloud options, such as VMware Cloud on AWS and Microsoft Azure VMware Solutions, delivers the greatest breadth of cloud infrastructure options unified by a consistent developer and operator experience. Dell Technologies is the only provider offering a consistent hybrid cloud experience for optimal use across your application portfolio.

THE OPPORTUNITY AND CHALLENGE OF CLOUD COMPUTING

Within organizations, teams often disagree in setting the course for the right cloud strategy. Application teams that want to prioritize highly elastic infrastructure capacity and/or use of advanced application development features often advocate for public cloud focus. Other teams advocate for investment in private cloud capabilities. These teams can require control of specific infrastructure aspects for their applications due to performance, control, cost and/or location requirements, particularly for their existing application footprint.

Enterprises have the opportunity to deliver on the vision for hybrid cloud value with optimal flexibility provided to all teams. The challenge is to do so without fragmenting into separate management and use. To enable the organization to choose the right landing zone for applications based on business value and requirements, IT must provide a consistent hybrid cloud experience across all environments. This means holistically defining the optimal use of public and private clouds across an organization's application portfolio and having common infrastructure and operations models to enable portability across clouds.

Three top reasons to use public cloud infrastructure are as follows:

- Rapid application development via elasticity of capacity and breadth of features and services
- Cost savings on applications with highly variable and/or unpredictable capacity consumption
- Cost efficiency for specific use cases, such as disaster recovery and data retention

On the other hand, four top reasons to use private cloud infrastructure include the following:

- Applications with specific bandwidth and/or latency performance requirements
- Full control of infrastructure access and configuration to address policy, security and/or compliance requirements
- Cost optimization in operation of applications with predictable capacity consumption
- Location requirements due to specific country data sovereignty regulations

The following use cases illustrate how these reasons sometimes clearly guide preference for either public or private cloud. Other cases illuminate tradeoffs deserving careful consideration, including across the lifecycle of an application.

Public Cloud Use Cases

Public cloud became popular for the agility it offers application teams. Developers commonly need readily available computing capacity for short periods of work. These dynamic capacity needs can be significant, particularly when conducting scalability testing. The ability to flexibly provision capacity without specific budgeting eliminates the risk of unavailability and delay to projects. At the same time, it eliminates speculative spending on infrastructure that can go underutilized. In addition, public cloud platforms offer a plethora of platform services capabilities, such as hosted databases, application components and cognitive services. The cognitive services are based on very large-scale artificial intelligence models for capabilities such as speech-to-text, computer vision and text analytics. These non-industry-specific platform services allow accelerated development of applications and rarely make sense for individual companies to develop and maintain themselves.

Second, public cloud infrastructure elasticity also enables infrastructure cost savings for applications that do not have a consistent capacity footprint. A commonly cited example of this is where obtaining private infrastructure to meet maximum capacity need, such as in a highly seasonal e-commerce business, would result in wasted underutilization on an annualized basis. Businesses with capacity needs that are hard to predict, such as online / mobile gaming applications, may also benefit from this elastic capacity. In these cases, having extreme infrastructure elasticity within minutes avoids risky computing procurement decisions based on projected adoption. Applications with predictable capacity needs that only periodically use the capacity, such as analytics workloads executed as batch jobs, are a more subtle but applicable example, as well.

Third, almost all enterprises must ensure high availability of their applications in their normal hosting environment and their ability to operate in disaster recovery scenarios involving large scale power outages, extreme weather and other worst-case scenarios. Public cloud elasticity allows the data replication necessary for a re-instantiation of a business's applications without requiring procurement of dedicated – but normally unused – infrastructure. Similarly, data can be copied out from private infrastructure to public cloud for retention. Cloud storage services can offer greater flexibility in trading off access performance and storage cost than any flexibility individual enterprises might achieve in house. For example, public cloud cold storage offers costs comparable to magnetic tape storage with far faster retrieval times and greater reliability.

Private Cloud Use Cases

In contrast, there are numerous use cases where private cloud continues to be the optimal solution for applications with specific requirements on performance, control, cost and/or location.

First, when the application has a performance profile requiring bandwidth and/or latency characteristics not achievable in public cloud or deliverable to the application's users from the public cloud, private cloud is optimal. Transaction-intensive systems that serve as primary systems of record have typically been designed to rely on remarkably high throughput and exceptionally low latency communication between cluster nodes that can be difficult to achieve in a public cloud environment. Traditional ERP applications, such as SAP's ERP Central Component (ECC) backed by Oracle DB, IBM DB2, etc., commonly fit this profile.

Some more modern applications, such as SAP S/4HANA, can operate well on either side of a hybrid cloud using high vertical scale main memory and Intel Optane memory, available in public cloud, similar to private infrastructure options. Regardless, traditional private cloud deployments remain quite common as the SAP HANA example of hybrid cloud optionality is more the exception than the rule. Most other traditional enterprise applications designed to be backed by high vertical scale relational databases, such as Oracle RAC, IBM DB2 and Microsoft SQL Server, are highly sensitive not just to high throughput and low latency between application cluster nodes and database cluster nodes but to very tight consistency in that performance. This has been the main struggle with even 10Gb and now 100Gb Ethernet in public cloud versus the Infiniband and Fibre Channel network fabrics in private infrastructure since the latter are designed for single tenant use and, therefore, only available in niche bare metal infrastructure configurations in public cloud.

Users or devices running applications requiring tight turnaround from public cloud for a near real-time request/response experience also face the sustained throughput and consistent latency struggles. Edge devices in manufacturing and healthcare environments requiring tight timing on analytics informing automated decision loops on alarms and actions can similarly require private infrastructure. These applications are even more sensitive to loss of connectivity when they are business (or even patient) critical systems.

A second common private cloud use case is deployment of applications where organizational policy requires use of private infrastructure. Custom private infrastructure control can be necessary for compliance and security regulatory requirements. Compliance-driven policies are particularly common in industries with more stringent regulations, such as education, financial services, government and healthcare, which must be met through custom access, configuration and verification standards that are only achievable with private infrastructure. Security is a challenge with many legacy applications developed without an expectation of operating in virtualized or containerized

environments. These applications can be tethered to environments with specific security requirements unavailable in public cloud that allow for out-of-date / unsupported operating systems and drivers that lack basic security measures for a multi-tenant environment. Public cloud vendors have made some progress in these areas by adding resource isolation and security features, such as dedicated and bare metal servers, built-in encryption with customer-owned keys and the achievement of an array of compliance standards. However, even when compliance and security aspects are addressed, organizations commonly keep policies mandating that certain mission-critical applications stay on-premises due to the strategic nature of full control over the applications and the data.

Third, private cloud can deliver greater cost efficiency for some workloads. A common characteristic among the traditional and edge applications – that are commonly mission-critical applications for enterprise – is their continuous operation resulting in a relatively consistent capacity profile day-to-day compared to more cloud-native applications. When enterprises with enough private infrastructure scale to have invested in highly mature operational capabilities can reliably predict and utilize that infrastructure, they typically achieve cost savings even when compared to the steepest public cloud compute discount models available.

Finally, global enterprises may require private cloud infrastructure in countries without public cloud regions or in locations not close enough to the nearest public cloud region. For example, Germany and Russia have mandated types of citizen data that is to be kept in-country, and, while public cloud has been introduced in Germany, it is not on any providers' announced plans yet for Russia.

Hybrid Cloud as the Optimal Solution

Continued change in what each cloud can address influences the choice of public versus private cloud per application. Public clouds continue to progress in performance capabilities with higher performance networking, such as 100Gb Ethernet, as well as higher vertical scale compute with servers offering up to 24TB of memory. Meanwhile, private cloud elasticity continues to improve to rival that of public cloud for the needs of most applications. The vast majority of applications are highly consistent and predictable. Many of the other applications vary in capacity consumption at only small-to-medium scale, at well under 50% growth over periods of weeks, so infrastructure providers have introduced consumption models delivering pay-per-use options for this level of capacity growth.

What results is continuing enterprise reconsideration of the optimal operating environment for many of its applications. For example, GPU-based computing originally required private infrastructure because of lack of virtualization or availability of bare metal cloud compute for public cloud hosting. Now GPU-based computing is readily available in public clouds for application development; however, it is still commonly operated in private cloud for full control and performance customization

of applications in production use in industries running simulations at very large scale, such as oil & gas, automotive and aerospace.

This applies similarly to machine learning and deep learning model development where I/O bandwidth between CPUs, GPUs and storage is critical to scaling performance and has both economic and capability impact. Economically, you can see a more efficient infrastructure investment on a smaller capacity footprint. Regarding capability, you can see performance improvement from the time taken to run machine learning and deep learning model training. When training run time drops from hours to minutes, data science team experimentation and learning skyrockets. For example, the highest scale NVIDIA GPU-enabled servers feature 16 GPUs, while the highest scale virtual machines in public cloud from each of the top three providers top out at 8 GPUs. The vertical scale advantage of a 16-GPU system in private infrastructure enables training machine learning models four times larger with up to ten times the performance of an 8-GPU system², which far surpasses the available performance of using two 8-GPU servers in public cloud. The result is experimentation in public cloud that can, and often does, transition to large scale production operation in private cloud once it is clear the model training workload will be ongoing and will benefit from performance improvement and/or will be tied to business data from systems of record on private infrastructure.

In other words, public cloud and private cloud options are highly complementary. They enable purpose-built cloud infrastructure solutions for the different application lifecycle stages, such as the transition from experimental development to production operation and from unpredictable capacity needs to a relatively consistent footprint.

This continuing consideration of migration of applications across cloud infrastructures illustrates the utility not just of hybrid cloud optionality but the importance of application and data portability to enable ongoing optimization. Container platforms based on Kubernetes are being widely adopted to help reduce the barriers to portability as containerized applications are further abstracted from specific infrastructure configuration dependencies where possible. However, achieving seamless portability of applications often still comes down to the cloud platform layer. Containers can bridge cloud islands of underlying compute stacks of operating systems, virtualization and drivers, but they cannot bridge islands in network and storage architecture or lack of management consistency.

Without a cloud platform delivering consistency across all your cloud environments, usage fragments based on disparate tool sets per cloud resulting in disjointed use lacking portability. IT lacks the consistent tool set for full view management of policies, security, compliance and cost optimization to

² NVIDIA DGX-2 16-GPU server versus NVIDIA DGX-1 8-GPU server: <https://www.nvidia.com/en-us/data-center/dgx-2>

foster and inform application operation decision-making, portability improvements and migration planning.

DELL TECHNOLOGIES OFFERS UNIQUE, CONSISTENT HYBRID CLOUD PLATFORM

Only Dell Technologies offers a consistent cloud platform experience across cloud environments, spanning private infrastructure and the top public clouds of AWS, Microsoft Azure and Google Cloud Platform. Dell Technologies combines VMware Cloud Foundation with infrastructure offerings spanning uniquely integrated HCI, CI and Dell Technologies Cloud Validated Designs for more customized network and storage implementations.

VMware Cloud Foundation delivers this consistent cloud platform across these public and private cloud infrastructures by deploying VMware Software Defined Data Center's (SDDC) core bundled components: vSphere for compute virtualization, vSAN for storage virtualization, NSX for network virtualization and vRealize Suite for cloud management. This merges management of all cloud computing resources per infrastructure, as well as across cloud infrastructures via vRealize Suite, into a single consolidated management view for IT. While AWS, Microsoft Azure and Google Cloud offer options for hybrid cloud in predetermined, constrained configurations, Cloud Foundation uniquely delivers a common, empowering experience across the public and private cloud infrastructures. In addition, SDDC delivers virtual machine-based portability with container-based portability as an option when running VMware PKS as a Kubernetes platform on SDDC.

Private Cloud Options for Combining Scale Efficiency with Application-Specific Customization

For private cloud, Dell Technologies Cloud Platform's HCI solution is the starting focus for enterprises looking to mirror their infrastructure options and experience in public cloud with that in private cloud. Public cloud has proven many applications can be addressed with a set of standardized infrastructure platform configurations, and VxRail for HCI is targeted at the bulk of enterprise applications that consume common ratios of compute, network and storage resources. Its design focus is on heavy automation and cost effectiveness to deliver an infrastructure-as-a-service (IaaS) type of experience to private infrastructure at scale underlying the Cloud Foundation hybrid cloud platform. VxRail is the only jointly engineered HCI system with VMware to provide coordinated, pre-validated software updates for SDDC components and hardware infrastructure components down to the firmware. With full stack integration and automated lifecycle management, both the HCI infrastructure layer and the VMware cloud software stack are managed through SDDC manager, greatly reducing risk and increasing IT operational efficiency. The VxRail Manager and SDDC Manager components have been integrated to allow for an automated and seamless update and upgrade process. This enables organizations to rapidly and securely update and patch from one known good state to the next. This coordination allows customers to asynchronously deploy releases from Dell EMC and VMware of the

Cloud Foundation and VxRail software updates, so the latest cloud and HCI software benefits are available to customers pre-validated for reliability as part of the Cloud Foundation release cycle. These updates can be deployed independently without the delay for compatibility validation testing as is necessary for other HCI and private infrastructure vendors supporting Cloud Foundation.

Organizations can also utilize Dell Technologies Cloud Validated Designs, including CI options with PowerOne, for flexibility in network and storage configuration around compute that complements the VxRail HCI options. PowerOne CI options are more applicable to mission-critical traditional applications needing particular network and storage resource optimization, including disproportionately storage performance and volume-intensive applications, such as SAP and other applications backed by high vertical scale relational databases noted previously. This can also include processing-intensive applications dependent on high throughput storage, such as machine learning and deep learning model training and inferencing applications.

Dell Technologies Cloud Validated Designs are available with deployment guidance for pre-tested Dell EMC storage, compute and networking infrastructure that's been validated with Cloud Foundation. Dell Technologies Cloud Validated Designs are now available for Dell EMC Unity XT, PowerMax storage arrays and PowerEdge MX servers. These options offer enterprises with existing investments in Dell EMC storage deeper flexibility in meeting storage performance requirements for individual applications. Dell EMC PowerEdge MX supports interoperability with Cloud Foundation allowing IT to manage and scale storage resources at the individual drive level across multiple chassis for individual applications. This flexibility enables IT to deliver the value of infrastructure customization in private cloud for performance and cost optimization at a level not available in public cloud as needed for traditional and edge applications.

Public Cloud Options Delivering Consistency of Management

VMware Cloud Foundation offers a consistent management experience in public cloud across the top public cloud providers. VMware sells and supports a managed deployment of Cloud Foundation on AWS – just as it does on VxRail in private infrastructure – maintaining the availability and periodic updates of Cloud Foundation on behalf of the customer. This delivers a user experience on public cloud that exactly parallels that of private infrastructure.

Similar offerings of Cloud Foundation are available on Microsoft Azure and Google Cloud, but both are partner managed. VMware, Microsoft and Google's joint managed services partners sell, manage and support the offerings. Microsoft Azure VMware Solutions and Google Cloud VMware Solutions are both offered by CloudSimple. Virtustream – as a Dell Technologies company – is expected to introduce an offering by the end of the year. (IBM Cloud for VMware Solutions is available for virtual machine portability for migrations but does not offer Cloud Foundation.)

Dell EMC offers the full complement of competing hybrid cloud options, including Dell EMC Azure Stack solutions to pair with Microsoft Azure and Dell EMC VxFlex to support Google Cloud Anthos paired with Google Cloud Kubernetes Engine.

CALL TO ACTION

IT leaders challenged with inconsistent management capabilities across the various public and private cloud platforms adopted by their organization should consider extending their investment in VMware from private infrastructure to create a hybrid cloud that spans their data center and public clouds. With tight integration between Dell EMC infrastructure and VMware Cloud Foundation, particularly with VxRail, organizations can deliver a consistent hybrid cloud experience and bring as-a-Service levels of consumption and automation to the data center that strongly parallels that of public cloud IaaS. Dell EMC customers should inquire about the ability to onboard cloud capabilities into their data center using Dell Technologies services and infrastructure.

As the only infrastructure and cloud platform provider with a cloud platform available across the top public and private cloud infrastructure platforms, Dell Technologies uniquely enables IT to empower application teams with a consistent hybrid cloud experience. This consistency frees application teams to achieve optimal use of their public and private cloud options across their portfolio from new cloud-native applications to improvement and modernization of existing applications. Dell Technologies deserves strong consideration as strategic advisor and provider in your cloud journey.

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