Dell Technologies

An Ear to the Ground

App transformation across private, public and edge
A strategy to harness the evolution of apps and data

Abstract

Application architectures and the processes to develop, deliver and maintain them are changing. At the same time, more data is being generated in locations everywhere demanding that processing be pushed to the edge. These fundamental shifts are presenting tremendous challenges as organizations attempt to transform their IT foundation. Those who can harness the power of modern applications across public, private, and edge deployment options are dramatically increasing innovation and efficiency. Dell Technologies and VMware have a pragmatic approach that can help organizations evolve their existing infrastructure and processes so they can be ready for what's next.

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1.1 Introduction: An ear to the ground

"An ear to the ground" is an idiom that evokes the idea of someone who knows what is coming next. It provides an image of someone who is prepared because of their attention to detail, keen observation, and thorough analysis.

Today's organizations are interconnected collections of people and locations held together through communications and insights generated by data and the software that processes it. Whether your organization is a public agency, research firm, manufacturing facility, retail purveyor, or one of many others, you need to be ready for what is next. What is next may be a market trend that indicates shifting demand. It may be an inventory feed that alerts a shortage in supply. It may be a revolutionary way people interact that requires new models for engagement. Recent developments in data and software applications give all of us the opportunity to have an "ear to the ground" – if we have the right strategy to harness them.

1.1 A generational shift

The application ground is shifting underneath us. We are in the midst of a generational change in how data is collected, processed, and presented through software applications. This shift is being brought about because of the urgent need for organizations to innovate and react quickly in our dynamic macro environment.

Cloud-native applications are becoming a new standard. In fact, according to IDC in their most recent FutureScape study[1], by 2025, nearly two thirds of enterprises will be prolific software producers with code deployed daily, and over 90% of applications will be delivered using cloud native approaches. What's truly amazing is the sheer volume of applications that will be developed with these new approaches. IDC says that over 500 Million new apps will be built using cloud-native practices by 2024.
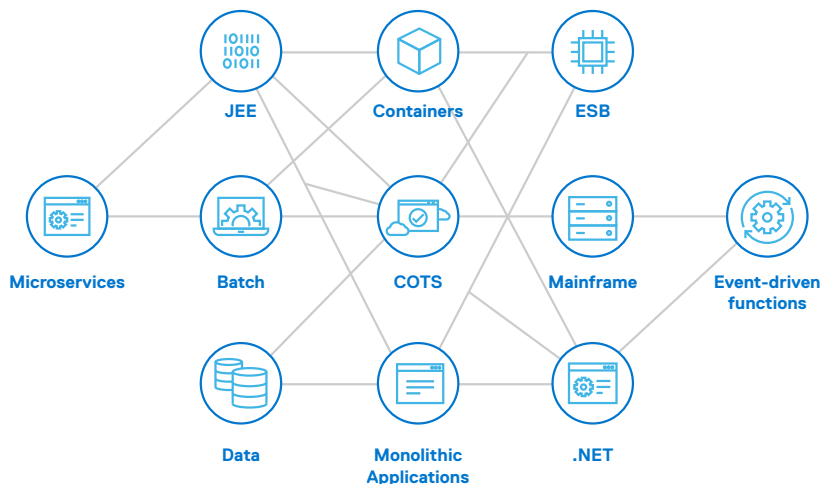

Figure 1 Application portfolio complexities

This move to cloud native is recognized by IT leaders. In a survey by Forrester they found that most CIOs agree that improving their portfolio of applications is a TOP priority. Yet, almost half of those organizations have not made any improvements in the last year or more. What is holding companies back?[2]

The reality is that this is a difficult challenge for most companies. I would suggest that if you have been in business for more than a few years, your portfolio looks something like figure 1.

It is a web of interconnected complexity made of millions of lines of code. This can include everything from commercial off-the-shelf packages to monolithic applications built using .NET or legacy Java frameworks. Chance are, for newer initiatives, you have started working with "cloud native" technology like microservices, containers, and event-driven patterns. You want to leverage the cloud and increase the value you deliver to your customers but feel held back by years of complexity. The older software can be difficult to update, integrate, and scale, and it may keep your teams buried in maintenance work that delivers no business value. This reality is what makes modernizing a difficult proposition for most companies.

[1]IDC FutureScape: Worldwide IT Industry 2020 Predictions, #US45599219, October 2019.

[2]A commissioned study conducted by Forrester Consulting on behalf of VMware. How Transformative CIOs Use Customer Experience to Differentiate & Deliver Results. February 2020.

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1.2 Cloud native

Let's dig into what companies face when approaching modernization initiatives. Consider the way that Joe Beda defines cloud native. He says that cloud native is about structuring teams, culture and technology to use automation and architectures, with the end goals of enabling you to manage the complexity while at the same time unlocking velocity. If you are not familiar with Joe, he is a Kubernetes leader who filed the first ever Kubernetes project commit, founder of Heptio, and now with VMware. Cloud native is a new way of thinking about how you build, run, and manage applications. It is about modernizing applications that make sense and removing toil from the software delivery lifecycle.

"Cloud native is structuring teams, culture and technology to utilize automation and architectures to manage complexity and unlock velocity."

Joe Beda, Principal Engineer, VMware (and filed the first-ever Kubernetes project commit)

It all starts at the definition of an application and how that has changed. Most developers work on existing applications today that are a web of tightly coupled and sparsely documented systems. These monoliths (as the name implies) are built as a single, large code base that must be updated as a unit. Releasing these applications is a high effort, high risk event that is done infrequently, which means developers must hop on a release train that is months away to get new features out to customers.

Modern applications, on the other hand, are API-driven. While some data sources and processing may still be done with monolithic constructs, new logic modules are built with microservices. These are small, modular code bases with clear interfaces that enable them to be developed, deployed, and managed independently. The benefit is that a single microservice can be updated frequently without impacting all the other services. A distinction of microservices design is that they should be independently resilient. Code that consumes a service should strive to continue working if the service is down or misbehaving. That is right, you should expect things to break and build your code to ensure it keeps working.
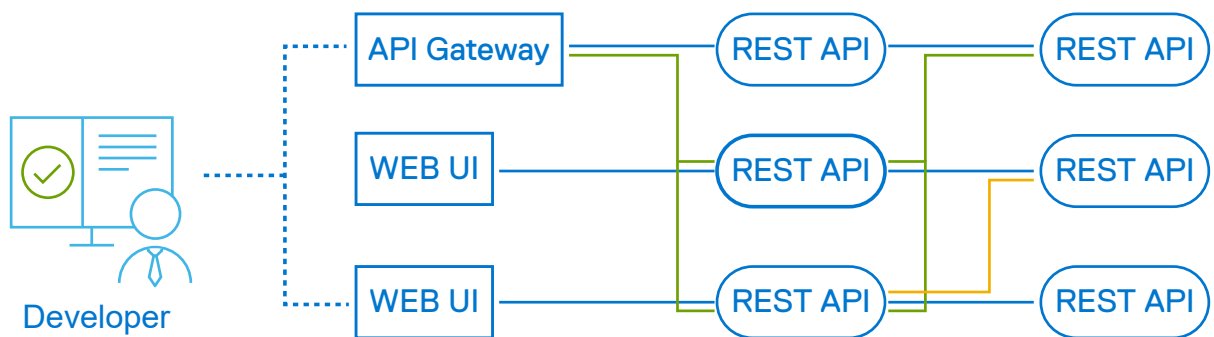

Figure 2 Modern apps are built with microservices and APIs

1.3 Containers and Kubernetes

Building applications as microservices has spurred the use of containers. These are self-contained applications packaged such that they are freed from infrastructure dependencies. The package includes the entire runtime environment, which is the application itself, plus all its dependencies, libraries and other binaries, and configuration files needed to run the application. Containers are exciting because they enable software to run reliably when deployed in different computing environments.

This means a developer could run code on her local machine and then move it to a test environment without problems—or code can move from staging to production anywhere: from a physical machine to a Virtual Machine in a private or public cloud. The code would run the same regardless of the environment.

As the number of containers increases rapidly, they become near impossible to manage using conventional methods. Kubernetes is a great technology that automates much of the management of containers. It is self-healing and declarative, meaning your setup can be version controlled and easily replicated. It automates deployments and rollbacks and can automatically restart containers that fail or have stalled. Additionally, Kubernetes automatically scales your services up or down based on utilization, so that you can scale up fast for events like cyber Monday or scale down when not needed. It basically helps your containerized services run better.

These new approaches facilitate modern applications. And this is where you will find the concept of "platforms" entering the picture. Platforms encapsulate these cloud native patterns and enable you to automate the full stack — from a unified Kubernetes runtime across clouds to simplified operations to a consistent developer experience — regardless of where your applications are running. In cloud-native approaches, you will find that the developer experience and operational efficiency are paramount. Productive, innovative developers and automated, efficient operations are needed to accelerate your business.

2 Modernizing applications

How do companies move from that web of existing and heritage applications to modern, cloud-native applications? It is not a one-size-fits-all approach for your existing applications. You must consider business requirements and technology factors. Does it make sense to move based on licensing costs or revenue opportunities? Is this a mission-critical system that requires urgent attention? And what is involved technically, based on existing tooling, frameworks, and dependencies.

Companies can choose to rehost or "lift and shift". This is moving applications to cloud infrastructure as is with a VM instance running in your cloud of choice. This could assist in infrastructure costs, but you will not see the benefits of running applications on the cloud (and performance may even be worse). Some may go a little further to take advantage of cloud services, like replacing legacy database instances with something managed by the cloud provider. This is more commonly termed replatforming.

Retire
Retire traditional app and convert to a new SaaS app

Retain
Optimize and Retain Existing Apps, as-is

Rehost/Migrate
Move apps to cloud and rehost

Replatform
Put apps in containers and run in Kubernetes

Build/Refactor
Rewrite apps using cloud native technologies

Figure 3 Application portfolio analysis

Then there is refactor and rearchitect. Think of these as similar intent (to end up with a cloud native application), but different approaches. Refactoring is about safely modifying small portions of your application over time to support cloud-native constructs. Rearchitecting is more wholesale application recoding to adopt cloud-native principals.

Then there are the options of replacing applications with a new cloud-native option, such as a SaaS application. Or, companies may simply choose to retire an application because it is obsolete, or retain it untouched. This may be a valid option, particularly if the application does not require frequent change.

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2.1 An example

Organizations today rely on data and software applications to create and deliver value in almost every aspect of their operations. Dell Technologies as a company is no exception. With rapidly changing user requirements and a dynamic market landscape, we need to respond quickly to the needs of our customers, partners, and employees. The old way of developing and delivering software was too slow, so we set out to reinvent the way we deliver value through information technology.

It does not get more real than Dell.com. One of the internet's busiest commercial web sites, Dell.com needs to keep up with the latest trends. The challenge was that implementing capabilities required by the business – such as providing updated search capabilities – took too long to implement, averaging 3-8 months to deliver new application features. In order to speed innovation, Dell Digital (the team responsible for developing and delivering innovation for our website) has modernized its application development infrastructure with VMware Tanzu cloud-native infrastructure.

"With a few clicks, developers provision resources, select cloud features on demand or move applications across on-premises and public clouds without porting."

Raj Markala, Director IT Infrastructure, Dell Digital

The results have been impressive. Dell Digital has deployed 7,500 microservices running in production across six data centers providing 24×7 availability. The infrastructure incorporates VMware vSphere®, 71,000 VMware Tanzu application containers and 28,000 Kubernetes pods. The environment enables developers to build microservices by provisioning cloud services, containers, and virtual machines on their own.

According to Raj Markala, Director of IT Infrastructure, Dell Digital "with a few clicks, developers provision resources, select cloud features on demand, or move applications across on-premises and public clouds without porting." These automated, orchestrated capabilities have reduced development time from typically six months to a few weeks or less — an 85 percent improvement. The Dell.com team has improved the customer shopping experience by increasing feature launches from 8-10 per year to 55 per year. The Dell B2B website, Dell Premier, has compressed release cycles for upgrades from four weeks or longer to just days. Innovation and meaningful business outcomes have become hallmarks of the VMware Tanzu platform. The Dell Premier team used the platform to develop a smart recommender feature for the B2B website. That feature alone accounts for more than $1 million of annual revenue.

For more information see this infographic and detailed writeup.

2.2 The "speedbumps"

If applications are so important and cloud-native patterns are so compelling, what isis keeping organizations from making progress faster? There are a few speedbumps in the road that are slowing down progress for organizations that are trying to adopt these new approaches.

First of all, it is challenging to source and stand-up a cloud-native stack – we call this day 0. The modern application ecosystem is comprised of many open-source tools. Kubernetes — the leading container orchestration software is curated by The Cloud Native Computing Foundation. A modern applications platform requires many other capabilities, including image registry, persistence, networking, monitoring, security, and more. Selecting and integrating those components to assemble a production-ready platform requires hard-to-find skills and very rarely adds any unique value. Furthermore, a custom-built cloud-native platform usually results in a snowflake configuration that is difficult to sustain and scale to production.

The second speedbump is your "technology estate" – the legacy of existing skills and infrastructure in your organization. It would be best if you determined how to curate and evolve existing operations, assets, and people while adopting new technology. Few organizations can afford to start from scratch and walk away from existing investments in infrastructure and staff. For your modern applications approach to be successful, traditional and cloud-native approaches must co-exist pragmatically. While proprietary cloud-native stacks excel at delivering new functionality in containerized microservices, they are incompatible with valuable legacy applications that run the business. If existing infrastructure and current skills are not extended into your modern applications practice, DevOps process flows will be inherently disjointed and your architecture unsustainable.

1. Day 0   **2. Tech Estate**   **3. Day 2**   **4. Consumption**

5. Multi-cloud
This must be done in the reality of workloads running
across multiple clouds in private, public and edge locations.

Figure 4 The "speed bumps" that are slowing down progress

The third challenge area concerns day 2 operations – provisioning resources, applying patches and upgrades, scaling up and down, and meeting service levels for availability, security, business continuity, etc. With so many components in a modern application stack, lifecycle management can become overwhelming quickly. Feature enhancements and security patches require regular updates to the platform. Failure to apply patches and updates comes with the risk of downtime and security incidents. Developers and operators can end up spending their time maintaining the integrity of the stack instead of deploying features that differentiate the business. Modern applications are being used for more business-critical systems. This drives the need for the right business continuity and disaster solution to avoid the risk of data loss. Perhaps most important is organizational readiness. Do you have the right skills and processes in place to truly transform your operation as well as your infrastructure and applications?

Fourth, these changes all must take place in the backdrop of IT infrastructure today. This means you need a strategy for application compatibility and operational efficiency across private, public, and edge cloud locations. Most organizations plan to support multiple cloud deployment options, including private cloud and public clouds. Many organizations are driving more and more processing closer to data sources across widely distributed operations. When applications are incompatible across clouds and when processing is confined to traditional data centers, IT can't simply place workloads in the deployment option best aligned to their needs. Governance and compliance across multiple deployment options is complicated because of variations in operational procedures, management interfaces, security policies, and monitoring tools.

Lastly, while all this sounds good in theory, what will it cost? And, how can you align cost with how you are consuming technology? Of course, part of any cloud conversation is how to consume the infrastructure to have maximum flexibility and deliver the lowest costs, and most importantly to align costs with your business objectives and growth.

Let us discuss how Dell can help.

3   A pragmatic approach: The Dell Technologies Tanzu Advantage

VMware vSphere with Tanzu now includes Kubernetes. Dell Technologies works closely with VMware to deliver the solutions and services for Tanzu. These solutions enable a pragmatic approach to adoption of cloud-native patterns by adding them incrementally and non-disruptively to your existing operation. This simplifies and accelerates the ability of organizations to transform their application portfolio and be ready for what is next.

The vSphere kernel has been rearchitected around Kubernetes. vSphere 7 and up is now a unified environment that provides support for both virtualized monolithic applications as well as containerized microservices. It is available today, and Dell Technologies has worked with VMware to create a portfolio of solutions that enable organizations to get started right now.
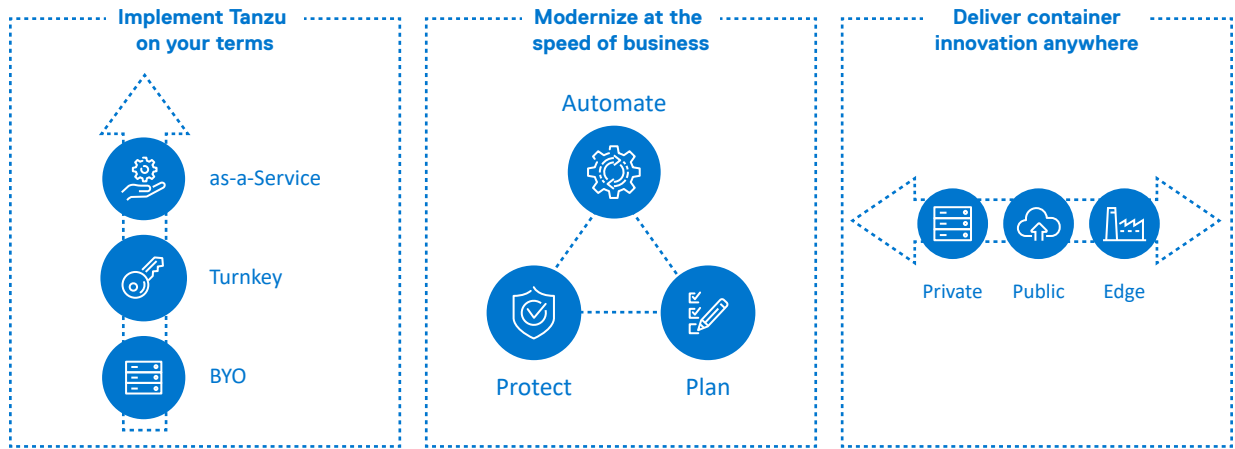
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Figure 5 The Dell Technologies Tanzu Advantage

The Dell Technologies Tanzu Advantage is our full portfolio of solutions that incorporate the best of our industry-leading infrastructure with VMware's industry leading software. We will go into the three main aspects of how this portfolio approach helps organizations smooth out the speedbumps on the road to application modernization.

- "Implement Tanzu on Your Terms" addresses the challenges around consumption and day 0. It covers standing up and scaling your modern applications environment, giving you ultimate flexibility in how you architect and consume the private cloud infrastructure for modern applications.

- "Modernize at the speed of business" addresses the challenges of ongoing operations for modern applications infrastructure – often referred to day 1 and day 2 operations. This includes extensive automation of management tasks, developing a plan and executing on that plan for evolving your technology estate and achieving operational readiness in your organization, as well as ensuring business continuity and disaster recovery.

- "Deliver container innovation anywhere" gives you the agility that you need to deploy and manage apps in a multi-cloud world. It gives you the flexibility to deploy your applications to private cloud, public cloud, and edge locations – dependent on the parameters of each workload. It provides a consistent governance framework for establishing and enforcing policies across all your deployment options.

We will address each of these advantages in the following sections.

3.1   Implement Tanzu on Your Terms

Each organization and sometimes each product delivered by your organization may have different requirements for the platform where you will run your applications. The level of architectural control in terms of the underlying components, the level of integration (or conversely the level of configurability) of the solution and the amount of responsibility for ongoing operations of the resultant platform are driven by unique requirements.

You need the ability to choose from a portfolio of solutions with a variety of options to fit your needs. Best-of-breed components offer the highest level of configuration and control. Turnkey options are pre-configured and highly integrated for rapid, worry-free stand-up. As-a-Service approaches provide flexible consumption, bundled delivery, and implementation services, and even fully managed services should they be needed.

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3.2 Best of Breed

Customize your modern applications platform. For organizations that want the most control of their modern applications platform design, Dell Technologies has the leading portfolio of best-of-breed components that support VMware Tanzu. With the industry leading PowerEdge server line, our robust set of purpose-built storage and our complete line of open networking switches, every aspect of designing and delivering a modern applications platform is covered.

We have designed PowerEdge servers to help drive business outcomes. Each server is designed to effectively tackle the key workloads that drive business. Dell EMC PowerEdge delivers a worry-free infrastructure that is secure and scalable with no compromises. It starts with a scalable business architecture designed for modern workloads. Whether it is a scale-up or scale-out need, our servers are designed to have the capability to support it. This includes flexibility on the processors, accelerators, memory, storage, and networking.
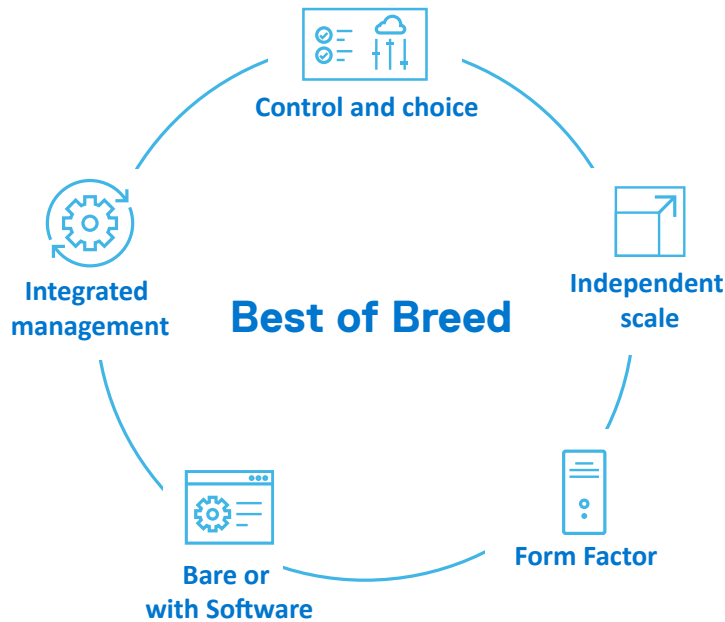

Figure 6 Flexibility and control from Best-of-Breed

This flexibility provides you with a platform that offers superior performance - ability to scale storage and compute independently, leverage existing investments - and build your platform with validated designs that guide your implementation. You can start with rack mount or blade form factors, build from the ground-up with bare hardware or start with ready nodes that come with software. But it is also important to bear in mind that servers operate in complex, heterogenous environments. So, managing this effectively and easily is a crucial requirement. We developed a series of new technologies around our OpenManage suite of systems management tools that significantly help automate critical tasks and make system management more productive and efficient. All these options feature streamlined operations with OpenManage Integration for VMware vSphere.

When it comes to the storage vSphere and VCF support persistent volumes through vSAN and more recently also support Dell EMC purpose-built storage such as PowerMax and PowerStore. Purpose-built storage provides the flexibility to scale storage and compute independently and is designed from the ground up to provide reliable, high performance storage for business-critical data. The good news is that nothing special needs to be done to leverage Dell EMC storage arrays when using containers with vSphere. VMware has developed CNS – the Cloud Native Storage interface - to allow seamless integration of storage into vSphere. There are no plugins or special tooling needed. Dell EMC storage platforms seamlessly support the VMware infrastructure needed to deploy and run Tanzu. Storage Based Policy Management (SPBM) can be used to deploy and manage vVols and VMFS datastores on our purpose-built storage. Dell EMC storage platforms provide additional value to VMware Tanzu deployments with persistent volumes that can be de-duplicated and compressed, increasing the effective storage capacity, sometimes by 4:1.

Policy-driven dynamic provisioning   **Transparent storage infrastructure**   **Advanced storage efficiency**

Figure 7 The benefits of purpose-built storage for Tanzu

3.3 Turnkey

Kubernetes is open source software curated by the Cloud Native Computing Foundation (CNCF). The community is building a rich ecosystem of tools and Kubernetes is only one of the required pieces for a full cloud-native stack. Building a cloud-native stack from scratch is complex, and the resulting system can be like "a science project" and it is unlikely to be a "production-ready" platform. The result of building a platform from scratch is usually a "snowflake" one-off design. It is guaranteed to take a long time to produce and is unlikely to be the right environment with which to entrust your business-critical applications in the long run.

Contrast that to our turnkey approach to implementing modern applications infrastructure with VMware Tanzu on VxRail.

- It is Complete = We have selected the best components to create a full stack and deliver Dell EMC VxRail as a complete package.

- It is Turnkey = we have integrated them so that they work together out-of-the-box and we've automated many of the manual tasks involved

- It is Standard = it works with today's applications and we have incorporated the latest upstream open source Kubernetes in VMware Tanzu so you're not locking into proprietary extensions

- It is Trusted = it is running in production today at some of the leading organizations that have adopted cloud-native patterns.
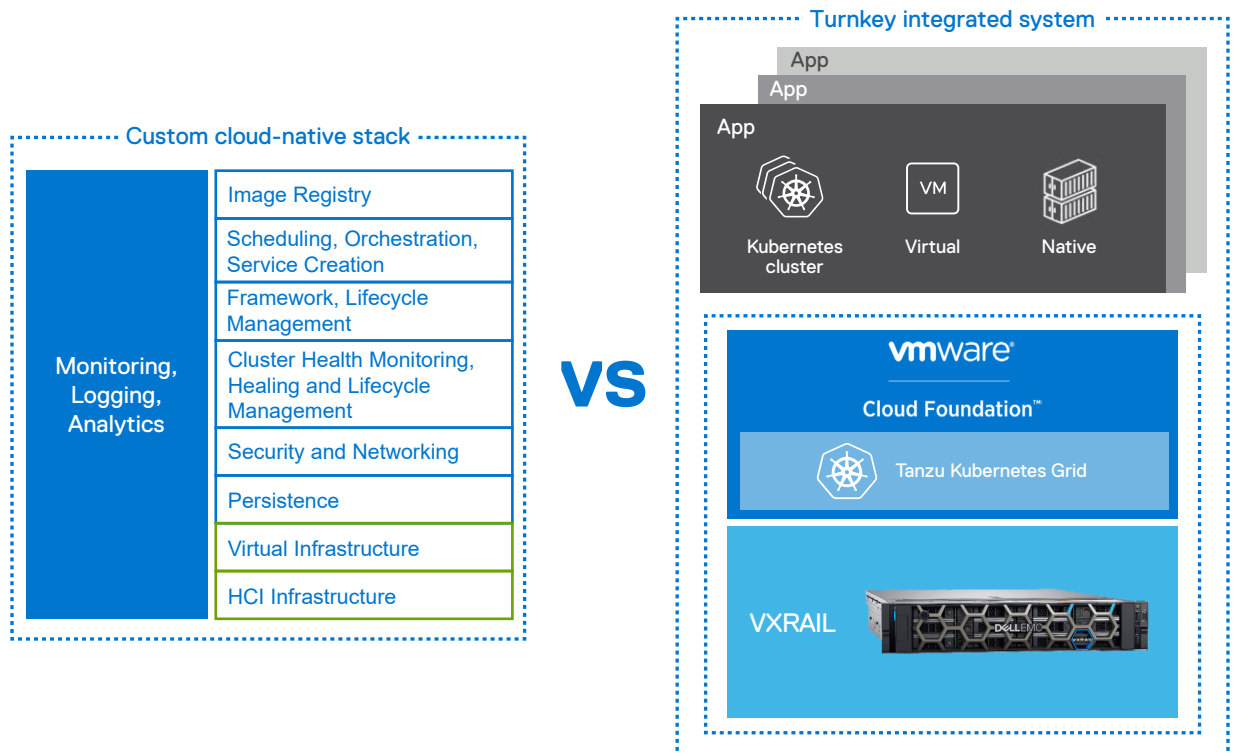

Figure 8 Don't reinvent the wheel

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Our turnkey platform options feature uniquely engineered, deep integration developed in collaboration with VMware. It enables the rapid stand-up of Tanzu environments in several configuration choices. Our multiple VMware Tanzu on Dell EMC VxRail infrastructure options enable customers to keep pace with the speed of business.

Our curated VxRail systems come fully integrated and ready to deploy, helping accelerate the adoption of Kubernetes infrastructure. We automate Kubernetes infrastructure deployment and provisioning, accelerating operations and developer productivity. This speeds Kubernetes infrastructure delivery so developers can operate at the pace of today's digital business. New nodes can be non-disruptively added to a cluster in as little as 15 minutes, either to provide additional compute and storage to support application development or roll a new application into production.

VxRail has several fully integrated HCI infrastructure options to run vSphere with Tanzu, an enterprise-grade, consistent Kubernetes runtime that enables customers to build, run, and manage Kubernetes controlled container-based applications. Customers can choose the best infrastructure to fit their organization's operating model and level of Kubernetes expertise, from a fast and simple deployment of vSphere with Tanzu on VxRail to a fully integrated, secure private cloud deployment with VMware Cloud Foundation with Tanzu on VxRail. Dell Technologies is the ONLY vendor offering this breadth of Tanzu infrastructure deployment options, enabling customers to deploy the optimal infrastructure that meets their Kubernetes readiness journey.

3.4   As-a-Service

Our as-a-Service offerings deliver application-ready cloud infrastructure with pre-configured offerings supporting a wide range of enterprise workloads running on virtual machines and containers.

3.5   Apex Cloud Services

In a few clicks, you can subscribe to instances designed for your workloads through the Dell Technologies Cloud Console — and get it deployed in your data center, colocation facility, and edge locations in as few as 14 days.[3] A simple way to size and order on-premises cloud resources enables you to focus on your applications instead of infrastructure procurement and upgrades.
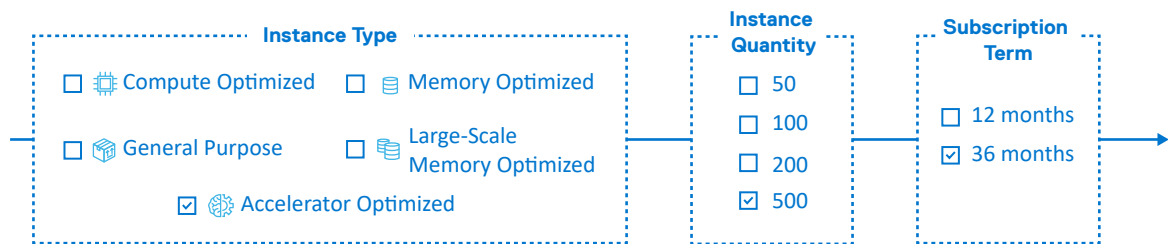

Figure 9 APEX workload instances

Now you can develop, test and run both cloud-native and traditional applications on a single platform to deliver a simple path to on-premises cloud through automated operations. With pre-configured private and hybrid cloud solutions, we are delivering value to customers around flexible consumption, time-to-value and bundled services – i.e., getting up and running quickly with the right level of ongoing support. To deliver in as few as 14 days, we are pre-building and stocking nodes/racks, leveraging our strong supply chain together with second touch facilities and services.

Why are we confident our deployment times are faster than our competitors? We are making the claim "Industry's fastest hybrid cloud deployment" because based on internal research and conversations with analysts and customers, we believe we are faster (better time-to-value) than our competitors. Our expertise in supply chain and operations means we believe this is a sustainable advantage.

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3.6 VMware Cloud on Dell EMC

You may want to let Dell Technologies manage your data center. VMware Cloud on Dell EMC is a fully managed, subscription-based on-premises cloud solution. It combines the latest VMware Cloud infrastructure software with Dell EMC VxRail hardware, creating a unique and powerful combination. This solution gives organizations greater control of their workloads by deploying modern hyperconverged infrastructure across on-premises datacenters, edge, and colocations.

VMware Cloud on Dell EMC delivers the VMware SDDC platform—including VMware vSphere , VMware vSAN®, and VMware NSX® virtualization technologies—and integrates with Dell EMC VxRail hyperconverged infrastructure. Within the VMware Cloud Services portal, you can select the rack size and number of host instances and configure network requirements to meet your exact specifications. The VxRail appliance architecture enables you to start small and grow, scaling capacity and performance easily and non-disruptively from 3 to 24 nodes. Once you place your online order, the infrastructure is delivered, installed, maintained, and supported end-to-end. With VMware's hybrid cloud control plane, you can provision and monitor resources as you already do with existing VMware on-premises infrastructure. VMware continually monitors the service infrastructure, patching and updating software across the network while proactively addressing any issues that may surface. Should there be a hardware issue that needs to be addressed, Dell Technologies provides 4-hour on-site break fix service.
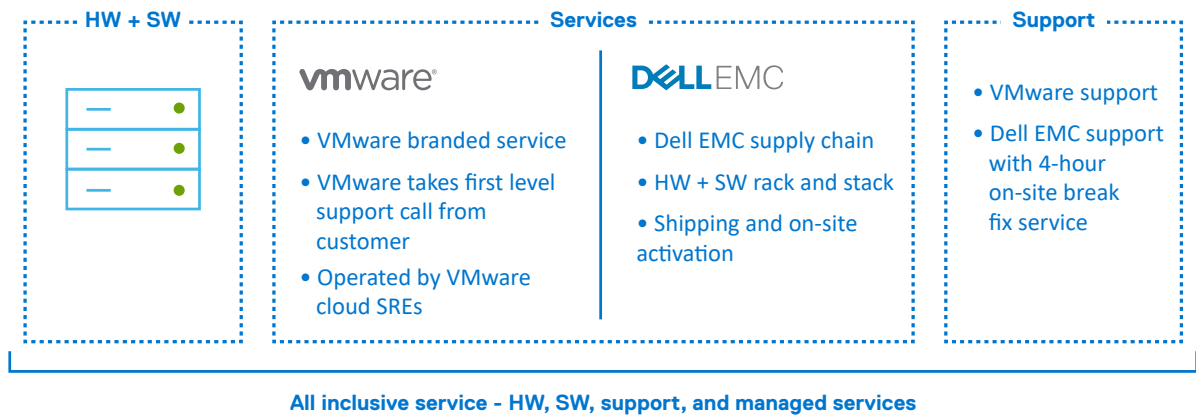

All inclusive service - HW, SW, support, and managed services

Figure 10 VMware Cloud on Dell EMC

4 Modernize at the speed of business

When we say *Modernize at the speed of business*, we mean that once you get your environment stood up, you can start to reap the benefits every day with streamlined ongoing operations.

4.1 Automate

Dell Technologies turnkey and as-a-Service options for your platform help you get started quickly. But stand-up only happens once – the bigger challenge may be day 1 and day 2 or the ongoing need to maintain, patch, update, and scale the right service levels for your modern applications.

The benefits of rapid innovation are many – Kubernetes is released every quarter, but that is just one component of the stack. VMware publishes regular updates to their software. Patches and security fixes can be released at any time. This is why automation through the APEX Console and VxRail's Full Stack Automated Lifecycle Management are crucial capabilities for keeping things secure, reliable, and compliant.

[3]Applies to select nodes with DTCP subscription pricing, contact your sales representative for details. Customer site survey and configuration workbook must be completed before order is placed. Excludes orders over 24 nodes, VMware NSX configuration, vRealize (vRA, vRO) components, and some other features. Product availability, holidays and other factors may impact deployment time. US only.

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	DEVOPS AUTOMATION Automate workload provisioning
	DEVELOPER SELF SERVICE Automate self-service provisioning
	ONE-CLICK UPDATES Automated Life Cycle Management
	ADD A NODE IN 15 MINUTES Automate scale and configuration

Figure 11 Automate the full stack

Dell Technologies and VMware have co-engineered deep integration to deliver automated operations. With Dell EMC VxRail we provide a one-click, non-disruptive, cluster-aware automated update process so organizations can easily evolve their Kubernetes infrastructure. Dependent components are upgraded in a pre-determined sequence to optimize the process and eliminate the potential of failure due to incompatible versioning or changes in best practices. This includes the HCI Systems Software containing firmware for the specific components, as well as the core VMware SDDC software – to include VMware Tanzu. This type of automation allows you to stay up to date with the latest patches and feature enhancements. In fact, with our 30-day synchronous release commitment, you can rest assured that updates from VMware will be quickly available to keep your production clusters current with our Automated Lifecycle Management.

When it comes to scaling or taking advantage of specific hardware enhancements – VxRail provides a non-disruptive process that allows nodes to be added to a cluster without causing downtime or negatively impacting workload performance. Uniquely, VxRail supports heterogeneous nodes in clusters. You can even replace existing nodes with newer models without downtime. With Dell Technologies Cloud Platform, you can evolve predictably. Adding nodes based on new generations of hardware is supported so customers can quickly and non-disruptively evolve both hardware and software to keep pace with digital advancements. The days of the "forklift upgrade" are over. Data migrations and other disruptive events due to the introduction of new generations of technology are a thing of the past.

We also have pre-engineered integrations with common workloads. A couple of examples are automated provisioning of a Horizon Workload Domain for standing up Virtual Desktop Infrastructure and automated provisioning of Kubernetes clusters as needed for cloud-native applications. This enables your DevOps teams to stand up workload domains quickly in support of key initiatives.

Your users are looking for a low-friction environment where they can get rapid access to the resources they need. Automated self-service provisioning enables your developers to stand up their own Kubernetes clusters from pools of resources based on governance policies that you establish. No more complaints of slow service and no more shadow IT!

4.2   Plan

Technology is only part of the solution. Organizational readiness is key in for modern applications, and Dell Technologies consulting services have developed specific offers to address organizational readiness for modern applications and multi cloud.

Operating model services are all about making sure you have the right processes and roles in place within your organization for modern applications, including assessing your skill sets to make sure you have the right capabilities for those roles. We also help you determine what IT services you want to expose to your users. We can help you stand up that set of services in a catalog so you can deliver self-service capabilities to your constituents based on the foundation of infrastructure as a service and containers as a service.

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Operating Model   **Application Profiling**   **Workload Migration**

Figure 12 Common consulting engagements

An application profiling engagement examines the entire application portfolio. As touched upon earlier in this paper, for each application, you want to decide whether to retire, retain, re-host (for example in an efficient IT-as-a-Service environment), re-platform on containers or deconstruct the monolith and completely refactor that application into microservices.

Once you have determined the disposition of your applications, you will likely need to migrate some workloads to cloud-native patterns. We have a proven and repeatable process that can help improve the reliability and predictability of your move to modern applications.

These are just some ways that we can help you address the people and process aspects of your move to modern applications.

4.3   Protect

Modern applications are business critical. You need an enterprise-grade business continuity and disaster recovery solution that protects both VMs and containers. As more organizations move to cloud native, a transition from traditional to cloud-native approaches requires a solution that values innovation while giving organizations a data protection strategy with choice of consumption and one platform. Dell Technologies has collaborated with VMware and the open-source community on project Velero to provide enterprise-grade data protection for Kubernetes environments. Dell EMC PowerProtect software builds on those capabilities to enable customers to set protection policies, backup and recover, deduplicate and tier apps, containers and VMware VMs to protection storage (physical or virtual). Data owners and VM admins can protect critical workloads directly from native interfaces while IT maintains governance and compliance. In addition to the graphical user interface, data protection can be administered through the Kubernetes command line, which is often the preferred interface for developers.

PowerProtect software is built for Kubernetes, which is important as more organizations move to a Kubernetes-native architecture. By using the Kubernetes APIs, we allow flexibility in which clusters can be protected as well as manageability for Kubernetes admins through their tools. Also, built for Kubernetes, we discover, show, and monitor k8s resources – namespaces and persistent volumes. Since it is built for Kubernetes, there are no sidecars – there is no need to install a backup client container for each pod. By providing protection data movers on-demand and per k8s node, we avoid cross-node traffic.
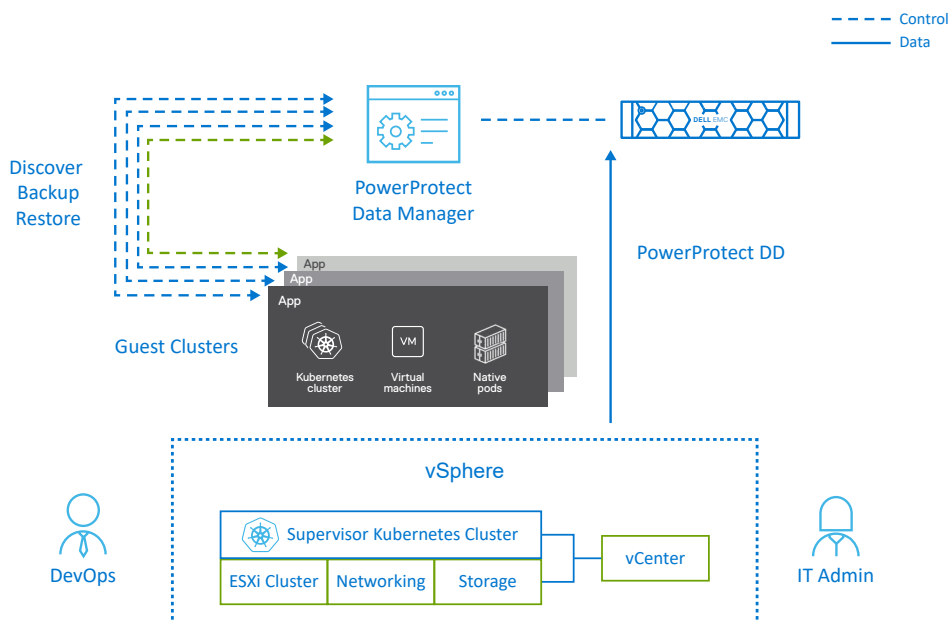

Figure 13 Protect your modern apps and data

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Users of PowerProtect Data Manager enhance the protection of their data by protecting directly to PowerProtect appliances to benefits from unmatched efficiency, deduplication, performance, and scalability. PowerProtect appliances scale seamlessly without disrupting operations by simply adding shelves on the fly while the system is running. Massive scalability means organizations have fewer devices to manage, require less infrastructure and achieve higher deduplication ratios because there can be more data within a single deduplication pool. Efficient inline variable length deduplication becomes the enabling technology for a cost effective tapeless disaster recovery approach. PowerProtect appliances only replicate unique data to the remote site and begin replication while backups are still in process. Organizations that invest in Data Manager and PowerProtect appliances would benefit from economic benefits over time, improved performance, and, most importantly, a low cost to protect.

Enterprise-ready data protection and disaster recovery is a requirement for any successful modern applications operation.

4.4   Deliver container innovation anywhere

Let us zoom out from the discussion of managing modern applications in a single cloud to the multi-cloud challenge. At Dell Technologies, we believe that cloud is an operating model – not a place. Where applications are run should be driven by business, technical, operational, and financial considerations— not compatibility limitations. The right approach allows the same VM or container to be moved between clouds unchanged. This eliminates the multi-cloud application re-work tax. We call this "consistent infrastructure".

Our solutions provide an operational framework that allows VI admins to apply policies consistently across virtual machines and containers. This capability extends across private, public and edge cloud locations. It reduces problems inherent in using different tools and teams to manage different clouds. It also reduces operational silos - improving governance, security and compliance - as well as enhancing DevOps productivity. We call this "consistent operations".

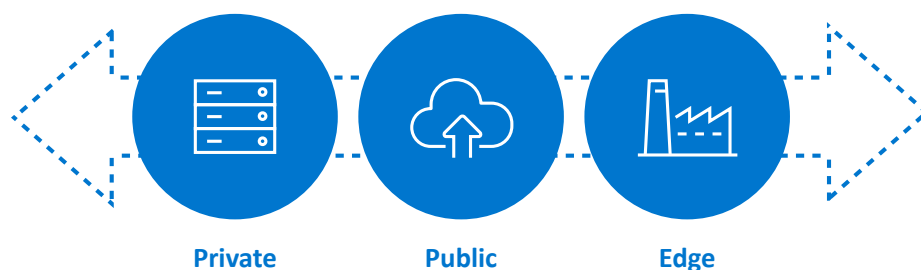**Private**   **Public**   **Edge**

Figure 14 Consistent infrastructure, consistent operations

ESG recently surveyed IT professionals about cloud operations. When asked about the prospect of using consistent infrastructure management tools across private and public cloud locations, 74% of respondents said they would expect to increase their pace of innovation, ultimately resulting in five incremental products/services launched annually.[4]

4.5   Connecting your private cloud to public clouds

For the workloads you want to run outside your datacenter, Dell Technologies has developed and continues to curate the world's broadest cloud provider ecosystem beginning with the biggest hyperscalers, AWS, Azure, and Google Cloud. This reduces the friction for customers who want to extend their hybrid cloud environments to the public cloud and maintain a consistent operating experience.

In addition, customers have the flexibility to extend their hybrid environment to over 4,200 cloud partners operating in more than 120 countries delivering global reach as well as bespoke offerings that address specific verticals and application stacks. Examples here are IBM Cloud, Rackspace, and Equinix. These partners provide VMware-based cloud and hosting, including a range of related services that optimize for specific customer requirement. They can provide a more tailored approach to off-premises public and private cloud deployments.

Together, Dell Technologies Cloud and VMware combined with carefully selected cloud partners, deliver a complete hybrid cloud experience that provides consistent infrastructure and consistent operations from private cloud to public cloud to the edge.

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This is how it works. The public cloud solutions from Amazon, Microsoft, Google and other partners enable the provisioning of a VMware SDDC on the bare metal hardware in the public cloud data center. It is not implemented in some sort of "emulation" mode, it is based on native vSphere deployed right on their hardware. Your private cloud data center also features a VMware-based SDDC. To create the hybrid cloud, a secure network tunnel is established between them so they can be operated and managed by the VMware tools that you are familiar with, such as vCenter and vRealize. The cluster in the public cloud looks like just another cluster to your vCenter. One of the most impactful results of this is the ability to apply policy consistently across multiple deployment options.

This enables seamless workload mobility for VMs and containers. What is exciting is that the interesting backing services provided by the public cloud providers are available to the applications running there, so you can get access to those unique services from your applications.
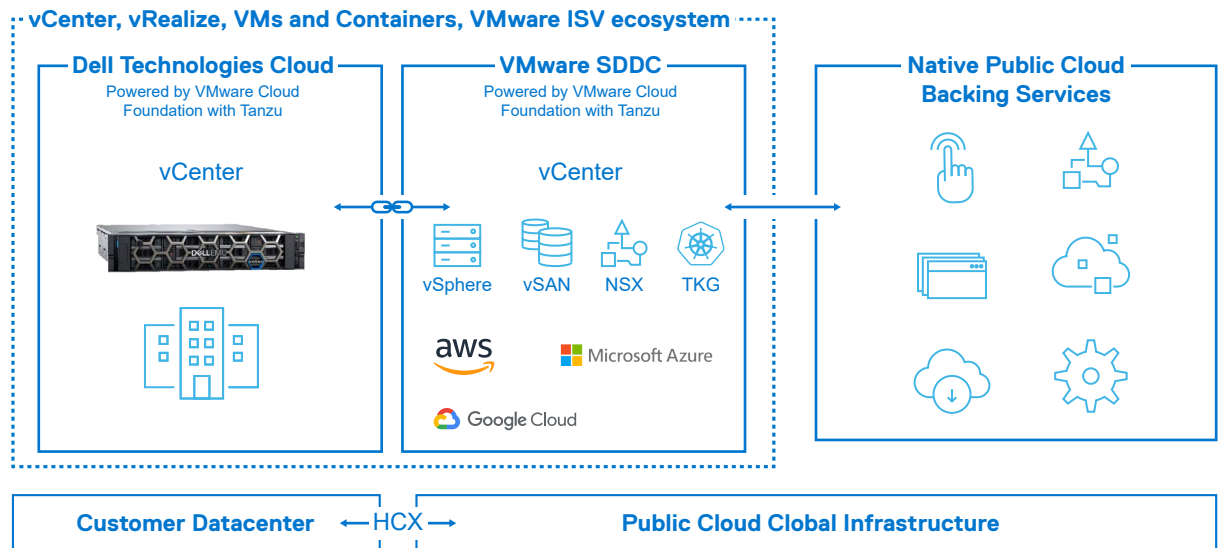
Figure 15 How it works: consistent hybrid cloud

The result is a consistent hybrid cloud that delivers consistent infrastructure and consistent operations wherever workloads are deployed. This increases business agility because application developers can focus on business needs and developing software features without worrying too much about the underlying infrastructure. IT organizations can choose where to deploy workloads, guided by a combination of business and technology requirements. It optimizes IT efficiency by reducing the number of operational silos. It reduces business risk by eliminating multiple governance frameworks, allowing a policy to be applied once and enforced everywhere. IT can quickly respond and shift workloads without being locked into a particular environment.

4.6   Extend to the Edge

The Edge exists wherever the digital and physical worlds intersect, and data is securely generated, collected, processed, and used to create new value. Edge might include the Internet of Things (IoT), connected cars, and smartphone applications, but more importantly, it is where your business happens. Bringing compute, storage, and networking closer to the data improves the customer experience by enabling faster insights from more data on their device of choice. This also opens a new world for businesses to monetize data and applications or for public sector organizations to improve health and safety.

IT professionals are under pressure to respond quickly to changing business needs. At the same time, edge technologies are rapidly evolving, enabling extraordinary speed for business and technology innovation. However, deploying edge point solutions using an ad hoc approach can lead to inconsistent standards between edge, core, and hybrid cloud environments, resulting in inefficiencies and dysfunction across the business.

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One team needs to strategically stay in control of the pace of innovation, deploying thoughtful edge solutions that integrate and enable applications and data-focused operations across edge, core, and hybrid cloud environments. Design applications that are cloud native and hardware agnostic so they can run in your choice of environments and standardize applications across edge, core and hybrid clouds. Maintaining multiple versions of an application increases costs and lengthens test cycles. Standardize operational processes and tooling between environments to maintain consistency for edge sites. Using different tools and processes between edge, private and public clouds introduce complexity and risks.

Recently, VMware announced support for remote VMware Cloud Foundation clusters, extending the existing VCF operational capabilities to remote locations. VCF Remote Clusters takes the power of the existing VCF operational capabilities which are now delivered to edge locations to support widely distributed compute processing, managed from a central data center out to multiple remote locations. With VCF Remote Clusters, customers experience a consistent cloud operating model across the data center and the remote edge sites, which are centrally managed from Cloud Foundation.
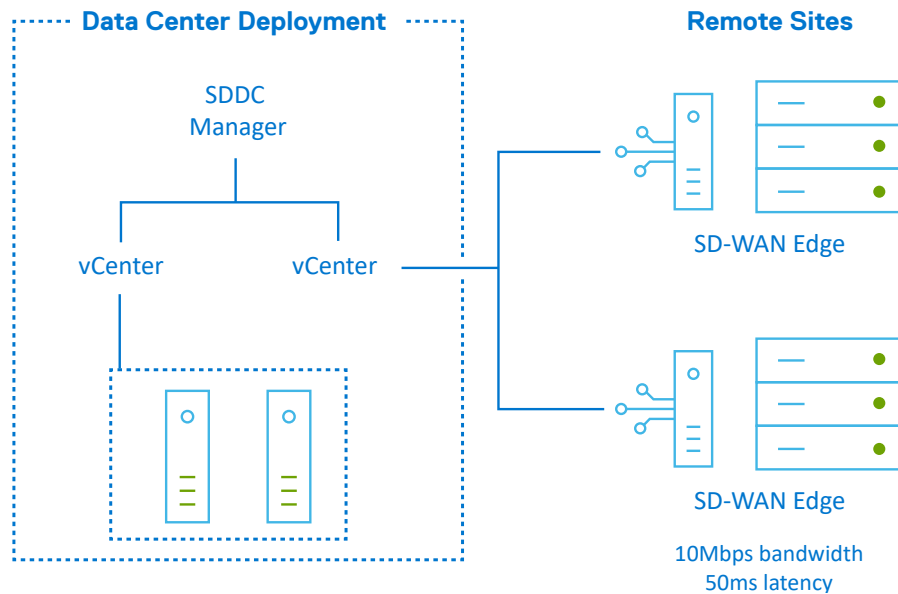

Figure 16 Consistent infrastructure out to the edge

All Cloud Foundation operational management can be administered from the central or the regional data center out to the remote sites. Central administration and management is an important aspect because it eliminates the need for technical or administrative support personnel at remote locations, resulting in improved efficiencies with much lower operating expenses. Edge compute processing also allows customers to comply with data locality requirements driven by local government regulations. VCF Remote Clusters establishes a means to standardize operations and centralize the administration and software updates to all remote locations.

With this functionality, customers can take advantage of all of the benefits of VCF on VxRail integration, including full stack lifecycle managements from the core to the edge, delivering consistent operations and the ability to rapidly and seamlessly evolve across edge environments. By extending the existing VCF operational capabilities to remote locations, remote cluster support delivers consistent operations and integrated full stack HW & SW upgrades across core and edge locations. Customers can even extend cloud to the extreme edge on ruggedized nodes with VCF on VxRail D-Series.

Whether you are developing retail or manufacturing solutions controlled and orchestrated by edge technologies, digital cities where edge solutions improve and automate a host of services, self-maintaining manufacturing lines, or a host of other edge use cases, Dell Technologies can help you achieve new business outcomes enabled by insights from edge data.
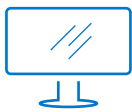
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5   Conclusion

Organizations today thrive or whither based on their ability to harness technology. Technology can enable dynamic operations that feed on data sources, wherever they are. New tools and processes can accelerate the benefits of technology, but adoption is not straightforward. The temptation exists to make a wholesale shift toward these new technologies, but the benefits can be outweighed if that shift injects additional complexity into operations.

It is important to be aware of the risks that exist and the impediments to progress that early adopters have faced. Don't reinvent the wheel. A custom-built platform based on raw open source software rarely results in a stable platform or rapid start. Leverage your existing skills and infrastructure in a way that avoids duplicate effort, stranded capacity, and silos of operation. Eliminate manual tasks that slow progress and inject risk into your ability to provide secure, reliable operations. Align consumption with use to avoid budgets being burdened with unused capacity. Avoid islands of infrastructure and locked-in application deployments that increase effort and reduce agility.

Be ready for what is next. There is a new way to harness the power of technology. The signs are everywhere if you listen closely; if you keep your "ear to the ground". Cloud-native technologies and multi-cloud operations hold the promise of significant gains through modern applications approaches. Accelerated development cycles, rapid innovation opportunities, and flexible deployment options can lead to improved outcomes for all organizations. These are enabled by a consistent approach that unifies operations for both containerized microservices and virtualized monoliths across private, public, and edge locations.

Dell Technologies is here to help. We have adopted these technologies for our own operations. We have proven expertise in helping organizations with the people, process, and technology challenges around modern spplications and multi-cloud operations. We want to help you reach your goals using technology in a way that truly drives human progress. We will stop at nothing to make that happen.

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