White Paper

Foundational Strategies to Future Proof Your Enterprise Digital Infrastructure Platform

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July 2021

IDC OPINION

Enterprises across geographies and industries are rethinking IT-enabled business strategies in the wake of a turbulent period that saw a global pandemic, the emergence of a new generation of cyberthreats, expansive supply chain disruptions, business closures, and rising levels of social unrest. The amount of digital data is growing exponentially, with much of the new data created at the edge and in nontraditional computing and service platforms including public cloud services. Simultaneously, workloads are becoming more dynamic while business processes are becoming more automated. AI/ML-driven insights paired with automated processes and virtual interaction via chatbots or natural language processing are resulting in different network, computing, and storage architectural and management requirements.

The role of digital infrastructure as the highway for collaboration and data sharing is becoming increasingly vital to the success of the business. IDC's recent surveys tracking plans for digital business investment show that 71% of organizations worldwide rank digital infrastructure resiliency as a priority or top priority over the next two years as they return to growth and plan for the future.

These organizations recognize that their ability to anticipate and react more quickly to unexpected conditions is nonnegotiable. To compete and expand their digital footprint, these organizations need to take full advantage of a new generation of compute, storage, and network infrastructure in datacenters and at the edge, as well as leverage public cloud services and open source projects.

IDC's research has identified a number of critical digital infrastructure capabilities that organizations will need to address these challenges and opportunities, including:

- Taking full advantage of containers, Kubernetes, AI/ML, and automation to augment many business and IT activities while maximizing the value of staff and skills and increasing internal productivity (Containers enable organizations to architect workloads for easier portability and scalability. In addition, containers promote faster software velocity with faster patching and release cadences.)
- Implementing new approaches to cybersecurity and data recovery to protect data in transit, at rest, and in use as applications become more data intensive and distributed, including new environments enabled by edge and low-latency connectivity such as 5G
- Being aware that massive data sets offer potentially valuable business insights but also cause data gravity (As compute becomes increasingly distributed across hybrid, multicloud, and the

edge, application dependencies on data have significant impacts on architecture and portability.)

- Ensuring consistent policy-driven compliance, access, performance, and connectivity across all workloads, data sources, and infrastructure resources — spanning datacenters, edge, and public clouds (A diverse hybrid and multicloud environment is becoming standard for enterprises, but it brings many challenges in how to manage across them effectively.)
- Strengthening and extending digital relationships and digital experiences with customers, employees, and partners that have become more comfortable and demanding of remote work, online commerce, and contactless fulfillment offerings, regardless of where they are physically located or the specific device they choose to use at a given moment

This white paper considers the emerging, mission-critical business priorities around digital infrastructure resilience and how VMware vSphere is evolving to meet these needs.

SITUATION OVERVIEW: DIGITAL INFRASTRUCTURE ENERGIZES DIGITAL BUSINESS

The challenges facing many organizations through a tough 2020 and into 2021-2022 are driving a comprehensive conversation around how to better prepare for the unexpected in the future. In February 2021, IDC's ongoing *Future Enterprise Resiliency and Spending Survey* found that 61% of organizations worldwide are making business operations resiliency programs a priority. These efforts typically emphasize investments in automation and augmentation technologies to adapt business operations faster to market disruptions. The most successful companies are looking beyond short-term modifications to consider fundamental transformations to every aspect of their business operations.

Specifically, organizations are evaluating the longer-term impacts of recent disruptions and asking:

- To what extent should emergency work-from-home programs be transformed into permanent work-from-anywhere programs, and what does that mean for connectivity, collaboration, data sharing, security, equity, and innovation?
- In the context of many recent ransomware events, and other significant cybersecurity crises, how does the organization pivot to a zero-trust environment that protects data regardless of where it is created, processed, or transported?
- How best to shift from digitized transactions and contactless delivery to more hybrid experiences that blend virtual and in-person?
- How to dynamically optimize digital spend, performance, and scale in the context of hybrid architectures connected across datacenters, edge, and public cloud platforms?
- How to ensure that investments in digital leadership innovation remain a top business priority even as the world begins to reconnect face to face?

IDC's research shows that digital infrastructure leaders are working collaboratively with business decision makers to fully assess these questions and address these opportunities. Corporate boards are becoming more and more interested in the status of technology investments, with many digital infrastructure leaders stating that they now brief their boards on a quarterly or monthly basis. Top board-level topics include using AI/ML to improve decision making and examining ways to extend the reach and reliability of digital infrastructure to support hybrid work and new data-intensive business strategies.

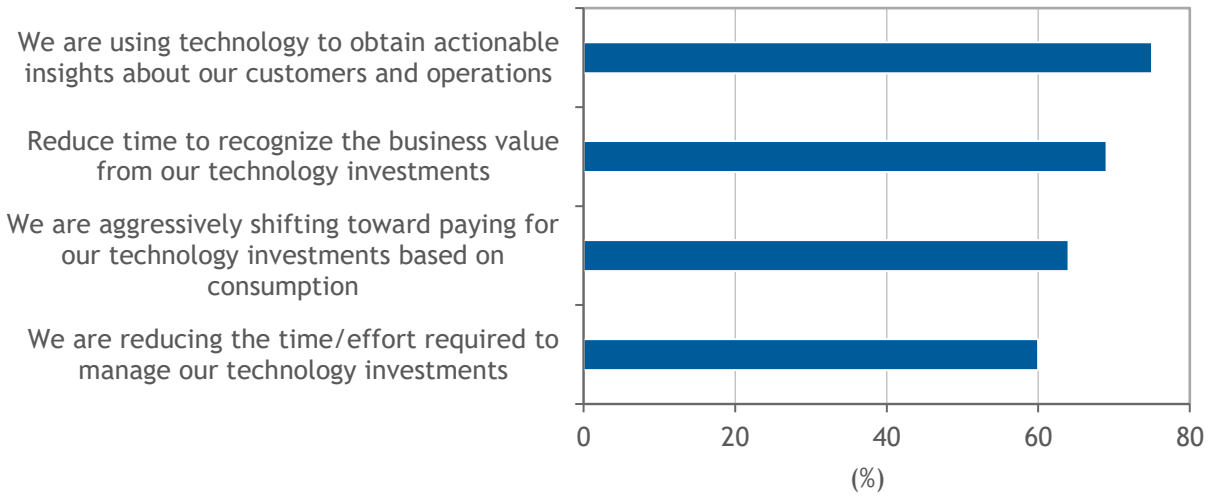
As a result, IT leaders are becoming much more business oriented and thinking strategically about where to target finite investment dollars and staff post-pandemic. Increasingly, they are seeking

solutions that can help simplify and standardize infrastructure operations while freeing up resources to improve the quality and speed of data-driven business decisions (see Figure 1).

FIGURE 1

Impact of Pandemic on Organization's Technology Objectives

Q. As a result of the new business requirements brought on by the COVID-19 pandemic, to what extent do you agree with the following statements about your organization's technology objectives?



n = 738 for worldwide IT and business decision makers

Source: IDC's *Future Enterprise Resiliency and Spending Survey,* February 2021

IDC's research shows that well over 90% of enterprises rely on a mix of traditional IT, private cloud, and one or more public clouds, and most are rapidly ramping up the use of edge platforms. In most organizations, software built for different bare metal, virtual machine (VM), and containerized platforms represent decades of development and detailed business best practices. Cloud-native applications are being built and deployed side by side with legacy software and integrated with traditional databases while trying to harness the power of AI. Enterprises are quickly adding intelligent edge systems and IoT devices to the mix as the power of 5G and campus Wi-Fi enables new generations of local computing and analytics. These trends are quickly driving up data volumes and creating new levels of operational complexity for staff that is already spread thin.

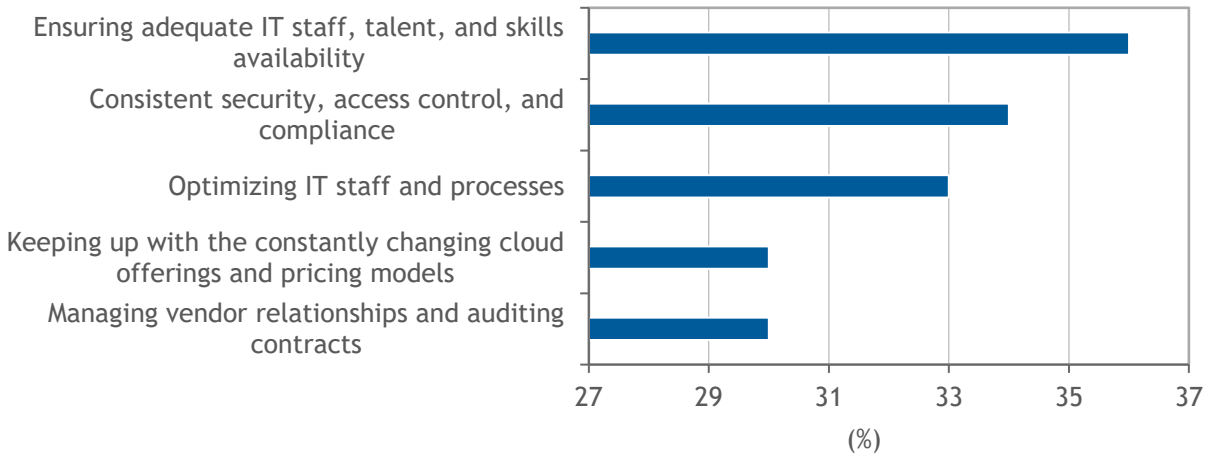
This kind of diverse environment is often described as hybrid, distributed, or multicloud. Regardless of how it is described, the diversity and interconnectedness of multiple generations of applications, data, and digital infrastructure have resulted in many organizations that are forced to run their business using a mix of disconnected configuration and automation tools, standalone monitoring and observability solutions, and fragmented approaches for security and cost optimization. All this diversity results in suboptimal application performance and operational challenges around integrating workflows and data (see Figure 2). As many organizations went virtual and remote over the past year, the imperative to ensure both basic collaboration and consistent secure access to data and end-to-end automation has become clear.

As shown in Figure 2, ensuring adequate staff and skills to support these complex environments continues to be the number 1 operational concern for many organizations. IDC interviews with ITOps, DevOps, and cloud SRE teams indicate that most organizations are proactively working to offload many existing, repetitive activities and consolidating management tools. These organizations are looking to automation, AIOps, and subscription-based infrastructure and cloud services to enable a more autonomous, self-regulating approach to digital infrastructure operations.

FIGURE 2

Top Multicloud Management Operational Challenges

Q. What are the most pressing operational challenges resulting from your multicloud strategy?



n = 409 for worldwide IT and business decision makers

Source: IDC's *Enterprise Management Priorities Cloud Pulse Survey,* August 2020

BENEFITS OF DIGITAL INFRASTRUCTURE MODERNIZATION

By design, efforts to modernize digital infrastructure must align with business priorities and improve overall operational agility. Hardware-driven innovation, ranging from quantum and confidential computing to accelerators, low latency networks, and complex edge systems, is introducing greater power- and system-level diversity across enterprise digital infrastructure. Cloud services offer a wide range of advanced capabilities from serverless to AI and natural language analytics.

Cloud-native applications built on containers and Kubernetes enable modular, microservices-based development and more rapid innovation but depend on the consistent availability and security of Kubernetes infrastructure wherever those applications and analytics need to run. Simultaneously, organizations must maintain the integrity of many existing applications and data sources without creating more inefficiency within the operational environment. Another challenge is that modern applications in containers do not run within a vacuum. Many refactored applications have parts that are in containers and parts that are in VMs. Even fully containerized applications still have many connections to and dependencies on things that are in VMs. Enterprises need to be able to manage workloads across different generations of digital infrastructure.

Each business workload has its own set of security, compliance, performance, and cost requirements, which need to be respected and supported regardless of whether the application is written using DevOps and cloud-native principles and public cloud infrastructure or depends on traditional infrastructure and data structures. Enterprise digital infrastructure and application modernization efforts need to be closely coordinated and complementary to ensure that the infrastructure can consistently deliver the performance, security, and scale required by rapidly changing workloads, analytics, and automation.

The choices that enterprises make today about the core digital infrastructure platforms and operations models will directly impact how quickly the business can adapt and address unexpected events and challenges going forward. For organizations that are seeking a more open and standardized approach to operations and a consistent way to deploy and mature applications, it will be important that both existing virtual machine platforms and container-based services are well integrated and consistently managed. In developing their platform strategy for the future, enterprises should consider how to best future proof their digital infrastructure to ensure a number of capabilities including:

- The ability to deliver consistent performance and security over time as underlying technology platforms (VMs, containers, datacenters, and clouds) continue to evolve and migrate
- Reducing silos and friction by enabling easier and more consistent workflow and data integration, policy-based operations for consistent configuration, and security controls and software-defined automation to improve operational scale and agility
- The ability to take advantage of emerging infrastructure innovations including hardware-based GPUs, data processing units (DPUs), and confidential computing solutions as well as new, AI/ML-intensive workloads and tooling (The key to success is making these technologies easier to implement and more turnkey in order to expand the user base that can access them.)
- The ability to offload low-value internal support work using automation, standards, and intelligent remote vendor support services — while maximizing the value provided by internal staff — including ongoing modernization and upgrading of internal skills and processes
- Strategies around how to shift in a nondisruptive way to new consumption models such as pay as you go, SaaS, and flexible/portable software licensing, which may be common in the cloud, but fairly new for on premises (Organizations have varying investments into on-premises capex; shifting to a more flexible model that can be transferred to cloud when ready is essential in preserving investments and managing costs.)

The demands of digital infrastructure today are very different from just a few years ago, with many more changes coming over the next couple of years as the world recovers from the pandemic. The implications across the IT industry will be broad and extend across the complete stack, even down to the hypervisor. While virtualization is standard operating procedure today, the hypervisor must continue to evolve and reinvent itself to adapt to a fast-changing IT landscape.

CONSIDERING VMWARE VSPHERE

20 years ago, VMware introduced its first server hypervisor and kicked off a revolution in the datacenter. Today, the hypervisor is standard fare on most servers in the datacenter, public clouds, and beyond. However, vSphere has undergone many significant transformations over the years to take advantage of new hardware and adapt to new use cases. Today's digital agility and resilience initiatives will require a more robust and capable infrastructure than ever to support a new class of

applications. Given that vSphere has undergone many modernization efforts over its lifetime, we examine the most important and recent changes.

Containers and Kubernetes

VMware has embraced and made major investments in Kubernetes as the future for containerized microservices-based applications. VMware vSphere with Tanzu is VMware's integration of Kubernetes into ESXi. vSphere with Tanzu is not simply a bundling of Kubernetes with vSphere or Kubernetes running on top of vSphere. In vSphere with Tanzu, Kubernetes is a native component within ESXi. The Kubernetes control plane runs inside ESXi, which is able to join Kubernetes clusters, and containers run natively on the hypervisor.

Containerizing on vSphere enables the convergence of VM and container infrastructure, allowing both traditional and modern applications to run together. vSphere with Tanzu exposes both VMware vCenter Server and Kubernetes interfaces, allowing VMware admins to manage vSphere with familiar tools while allowing developers to directly access the Kubernetes API. The Kubernetes API and the Open Container Initiative container format used by Tanzu are open standards and enable containers to move between different providers.

The newest innovation, the Virtual Machine Service that is part of vSphere with Tanzu, allows VMs to be provisioned and managed with Kubernetes. This further enhances the convergence of VMs and containers and management of mixed VM and container applications. Kubernetes developers can now work with VMs the same way as they do with containers.

Multicloud Operating Model

The need for more digital resilience is pushing companies to embrace cloud models that are more dynamic and flexible, transitioning from virtualization farms to private clouds. VMware Cloud Foundation (VCF) brings together vSphere, vSAN, NSX, and vRealize management tools to provide the foundation for building hybrid clouds. The convergence of compute, storage, and networking enables a coordinated, fully virtualized approach to a cloud platform and simplifies the life-cycle management of the platform.

VMware Cloud Foundation also provides the foundation for VMware-based public clouds, such as VMware Cloud on AWS, as well as from numerous other providers including Microsoft and Google. Extending vSphere into a complete cloud platform with VMware Cloud Foundation enables VMware to provide a fully consistent cloud across hybrid and multicloud, with seamless portability and management across all locations. VMware's recent initiative, VMware Cloud, provides a cloud solution that integrates VCF-based clouds across a distributed hybrid and multicloud environment.

Accelerated Computing

- **GPUs for AI/ML.** VMware supports AI/ML workloads with the AI-Ready Enterprise Platform, a joint solution with NVIDIA. The NVIDIA partnership extends vSphere GPU support to a full-stack AI/ML solution that includes performance scaling features, GPU virtualization, DPU acceleration, AI applications and frameworks, and Tanzu container support. The solution is fully supported and certified by both VMware and NVIDIA to enable enterprises to deploy AI platforms quickly and support the growing needs of businesses for AI-enabled workloads.
- **Data processing unit.** The newest accelerator on the horizon is the DPU, also referred to as a SmartNIC. DPUs accelerate networking for data processing, a key function as data-intensive applications become more popular. Project Monterey is VMware's initiative to rearchitect

vSphere and VMware Cloud Foundation for DPUs. A DPU will allow for two ESXi instances per server, one on the main x86 CPU for applications and a second smaller instance on the DPU that will offload vSAN, NSX, and management tasks. This will improve performance and security and enable new functionality like allowing vSphere and VMware Cloud Foundation to manage bare metal. Since the DPU can also be accessed by remote hosts, VMware Cloud Foundation clusters can be redesigned to be more dynamic and composable. While DPUs are not widely available or supported on VMware today, VMware is laying the groundwork for its vision with Project Monterey, which promises to be a major leap forward for virtualization performance, manageability, and security.

Security

While VMware offers standalone security products with Carbon Black and NSX that can enhance overall datacenter security, vSphere itself has added many security features into the core platform. It supports modern hardware-based security functions such as smart card authentication, UEFI secure boot, encrypted memory and confidential containers with AMD's SEV-ES, and Trusted Platform Module (TPM/vTPM). vSphere also can encrypt VMs and vSAN for data-at-rest protection, available out of the box using the built-in vSphere Native Key Provider. Securing vSphere and providing security features deeply integrated into the hypervisor is a key tool in the ongoing defense against ever more sophisticated threats.

The Modernization of vSphere Continues

vSphere has undergone a tremendous number of changes and enhancements since its inception. While virtualization is still its core function, the modern environment demands a robust platform to be built around it. These vSphere enhancements are not trivial, with many of the features such as vSphere with Tanzu requiring major internal architectural changes. The upcoming DPU support with Project Monterey will also introduce more fundamental changes to vSphere architecture. The world around vSphere is changing, with new hardware, new workloads such as AI, new formats such as containers, and new cloud operating models. VMware has reinvented vSphere numerous times and will have to continue to do so in order for it to continue to be the platform of choice for enterprises. The hypervisor is still a key element of the stack today, and the modernization of vSphere continues with each generation.

CHALLENGES/OPPORTUNITIES

Challenges

- New computing models such as containers on bare metal are drawing interest and might find traction in new deployments such as edge and IoT. While containers on bare metal are still nascent and certainly have their own set of challenges, customer conceptions (right or wrong) about cost or simplification by removing virtualization could cause headwinds for VMware. In addition, the rise of non-x86 server platforms such as ARM may also disrupt the virtualization market. While VMware does have ARM support for ESXi, nearly all of VMware's existing business is in the x86 space.
- The major public clouds all depend heavily on virtualization but use open source-based hypervisors for the majority of their clouds. While VMware has created partnerships with most of these cloud providers to offer a vSphere-based option on their cloud, the reality is that most customers are going to have some non-vSphere-based cloud footprints. While VMware has

been able to create a seamless experience across all vSphere-based datacenter and cloud deployments, this experience does not extend to non-vSphere environments.

- The industry is shifting to new consumption models such as pay as you go, SaaS, and flexible/portable software licensing, much of it inspired by cloud models. With vSphere also extending beyond the datacenter, consumption and licensing are key to helping customers make the transition. VMware's historical business was primarily traditional software license based, but in recent years, VMware has made an increasingly concerted effort to move toward SaaS and consumption-based/flexible licensing with VMware clouds and the newly minted VMware Cloud Universal program. The entire industry is still figuring out this transition, and it is still in the early stages for nearly every vendor including VMware.

Opportunities

- DPUs potentially offer a leap in performance and security. Changes this large that affect the hypervisor at this level don't come around often, and this could potentially be a major architecture change for vSphere.
- VMware clouds can help solve the hybrid and multicloud complexity issue and offer the easiest migration path for VMware workloads to cloud. VMware's success over the years means that there are a lot of VMware workloads running in enterprise datacenters, and customers are evaluating the future of each and every one of these. For many workloads, migrating to a VMware-based cloud will be the cheapest and quickest path.
- AI and ML are all the rage today, and enterprises are eager to take advantage of this technology. VMware's partnership with NVIDIA can help put AI in more enterprises' hands by making it accessible to the vSphere install base and reducing many of the complexities to deploy it.

CONCLUSION

The hypervisor continues to be a key foundation element of the datacenter and cloud and expanding into new places like the edge. However, the world around the hypervisor continues to innovate and evolve. Below the hypervisor, we see a changing landscape that includes new server architectures and hardware accelerators. Above the hypervisor, the applications are changing rapidly, with container-based cloud-native architectures and new workloads such as AI. Computing environments continue to diversify, with enterprises expecting to juggle on premises, multiple clouds, edge, IoT, and SaaS, creating many challenges on how to manage consistently across environments. As enterprises grapple with these changes, they must consider the hypervisor around these key decision points:

- **Choice.** What platforms, clouds, and deployment models will the hypervisor support, and how can workloads be deployed consistently across all these locations?
- **Speed.** How will the hypervisor support new application models such as containers and accelerate complex workloads with GPUs and DPUs?
- **Control.** How can one manage, operate, and have observability into workloads running across all infrastructure in hybrid, multicloud, and the edge?

Hypervisors, such as vSphere, are mature platforms but have been continually innovating and adapting to remain on the leading edge of modernization. Many significant changes are happening simultaneously in the IT industry today, along with global forces such as the pandemic, to create a large wave of modernization for digital resilience that will be a high priority for enterprises in the coming years.

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