The CIO Roadmap to Hybrid and Multi-Cloud:

A comprehensive guide to maturing the cloud journey and accelerating business value across the enterprise

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From SaaS to PaaS, on-premises to the public cloud, containers to Kubernetes, we're living in a hybrid, multi-cloud world. With a realistic roadmap that ties IT strategy to business outcomes, and identifies the people, processes, and technologies required at each stage of the hybrid cloud journey. CIOs who have begun their cloud journeys can confidently assess what they have achieved and move toward a more seamless multi-cloud operating model based on the business goals they are trying to accomplish.

Executive Summary

The impact of the cloud on both the business and IT is undeniable. As part of a broader enterprise digital strategy that embraces data center and application modernization, the cloud has become a key driver of business expansion and operational efficiency. It enables the agile development of new products and services allowing companies to build competitive differentiation. Yet business and IT leaders who have made moves to embrace the cloud may feel stuck, and struggle to understand how to truly transform their organizations into fully cloud-driven and cloud-optimized enterprises.

In this paper, we present a CIO roadmap to hybrid and multi-cloud, giving CIOs a benchmark they can use to measure their cloud aspirations against organizational realities. This roadmap offers a personalized, actionable approach to hybrid cloud adoption that supports current and future-facing business and IT objectives.

The Market Opportunity

Today's CIO is an architect of new business models, leveraging technology to break into new markets, improve the customer experience, drive down costs, and create new sources of revenue.

This evolution is happening within a reality in which any industry or company can be disrupted by an innovative startup or competitor using applications to provide superior customer experience at scale. The cloud is becoming the standard approach to building and delivering applications for the modern enterprise. This is bolstered by the recognition of the value of applications to the business. Another critical factor is the need to match each application to the environment that provides the best resources and support. Increasingly, those environments are located outside of capital-intensive, on-premises data centers.

Economies of scale give public cloud providers the advantage by amortizing across a broad customer base many of the financial pressures of running a data center—such as maintenance, upkeep, power, cooling, and staffing costs—across a broad customer base. These savings can be passed on to the enterprise, providing a more cost-effective supply of storage, compute, and connectivity for applications. Migrating to a public cloud also allows organizations to take advantage of flexible pricing models, paying only for the computing resources being used by the applications active in the cloud at any given time. Perhaps most important in the era of competitive disruption and differentiation, public cloud gives enterprises access to an expansive new world of development, deployment, management, and data services that recast the role of CIO into that of trusted advisor and innovator to the business.

Last century, the average lifespan for a company was more than 50 years. Today most S&P 500 companies survive just over 20 years, with predictions that the lifespan will shrink to just 12 years by 2027.[1]

1. Innosight, Corporate Longevity Forecast *Creative Destruction is Accelerating*, 2018.

HYBRID CLOUD'S TOP USE CASES

CLOUD MIGRATION

- Move specific applications to public cloud due to specific business needs
- Move enterprise applications (Oracle, Microsoft, SAP, etc.) to public cloud
- Consolidate and/or evacuate data centers

DATA CENTER EXTENSION

- Expand geographical footprint
- Leverage elastic capacity on demand
- Extend on-premises virtual desktops and published apps
- Perform test and development activities in public cloud

DISASTER RECOVERY

- Implement disaster recovery (DR) delivered as a cloud service
- Reduce secondary DR site costs
- Protect workloads with additional cloud-based DR for specific applications

NEXT-GENERATION APPS

- Modernize existing applications
- Build new applications using native public cloud services
- Build hybrid applications that span data center, cloud and edge environments

The Move to Cloud

Public cloud adoption is expected to continue to rise globally. Business and IT leaders have grown increasingly comfortable with the public cloud as a platform to support business-critical operations (Figure 1). On average, enterprise tech executives expect to add two new cloud environments in 2021 with 90% of them identifying "Migration and Modernization" as their major application initiative this year,[2] placing some workloads in the public cloud and some on-premises to balance the expectations for innovation, agility, stability, and security.

It remains the rare exception for a company to pursue a cloud initiative that is purely on-premises or purely public. Private clouds remain valuable, and hybrid and multi-cloud deployments are becoming the norm—not the exception—for use cases ranging from disaster recovery as a service to lowering storage costs or taking advantage of new cloud-native services.
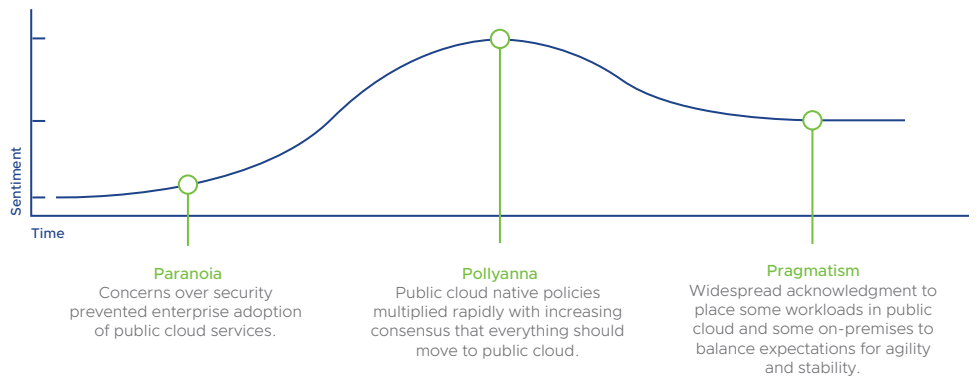

Figure 1. The history of public cloud sentiment in the enterprise

The vast majority of enterprises are going toward some type of cloud model. For any business looking to go this route, it's important to develop a strategy. VMware Cloud CTO Kit Colbert says, "Whether it's a proactive strategy or some kind of a reactive outcome, we suggest that your strategy be as proactive as possible." Even if a business decides they don't want to use the cloud at the moment, it's still important to plan, because it may be inevitable at some point in the future. Colbert says, "If you didn't properly plan for this transition you may end up using a multi-cloud or hybrid cloud in a way that doesn't get you all the benefits that you're really looking for, and in fact can actually slow you down if you're doing it incorrectly."

Migrating to public cloud doesn't have to be difficult, but it can be. Despite the market increasingly viewing the data center and public cloud as part of a singular hybrid strategy with the ability to leverage pools of resources from multiple resources, McKinsey has it right: "Moving applications and data to public-cloud platforms involves working through a formidable set of technology, security, operational, and financial issues."[3]

A well-thought-out migration strategy can help you avoid failure, loss of time, and loss of money. Such a strategy must incorporate the technology, people, and processes needed to run and extend a best-in-class private cloud on-premises to one or multiple public clouds. A key component that can lessen the burden of managing hybrid or multi-clouds in the future is infrastructure consistency and compatibility between on-premises and cloud environments.

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2. VMware Executive Pulse, January 2021
3. McKinsey, The progressive cloud: *A new approach to migration*, 2018.

"Unless an organization is literally born in the cloud, every enterprise's cloud journey must include preparation for simultaneously supporting a cloud infrastructure and a legacy infrastructure."

NEAL MATTHEWS, PRINCIPAL ARCHITECT, CLOUD TECHNOLOGY PARTNERS.[4]

COMMON HYBRID CLOUD STRATEGIC PLANNING CHALLENGES

• Failure to develop a clear business case for cloud migration

• Ignoring dependencies among infrastructure, applications and operations

• Lack of equal consideration of technical requirements, skill sets, and business needs

• Attempting to migrate before testing and learning

"I think it's really imperative that you tie any of these efforts to the business value like… how does it make it faster, how does it make it less risky, how does it deliver better value to customers?"

KIT COLBERT, VMWARE CLOUD CTO

To establish consistent infrastructure, consider fine-tuning your data center to build or optimize a private cloud instance that leverages virtualization of the entire infrastructure stack, automation, and self-service capabilities on-premises. Doing so will make your infrastructure more aligned to and compatible with the infrastructure available from public cloud service providers. A focus on creating an agile, automated, software-defined data center will allow your organization to get all the benefits of the public cloud, without the interoperability and dependency challenges that cause so many hybrid cloud strategies to flounder. Intel has delivered support for vMotion across five generations of Intel® Xeon® Scalable processors with Intel® Virtualization Technology. Basing infrastructure on Intel technologies enables a more seamless interoperability to move and place workloads across private and public cloud instances, wherever it makes the most sense for the business.

Enterprises running optimized private clouds should focus on delivering hybrid cloud infrastructure as a service to various stakeholders and leveraging cloud-native development platforms and services to create new revenue streams and enhance business models.

No matter where you are in your cloud computing journey, the following roadmap can help you successfully plan and implement a hybrid cloud strategy that supports both your current and future IT initiatives and business goals.

The CIO Roadmap to Hybrid and Multi-Cloud

1. Prepare and Educate Your Organization

Public cloud education and buy-in stretches far beyond the IT organization. It's imperative that CIOs educate their CEO, C-suite peers, and board of directors about the need to invest in public cloud as a style of computing that drives greater speed, agility, and innovation for the business. CIOs should use their digital strategy to develop clear business cases for running workloads in their most optimal IT environment (on-premises, public cloud, hybrid) and justify the investments needed to do so. Justification often comes from exhibiting how the public cloud will enhance customer experiences, improve agility, lower total cost of ownership, and accelerate innovation.
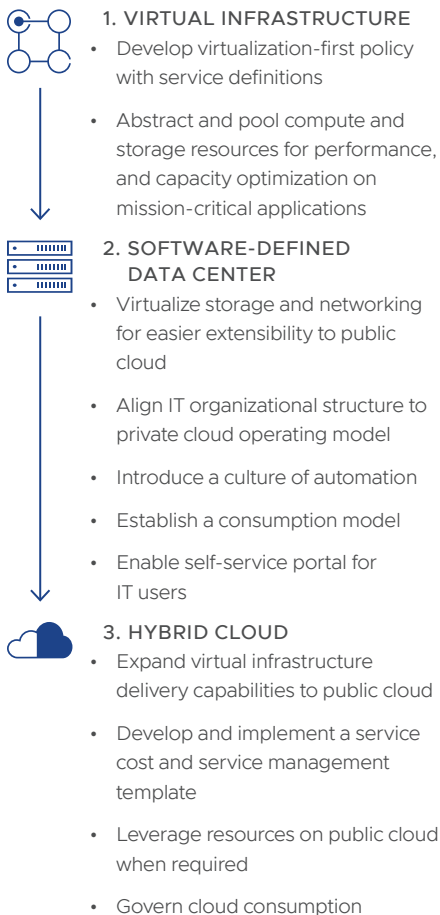
Colbert says it's important to be able to demonstrate value to the organization. "I think it's really imperative that you tie any of these efforts to the business value like… how does it make it faster, how does it make it less risky, how does it deliver better value to customers?… That's a core mindset shift that has to happen."

According to Colbert, the bottom line is, "What a lot of people actually are trying to get to is modernization… underneath the covers it's really about: how to deliver faster to customers, give them a better experience, drive more top-line revenue. And on the flip side from an infrastructure standpoint, how to optimize things to lower costs at the same time."

CIOs must also work with line-of-business leaders to understand their needs and what matters most in their world: typically applications and services that can speed up and simplify processes and operations. They must collaborate with cloud-native developers, who will undoubtedly provide insight on their preferred cloud platform and services for application innovation. When business and IT priorities are aligned to business outcomes it's easier to gain buy-in and measure success against public and hybrid cloud initiatives.

4. cloudtp.com/doppler/hybrid-cloud-vs-multi-cloud-whats-difference-matter/

PEOPLE, PROCESS AND TECHNOLOGY MILESTONES AT EACH STAGE OF HYBRID CLOUD MATURITY

1. VIRTUAL INFRASTRUCTURE
- Develop virtualization-first policy with service definitions
- Abstract and pool compute and storage resources for performance, and capacity optimization on mission-critical applications

2. SOFTWARE-DEFINED DATA CENTER
- Virtualize storage and networking for easier extensibility to public cloud
- Align IT organizational structure to private cloud operating model
- Introduce a culture of automation
- Establish a consumption model
- Enable self-service portal for IT users

3. HYBRID CLOUD
- Expand virtual infrastructure delivery capabilities to public cloud
- Develop and implement a service cost and service management template
- Leverage resources on public cloud when required
- Govern cloud consumption

2. Assess Your Organization's Hybrid Cloud Readiness

Developing a comprehensive migration strategy is the best assurance against failure. Understanding dependencies among infrastructure, applications, and operations is key when making your initial assessment. Equally important is doing your homework about various migration strategies—for example, lift-and-shift versus rearchitecting—then matching a strategy to the applications in your portfolio and desired business outcomes. This will require an extensive evaluation of your existing application portfolio and its suitability for migration across different cloud pathways.

Put yourself in the best possible position by choosing an experienced cloud provider that can become an extension of your data center, while providing access to best-in-class tools and services.

Not every application in your portfolio will be suited for migration. You will likely choose to keep some apps on-premises due to concerns over security, compliance, cost, or complexity. And you will find it very helpful to modernize some infrastructure before moving them. Colbert says, "A lot of times we find that people are running infrastructures that are very old and sometimes it's helpful to modernize the on-premises infrastructures to better prepare them to migrate to the cloud."

When planning a migration, it's critical to assess your workloads' application and infrastructure dependencies and governance models across all environments. The value of a hybrid cloud is ultimately tied to the value of an application to the business and the value of deploying that application in a variety of environments. Evaluate how private, native public, or hybrid cloud meets the needs of existing and new applications, tying each application to the business' priorities and value. Emerging areas of need—such as exponential scale, machine learning and artificial intelligence capabilities, containers, and microservices—are well suited for native public cloud platforms.

Successful cloud migration also requires careful planning. A basic "lift-and-shift" isn't technically feasible for most organizations and often lead to performance issues or, in worst-case scenarios, incompatibility with the new environment. While there are a number of clear benefits to leveraging resources across on-premises and public cloud environments, achieving these is more complex than simply running in both environments at the same time. A carefully crafted bridge to the cloud must be developed.

From infrastructure incompatibilities to moving workloads without disrupting tightly bound networks of dependent applications, the most common hybrid cloud compatibility issues include:

- Limited network integration between on-premises and public cloud environments
- Conflicting APIs, policies, UIs, and other components
- Compromised data integrity during updates and patches to environments
- Differing security architectures between on-premises and cloud service providers
- Lacking connectivity among environments for authentication, usage tracking, cost, and performance optimization

The ideal model for a hybrid cloud is a common cloud stack that includes consistent underlying hardware infrastructure and management functionality across private and public clouds.

3. Understand the Stages of Hybrid Cloud Maturity

Hybrid cloud readiness begins in the data center. The trend within enterprises has been to emulate the services public cloud providers offer by modernizing on-premises data center infrastructure and operations with more cloud-like capabilities, such as self-service and automation. Companies looking to keep up with business and customer demands face roadblocks, such as the complexity and expense that come with running a disparate infrastructure.

> "What a lot of people actually are trying to get to is modernization... underneath the covers it's really about: how to deliver faster to customers, give them a better experience, drive more top line revenue. And on the flip side from an infrastructure standpoint, how to optimize things to lower costs at the same time."
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> KIT COLBERT, VMWARE CLOUD CTO

> "2020 taught enterprises that hybrid and multi-cloud are a necessary path for corporate resiliency, but the question remains: what mix of cloud best meets the needs of my organization? Performance, TCO, security, consistency from an application perspective, IP control—there are many factors to consider to ensure the decision makes your company more resilient and not less secure."
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> REBECCA WEEKLY, VICE PRESIDENT, GM, HYPERSCALE STRATEGY AND EXECUTION, SENIOR PRINCIPAL ENGINEER AT INTEL CORPORATION

Building a hybrid cloud working model means abstracting away traditional complexity in the data center, beginning with the hypervisor and extending to the software-defined data center. However, specific investments in people, processes, and technology must be made at each stage of hybrid cloud maturity. When on-premises services become indistinguishable from those of a public cloud, the IT organization itself matures into a true business partner focused on delivering agile applications and services to the business end user.

4. Develop a Forward-Looking Migration Strategy

The ideal infrastructure for the majority of enterprises is one that provides the stability and familiarity of on-premises solutions while jointly leveraging public cloud services and scalability. While many cloud migration strategies are developed in response to top-down mandates or budget cuts, the decision to migrate to a public cloud should include considerations for the cost and complexity of migrating an application or data center and the benefits achieved once in the cloud. CIOs should consider desired business outcomes, investment priorities, deployment models, service providers, talent sourcing, and cloud policies. In addition to financial considerations, many elements of a sound migration strategy depend on organizational factors. This includes the organization's structure and culture, infrastructure, operations, and applications—which may have dependencies and present complications.

Each application within your portfolio should also be evaluated against the following migration options:

- Maintain the application unchanged in its current environment.
- Replatform the application, keeping it unchanged but moving from a highly virtualized environment to the cloud.
- Refactor the application for the cloud, taking advantage of cloud's modern architecture, microservices, and developer environments. This can be done on-premises or through a public cloud provider.
- Develop for the cloud to deliver next-generation applications that are built-in environments developed specifically to take advantage of cloud architectures.
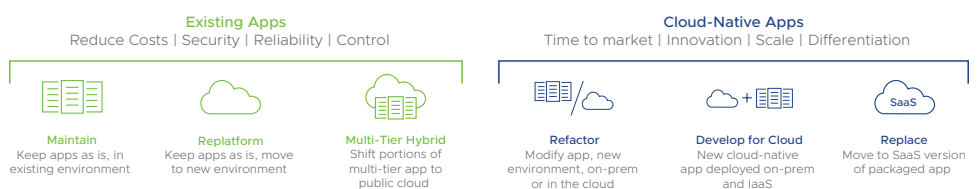- Replace with a SaaS version of a packaged application.

Figure 2. Application migration strategies

Also, consider these questions regarding application dependencies:

- Do I understand all of the applications, platforms, and their dependencies currently in use in the organization, including: contracts, terms, service-level agreements, compliance requirements, infrastructure and data?
- Do I understand the application architecture requirements of the cloud compared to a virtualized environment?
- Do we have a documented application portfolio assessment, including all architectural details and dependencies of each application in our portfolio?

"A consistent technology foundation enables workloads to be optimally placed and managed, facilitating workload portability, and avoiding lock-in to a particular cloud vendor. When an enterprise comes to the cloud they want elasticity on demand—for that you need a consistent hardware foundation across all availability zones."

REBECCA WEEKLY, VICE PRESIDENT, GM, HYPERSCALE STRATEGY AND EXECUTION, SENIOR PRINCIPAL ENGINEER AT INTEL CORPORATION

5. Develop an Enterprise Cloud Management Strategy

The ideal scenario for any enterprise IT organization is the flexibility to develop any type of application, deploy to any cloud, and deliver to any device—all while maintaining security and governance as users and application requirements continue to escalate. But delivering this level of flexibility brings complexity, and complexity means risk.

Diverse management tools and models, inconsistent security models, and heterogeneous user policies mean more for IT to manage and master. At the least, this can be a drain on efficiency and introduce unexpected costs. At worst, it could threaten the security of intellectual property and customer information.

To deliver upon the promises of hybrid cloud without increasing complexity and risk, enterprises need consistent operations across clouds that provide:

• **Security**. Consistent security models and policies that reduce risk and vulnerabilities connected to core infrastructure, applications, and devices

• **Governance**. Clear policies for how resources are used, and by whom, to optimize cost and ensure compliance

• **Visibility**. Insights into where workloads are deployed and how these resources are being used

• Ongoing management. Ensure the health of production workloads and proper resource utilization amid ever-changing behaviors of resources, end users, and networks

• **Automation**. Intelligent systems to manage the provisioning, capacity, performance, and availability of infrastructure and application environments

A misconception of the public cloud is that it can substantially offset cost without the need for additional planning and implementation. The fact is that many enterprises overspend on public cloud services because the proper steps are not taken. This is in part due to the lack of visibility most enterprises have into spending and usage per business unit. Economies of scale give public cloud providers an advantage, allowing them to reduce many of the financial pressures of running a data center on-premises, such as maintenance, upkeep, power, cooling, and staffing costs per server unit. These savings, if the cloud is used well, can be passed on to the enterprise, providing a more cost-effective supply of storage, compute, and connectivity for applications.

Migrating to a public cloud also allows organizations to take advantage of flexible pricing models, paying only for the computing resources being used by the applications active in the cloud at any given time. Underlying infrastructure matters. Different instances deliver different capabilities, and less expensive instances may be based on older infrastructure that does not meet current performance or security requirements. Careful planning can help keep costs down while also meeting expectations, but organizations with unpredictable usage may find it hard to avoid spending a lot of money on public cloud services when usage suddenly surges.

Security and compliance are also substantial issues that may be difficult to manage without proper oversight into the configuration and other practices of the cloud provider. Choosing a vendor that offers public cloud computing services that are compatible with both your private cloud setup and your security measures requires careful consideration.

Last, because using a hybrid cloud is more complex than using either a public or private cloud alone, organizations must carefully plan how a hybrid cloud will scale up as well as down, when more or fewer resources are required.

6. Test, Learn and Adapt Your Approach

Gain migration experience by experimenting with non-critical workloads and test cases. Learnings from these test cases will inform how to execute mission-critical workloads effectively. Use this opportunity to onboard or upskill your IT staff in different migration paths (replatform, refactor, etc.), workload complexities, and dependencies. This will reduce the cost of employing new staff and minimize the risks that come with larger migration projects.

7. Identify and Nurture the Right Skills

Although the cloud can offer speed and flexibility, it also requires additional talent and skill sets that can be difficult to find or develop. Such skills include not only in development and integration, but also business acumen. An emerging role, cloud architect, can help enterprises achieve their hybrid and multi-cloud goals. These individuals can lead the essential cultural change for public cloud adoption, develop a cloud strategy and architecture, and coordinate adoption.

Organizations that put off selecting or hiring a cloud architect may end up adopting cloud services through ad hoc processes that lead to issues, frustrations, duplicate work cycles, general inefficiencies, or inappropriate, risk-filled use of cloud services. As public cloud computing increases in complexity and popularity, appointing a responsible party or team will help streamline the process.

8. Adopt New Ways of Working

The path to a hybrid cloud has emerged from different enterprise needs, driven by different teams. Infrastructure and operations teams aim to extend on-premises environments to the public cloud to support data center consolidation and optimization strategies. The rise of the microservices architecture—a modular, distributed component of a larger application—has enabled organizations to release new code and evolve applications quickly, flexibly, and on-demand.

This second path has led to the emergence of a multi-cloud network by default rather than by design. The complexity of managing multiple public cloud environments has increased as the scale of operations in the public cloud has increased. Today, many development operations teams are looking to offload operationally oriented tasks so they can exclusively focus on delivering features and functionality that drive business differentiation and competitive advantage.

While hybrid and multi-cloud strategies can coexist, it's important to note their separate, complementary goals. A hybrid cloud integrates public cloud services or data with on-premises infrastructure and is often employed to migrate workloads to the cloud, manage spikes in demand, or build modern applications. A multi-cloud approach leverages cloud services from two or more providers, enabling more choice and flexibility in features and geographies. But these implementations are not necessarily integrated or orchestrated, and can cause major disruption to management, configuration, security, and performance between on-premises data centers and public clouds.

While the vast majority of teams that are responsible for application development and IT operations are on a single cloud, increasingly these teams are looking to build and run applications across more than one cloud. Today most clouds are operational silos, with each cloud coming with a different operating model, a unique set of APIs, and a unique set of semantics. In order to get more operating leverage and workload placement flexibility, organizations need to adopt technologies that can run across more than one cloud environment.

FUTURE-PROOF YOUR CLOUD STRATEGY

Organizations should consider:

- Using a set of management tools and practices that can work across multiple clouds/environments

- Using a common infrastructure that can be deployed on multiple clouds/environments

- Using a common set of cloud services that that can work across multiple clouds/environments

Multi-Cloud Journey
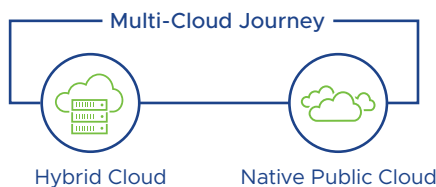
Hybrid Cloud   Native Public Cloud

Figure 3. The new multi-cloud journey

For these reasons, maintaining a system of control and common operations across an organization's public cloud environments is critical to centralizing all public cloud operations, improving visibility and efficiency, and reducing the cost of public cloud.

Realizing this goal requires cloud operations teams that are specifically focused on these outcomes, in addition to managing user access, ensuring security and compliance, establishing guardrails and policies for cloud usage, and overseeing enterprise-wide public cloud management capabilities.

The CIO Roadmap to Hybrid and Multi-Cloud

Migrating workloads to the public cloud can open up a host of new possibilities for your business, helping you achieve IT agility, operational consistency, flexible scalability, and lower TCO. Get started on your journey to building, deploying, running, or evolving your hybrid cloud.

1. Educate your organization

- Identify clear business needs for migration
- Rationalize and justify move to the cloud
- Ensure cloud strategy is aligned to business goals

2. Assess your organization's hybrid cloud readiness

- Understand dependencies among infrastructure, applications and operations
- Research migration strategies
- Evaluate application portfolio and suitability across different cloud pathways

3. Understand the stages of hybrid cloud maturity

- Modernize on-premises infrastructure and operations with a focus on creating an agile, automated, software-defined data center
- Ensure on-premises compatibility with infrastructure available from public cloud service providers

4. Develop a forward-looking migration strategy

- Evaluate migration and deployment models, investment priorities, talent sourcing, and service providers
- Engage with trusted tech and professional services providers to help guide technological, cultural and organizational changes

5. Develop an enterprise cloud management strategy

- Deploy enterprise monitoring software to keep track of cost, security, governance, access and usage
- Leverage automation to manage provisioning, capacity, performance and availability of infrastructure and application environment
- Ensure security models and policies are consistent across all computing environments connected to core infrastructure, applications and devices

6. Test, learn and adapt your approach

- Experiment with non-critical workloads and test cases to determine migration timeframe, use of resources, and other variables
- Onboard or upskill your IT staff in different migration strategies

7. Identify and nurture the right skills

- Enable a team of workers skilled in cloud migration
- Support your team with sufficient tools and resources

8. Adopt new ways of working

- Embrace the different—yet complementary—goals of hybrid and multi-cloud with the necessary infrastructure, tools and services that balance and support data center optimization initiatives, cloud-native application development, continuous integration, and continuous delivery practices
- Ensure cloud operations teams are specifically focused on maintaining a system of control and common operations across all cloud environments to centralize cloud operations, improve efficiency, reduce costs, and ensure security and compliance

Conclusion

Hybrid cloud and multi-cloud options are creating enhanced opportunities for innovation and efficiency across today's organizations, leveraging the best of both on-premises systems and cloud services. As organizations continue to transform, they will leverage public cloud services to drive revenue, become more agile, and maintain competitiveness.

But as they look to meet the needs of specific applications and business objectives, the risk of adopting multiple, differentiated platforms increases operational complexity and risk. Enterprises are looking to develop a foundational on-premises cloud solution rooted in software-defined infrastructure and operations, a comprehensive roadmap, and putting dedicated teams in place to plan, execute, and manage hybrid and multi-cloud deployments. This approach will deliver agility, efficiency, and innovation without the interoperability, security, and cost challenges that cause so many cloud migration initiatives to stall.