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IDC Opinion

Enterprises adopting digital transformation today are seeing a competitive advantage to their business. Firms that deploy an infrastructure ready for what is next to come (e.g., artificial intelligence [AI]) are paving the way to take advantage of new opportunities. As a major factor in technology investments for the past few years, digital transformation seeks to modify business processes, work culture, and customer experiences to meet changing business and market requirements. IDC estimates that by 2022, 46% of enterprises’ products and services will be digitally delivered, in turn increasing the reliance on their IT infrastructure. For example, new AI-enabled customer experiences will soon be commonplace. This means that businesses are constantly under pressure to gain insights from data available to them. It requires businesses to invest in new infrastructure and information systems while maintaining existing ones. To develop digital services that deliver modern and increasingly automated customer experiences and intelligent business operational systems depends on having timely access to innovative but resilient and trusted technology, building an autonomous business infrastructure.

At the heart of digital transformation is the cloud. Over the past year — and especially during the pandemic — businesses rapidly adopted public cloud services to improve upon the responsiveness, scalability, and resiliency of their infrastructure. Many companies are realizing that the decisions they made may not be ideal for long-term workload placement. An IDC survey of 2,374 IT buyers and decision makers showed that many organizations now face the challenge of repatriating applications back to on-premises infrastructure or a hosted dedicated cloud. Half of the respondents indicated they migrated applications to the public cloud that should have stayed on premises. Businesses are now moving from “should I use the cloud?” to “how can I optimize my cloud strategy to further my business?”.

A cloud optimization strategy seeks to bring together the best capabilities across multiple infrastructure platforms and deployments. A hybrid cloud architecture is key to developing a cloud optimization strategy. Thanks to the pace of innovation and changes to public cloud services and dedicated cloud platforms, hybrid cloud architectures are becoming stable and mature. Hybrid cloud architectures can be procured as an integrated stack complete with appropriate tooling that connects all the deployments together. Further, a structured approach in place to effectively design, deploy, and operate the mix of infrastructure options enables organizations to make the most of their hybrid infrastructure. This approach must constantly evaluate workload placement, fine-tuning the strategy for optimized outcomes in an ongoing manner.

This white paper discusses how enterprises can gain the most out of their cloud optimization strategy with a consistent dedicated and shared cloud infrastructure. It addresses best practices for deploying workloads (applications and their associated data sets), including location placement strategies and repatriation. Finally, it makes the case that a cloud optimization strategy underpins a hybrid cloud operating model.
Situation Overview

A Cloud Optimization Strategy Enabled by a Hybrid Cloud Architecture

The core of any organization’s transition to digital infrastructure is “cloud everywhere,” in all its diversity and ubiquity. Digital infrastructure enables businesses to scale into the future by:

- Optimizing application deployments across locations so that they can set the pace and direction of innovation across the entire business
- Making IT and business operations resilient so it can usher in new revenue streams while scaling existing ones
- Enabling the business to differentiate using data-driven insights harnessed as soon as the data is born

The foundation for digital infrastructure rests on a hybrid cloud strategy and operating model. However, businesses are confronted with growing public cloud costs, data security, and compliance challenges — let alone the fact that workloads need the right operating platform. In other words, businesses need to develop a cloud optimization strategy that takes a policy-based approach to support their ever-changing business requirements. As Figure 1 illustrates, this requires that the hybrid cloud incorporate the following essential attributes for organizations to accelerate their digital transformation.

**FIGURE 1**

Hybrid Cloud Underpins the Future of Digital Infrastructure

Source: IDC, 2021
Cloud-Native Technology

A cloud-first approach to technology adoption is different from how organizations deploy traditional infrastructure. This fundamental shift is necessary for digitally transformed enterprises to embrace cloud-native and workload-optimized solutions that enable real-time processing, data-intensive analysis, and low-latency interconnection.

A cloud-first approach to technology adoption:

- Requires a consistent hardware infrastructure approach, which in turn addresses application placement challenges
- Includes a cloud-optimized software stack, new data representations, new resource abstractions, and functional convergence of previously independent components

IDC anticipates that in the next three years, major technological trends that follow will have considerable influence on the capabilities and usability that chief information officers (CIOs) and IT decision makers (ITDMs) can expect from their digital infrastructure investments. By taking a cloud-first approach, CIOs and ITDMs can prepare their organizations to better evaluate and embrace these trends, thus enabling more effective use of digital infrastructure resources.

Some examples of these trends are:

- **Software-defined infrastructure**: This allows organizations to dial in resource allocations and load balancing and scale as needed by different workloads and use cases. Software-defined infrastructure approaches enable IT organizations to reduce costs of globally deployed infrastructure by being more agile and location independent — this means they can service the needs of the business wherever the business needs IT.

- **Memory-driven infrastructure**: IDC anticipates that by 2024, a quarter of all data being captured will be real time in nature, and IT organizations will need to evolve their infrastructure to support this shift.

- **Heterogeneous computing**: By investing in heterogeneous computing, organizations can compress the time to value of data they collect, thus gaining unprecedented, differentiated, and timely insights into their business.

- **Orchestration platforms**: These offer increased consistency and flexibility in delivery of infrastructure resources across all deployment options, with an eye toward improved workload portability.

- **Hyper-customization**: A cloud optimization strategy for digital infrastructure requires economies of scale within mainstream as well as niche use cases. Businesses can partner with technology providers to provision specific performance capabilities to match the workload needs; deploying workloads on this hyper-customized layer can drive down costs while increasing agility.

In the next three years, developing the ability to weigh the advantages across all three axes of deployment flexibility, asset usage and tenancy, and consumption models will have a major influence on where and how effectively CIOs can use digital infrastructure to improve business agility and resilience.
Building a Cloud Optimization Strategy

► **Ubiquitous deployment:** This means making effective use of, and timely access to, innovative and fit-for-purpose infrastructure resources anywhere and everywhere the business operates. Digitally driven businesses must take a comprehensive approach to assessing and leveraging all available deployment options across the digital infrastructure ecosystem.

► **Asset usage and tenancy:** Enterprises will need to improve their ability to quickly deploy and efficiently operate cloud-centric infrastructure in their core facilities as well as a growing range of edge locations. Prebundled solutions will make it easier to make dedicated clouds more consistent in capabilities and operations, and a growing range of local cloud-as-a-service solutions further automate operations while aligning dedicated infrastructure spending with business activity.

► **Procurement and consumption models:** As IT organizations turn their focus to business resiliency, adoption of as-a-service models will be a key part of digital infrastructure strategies. Business and IT leaders that embrace as-a-service models quickly realize the benefits of real-time insights to make strategic business decisions, bring cloud economics to their datacenters and edge locations, and improve business agility and flexibility. These leaders can improve the speed with which they can introduce innovative technologies and can also enable greater automation of IT operations when delivered effectively.

► **Autonomous operations:** Autonomous operations rely on proactive AI-powered analytics, policy-driven automation, and low-code or serverless workflows to enable consistent self-driving infrastructure that spans all physical and logical assets. As part of these capabilities, cloud-based provisioning offers a control point and self-service capability that empowers development and DevOps teams to quickly access resources while intrinsically providing guardrails that limit business risks.

► **Cloud-based provisioning, optimization, and control:** CIOs should look for cloud infrastructure partners that enable tight API integrations to allow for bidirectional policy management, the integrated exchange of performance and availability data, and a straightforward set of guidelines that govern security, compliance, and audit requirements. There must be a clear line of sight for the shared responsibilities between the cloud infrastructure provider and the IT organization.

► **Cross-cloud data management:** The growing prevalence of siloed data in existing datacenters, edge locations, and diverse cloud environments poses major data use and control challenges. Automating data management using cloud-centric platforms enables organizations to maximize the value derived from data by centralizing data control while applying consistent data compliance, security, and governance policies and frameworks to data across different destinations.

The adoption of such a data management platform must be a cornerstone of every CIO's infrastructure modernization agenda as these executives help transform their organizations into data-driven enterprises.
**Self-regulating infrastructure:** Self-regulating infrastructure depends on dynamic and continuous assessment and statistical analyses that provide probabilistic guarantees. It is emerging as a compelling area of IT investment because of its capacity to extend the use of intelligent automation throughout the infrastructure life cycle.

**Planning and operations:** Planning and operations enable organizations to embrace policy-driven automation, improve scaling, increase security and resiliency, and have better cost management. This is critical for IT organizations to maintain an appropriate infrastructure environment.

**Skills transitions:** CIO and IT managers will need to prepare for a significant shift in the IT skills required to manage the innovative but complex new IT environments. Enterprises that use tools and platforms to further automate infrastructure operations report a significant increase in uptime and increased visibility across all assets. To fully capitalize on these gains, however, the CIO must also be ready to intelligently redeploy high-value resources to more strategic initiatives across the business.

*Note: Please refer to the Appendix for a full discussion of these important trends.*

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**Examples of Cloud Optimization Tools**

- **CloudGenera** automates the collection and aggregation of datacenter and cloud supplier information, thus enabling customers to simulate application transformation scenarios to generate business cases for optimization and migration.

- **Densify** is an AI-based solution that understands workload demand patterns and identifies how efficiently businesses are using their cloud and/or container service resources. It determines very precise cloud instance cost and performance improvement potential and recommendations. Whether businesses are choosing cloud services or already running in the public cloud, Intel Cloud Optimizer by Densify delivers recommendations to achieve optimized performance and price.

- **Granulate** is a real-time continuous optimization tool that performs Linux kernel-level resource management optimization to create an application-aware infrastructure with improved performance and efficiency and reduced cost.
When public cloud services first became available, organizations were running all workloads in on-premises traditional infrastructure. At that time, workload placement strategies typically revolved around determining which workloads could move to public cloud, and how (rehosting, refactoring, or replatforming). This early usage of public cloud exposed organizations to different and better operating models in terms of acquisition, agility, provisioning, infrastructure expansion and contraction, and technology refresh, among others.

Much has changed since then, including both deployment and consumption model options. Many of the original advantages of public cloud can now be easily replicated with on-premises IT infrastructure and deployment options that can better meet performance, availability, security, compliance, governance, and cost requirements for many workloads. Today, workload placement strategies need to take these distinct options into account and focus much more specifically on individual workload requirements to determine where the workload resides.

A cloud optimization strategy enables enterprises to select the right infrastructure for the right workload, thereby enabling them to make efficient workload placement decisions that help better meet requirements while controlling costs.

A core operating principle of a cloud optimization strategy is workload centricity. CIOs should ask their teams to partner with their stakeholders and review their existing workloads to determine whether they need to keep or retire them. If organizations decide to keep them, then they need to determine whether these workloads should reside where they are or be moved to a different deployment model (which could be a new type of modernized on-premises infrastructure or a cloud-based environment).

Workload placement decisions should be guided by each workload’s usage patterns and requirements. It is IDC’s considered opinion that these decisions need to be made assuming a hybrid cloud strategy that offers three deployment models: traditional on premises, private cloud, and public cloud. This means crafting a hybrid cloud strategy up front to guide technology refresh, modernized infrastructure, and workload placement decisions. The goal of this strategy should be to achieve a consistent cloud experience across all deployment models that supports simple and efficient workload placement and data mobility, all managed from a unified dashboard. Workloads can then be evaluated and placed in the optimal deployment model and, if things change over time, easily moved to a different model.
Organizational Readiness for Embracing Hybrid Cloud Is a Work in Progress

IDC research finds enterprises are still trying to chart their path to hybrid cloud adoption as they digitally transform themselves. This white paper — via empirical data — seeks to demonstrate that the reason any hybrid cloud implementation can be arduous and treacherous (and not to mention expensive) is because it requires a solid strategy to be in place. This strategy is business and technical outcomes focused. Crucially, it seeks to solve the problems that businesses face with their traditional IT as well as public cloud deployments.

Legacy Operating Models

Figure 2 illustrates the datacenter challenges that directly inhibit digital transformation. Organizations overwhelmingly cite support and integration challenges with legacy infrastructure as the key barriers to improving internal or company-owned datacenter operations. This is followed by those identified by a third of surveyed organizations — the lack of visibility into total cost of operations and internal silos and organizational challenges that create inconsistencies among different infrastructure platforms and systems. Finally, one in five organizations struggle to find budget to fund the changes necessary to shift away from legacy operating models and infrastructure.

IDC PERSPECTIVE — LEGACY OPERATING MODELS

Legacy infrastructure, lack of operational visibility and transparency, and a rigid organizational culture can hinder digital transformation initiatives. Such organizations cannot embrace a hybrid cloud operating model effectively simply because it can make underlying challenges even worse. For CIOs and ITDMs, digital transformation and an enabling hybrid cloud strategy start with first addressing these challenges. Organizations may choose not to invest in on-premises datacenters going forward, but it does not take away their responsibility to address legacy technology or organizational issues.

FIGURE 2
Barriers to Enabling Digital Infrastructure with Self-Owned Datacenters

Q. Do you experience any of the following barriers to improving your internal or company-owned and/or company-operated datacenters?

(% of respondents)

<table>
<thead>
<tr>
<th>Barrier</th>
<th>(% of respondents)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrating newer systems with legacy infrastructure</td>
<td>36%</td>
</tr>
<tr>
<td>Lack visibility into total cost of operations or service</td>
<td>33%</td>
</tr>
<tr>
<td>Busy supporting older, legacy systems</td>
<td>32%</td>
</tr>
<tr>
<td>Internal silos or organizational challenges inhibit operational efficiency</td>
<td>27%</td>
</tr>
<tr>
<td>Lack of staff or staff with adequate skills</td>
<td>24%</td>
</tr>
</tbody>
</table>

n = 400, Source: IDC’s Datacenter Operational Survey, May 2020
Multicloud Environments

Figure 3 illustrates a reality that is becoming common in businesses of all sizes, and especially medium-sized and large enterprises. That reality is a multicloud world for digital infrastructure. Most businesses expect to have a dedicated cloud or traditional IT footprint that is in their owned and operated datacenters or, in some cases, a hosted facility. This will of course complement their public cloud investments.

IDC PERSPECTIVE: MULTICLOUD ENVIRONMENTS

The earlier sentiment that most organizations will go all in with the public cloud is no longer valid. CIOs and ITDMs are compelled to take a more nuanced and workload-by-workload view of their deployment strategy. They anticipate running their workloads across multiple IT environments, with the highest percentage utilizing on-premises dedicated cloud and traditional infrastructure. In other words, the mix of multiple locations is here to stay for the foreseeable future.

This response illustrates and underscores the need for a hybrid cloud operating model for a simple reason: operating multiple locations without a common orchestration, automation, and management framework can be taxing on the IT organization and leave the business vulnerable to service quality and outage issues. This situation is exacerbated if the business still has a legacy operating culture in place and if its deployments include traditional IT (non-cloud) environments. Building on consistent, interoperable platforms, on the other hand, can reduce complexity and improve outcomes when operating in multiple locations.

FIGURE 3

Multiple IT Environments

Q. Thinking about your digital infrastructure in the next two years, in what environments do you expect your workloads will run?

(% of respondents)

<table>
<thead>
<tr>
<th>Environment</th>
<th>% of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-premises dedicated cloud</td>
<td>37%</td>
</tr>
<tr>
<td>On-premises traditional</td>
<td>35%</td>
</tr>
<tr>
<td>Off-premises dedicated cloud</td>
<td>25%</td>
</tr>
<tr>
<td>Off-premises traditional</td>
<td>24%</td>
</tr>
<tr>
<td>Off-premises public cloud</td>
<td>20%</td>
</tr>
</tbody>
</table>

n = 2,374, Source: IDC’s 2H20 Servers and Storage Workloads Survey, February 2021
Workload Considerations

IDC finds that businesses foresee a combination of on-premises and off-premises infrastructure resources for deploying their workloads. This mix varies based on company size, with larger companies making greater use of off-premises cloud environments across all workload categories compared with smaller organizations.

The needs of the business dictate workload considerations when exploring a cloud optimization strategy:

- Service quality (performance, availability and recovery, and business-centric user access)
- Governance requirements (security, privacy, and regulatory and compliance requirements)
- Cost optimization (align the type of infrastructure resources to operating budgets for workload)
- Resource optimization (ability to manage the deployment using the right type of people, process, and automation frameworks)

Workload Repatriation

Workload repatriation is an essential part of a cloud optimization strategy. It is a universal process — IDC believes most organizations with a hybrid cloud strategy perform workload repatriation on an ongoing basis.

Figure 4 illustrates that at an aggregate level, organizations expect to continue moving workloads (applications and their associated data sets) from the public cloud to other IT environments in an effort to find an optimal balance of workload distribution across their deployments.

**FIGURE 4**

**Workload Placement in Two Years**

*Thinking about your workloads that currently run in the public cloud, do you expect any of them will be repatriated and/or moved in the next two years? If yes, where?*

- 24% On-premises traditional
- 21% Off-premises dedicated cloud
- 19% Public cloud only
- 15% Off-premises traditional
- 10% Hybrid environment
- 7% On-premises dedicated cloud
- 5% Don’t know
- 7% Don’t know

Notes: *Multiple responses were allowed. Hybrid environments comprise one or more public cloud, dedicated, and traditional IT infrastructure deployments. n = 2,374, Source: IDC’s 2H20 Servers and Storage Workloads Survey, February 2021*
Figure 5 illustrates that the priority in workload repatriation is dependent on business criticality and related security concerns. Performance and price unpredictability are important considerations. The primary deployment choice for organizations repatriating public cloud workloads is an on- or off-premises dedicated cloud. These findings are quite consistent across company sizes and industries.

**FIGURE 5**

**Top Five Key Reasons for Workload Repatriation from Public Cloud**

Q. *What are the key reasons your organization plans to repatriate workloads from the public cloud?*

(% of respondents)

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data security concerns</td>
<td>43%</td>
</tr>
<tr>
<td>Data privacy concerns</td>
<td>36%</td>
</tr>
<tr>
<td>Performance issues</td>
<td>24%</td>
</tr>
<tr>
<td>Unpredictable pricing of services</td>
<td>22%</td>
</tr>
<tr>
<td>IT consolidation efforts</td>
<td>20%</td>
</tr>
</tbody>
</table>

n = 2,374, Source: IDC’s 2H20 Servers and Storage Workloads Survey, February 2021

**IDC PERSPECTIVE: WORKLOAD REPATRIATION**

Organizations are quickly realizing that an all-in public cloud strategy does not work for the entirety of their workloads. Legacy workloads, for example, are difficult to maintain in the public cloud and require a dedicated or traditional (non-cloud) deployment.

Workload repatriation is an active tactical approach at many organizations, and IDC believes this will eventually lead to organizations embracing an active cloud optimization strategy as a long-term solution. Data security and privacy concerns as well as a lack of performance predictability and pricing lead to organizations seeking to move these workloads back to on-premises environments.

This does not mean organizations are reducing their spend on public cloud. On the contrary, IDC research shows that newer workloads like AI platforms, web serving, and security that are currently hosted in public cloud will continue to run more frequently in the public cloud. Organizations expect that 12% of workloads currently running partially in public cloud will be fully hosted in the public cloud within a span of two years.

*The net here is that a hybrid cloud strategy must encapsulate optimized deployment scenarios for a diverse mix of legacy and new-generation workloads into a new operating model.*
Organizations Are Attempting to Embrace Hybrid Cloud

Figure 6 illustrates key ways in which organizations use or plan to use their hybrid cloud deployments. At the top is the ability to move workloads between clouds, followed by the use of public cloud for backup or disaster recovery. Organizations also expect to use hybrid cloud as a transition stage for workload migration (to the public cloud) and as a testing and development layer for various environments.

**FIGURE 6**

Key Objectives of a Hybrid Cloud Strategy

Q. Which of the following best describes how your organization uses or plans to use hybrid cloud?

(% of respondents)

- Workloads are moved between clouds based on the optimal location: 63%
- Public cloud used for backup or disaster recovery for workloads running in dedicated cloud: 54%
- Transition stage for migrating workloads into public cloud: 50%
- Testing and development in different environments: 50%
- Public cloud used for data tiering for archived data for workloads running in dedicated cloud: 49%
- Public cloud resources used for short-term needs in case of burst in compute and storage needs for workloads running in dedicated cloud: 27%

n = 2,374, Source: IDC’s 2021 IT Infrastructure Plans Survey, December 2020
Figure 7 illustrates the top challenges with operating hybrid cloud environments. It underscores the importance of ensuring objectives are met during the implementation and operations phase. Security and compliance remain top concerns. The ability to migrate applications between environments and operating and ownership costs remain top concerns as well. These show that a holistic cloud optimization strategy is a must for hybrid cloud environments.

**FIGURE 7**

**Top Five Challenges When Operating Hybrid Cloud Environments**

Q. What are your top challenges in operating a hybrid environment? (% of respondents)

<table>
<thead>
<tr>
<th>Challenge</th>
<th>% of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security concerns</td>
<td>37%</td>
</tr>
<tr>
<td>Concerns around migrating applications/data</td>
<td>28%</td>
</tr>
<tr>
<td>Compliance concerns</td>
<td>25%</td>
</tr>
<tr>
<td>Unpredictable cost/TCO</td>
<td>25%</td>
</tr>
<tr>
<td>Too complex to integrate with our workflows/processes</td>
<td>23%</td>
</tr>
</tbody>
</table>

n = 500, Source: IDC’s 2H20 Servers and Storage Workloads Survey, February 2021

**IDC PERSPECTIVE: HYBRID CLOUD ADOPTION**

Often, organizations think of hybrid cloud as one of their deployment models with a set of transient objectives the investment must meet in the short term. They see this as a way to bridge together their multiple cloud investments. CIOs and ITDMs at these organizations are seldom involved in the strategic decision-making process. It is not uncommon to find each business unit implementing its own flavor of hybrid cloud.

Such approaches — while a step in the right direction — fall short of a forward-thinking view that is essential for digital transformation. Organizations that view hybrid cloud in these terms risk failing to make it a foundation for their organization-wide digital transformation. It ends up becoming a one-time initiative, fails to serve as a catalyst for people and process change, and ends up costing the organization a lot in the long run. Businesses that fail to capitalize on the potential for a hybrid cloud strategy will fail to catapult the organization into the future. A hybrid cloud must address the long-term needs of the business — such as business resiliency, optimizing application deployments, and enabling the business to differentiate using data-driven insights.

These hybrid cloud approaches share at least one common attribute: an expectation that workloads will run in multiple locations throughout their life cycles. This suggests a need for seamless migration from one landing zone to another as business needs evolve.
CASE STUDY

Scaling Containers Across the Hybrid Cloud

A premier publisher of massively multiplayer online role playing games needed to host its established games in-house, both to lower costs and to enable performance optimization in its stack. However, if there is an unexpected rise in demand from players, the company needed to be able to scale into the hybrid cloud smoothly. Accordingly, the company used Kubernetes to establish a shared resource pool between the public and private clouds for hosting its application containers.

Challenges

- Optimizing performance using in-house infrastructure to ensure players have an enjoyable gaming experience
- Enabling applications hosted in the datacenter to scale smoothly into the public cloud

Solution

- Implemented Intel Xeon Gold processor for software modules that require dynamic performance and scalability
- Worked with Intel to optimize application performance using Intel developer tools and compilers
- Used Intel SSDs to accelerate the writing of player logs and other files
- Deployed a hybrid cloud container-based infrastructure, using Kubernetes to orchestrate containers in the hybrid cloud

Results

- Enabled fluid scalability in the hybrid cloud, striking a balance between the performance optimizations that can be achieved in-house and the scalability of the public cloud
- Increased performance by removing storage bottlenecks
Empirical data presented in the previous sections underscores the need for organizations to start with a comprehensive hybrid cloud strategy. This strategy — grounded in business, not technology — must enable an organization’s digital infrastructure upon which it can propel itself into the future with products and services that are well differentiated from its competition. IDC recommends that CIOs and IT decision makers (ITDMs) seek to:

- **Build an organization-wide unified cloud strategy.** A key aspect of the future of digital infrastructure is to think long term and that means a departure from a per-business unit way of thinking about infrastructure.

- **Make business resiliency the core foundation that drives design decisions.** CIOs must ask their infrastructure architects to develop and design an operating model that ties together public and private cloud resources with common management tools.

- **Build key performance indicators (KPIs).** The transition to hybrid cloud infrastructure requires commitment to a new set of key performance indicators. This digital strategy ensures quick deployment and effective operation of the underlying resources required to support a resilient, trusted, and compliant digital organization. The end state is infrastructure that is always optimized, resilient, and self-regulating.

- **Explore as-a-service options that go beyond just flexible (operational) consumption of infrastructure and truly deliver a public cloud-like experience on premises.** Invest in dedicated cloud-as-a-service solutions from original equipment manufacturer (OEM) vendors, independent software vendors (ISVs), and public cloud providers to enable seamless operations and workload mobility between on-premises and off-premises deployments.

- **Mitigate risk by building contingency and failover scenarios into the design.** If business resiliency is the foundation, then the choice of technology must support agility and service availability (without degradation) if objectives or options change.

- **Focus on management tools that have limited overhead.** Cloud-based management tools are gaining popularity as they offer a software-as-a-service (SaaS)-like experience and can be used to operate multiple installations of dedicated cloud infrastructure (and integrated with public cloud services).

- **Take a workload-centric approach for deployments.** Determine where the workload needs to be deployed and what kinds of technologies this workload must access in order to deliver an optimized experience for the business. Forcing a workload to run at the cheapest location may not always support the success of a hybrid cloud strategy.

Finally, hybrid cloud infrastructure is a strategy and getting there is a journey. It requires charting out a long-term plan and a course to get to a desired state. This state itself must not be an end state but an operational state that constantly adapts and changes to suit the needs of the business.
The Role of Silicon and Computing Platforms in a Hybrid Cloud Strategy

Having established the key objectives of a hybrid cloud strategy and operating model, it is imperative that CIOs and ITDMs ensure they address implementation criteria for its successful rollout. A hybrid cloud operating model requires a consistent approach to solid computing and data management infrastructure platform selection for the various deployments. Such platforms are in turn reliant on the silicon that powers them and the software stack that runs on them.

The role of a common processor platform is often underestimated in delivering on the requirements of portability across multicloud deployments. Today, the reason companies can achieve this mobility and portability is because the choice of silicon is taken for granted. In an increasingly heterogenous world, the choice of silicon becomes more nuanced. For example, it is not just speeds and feeds or cores, but the silicon vendor’s ecosystem of ISVs, OEM vendors, and cloud providers that enables customers to deploy their hybrid cloud strategy seamlessly.

At the same time, the flexible consumption of infrastructure resources requires that the unit of consumption be ubiquitous. This is enabled by a family of processors (usually from the same vendor) that offers consistent experience regardless of where it is deployed: core, cloud, on premises, hosted, and at the edge. Again here, the silicon vendor’s ecosystem of ISVs, OEM vendors, and cloud providers means that flexible consumption options can be seamlessly deployed and minimizes platform or deployment lock in. Underlying capabilities from the silicon vendor (e.g., Intel Virtualization Technologies across the past five generations of Intel Xeon processors) may enable easier placement and migration of workloads across generations of hardware as well as across cloud environments.

It enables a transparent transition from a capex model to an opex model without any changes to the hardware or software side.

With Intel, enterprises have the power to move, store, and process data across any cloud environment — public cloud, private cloud, or hybrid multicloud.

Based on Intel’s end-to-end portfolio, including Intel Ethernet for networking, Intel Optane technology for storing and moving large data sets with ease, and the latest third-generation Intel Xeon Scalable processors, enterprises have the consistency they need to successfully advance their digital strategy.
Making the Most of Dedicated (Private) and Shared (Public) Cloud Investments with Intel Xeon

Adopting a hybrid cloud strategy gives businesses incredible flexibility while helping them maximize their technology investments. With a combined on-premises and off-premises approach to cloud infrastructure, businesses can control costs, increase security, and improve performance. They can also shift traditional IT spending to emerging technology initiatives that drive new revenue. Hybrid cloud benefits include:

- **High scalability and agility**: Balance rapid innovation with compliance requirements on a scalable infrastructure that is interoperable, federated, and open.

- **More coordinated efforts**: Provide IT and DevOps with a common ground to share engineering, management, and workload optimization.

- **Maturity**: Get scaled environments and security features for cloud-aware applications or legacy IT operations in public and on-premises clouds.

- **Virtualization**: Leverage virtualization and containerization to prepare for software-defined infrastructure and the management of pooled datacenter resources.

- **Unified and open platform**: Individual infrastructure components are united to manage, automate, and orchestrate a datacenter on open or proprietary technology.

- **Simplified innovation**: Support business growth with broad choices and capabilities for new applications and workloads.

Intel is at the heart of a hybrid cloud architecture, delivering a trusted and scalable foundation for current and next-generation workloads. Intel's comprehensive portfolio is optimized for diverse cloud environments and supported by a broad industry ecosystem. This gives businesses seamless application portability and data mobility across multicloud environments — dedicated and shared — alongside consistent performance that scales securely and reliably from edge to cloud.
Conclusion

The future digital infrastructure is built on hybrid cloud. For businesses, it means more ubiquitous deployment options and more automated IT operations. The focus of a hybrid cloud operating strategy should be to ensure ever-faster delivery of innovative infrastructure hardware, software, resource abstraction, and process technologies to support the development and continual refinement of resilient digital services and digital experiences. The transition to cloud-centric digital infrastructure depends upon commitment to a digital strategy focused on resource optimization, consistent resilience, and continual enhancement.

As enterprises mature in their use and deployment of hybrid cloud, they are seeking and building greater workload portability. The need to finely delineate the subtle differences between the use of several types of on-premises, hosted, edge, and public clouds has been surpassed by mission-critical requirements to integrate workflows and simplify data sharing across multiple cloud deployments. This interdependency between clouds requires the use of standardized and unified cross-cloud operational strategies to maintain business continuity, reduce risk, control costs, and ensure end-to-end service levels. The requirements dramatically increase the complexity around managing and governing the cloud environment and services, driving the need to deploy unified control planes and increased governance to ensure compliance and manage risk.

The holy grail for the future of cloud infrastructure is a frictionless hybrid cloud environment that represents the next generation of IT infrastructure and is becoming the de facto gold standard for IT architecture. It offers end-to-end visibility, the ability to manage all clouds from a single dashboard, secure access to data from diverse sources, and a solid foundation for the future enterprise.
Appendix: Detailed Review of Key Trends

Software-Defined Infrastructure

As IT service increasingly lives in new edge locations, as well as in core datacenters and clouds, the ability to enable automated remote management becomes even more necessary. A software-defined IT infrastructure architecture:

- Separates infrastructure control, configuration, scaling, and security software controls from the underlying hardware platform
- Enables consistent operation of hardware regardless of the specific supplier
- Allows organizations to dial in resource allocations and load balancing and scale as needed by different workloads and use cases

Software-defined infrastructure places new requirements on enterprise IT teams. These requirements include building expertise that is more focused on policy automation, programmability, and analytics rather than on hardware-specific configuration and control. Software-defined everything approaches enable IT organizations to reduce costs of globally deployed infrastructure by:

- Being more agile and location independent — this means IT organizations can service the needs of the business wherever the business needs IT (IT can service edge locations with appropriate connectivity).
- Addressing challenges such as data sovereignty by ensuring that boundaries are placed on data depending on local regulations (IT organizations can create local copies of workloads, so the end customer is serviced by the business accordingly).

Memory-Driven Infrastructure

Memory-driven system architectures power an organization’s reliance on compressed or real-time insights from diverse data sources. IDC anticipates that by 2024, a quarter of all data being captured will be real time in nature, and IT organizations will need to evolve their infrastructure to support this shift.

Memory-driven systems are becoming an essential part of an organization’s digital infrastructure portfolio. They are:

- Used to host structured and unstructured analytics data stores
- An ephemeral and often stateless component of cloud-native workloads
- Used for analysis of data sources, many of which are streamed and have a short life span
- Becoming an essential part of newer artificial intelligence algorithms and models
Heterogeneous Computing

Heterogeneous computing delivers on a need for compressed time to insights by offloading a portion of the workload on to performant, purpose-built silicon. Faster and more extensive use of an expanding array of coprocessor technologies such as GPUs and field-programmable gate arrays (FPGAs) but based on a solid processor foundation accelerates:

- Infrastructure transformation that is crucial for a digitally resilient enterprise with a dramatic reduction in time to insights and/or business intelligence
- The deployment of modular and distributed infrastructure for data-intensive processing and application-driven outcomes

By investing in heterogeneous computing, organizations can compress the time to value of data they collect, thus gaining unprecedented, differentiated, and timely insights into their business.

Orchestration Platforms

Orchestration platforms are deployable as software or bundled with various standardized infrastructure systems. Key benefits of these platforms include:

- Increased consistency and flexibility in the delivery of infrastructure resources across all deployment options
- Faster introduction of more cloud-native software technologies into enterprise development and workload modernization efforts
- Improved workload portability that makes it easier to extend advanced services into edge locations
- When offered as software as a service, they are lightweight in terms of deployment and agility, especially in multicloud deployments

Hyper-Customization

Businesses enable cloud scale for digital delivery of infrastructure services via an approach called “hyper-customization.” This approach was not easily possible with traditional infrastructure systems. A cloud optimization strategy for digital infrastructure requires economies of scale within mainstream as well as niche use cases. Businesses can partner with technology providers to gain these targeted capabilities in multiple ways:

- Configure and create an infrastructure environment with the optimally desired compute-to-memory-to-storage ratios.
- Provision specific performance capabilities to match the workload needs, usually via policies and recipes that are part of the orchestration platform or service.
Deploying workloads on this hyper-customized layer can drive down costs while increasing agility. To make this an effective part of their strategy, CIOs need to train infrastructure operations and application developer teams. Similarly, new vendor partnerships are crucial in making hyper-customization a core part of their cloud optimization strategy.

**Ubiquitous Deployment**

Ubiquitous deployment means making effective use of, and timely access to, innovative and fit-for-purpose infrastructure resources anywhere and everywhere the business operates. This is an important consideration for business agility and resiliency. It enables CIOs and ITDMs to support adaptive, resilient, secure, and compliant digital business models.

Digitally driven businesses must take a comprehensive approach to assessing and leveraging all available deployment options across the digital infrastructure ecosystem. In the next three years, developing the ability to weigh the advantages across all three axes of deployment flexibility, asset usage and tenancy, and consumption models will have a major influence on where and how effectively CIOs can use digital infrastructure to improve business agility and resilience.

**Asset Usage and Tenancy**

The most significant impact of public cloud infrastructure services in the past decade was to first reintroduce, and then globally extend, shared infrastructure as an important deployment option alongside the more tried and evaluated dedicated infrastructure. Cloud services, regardless of whether they are dedicated or shared, provide the ability to:

- Offer and quickly introduce spot and on-demand access to compute and storage capacity on a global scale
- Align well with the performance characteristics of mobile and media applications as well as data and compute-intensive artificial intelligence and high-performance computing (HPC) workload
- Embrace more real-time and location-specific workloads that vary by time of day and circumstances
- Over time, make use location-specific customer experiences and intelligent industrial devices that have extreme low-latency, availability, and data control requirements

Enterprises will need to improve their ability to quickly deploy and efficiently operate cloud-centric infrastructure in their core facilities as well as a growing range of edge locations. Prebundled solutions will make it easier to make dedicated clouds more consistent in capabilities and operations, and a growing range of local cloud-as-a-service solutions further automate operations while aligning dedicated infrastructure spending with business activity.

**Procurement and Consumption Models**

As IT organizations turn their focus to business resiliency, adoption of as-a-service models will be a key part of digital infrastructure strategies. Business and IT leaders that embrace as-a-service models quickly realize the following benefits:
Use of real-time insights to make strategic business decisions and improve operational efficiencies. This is enabled by enhanced visibility and transparency offered via the self-service portals.

Bring cloud economics to their datacenters and edge locations. Businesses can deploy edge infrastructure using as-a-service consumption models and with software stacks from public cloud infrastructure or from OEM vendors.

Improve business agility and flexibility. Businesses can increase the speed with which they can introduce innovative technologies. Such consumption models can also enable greater automation of IT operations when deployed effectively.

CIOs will need their teams to move beyond thinking about subscription and as-a-service options simply as a shift from capex to opex budgets. They must see as-a-service IT as an operating model that provides better insights about infrastructure usage and improves responsiveness and cost management. Crucially, as-a-service IT enables a shift in IT staff focus on tactical break/fix to strategic thinking and business enablement.

Autonomous Operations

Autonomous operations rely on proactive AI-powered analytics, policy-driven automation, and low-code or serverless workflows to enable consistent self-driving infrastructure that spans all physical and logical assets. As part of these capabilities, cloud-based provisioning offers a control point and self-service capability that empowers development and DevOps teams to quickly access resources while intrinsically providing guardrails that limit business risks.

By moving infrastructure operations teams away from reactive monitoring, service request and ad hoc provisioning, and remediation strategies, intelligent autonomous operations enable greater levels of workload portability, consumption-based usage, and support for highly dynamic agile infrastructure while keeping a handle on application costs and security compliance. In the next three years, major operational initiatives will have a major influence on how effectively CIOs can leverage their digital infrastructure investments.

Cloud-Based Provisioning, Optimization, and Control

From a CIO perspective, cloud-based provisioning enables a modern and resilient IT environment with:

- Control points to reduce business risks by improving security, compliance, and audit trails
- Self-service interfaces for shared access to resources by operations and site reliability engineering teams
- Embedded and automated policies that govern or intrinsically dictate rules that drive decision making and generate expected, agreed upon, consistent outcomes
With these tools, application development and DevOps teams do not have to understand all the details that are required for a service to be secure, compliant, and auditable.

CIOs should look for cloud infrastructure partners that enable tight API integrations that allow for bidirectional policy management, the integrated exchange of performance and availability data, and a straightforward set of guidelines that govern security, compliance, and audit requirements. There must be a clear line of sight for the shared responsibilities between the cloud infrastructure provider and the IT organization.

These areas go well beyond simple technology integration and data sharing; they require CIOs to create a strategy that outlines the people, process, and technology requirements that the IT organization and its providers own or share together to drive a repeatable, consistent outcome.

Cross-Cloud Data Management

The growing prevalence of siloed data in existing datacenters, edge locations, and diverse cloud environments poses major data use and control challenges. Automating data management using cloud-centric platforms enables organizations to maximize the value derived from data:

► Centralize data control and take advantage of AI engines to address data discovery, metadata management, and data retention policies across disparate data sets.

► Apply consistent data compliance, security, and governance policies and frameworks to data across different destinations.

The adoption of such a data management platform must be a cornerstone of every CIO’s infrastructure modernization agenda as it helps transform their organizations into data-driven enterprises.

Self-Regulating Infrastructure

Self-regulating infrastructure depends on dynamic and continuous assessment and statistical analyses that provide probabilistic guarantees. It is emerging as a compelling area of IT investment because of its capacity to extend the use of intelligent automation throughout the infrastructure life cycle. The benefits include:

► Greater organizational agility and flexibility, faster service delivery

► Increased operational efficiency

► Better alignment between developer processes and infrastructure capabilities

► Higher levels of application and service availability, and improved infrastructure resilience

For enterprises, actions taken based on these inputs can have a significant impact on infrastructure operations postures, as environments move from manual people-centric processes to automated and autonomous software-centric processes.
Planning and Operations

Planning and operations enable organizations to embrace policy-driven automation, improve scaling, increase security and resiliency, and manage costs better. This is critical for IT organizations to maintain an appropriate infrastructure environment. In doing so they can:

► Shift away from traditional metrics such as uptime and availability that are no longer adequate in delivering on new customer expectations.

► Use AI and other analytics approaches to identify and track alignment with critical key performance indicators that impact business outcomes.

► Embrace deep proactive and predictive analytics across infrastructure cost, health, compliance, and performance to detect trends and automate responses that increase resiliency and flexibility.

CIOs and ITDMs must incentivize their staff to partner with their vendors and service providers to deliver, build, and actuate on insights and metrics that are foundational to greater automation of IT systems and processes. These include the following:

► Glean intelligent insights from infrastructure telemetry, combined with a robust historical knowledge base of asset performance available.

► Gain up-front consulting best practices across planning, design, and operations, incorporating AI into a digital infrastructure.

► Develop a foundation on which IT stakeholders can make more informed business, technology, and operational decisions with less risk.

Embedding AI into operations will have the biggest impact as enterprises shift more fully to cloud-native application architectures built around containers and microservices. In these environments, KPIs and policies are dynamically tracked, allowing the organization to proactively balance workloads, resolve problems, and mitigate risk.

Skills Transitions

CIOs and IT managers will need to prepare for a significant shift in the IT skills required to manage the innovative but complex new IT environments. Enterprises that use tools and platforms to further automate infrastructure operations report a significant increase in uptime and increased visibility across all assets. To fully capitalize on these gains, however, the CIO must also be ready to intelligently redeploy high-value resources to more strategic initiatives across the business.
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Ashish Nadkarni is Group Vice President within IDC’s Worldwide Infrastructure Practice. He leads a team of analysts who engage in delivering qualitative and quantitative research on computing, storage, and data management infrastructure platforms and technologies, via syndicated research programs (subscription services), data products (IDC Trackers) and custom engagements.

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