White Paper

AWS Outposts: Extend the Value of Cloud Investments On-Premises

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IDC OPINION

Over the past decade, the aggressive adoption of agile and scalable cloud services made it possible for innovative mobile and content-intensive technologies and services to permeate nearly every aspect of people's business and personal lives. These cloud-based technologies, deployed by virtually all organizations today, create a tight link between customers and the organization. The distinction between internal operations and the external ecosystem (e.g., customers, markets, competitors, partners, and regulators) is rapidly disappearing, which has implications for where infrastructure and services that support richer transactions and interactions must be deployed and how they need to be governed.

The next decade will see an even greater transformation based on a cloud foundation, where we all work, play, and live. People, acting as consumers and as business employees, want to react faster to current and new data and take full advantage of a growing array of "smart" things. Those interactions increasingly occur in digitally optimized locations that deliver better experiences and enable the use of autonomous systems anywhere and everywhere. The extension of existing cloud investments in applications and data to make this transformation a reality is the most important new challenge for organizations around the world. IDC believes that this next stage of cloud-driven innovation will require new thinking about the consumption of IT resources on-premises in increasingly "smart" business locations such as factories, warehouses, hospitals, and content creation/production facilities.

Many new, innovative applications in areas such as industrial automation, real-time health diagnostics/analysis, content creation/production/distribution, and fleet routing/management must reside at least partially in such "smart" spaces to meet latency and local resiliency requirements. Their effective delivery at scale depends upon effectively deploying a number of consistent, reliable, and substantial local cloud platforms ranging in scale from a single rack to tens or even hundreds of racks of modern compute, storage, and network resources that are tightly linked with a broader portfolio of advanced cloud services. This approach will need:

- Local performance at any location without adding application complexity
- Local resiliency of critical services and availability of required data at locations without reducing servicewide recoverability
- "Cloud everywhere," the ability to consume cloud services at customer premises, with the same breadth of service and the same managed experience

This White Paper introduces AWS Outposts by Amazon Web Services (AWS), which functions as and is managed as a local extension of an existing AWS Region. AWS Outposts enables the use of AWS infrastructure and services on customer premises, making "cloud everywhere" a reality for AWS customers. By enabling faster new service delivery, business scaling, and greater operational flexibility, AWS Outposts will be a catalyst in the modernization of infrastructure across many customer premises locations.

CLOUD COMPUTING IS NOW MAINSTREAM

Cloud computing has evolved since its initial introduction in the mid-2000s. Evolving from its initial adoption for developer, start-up, and test/dev use cases, cloud computing has now become an integral element of the enterprise IT environment. IDC's market forecast in *Worldwide Public Cloud Infrastructure as a Service Forecast, 2019-2023* (IDC #US44178519, July 2019) shows that spending on public cloud infrastructure services will exceed spending on traditional on-premises infrastructure systems by enterprises within the next five years and that a majority of enterprises are already using public cloud in one form or the other for their IT needs.

Early success stories have shown enterprises that the benefits delivered by public cloud — flexibility with technology investments, unprecedented scalability including geographic reach, and the access to new technologies — are uniquely suited for today's evolving business environment. Digital technologies are now an integral part of nearly all businesses and verticals, and cloud offers an easy platform to build these digital transformation (DX) initiatives. These have elevated cloud to become a critical part of mainstream enterprise IT and the preferred platform for digital innovation at enterprises today.

EARLY ADOPTERS GO FROM CLOUD FIRST TO CLOUD EVERYWHERE

Cloud computing early adopters, a majority of which are AWS customers, have rapidly expanded their use of public cloud. An early common theme seen in these customers' IT strategies was "cloud first," where cloud would be the preferred destination for all new developments, where feasible. The cloud platform, and processes built around cloud capabilities, grew to become the de facto at these enterprises for their new digital initiatives. The expanded application of cloud and growing familiarity with cloud platforms helped highlight the benefits that cloud brought — both to existing enterprise IT use cases and for new digital innovation initiatives.

With the growing maturity of cloud-related skill sets and processes, cloud customers are continuing to look at ways to bring cloud benefits to a broader portion of their enterprise IT portfolio. Initial concerns with cloud — such as lack of familiarity, concerns with security, and limited enterprise application qualification — are no longer obstacles to broad cloud adoption at these organizations. This has resulted in the emergence of a new demand from cloud customers, "Cloud everywhere," where the cloud experience and benefits would be broadly available to customers at any of their locations.

Early indicators that highlight this trend are the emergence of cloudlike infrastructure consumption models, such as pay-as-you-go hardware systems, and interest in the use of cloud-native technologies in the customer premises. IDC estimates that by 2023, over a quarter of all the CPU cores running public cloud stacks will reside on customer premises (see *Growth of Public Cloud Stacks in Dedicated and On-Premises Customer Environments,* IDC #US44884219, February 2019).

The advent of cloud has raised the bar for customer expectations and developer experience in terms of how applications are developed, deployed, and managed, and there is a growing desire to leverage public cloud-like services on-premises. But the benefits customers wish to leverage are no longer limited to just the pay-as-you-go flexibility or just access to the same services. The value propositions that customers associate with public cloud have evolved over time, and there is a growing desire among cloud customers to have exactly the same experience and value delivered when they consume cloud services from their own premises.

Evolution of the Cloud Value Proposition

The initial use cases on cloud placed a high priority on the low up-front costs, pay-as-you-go flexibility, and opex model that public cloud offered – enabling developer and start-up workloads to be deployed without the risk and expense of an up-front infrastructure buildout.

With growth in usage, customers realized that cloud also offered them an unprecedented level of agility in terms of rapidly scaling a deployment, allowing them the agility to make rapid changes and operating in an efficient manner by always staying optimized to the scale of usage. These characteristics gradually transformed the perception of cloud – from just a new consumption option that switches pricing from capex to opex to a fundamentally new agile way of architecting and consuming infrastructure through the life cycle of a workload or service (see Figure 1).

FIGURE 1

Evolving Value Proposition of Public Cloud

Pay-as-you-use flexibility, low up-front investment

Agility and scalability, including geographic reach

Ecosystem of managed services and technologies
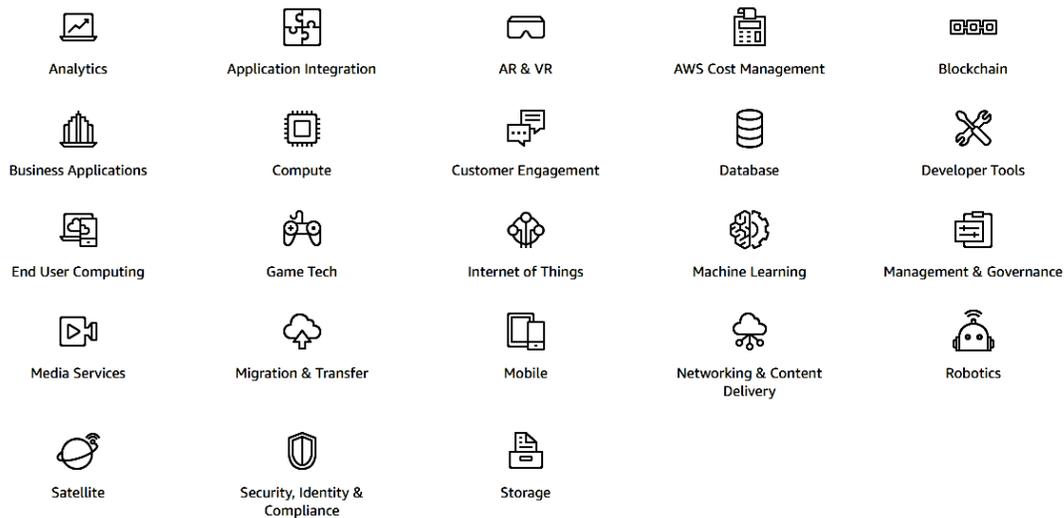
Source: IDC, 2019

The Broad Ecosystem of Services on AWS as a Digital Transformation Accelerator

A new dimension of value of public cloud platforms is the broader ecosystem of technologies and services launched in recent years. Public cloud-based services and, more specifically, AWS services – such as manageable database offerings (Amazon RDS and Amazon Aurora), highly scalable data warehousing (Amazon Redshift), access to emerging AI/machine learning (ML) platforms and training models (Amazon SageMaker), and new heterogenous infrastructure options (AWS Inferentia and

AWS Graviton) — act as catalysts for customer application delivery speed and evolution. IDC's surveys of public cloud adoption show the increasing prioritization of this ecosystem by customers that adopt public cloud and accelerating use of these services as customers mature on their public cloud capability. AWS' portfolio of offerings are gradually winning the trust of the enterprise IT community for its ability to empower customers to fully concentrate on business transformation and business outcome goals while delivering the building blocks needed to launch and execute on DX initiatives (see Figure 2).

FIGURE 2

Ecosystem of Technologies and Services on AWS Cloud

Analytics	Application Integration	AR & VR	AWS Cost Management	Blockchain
Business Applications	Compute	Customer Engagement	Database	Developer Tools
End User Computing	Game Tech	Internet of Things	Machine Learning	Management & Governance
Media Services	Migration & Transfer	Mobile	Networking & Content Delivery	Robotics
Satellite	Security, Identity & Compliance	Storage		

Source: AWS, 2019

AWS continues to expand its services to support both better management of the services and new technologies to drive business outcomes with introductions such as AWS GuardDuty and AWS Control Tower for better management and Amazon Managed Blockchain and Amazon Lumberyard for delivering applications faster. This broader ecosystem of services has emerged as one of the top reasons driving customers to select AWS for their applications. This growing ecosystem of services allows AWS to effectively handle an increasing portion of the "undifferentiated IT heavy lifting," allowing customers to concentrate their efforts on the business value and outcomes.

Cloud Everywhere as an Evolution of Hybrid Infrastructure Needs

Hybrid, or hybrid infrastructure in this context, refers to an organization's IT environment using a mix of on-premises infrastructure and public cloud services to run its application portfolio. IDC research shows that the most common reason customers build a hybrid environment is for application migration. As enterprises, which typically have existing infrastructure investments on-premises, start adopting public cloud, a planned hybrid infrastructure offers a natural path to integrate public cloud into their environment and to move applications to public cloud.

Hybrid needs from customers were initially centered around the extension of on-premises environments and tools into the public cloud. These "first-generation hybrid" needs were primarily driven by the existing skill sets and processes at enterprises, which were built around traditional on-premises tools and infrastructure. With the growing familiarity with cloud, particularly within the cloud customer base, a "next-generation hybrid" set of needs has emerged – the extension of public cloud environments to on-premises environments. The new focus on "cloud everywhere" reflects this shift in hybrid needs among cloud customers.

SOME CUSTOMER USE CASES NEED TO STAY ON-PREMISES TODAY

Even as public cloud adoption accelerates, there continue to be applications that cannot be moved to the cloud today for a variety of reasons. IDC's 2018 *Enterprise Datacenter Edge Survey* 2018 highlights that the top 2 reasons driving on-premises computing investments today at enterprises are the need to improve content delivery and to support better aggregation and processing of data at edge locations. Three other commonly seen reasons for with applications cannot be moved to public cloud today are:

- **Low-latency requirements, for applications that need to respond to real-world entities with single-digit millisecond latency.** This is a commonly seen requirement in environments that use industrial automation – such as electronics fabrication plants or automotive assembly lines – and in other time-sensitive use cases such as value-based, high-precision medical care and high-frequency trading. Applications may need to implement functions such as error detection, pattern matching, or device calibration, for which the round-trip latency to the cloud may not be acceptable or may have risk of not meeting the required SLA.

- **Local data processing requirements, for applications that are unable to or prefer to process the customer data on-premises, often because of the large volume of data that would need to be transferred to and from the customer premises if processing the data on public cloud.** These include content processing use cases such as video and image processing, healthcare and genomics data analysis, and video rendering.

- **Application refactoring needs, for distributed software systems where certain components need extensive rework and rearchitecting before they can be moved to a cloud environment.** This is often the case for legacy enterprise IT environments, where a business management system is implemented across a set of components, including modern end-user-facing web servers and monolithic legacy back ends built on COBOL or FORTRAN. Until the legacy back ends are refactored to make them cloud ready, customers cannot move the rest of the application components to the cloud as they need to be hosted together for latency or throughput reasons.

Customers increasingly wish to have the same flexibility, managed experience, and access to services as they do in the public cloud for these location-constrained applications. "Cloud everywhere" would connect these applications to the breadth of services available on cloud – bringing the ease of management of cloud to these use cases and augmenting the value delivered by these applications. This demand is the genesis for the AWS Outposts introduction.

Examples of opportunities to connect cloud services with these on-premises applications include the use of EC2 instances to modernize the web-facing components of enterprise applications while keeping the back end untouched, use of data analytics and machine learning alongside large data sets that cannot be moved to the cloud, and use of advanced pattern-learning and image-recognition frameworks for automated manufacturing use cases.

AWS OUTPOSTS: BRINGING THE CLOUD EXPERIENCE TO CUSTOMER PREMISES

AWS Outposts is a local extension of the AWS public cloud into the customer's premises. It is owned and operated as a fully managed service by AWS and brings native AWS services to customer premises, with the same management API and automation capabilities and access to the rich ecosystem of services available in the AWS public cloud. Through this, AWS Outposts allows customers to directly leverage AWS services on-premises and truly delivers a "cloud everywhere" experience.
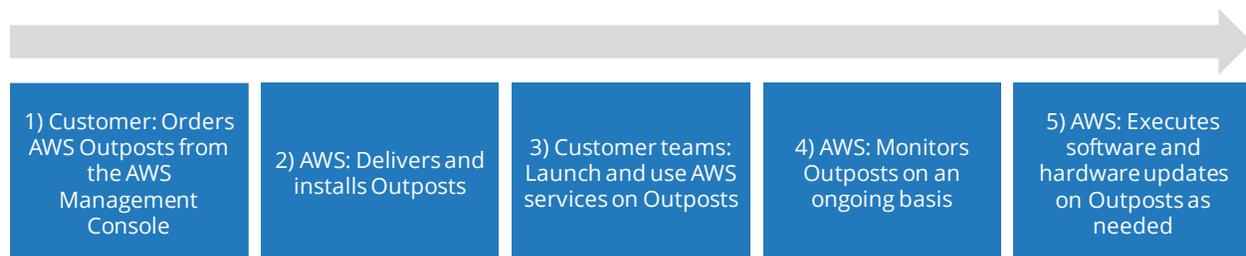
AWS Services and Experience On-Premises

Outposts units are delivered pre-integrated and are qualified systems built on the same infrastructure as the AWS public cloud and delivering AWS services on-premises. This allows customers to accelerate transformation and innovation efforts on-premises using the same AWS services. Customers can launch services to deploy and optimize on-premises use cases, such as EC2 instances and EBS volumes, Amazon ECS and Amazon EKS for container workloads, and Amazon EMR for big data and analytics needs. These can all be managed through the same AWS Management Console and operated through the same SDK and command line tools as services on the AWS cloud. The on-premises workloads in Outposts can also be connected with services on the AWS cloud such as Amazon S3 and DynamoDB using interface endpoints (powered by AWS PrivateLink) in private VPC environments and take advantage of services such as EBS snapshots in the AWS Region. These ensure that customers are able to integrate on-premises and public cloud-based components and operate them under a unified management framework.

From a logical and functional perspective, AWS Outposts operates as an extension of the AWS Region that resides in the customer premises. AWS monitors and maintains the infrastructure and software stack on the Outposts rack, just like other AWS infrastructure in the region.

FIGURE 3

AWS Outposts Management, Operations, and Usage

1) Customer: Orders AWS Outposts from the AWS Management Console	2) AWS: Delivers and installs Outposts	3) Customer teams: Launch and use AWS services on Outposts	4) AWS: Monitors Outposts on an ongoing basis	5) AWS: Executes software and hardware updates on Outposts as needed

Source: IDC, 2019

Completely Managed Experience

AWS Outposts will be completely managed by AWS, just like all other AWS services and regions. AWS Outposts installations will be associated with a specific AWS Region, and the Outposts infrastructure is managed by AWS, just like all other infrastructure for that region. As shown in Figure 3, AWS will also carry out ongoing monitoring and software updates as needed to keep Outposts up to date with patches and updates through the life of the subscription. Customer operations to launch, terminate, and configure

services on AWS Outposts will be using the same tools and services as the broader AWS Regions, such as the AWS Management Console and AWS Command Line Interface (CLI) tool.

Management operations on Outposts require network connectivity between the Outposts installation and the AWS Region. Continuous availability of this connection can be ensured with an AWS Direct Connect link with the AWS Region or through a virtual private network (VPN). As part of the service, AWS will manage the upgrade and assets disposal processes, which have often led to unplanned expenses in the past.

Flexible Environments: Native AWS and VMware

AWS Outposts will be available to customers in two variants: the native AWS variant and the VMware Cloud on AWS Outposts. In detail:

- **The native variant of AWS Outposts** will bring customers a native AWS environment on their premises. As discussed previously, this will include commonly used AWS services such as EC2 instances, EBS storage volumes, ALB for managed load balancing, ECS and EKS for container-based applications, and Amazon RDS (available at launch or soon after). Customers can deploy workloads and manage them from the AWS console and API, exactly as they would when deploying workloads in any AWS Region.

  This will allow customers to benefit from the rich management and automation services of AWS for applications that need to be on-premises and to use emerging technology platforms like Amazon SageMaker for AI/ML model creation and training, alongside their existing physical and software assets on-premises.

- **The VMware Cloud on AWS Outposts** will deliver a managed VMware Cloud Foundation (VCF) on AWS Outposts, providing customers a VMware environment to use within their Outposts unit. For customers that currently use VMware on-premises, this variant will provide a common infrastructure environment for use across their existing infrastructure and the new footprint built out using VMware Cloud on AWS Outposts. This will provide an easy path to "in-place modernization" of infrastructure for workloads that need to be running on-premises. As in the case of VMware Cloud on AWS, the on-premises service will support integration into an Amazon VPC and to native AWS services. Jointly, these have potential to extend the power of AWS cloud to a broad range of customer use cases and customer environments.

Customer Benefits: Agility On-Premises — Here's How AWS Meets It

AWS Outposts brings to customer premises several of the same benefits that the AWS public cloud introduced into the broader IT world.

Accelerating Innovation On-Premises by Leveraging AWS Services

AWS Outposts brings AWS cloud services on-premises to customers and allows customers to leverage them for applications that cannot be moved to public cloud today. Use cases where the AWS Outposts offering can immediately add value include manufacturing automation and healthcare, as well as network function virtualization (NFV) for telcos and operational technology (OT) environments such as industrial assembly floors. Outposts can allow easy integration of advanced analytics, machine learning, and cloud-native compute services into these use cases while staying within the required latency requirements.

Consistent AWS Experience On-Premises and in Public Cloud

With the growing adoption and familiarity of public cloud, there is a growing demand to enable the public cloud experience and capabilities for on-premises application modernization as well. AWS Outposts offers the same experience as AWS and is managed from the AWS control plane, just like any other AWS services in the associated AWS Region.

This consistency allows customers to manage their applications on-premises through the same tools, and leverage the same automation, monitoring, and authentication tools, that they are already using in AWS. This also allows customers to move more of their on-premises IT infrastructure spending from a capex to an opex model, allowing them to move to a more asset-light financial structure if needed.

Fully Managed Service Delivered Directly to the Business

AWS Outposts is delivered to customers as a pre-integrated service, with infrastructure and software that have been designed bottom-up to work together just as they do in the AWS public cloud datacenters. This reduces the risk of operational and compatibility issues as customers go through iterative updates of their infrastructure and software components.

AWS Outposts allows customers to choose from a wide selection of compute, memory, and storage options based on their needs. Customers can focus on building applications using AWS services, which relieve them from managing hardware and long infrastructure life cycles. Customers can focus on building applications to suit their business needs, security policies, and compliance goals, leaving infrastructure management to AWS.

Flexibility in Choice of Management Environment

Customers can choose between the native AWS variant or the VMware Cloud on AWS Outposts variant for their management planes. VMware Cloud on AWS Outposts delivers all the benefits of AWS Outposts discussed here, including the flexibility to be managed and operated through VMware infrastructure management tools. For use cases that prefer to operate within a VMware environment and use VMware-based processes, VMware Cloud on AWS Outposts offers a path to in-place modernization of the infrastructure platform without any change in environment or management tools. Adoption of AWS Outposts for such use cases will offer an operational experience that is consistent with a VMware environment while providing access to native AWS services alongside the VMware-based workloads.

CHALLENGES AND OPPORTUNITIES

AWS Outposts is well positioned to address the emerging need for local clouds with a fully managed infrastructure service in on-premises locations; however, its success is dependent on how well AWS and its partners provide use cases and deployment/management options that resonate with customers' changing IT procurement and usage needs.

The increasingly diversified technology, workload, and data portfolios that underpin modern digital business services along with the acceleration in the rate of change required to sustain a modern digital service are the greatest source of stress for today's CIOs and their teams. Adoption of solutions such as AWS Outposts is part of an ongoing shift from acquiring/managing/supporting products to delivering the diverse and ever-evolving portfolio of resources that underlay an organization's modern digital environment. AWS and its partners must ensure that IT teams can quickly and efficiently deliver and

track the use of these resources wherever they reside, whether in large, shared facilities; in internal datacenters; or in critical business facilities.

The priority in the next several years must be to help organizations change the culture (the standard processes and policies) of their IT teams (and associated teams in finance, security, and risk management) from acquiring/operating products that support the business to selecting/delivering resources such as Outposts that the business can rely upon as it transforms itself.

CONCLUSION

Cloud customers around the world are embarking on an accelerated journey to become digitally determined through greater exploitation of a growing range of cloud-delivered capabilities. Success depends on the customers' ability to make infrastructure and the IT team more responsive to business needs and drivers of business innovation across the organization. These needs include:

- Reducing the time to market for customer-facing applications and services, thus taking advantage of more business opportunities and winning more business
- Improving the quality of existing applications and services, including increasing employee productivity levels, thereby better serving customers
- Having the capacity and capabilities to quickly propose, test, and scale innovative products, services, and offerings anywhere and everywhere

"Cloud everywhere" is now seen as an approach to meet these needs. For the CIO and the IT team, ensuring that they can extend the value of cloud-based applications and data analytics within their own premises with a local cloud solution in the next few years must be a strategic objective. The key steps that IT leaders and their business unit/critical facilities' colleagues need to prioritize to take full advantage of emerging local cloud solutions such as Outposts include:

- Selecting a companywide, standard local cloud platform upon which internal DevOps teams and industry-specific SaaS providers can deliver/extend innovative services built on the full range of leading-edge open development and data management solutions
- Establishing standard processes and governance policies that IT and business teams must follow when deploying/operating local cloud solutions across the organization
- Implementing centralized physical, application, and data asset management and service assurance systems that enable consistent and secure delivery of innovative digital services anywhere without jeopardizing resiliency, performance, and trust

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