Unify operations across hybrid and multicloud environments

Efficiently implement your hybrid and multicloud strategy by extending Microsoft Azure services to every corner of your IT estate with Microsoft Azure Arc–enabled infrastructure on Intel® technology.

Microsoft Azure

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Contents

Market challenges and opportunities

Organizations are transforming their businesses at an accelerated pace. Worldwide investment in digital transformation has skyrocketed and is expected to total $6.3 trillion between 2022 and 2024.[1] Meanwhile, climate change is pushing sustainability to the forefront as a key priority. The following examples from different industry verticals illustrate some of the challenges and realities that today's business leaders face:

- **Manufacturing**: 92 percent of manufacturers are piloting or scaling digital technologies to target cost reduction and security. At the same time, 83 percent of manufacturers currently see a services business model as a major area of opportunity.[2,3]
- **Retailers**: 72 percent of consumers say that they are engaged only by personalized marketing; this increases pressure on retailers to customize messaging. Meanwhile, to address sustainability issues, 55 percent of retail leaders are exploring circular business models, that is, businesses creating supply chains that recover or recycle the resources used to create products.[2,4]
- **Healthcare**: Despite their digital-transformation efforts, healthcare companies are estimated to lose $6.2 billion per year due to data breaches amid growing pressure in security, compliance, and privacy. 52 percent of these same healthcare leaders are prioritizing sustainability by introducing sustainable business models.[2,5]
- **Finance**: 54 percent of banks think removing friction from the customer journey is the most important trend in retail banking, and 74 percent of financial services leaders are launching new products and services for sustainability.[2,6]

To overcome these challenges and embrace the opportunities that come with them, enterprises need an agile and flexible infrastructure across software and hardware that gives them a digital edge and enables them to:

- Quickly deliver products as a service in order to provide an improved customer experience.
- Transform data into insights, innovations, and new products.
- Accelerate application development and modernization, and support DevOps and agile-development best practices.
- Make use of new technologies for increased performance, improved efficiency, and reduced costs.
- Improve security and data protection and comply with changing regulatory requirements.
- Accelerate sustainability goals and increase business efficiency.

Workload-placement flexibility is critical to supplying these abilities to organizations. Because workload flexibility is so central to meeting business needs, public and hybrid cloud are integral parts of organizations' strategies for meeting market challenges and embracing new opportunities. However, enterprises need a bridge that provides a way to take advantage of cloud services on-premises in a way that is consistent with their overall cloud strategies and operating models.

Bridging multiple environments: Azure Arc

The cloud is both an architectural model and an operational model. Microsoft Azure is a resilient, scalable platform for your workloads and app development, topped with a set of management and operations services. At the same time, innovation should go beyond the public cloud and be able to permeate every part of an organization's infrastructure.
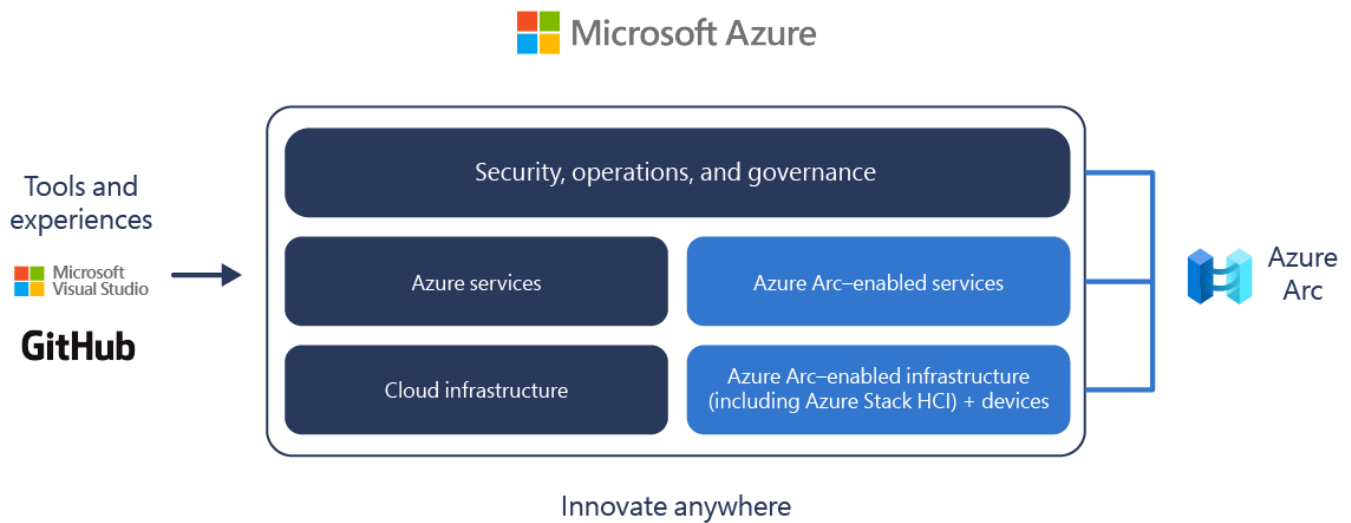
Figure 1. The relationship of Microsoft development tools and Azure services with Azure Arc–enabled services and infrastructure

Microsoft Azure Arc brings the value of cloud operations and architecture to any environment. Azure Arc can help make your cloud-to-edge ecosystem simple, flexible, and secure. Azure Arc is a bridge that extends the Azure platform to help you build applications and services with the flexibility to run them from cloud to edge. With this bridge, you can develop cloud-native applications with a consistent development, operations, and security model. And Azure Arc runs on both newly purchased and existing hardware, virtualization and Kubernetes platforms, Internet of Things (IoT) devices, and integrated systems. Understand that using existing hardware opens the door to a range of experiences: newer existing hardware may be a good fit, but older existing hardware may not be a bridge to a consistent development and operating model.

Azure Arc–enabled infrastructure and Azure Stack HCI

Azure Arc–enabled infrastructure allows organizations to extend the management and governance capabilities of Azure to on-premises, multicloud, and edge environments. Using Azure management solutions like Azure Resource Manager, Azure Policy, and Azure Security Center, organizations can manage resources across all of their environments including servers, virtual machines, and Kubernetes clusters. The Azure portal, a web-based management tool, provides a unified experience for managing Azure Arc–enabled infrastructure.

Azure Stack HCI is a hybrid cloud solution that merges the power of the Azure control plane with hyperconverged infrastructure (HCI) and enables organizations to modernize with cost-effective technology.

Azure Arc–enabled infrastructure optimized on Intel: Azure Stack HCI

Not all Azure Arc–enabled infrastructure implementations are Microsoft-centric. Moving forward, other third-party virtualization and container solutions will also be Azure Arc–enabled. These new solutions extend Azure-based provisioning and management to on-premises architectures built on such third-party infrastructure.

Azure Stack HCI is the Microsoft implementation of Azure Arc–enabled infrastructure. It delivers the best of Azure to organizations' on-premises servers, from the datacenter to the edge.

Microsoft customer scenario

A Microsoft customer that is determined to implement Azure Arc could consider migrating existing virtual machines (VMs) from a third-party virtualization platform to Microsoft Hyper-V. However, if that 3rd-party platform is Azure Arc–enabled, the customer can now use Azure Arc–enabled infrastructure to keep existing VMs on the original virtualization platform. In addition, Azure services can perform full lifecycle management of the VMs in the datacenter and provide Azure role-based access control (RBAC). This enables the customer's teams and workload owners to provision and manage on-premises VMs and unify operations, all while avoiding having to expend the resources required to migrate or refactor. This is the value of Azure Arc–enabled infrastructure.
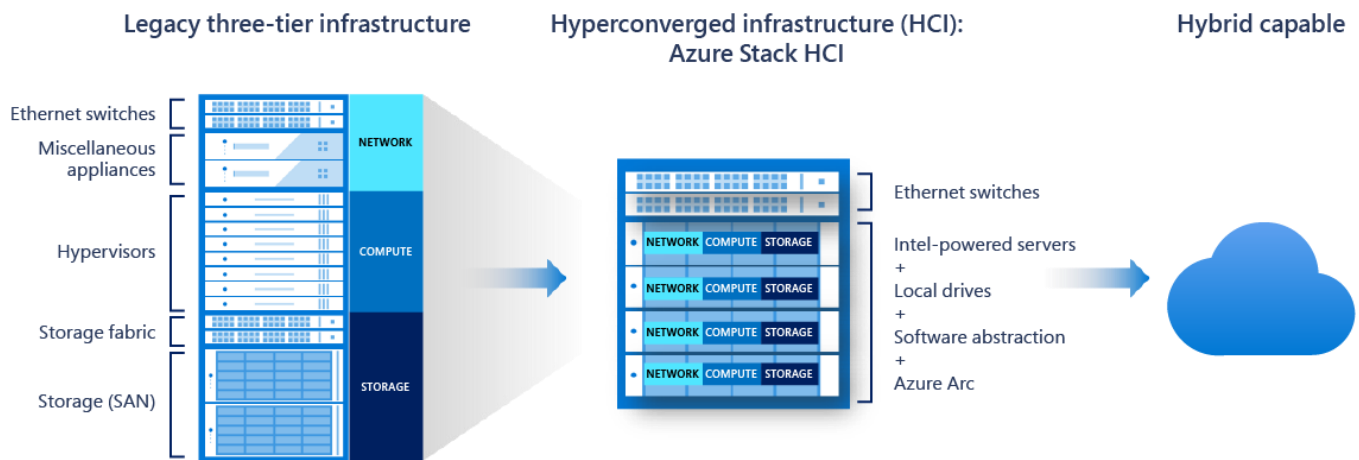

Figure 2. The relationship between legacy servers, hyperconverged infrastructure (HCI), and hybrid environments

Azure Stack HCI relies on software-defined storage and networking to enable aggregation of all server resources into a virtual pool that can be accessed directly from any of the servers in the cluster. Azure Stack HCI extends this abstraction of on-premises resources to the cloud. The native hybrid capabilities of Azure Stack HCI ease the movement of data, containers, VMs, and workloads between multiple clouds and on-premises deployments.

These hybrid capabilities improve flexibility for workloads and provide for a consistent management experience and hardware infrastructure that can increase operational efficiency. Intel Virtualization Technology (Intel VT-x) extends this flexibility across seven generations of Intel Xeon processors to ease migration between generations of hardware and across clouds.

Azure Arc–enabled by design

Azure Stack HCI is Azure Arc–enabled by design and is delivered as an Azure subscription. It provides native integration with Azure Arc, in addition to easy enablement of Azure services such as Microsoft Defender for Cloud, Azure Monitor, Azure Backup, and Azure Site Recovery. Due to the built-in integration with Azure Arc, organizations can centrally manage Azure Stack HCI VMs from the Azure portal as Azure Arc–enabled VMs. No matter where the HCI clusters are, VMs can be managed and monitored from one central management plane with Azure Arc.
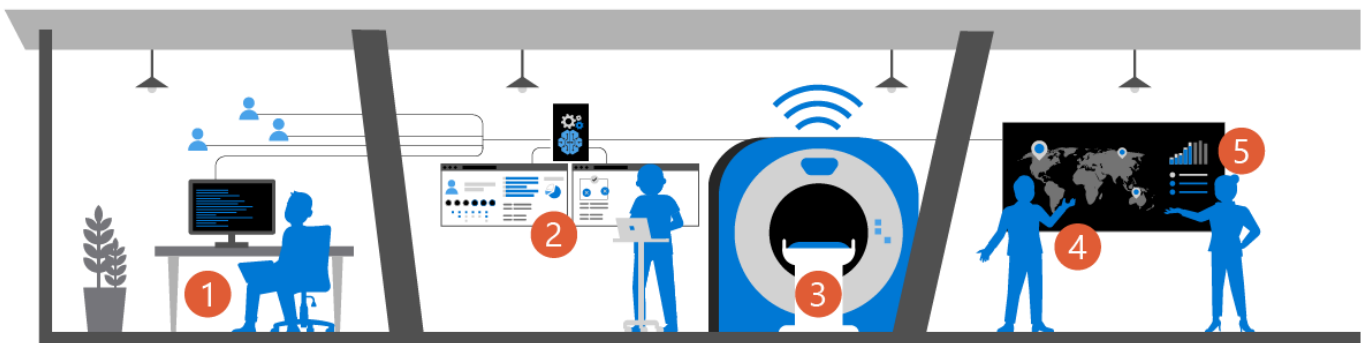

Figure 3. The A healthcare company can develop cloud-native applications on-premises using Azure Stack HCI with Azure Arc

For an example of an enterprise using Azure Stack HCI with Azure Arc, consider a healthcare company developing cloud-native applications on-premises. Azure Stack HCI capabilities used in modern app development could include:

1. **DevOps**: Developers at the company collaborate using their preferred development tools, including Microsoft Visual Studio Code and GitHub. Development is faster and more efficient due to workflow automation with GitHub Actions and infrastructure automation courtesy of GitOps.
2. **Collaboration**: With Azure Arc, developers and app users in the company can also use Azure Virtual Desktop (currently in preview) for a familiar Windows 11 desktop experience that can be either on-premises or remote and fully secure, while also being compliant with corporate policies and regulations. Local apps and data: Even though the company needs to keep data local for reasons of regulatory compliance and data gravity, it develops fully portable apps using Azure Kubernetes Service (AKS) on-premises with a scalable, evergreen database back end with Azure SQL Managed Instance running on Azure Stack HCI.
3. **Local apps and data**: Even though the company needs to keep data local for reasons of regulatory compliance and data gravity, it develops fully portable apps using Azure Kubernetes Service (AKS) on premises with a scalable, evergreen database back end with Azure SQL Managed Instance running on Azure Stack HCI.
4. **Security**: Azure Arc enablement in Azure Stack HCI lets the company harden its security posture and detect threats by monitoring infrastructure and applications end to end. The company uses Microsoft Defender for Cloud and Microsoft Sentinel to protect its entire environment from cloud to edge. And because these solutions integrate with the rest of Microsoft's security portfolio, the company enjoys a holistic DevOps experience across the entire organization.

5. **Operations**: The company enforces organizational standards and assesses regulatory compliance at scale using Azure Policy through Azure Arc. And because the company is running its VMs on Windows Server Azure Edition on Azure Stack HCI, it can apply most monthly updates without having to restart the operating system. Hotpatching like this in Windows Server Azure Edition helps maintain server uptime and uninterrupted operation.

Azure experience at the edge

Azure Stack HCI enables you to bring cloud intelligence, operations, and Azure services to the edge, close to where your data is created and consumed. You can build and train models on-premises by using Azure Machine Learning or infuse applications running on the edge with intelligence by using Azure Cognitive Services.
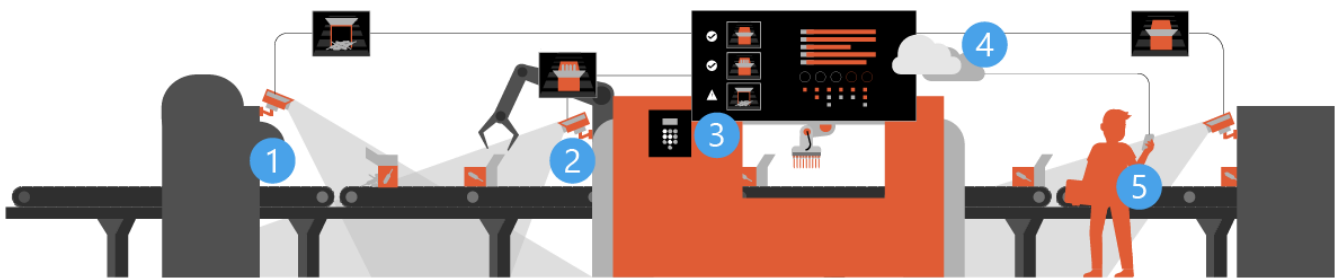

Figure 4. A manufacturer uses Azure Stack HCI to bring cloud intelligence to the edge

To see Azure Stack HCI in action at the edge, consider a manufacturing company using Azure capabilities at its network edge on the factory floor for predictive maintenance:

1. **IoT devices:** The company uses Azure IoT Edge to bring cloud intelligence to the IoT devices that it uses to monitor its production lines through Azure Arc.
2. **Inferencing:** Azure Machine Learning running on Azure Stack HCI runs artificial intelligence (AI) models in production on IoT data to look for patterns indicative of assembly-line machines that need maintenance before they break down. Intel Advanced Matrix Extensions (Intel AMX), built into 4th Gen Intel Xeon Scalable processors, accelerates AI models running inference in production environments without the need for a discrete graphics processing unit (GPU).
3. **Edge processing:** The company runs Azure SQL Managed Instance on Azure Stack HCI in order to take advantage of its onsite scalability and intelligence for localized insights with minimal latency.
4. **Training:** Azure Stack HCI also enables the company to train and tune models on-premises using Azure Machine Learning.
5. **Operations:** The company uses Azure IoT Hub on-premises to monitor all of the IoT devices in the factory and keep them up to date via Azure Arc.

Familiar management and operations

Azure Stack HCI is built on the foundation of Windows Server and Hyper-V. It supports management tools that your administrators already know and use, such as Active Directory and Group Policy Objects. Azure Stack HCI also works seamlessly with familiar tools such as Windows Admin Center, in addition to cloud-based tools such as the Azure portal. It is also compatible with popular third-party tools like Altaro, Commvault, Datadog, Veeam, and Veritas, to name a few, so that IT can continue to make the most of the management investments that it has already made. And management tasks are completely scriptable using the popular, cross-platform Windows PowerShell framework across your entire IT estate, both on-premises and in the cloud.

Figure 5. A retailer uses familiar monitoring tools in Azure to monitor apps deployed on-premises on Azure Stack HCI

The following example illustrates how an IT team at a retail company could use familiar monitoring tools in Azure to monitor apps deployed on-premises on Azure Stack HCI:

1. **Organize and inventory:** Administrators inventory, organize, and provision resources for point-of-sale apps and other apps at the edge by using Azure Resource Manager through Azure Arc.
2. **Configure and deploy:** The retailer's IT team can easily and consistently deliver infrastructure as code at the edge at retail locations by using Azure Automation via Azure Arc. They can also deploy and update cloud-native apps at scale by using AKS enabled by Azure Arc on Azure Stack HCI.
3. **Monitor:** DevOps professionals at the retailer use the Application Insights feature in Azure Monitor to automatically detect performance anomalies and diagnose issues in deployed web apps at the edge through Azure Arc.
4. **Secure and govern:** The retailer uses Azure Policy and Azure Arc to maintain organizational data-sovereignty requirements for customer data.

Flexible deployment options

Infrastructure consistency in Azure Stack HCI—across both hardware and software—enables greater agility for workload placement. Agile workload placement can make it possible for your organization to meet its specific business needs while running applications in environments optimized for them. Moreover, operational consistency built into Azure Stack HCI means lower operating expenses (OpEx) for your business.

Azure Stack HCI is available in two forms: integrated systems and validated nodes. Integrated systems are solutions that come from leading hardware vendors with services and software pre-installed, with hardware "racked and stacked," and that only require the customer's Azure subscription to be configured. Because these systems are ready to go "out of the box," with minimal additional configuration, Azure Stack HCI integrated solutions represent your fastest path forward for best time-to-value. Some Microsoft partners also offer Azure Stack HCI in a "hardware-as-a-service" model, providing an OpEx experience for hardware for customers that prefer this flexibility.

Azure Stack HCI is also available in validated nodes. With validated nodes, you or a system integrator can build the Azure Stack HCI solution by using a range of validated components. Doing so provides the broadest choice of hardware components to meet your organization's needs, and it supports more diverse configurations for demanding workloads and customization. In addition, you can repurpose existing hardware that matches a current validated node solution in the Azure Stack HCI catalog (https://aka.ms/azurestackhcicatalog).

Efficiencies that drive sustainability

Because Azure Stack HCI combines compute, storage, and networking capabilities in a single system, it can help reduce power consumption, space requirements, and cooling costs. These efficiencies can drive sustainability in several ways.

Azure Stack HCI takes advantage of the latest server hardware like 4th Gen Intel Xeon Scalable processors, the latest datacenter processors from Intel. They feature built-in Accelerator Engines that help improve performance per watt for select workloads, making them Intel's most sustainable datacenter processors. They offer an Optimized Power Mode that can save up to 20 percent of power when workloads are not operating at peak, and new telemetry that enables monitoring and control of power consumption. The processors are manufactured with more than 90 percent renewable electricity.[7]

Organizations can achieve a 2.9x average performance-per-watt efficiency improvement for targeted workloads utilizing 4th Gen intel Xeon Scalable processors with built-in accelerators compared with 3rd Gen Intel Xeon Scalable processors.[8] This leads to more efficient CPU utilization, lower electricity consumption, and higher return on investment, while helping businesses achieve their sustainability and carbon reduction goals.

Azure Stack HCI also supports other new energy-efficient hardware technologies, such as solid-state drives (SSDs), which consume less power than traditional spinning disks. These efficiencies further reduce server energy consumption and cooling requirements, which helps optimize efficiency.

Azure Stack HCI efficiencies also extend to workload monitoring and management. Since Azure Stack HCI enables workloads to be managed more efficiently, both the amount of resources required and power consumed decrease. For example, you can use Azure Stack HCI to consolidate multiple workloads onto a single system with less need to keep excess capacity in reserve using Azure Stack HCI automated management and ease of scalability on demand. Streamlining hardware-capacity needs can help reduce the number of servers required and can thereby reduce power consumption, lessening environmental impact.

Powered by Intel technologies

Both integrated systems and validated nodes can take advantage of Intel's broad portfolio across compute, storage, and networking technologies. The Intel Xeon Scalable processor family offers a wide range of processors validated for Azure Stack HCI. This allows organizations to select the best solutions to meet workload requirements. Intel continues to enhance Intel VT-x with each generation of processors, with virtualization improvements in 4th Gen Intel Xeon Scalable processors. These enhancements save memory bandwidth and reduce latency, power, and time operating on data.

The twelve unique accelerators built into 4th Gen Intel Xeon Scalable processors address challenges with the most prevalent workloads in the industry by boosting performance without raising power consumption, freeing-up CPU cores, increasing data throughput, and lowering latency while increasing server utilization.

Azure Stack HCI takes advantage of several of these accelerators to harden security. Other accelerators are passed through to the VM and can be used to accelerate AI workloads and improve compression. For example, Microsoft SQL Server 2022 takes advantage of the built-in accelerator Intel QuickAssist Technology (Intel QAT) to compress data backups. These backups take less time, provide a higher compression ratio to reduce capacity requirements, and free up CPU cores for other workloads running on Azure Stack HCI.

Intel Ethernet 800 Series network adapters work with Intel VT-x to deliver outstanding input/output (I/O) performance in virtualized server environments. I/O bottlenecks are reduced through intelligent offloads, enabling near-native performance and VM scalability. Remote Direct Memory Access (RDMA) works with Azure Stack HCI to streamline and accelerate node-to-node network traffic.

Adding additional value, Intel Accelerated Solutions for Azure Stack HCI streamline the time required to evaluate, select, purchase, and deploy new infrastructure so that you can deploy and execute workloads with confidence. Intel Accelerated Solutions for Azure Stack HCI are workload-optimized, jointly developed with Microsoft, and delivered by server original equipment manufacturers (OEMs) or solution providers. Recommended hardware and software configurations are benchmarked across widely used workloads to deliver high performance, efficient price-performance, and security capabilities.

Hybrid capabilities enabled by Azure Arc with Azure Stack HCI

Azure Arc and Azure Stack HCI help realize the vision for cloud-to-edge computing.

Develop cloud-native applications that you can operate anywhere

Cloud innovation has radically changed the way applications are designed, built, and run. Truly portable applications need:
- Packaged code
- Cloud services
- Container infrastructure
- DevOps practices and tooling to deploy, secure, and operate applications

The future of apps is cloud-native because apps are designed to take full advantage of the latest innovations in the public cloud in the areas of containerization, microservices, and DevOps practices. Cloud-native apps are intelligent and infused with AI to provide advanced insights. Finally, cloud-native apps take advantage of open-source technology and libraries from across the community. (Both Intel and Microsoft are top contributors to open-source projects such as Kubernetes, which underscores their commitment to the open-source community.)

Azure Arc enables you to build and modernize cloud-native apps on any Kubernetes cluster while simultaneously bringing cloud data management to any infrastructure. It also enables you to use consistent GitOps and policy-driven deployment on any Kubernetes cluster. And with Azure Arc, you can integrate Azure security, governance, and monitoring into your DevOps toolkit. Figure 6 illustrates common cloud-native scenarios.
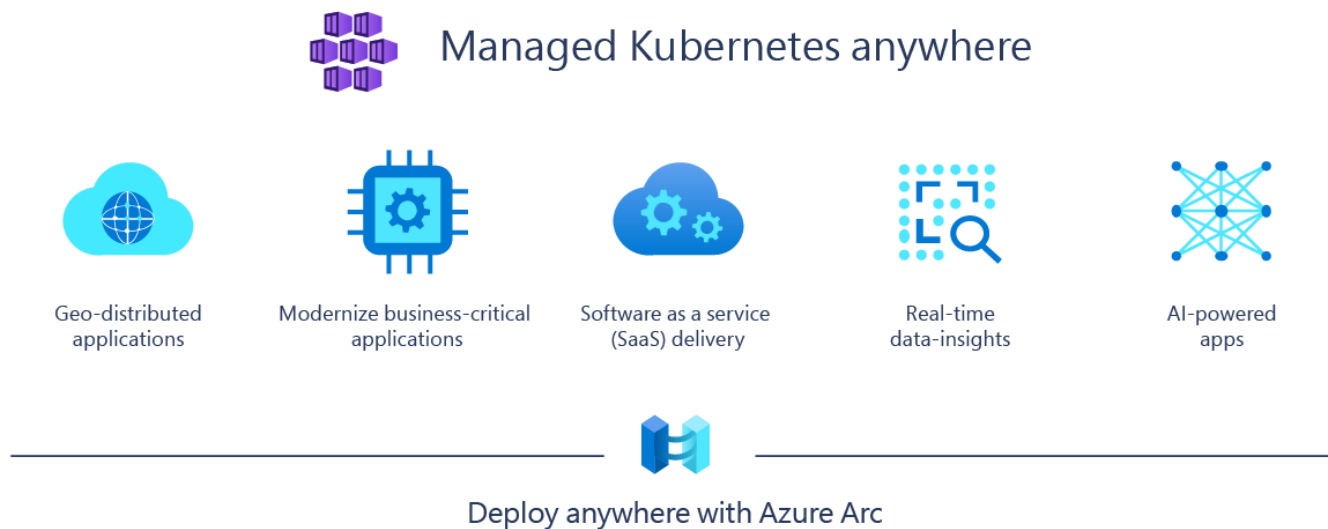

Figure 6. Common scenarios for cloud-native applications

AKS enabled by Azure Arc is an on-premises implementation of the AKS orchestrator. AKS enabled by Azure Arc running on Azure Stack HCI automates running containerized applications at scale, which enables your organization to develop and run cloud-native apps anywhere, from Azure to the edge.

It is important to evaluate the underlying capabilities of your organization's infrastructure and potential Azure instances to ensure that those capabilities will meet your workload requirements in terms of performance and security. A successful digital infrastructure starts with the right hardware. Intel helps enterprises develop a cloud strategy and an operating model that extend from private clouds to multiple public clouds and the edge, and that delivers a consistent hardware infrastructure that enables workloads to be placed wherever it makes the most sense for the business.

Harness data insights from cloud to edge

Organizations like yours should look for opportunities to extend Azure innovation and cloud benefits across the IT estate for many different reasons. Some organizations want to capture operational insights and new scenarios by innovating with legacy applications and data in a hybrid infrastructure. Others want to use AI and machine learning (ML) to accelerate insights and shift from reactive to proactive decision making. And some organizations are generating fresh business and operational insights by implementing IoT solutions that unlock and help make sense of the signals and data from the physical world. For all of those scenarios, Azure Arc is built to help you harness data insights, from cloud to edge.

With Azure Arc, you can accelerate innovation via cloud data and AI capabilities to build next-generation apps and gain fast, continuous insights. You can also get data services anywhere that are scalable, evergreen, and manageable from a single console with Azure Arc–enabled data services such as SQL Managed Instance and PostgreSQL Hyperscale. Moreover, you can improve operational efficiency and reduce IT overhead through cloud automations and consistent management with Azure Arc and Azure Stack HCI. Finally, you can reduce risk exposure through integrated multilayer security and data-governance solutions made possible by Azure Arc, Azure Stack HCI, and integrated Intel hardware-based security architecture (see Figure 7).
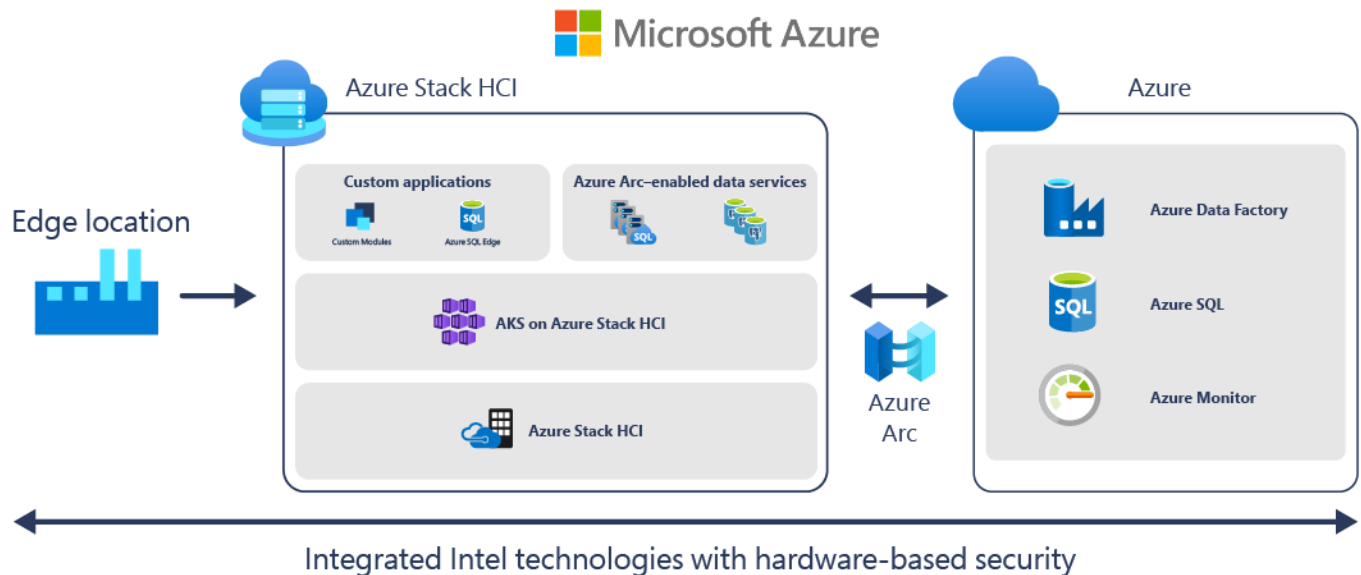

Figure 7. Azure hybrid deployment architecture with Intel hardware–based security

Successfully implementing AI remains challenging for many organizations. Enterprises want to get to real-world scale immediately, with the lowest possible cost and the least possible risk. Intel is helping address this challenge. The two latest generations of Intel Xeon Scalable processors have included a built-in accelerator designed specifically for AI inference, so you can run complex AI workloads on the same hardware as your existing workloads. The latest accelerator, Intel AMX, enables additional levels of precision on AI models, which can help enterprises like yours easily scale AI across different workloads and hybrid environments. AI integrated into the processor can be beneficial in edge environments as well, where there can be constraints on space, power, and cooling.

Secure and govern applications across environments

The more you scale your applications across diverse types of environments, the broader the attack surface and the greater the potential for security risks. As applications become more secure, attackers increasingly target other layers of the infrastructure. Microsoft and Intel see that most organizations keep large parts of their infrastructures on-premises, while also choosing to work across multiple cloud service providers (CSPs) and remote or edge environments. Distributed workforces accessing corporate data also increase the attack surface that organizations must secure. This new hybrid reality comes with its own set of challenges, making it even more important to implement a comprehensive and coordinated security and governance strategy.

Azure Arc enablement in Azure Stack HCI lets you harden your security posture and detect threats in order to protect your workloads. With Azure Arc, you can monitor your infrastructure and applications end to end so that you can proactively detect, diagnose, and resolve issues. Azure Arc also helps you conform to key compliance standards and enforce organizational policies. Intel is focused on delivering the right set of technologies that enable customers to meet compliance and regulatory requirements—and do so in a way that provides flexibility so that, as business needs change, customers have an agile hardware architecture that can help securely move, store, and process workloads.

Azure Stack HCI provides built-in layered security to help you secure your workloads across environments and across all stages of data in use, in transit, and at rest:

- Secure workloads anywhere by bringing Azure security services like Microsoft Defender for Cloud from the cloud to on-premises environments and the edge.
- Simplify operational hardening through confidential computing. Secured-core servers represent a collaboration between Microsoft, Intel, and leading hardware vendors that provides advanced protection and preventive defense for Azure Stack HCI nodes.
- Intel Crypto Acceleration accelerates data encryption, so enterprises can finally employ pervasive encryption without the typical performance penalty.
- Apply security down to the silicon layer with processor-integrated security in Azure Stack HCI. Intel Total Memory Encryption (Intel TME) encrypts data while it's being used in memory, and Intel Total Memory Encryption Multi-Key (Intel TME-MK) isolates VMs even if the hypervisor is compromised. For maximum security in the Azure public cloud, you can run sensitive workloads in Intel Software Guard Extensions (Intel SGX) enclaves.
- Add resources to your environment and protect servers from attacks on firmware during the boot process with a silicon-based root of trust.

Flexibly meet regulatory and connectivity needs

Finally, there are two motivators that drive many hybrid cloud needs: connectivity requirements and regulations. For example, a retailer might need to ensure that its point-of-sale system can operate disconnected so that it can continue to process purchases if internet services are down. Another example would be a hospital that simultaneously needs cloud-powered medical image processing and analysis but also needs to meet data-residency requirements for patients' medical records.

With a broad range of infrastructure and connectivity choices, Azure Arc and Azure Stack HCI can help you meet data residency and sovereignty needs with a robust array of infrastructure options. They also simplify edge computing infrastructure for low-latency applications. A hybrid architecture starts with the underlying technology. Intel's technology portfolio is designed for workload flexibility that enables premium performance where you need it, whether that is at the edge, on-premises, or in the cloud. This is coupled with built-in security capabilities for peace of mind. The result is hardware and software that work together to deliver a powerful foundation for workload performance, in addition to seamless management.

Conclusion

The rapidly evolving IT landscape brings new challenges and big opportunities for organizations like yours. From delivering your products as a service and transforming your data into new products, to meeting sustainability requirements, the hybrid infrastructure made possible by Microsoft and Intel can help your organization meet its business goals.

Azure Arc extends the Azure platform to help you build applications and services with the flexibility to run across datacenters, at the edge, and in multicloud environments. Azure Arc comes in different implementations, from those centered on Microsoft-based infrastructures to those based on VMware and others. Azure Stack HCI—the Microsoft implementation of Azure Arc–enabled infrastructure—reduces complexity and takes advantage of the latest hardware innovations (such as Intel Accelerator Engines, RDMA, and secured-core server), resulting in high-performing solutions that truly meet your company's needs. Moreover, Azure Arc is architected to scale with your organization.

Intel's broad portfolio and integrated accelerators provide flexibility and scalability to tailor your infrastructure to meet your workload requirements while meeting sustainability targets. And Intel Accelerated Solutions for Azure Stack HCI streamline the time to deploy new infrastructure so that you can deploy and execute workloads with confidence.

Azure Stack HCI provides a flexible means to quickly realize the value of Azure throughout your IT estate. With Azure Stack HCI, operational consistency is built-in, which translates into lower OpEx for your organization. Infrastructure consistency—across both hardware and software—enables greater agility for workload placement. Such flexibility can help you meet your strategic IT goals while also running workloads in disparate locations and on optimized hardware.

Learn more

To learn more about how Azure Stack HCI can help your organization do more, visit www.azure.com/hci.

To learn more about 4th Gen Intel Xeon Scalable processors, visit https://www.intel.com/content/www/us/en/products/details/processors/xeon/scalable.html.

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