



Adopting the Microsoft Cloud Operating Model

Framework to strategize, plan,
migrate, and optimize
infrastructure for Microsoft Azure



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Executive summary

The cloud is changing how companies consume technology and how business can be delivered, with drastically reduced time now required to go to market. Many opportunities exist to migrate to the cloud, providing significant cost savings over a traditional datacenter approach and the ability to quickly migrate on-premises workloads—building robust, resilient applications that scale up as traffic spikes and down as it recedes. The cloud also enables innovation, which is key given that the goal of most organizations' strategy is to create competitive differentiation and advantage. Cloud adoption is on the rise, with 87 percent of organizations indicating that they plan to merge their on-premises datacenter with a hybrid cloud or the public cloud, based on a recent survey (2017 IDC Worldwide Public Cloud Services Spending Guide).¹ Worldwide spending on public cloud services and infrastructure is forecast to reach 160 billion USD in 2018, an increase of 23 percent over 2017.²

Microsoft Azure is an ever-expanding set of cloud services to help organizations meet business challenges. It's the freedom to deploy, build, and manage applications on a massive, global network using your favorite tools and frameworks. You can increase efficiency and productivity, while simultaneously reducing IT operating expenses (OpEx) by implementing cloud and hybrid cloud scenarios. Taking advantage of scale and consumption-based billing in Azure, you can leverage services that might otherwise be far beyond your organization's means to implement. Azure also helps establish clear security, compliance, and privacy requirements for your organization, consistently meeting a broad set of international and industry-specific compliance standards and rigorous third-party audits to adhere to strict security controls and mandates. The cloud is envisioned as a means for a company's continuing evolution. Each organization requires a varied approach to adopting the cloud and is at a different stage of cloud adoption. This guide approaches cloud adoption from the perspective of organizational readiness.

¹ http://www.idc.com/getdoc.jsp?containerId=IDC_P33214

² <https://www.idc.com/getdoc.jsp?containerId=prUS43511618>

About this guide

The process of adopting cloud technologies is not linear. In this e-book, we elaborate on the Microsoft Cloud Operating Model—a framework that clearly defines how different cloud adopters can strategize, plan, migrate, and optimize their infrastructure for Azure cloud. In the past few years we have seen the conversation around cloud adoption move from “if” to “when” and “how.” It is, in short, now a fact of life.

This guide is intended for different levels of user roles within the organization, including business decision makers, IT decision makers, solution architects, and IT pros to help them with guidance about end-to-end cloud migration from on-premises.

Customer stages

Cloud computing represents a big shift from the traditional way businesses think about IT resources. Before preparing to migrate, organizations need to assess the stage they are at. This evaluation will help organizations define the right migration pathway for their technology transformation journey.

Cloud adopters

Cloud computing is about bringing technology transformation—encompassing a shift from traditional modes of consuming and administering IT services to the new on-demand model, where IT resources are provided as a service. Organizations are all at different stages of cloud adoption, as shown below.

New to cloud

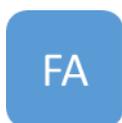
Some organizations are just beginning their cloud journey, still learning about and evaluating the cloud for their business requirements. They are at an early stage that requires exaggerated strategies, planning and defined pathways to the cloud. These organizations have yet to fully realize their ambitions when it comes to the cloud and require end-to-end guidance for cloud adoption.

Multi-cloud adopters

Other organizations are more progressive and have already evaluated multiple cloud platforms—perhaps even successfully moving a few workloads to the cloud. Migrating these workloads to Azure from other clouds can empower your organizations to implement the most reliable and trusted cloud platform. You can also strategize to leverage multi-cloud architecture in order to distribute workloads across many cloud environments to get the biggest bang for your buck—all while mitigating risks associated with individual cloud environments.

Stages of organizational readiness

We have identified three organizational readiness stages to help define your cloud level, including:



Foundational Adopters: Organizations with little to no cloud experience. These organizations are still envisioning cloud and require end-to-end guidance for cloud adoption.



Intermediate Adopters: Organizations with foundational cloud experience. At this stage, organizations have an understanding of cloud technologies, and are either evaluating or have migrated non-priority workloads to the cloud.



Advanced Adopters: Organizations with advanced cloud experience. These organizations are in the process of cloud adoption and want to optimize workloads on the cloud.

Some of the following sections of this e-book are marked with the stages of organizational readiness, so you can easily move to the content that is most relevant to your organization’s readiness stage.

Cloud Operating Model matrix

The matrix below will help you navigate your path to adoption, depending on what level of cloud adoption your organization has achieved.

Cloud Operating Model for Foundational Adopters								
Business			People			Technology		
Flow →								
Opportunities for moving to the cloud			Founding strategic team			Why Azure		
	Business use cases			Translation of roles, guidance, and training			Integrate Azure hybrid cloud consistency	
	Cost management			Skill-readiness paths			Define portfolio	
	Governance, compliance, and risk				Cloud security (CISO guidance)		Migrate to Azure for endless opportunities	
	Cloud security						Cloud security and compliance	
		Data governance					Method to Azure migration	
							Capacity planning and efficiency	
							Begin onboarding	
							Operations	
								Optimization

Cloud Operating Model for Intermediate Adopters								
Business			People			Technology		
Flow →								
Cost management			Founding strategic team			Why Azure		
	Governance, compliance, and risk			Skill-readiness paths			Integrate Azure hybrid cloud consistency	
	Cloud security				Cloud security (CISO guidance)		Define portfolio	
		Data governance					Cloud security and compliance	
							Method to Azure migration	
							Begin onboarding	
							Operations	
								Optimization

Cloud Operating Model for Advanced Adopters								
Business			People			Technology		
Flow →								
Governance, compliance, and risk			Founding strategic team			Integrate Azure hybrid cloud consistency		
	Cloud security			Skill-readiness paths			Cloud security and compliance	
		Data governance			Cloud security (CISO guidance)		Define portfolio	
							Method to Azure migration	
							Begin onboarding	
							Operations	
								Optimization

Why cloud for technology transformation

Technology transformation is about reimagining how you bring together people, data, and processes to create value for your customers and maintain a competitive advantage in a digital-first world—and it is all connected to the cloud. The cloud is the foundational enabler of technology transformation, creating an ecosystem to revolutionize how you operate and compete—and bringing limitless potential to empower your employees and boost customer engagement.

The cloud: What is it?

Simply put, cloud computing is the delivery of computing services—servers, storage, databases, networking, software, analytics, and more—over the internet (“the cloud”). The cloud is not a physical entity, but instead a vast network of remote servers around the globe that are hooked together and meant to operate as a single ecosystem. These servers are designed to either store and manage data, run applications, or deliver content or a service such as streaming videos, web mail, office productivity software, or social media. Instead of accessing files and data from a local or personal computer, you are accessing them online from any internet-capable device—the information will be available anywhere you go and anytime you need it.

Cloud deployment models

Businesses use different models to deploy cloud resources. In the following subsections, we define and examine the three cloud models.

Private cloud

The first set of definitions we’ll discuss is the distinction between “private” and “public” clouds.

The term private cloud is often misused, with some claiming it is the same as a traditional on-premises datacenter. In fact, they are very different. In the traditional on-premises model, IT departments purchase hardware as applications need them, and often this year’s servers will look and behave very differently from last year’s. Moreover, IT departments traditionally maintain a mix of hardware and software, ranging from mainframe to PC server, with a variety of operating systems, databases, and other system software. All this effectively prevents the notion of on-demand computing, which is the essence of the cloud.

In a private cloud, technologies specific to the cloud model are hosted in an on-premises datacenter. This includes a large amount of commodity hardware that runs identical system software and equates to a “cloud” that belongs to you. Private clouds can be useful because they can implement a technology stack that is consistent with the public cloud. This might be necessary in scenarios for which certain applications or data cannot be moved off the premises. However, private clouds are of very limited utility. They do not provide the cost savings and efficiencies that the public cloud can because private clouds require a significant capital expense budget and operations staff, thus remaining on your company’s balance sheet. Moreover, individual companies cannot achieve the economies of scale of a public cloud provider, so their costs are proportionately higher.

Public cloud

The public cloud is defined as computing services offered by third-party providers over the public internet, making it available to anyone for use or purchase. Public cloud is managed and maintained by a large technology vendor who makes computing, storage, and software available on a rental basis. The leading public cloud vendors have datacenters all over the world with literally millions of servers

available for use. Organizations can either take advantage of applications that already exist in the cloud, or they can migrate their own proprietary applications. As we shall see, there are several ways in which applications can physically exist in the cloud but appear to be private to the enterprise corporate network. While security concerns have been raised over public cloud environments, when implemented correctly, the public cloud can be as secure as the most effectively managed private cloud implementation—especially if the provider uses proper security methods, such as intrusion detection and prevention systems (IDPS), encrypted communication, network and infrastructure security, defense against threats, controlled identity, and user access.

Hybrid cloud

A hybrid cloud is a computing environment that combines public and private cloud by allowing data and applications to be shared between them. Often, an enterprise will want to keep some of its applications on-premises while moving others to the public cloud. Or, when computing and processing demand fluctuates, hybrid cloud computing gives businesses the ability to seamlessly scale their on-premises infrastructure up to the public cloud to handle any overflow—without giving third-party datacenters access to the entirety of their data. Organizations gain the flexibility and computing power of the public cloud for basic and non-sensitive computing tasks, while keeping business-critical applications and data on-premises, safely behind a company firewall.

To securely connect the two environments, multiple solutions exist. You can set up a virtual private network (VPN), which makes cloud applications appear to be on the same internal network as the enterprise. You can set up VPNs on a per-application basis or, with a hardware device, for the entire corporate ecosystem. Alternatively, enterprises can purchase through their telecom provider a dedicated line linking the corporate datacenter with the cloud, and bandwidth can be purchased as needed. This solution is preferable when it is desired to keep all traffic off the public internet, or when substantially higher bandwidth is required. However, it of course entails additional cost.

Defining your path to cloud adoption

In the new world of technology transformation, technology has become a source of competitive differentiation. An organization's IT is now the primary means of meeting the needs of businesses, consumers, and public service organizations, while evolving from a supporting role to an integral component of core business areas. Cloud adoption is an agile and scalable way to gain a competitive edge.

Cloud operating model

Cloud offers nearly unlimited flexibility in terms of design choices. Enterprises seek a proven and consistent methodology for the adoption of cloud technologies, which requires careful planning and strategy. One of the keys to cloud success is determining the optimal platform and priorities for running business applications. For successful cloud adoption, it's important to have a strong plan in place that covers the end-cloud environment, training, and, most importantly, the readiness of your workloads and applications. To do this, you need to determine how to successfully create business justification and initial technical plans. The goal is to ensure that your workloads will run as expected and perform the migration with limited impact to your business.

Each organization has different goals and timelines for cloud adoption, making a one-size-fits-all approach to adoption nearly impossible. To help our customers, partners, and field prepare for

transition to the cloud, Microsoft has defined a three-step “Cloud Operating Model” that centralizes and consolidates strategies to build an operating model for onboarding customers into the cloud.



Business strategy

The transformation to cloud computing is an exciting opportunity for any organization, but it’s not something to jump into blindly. There are business issues, financial issues, and a broad range of technology issues to face first. Choosing the right cloud solution typically involves going through a steep learning curve in which many company stakeholders are directly involved. Organizations are developing “cloud-first” strategies that meet the vision of everything running in the cloud and take advantage of cloud-enabled cost savings as well as agile development. Depending on business requirements, a few workloads might not be moved to the cloud, which means the organization can plan for hybrid cloud to get the best of both worlds.

Building business strategy for cloud adoption revolves around various aspects in which you need to analyze opportunities for cloud movement, financials, turnaround time, global reach, performance, and many more.

Opportunities for moving to the cloud

For many organizations, cloud technology is still very new. To leverage the cloud, they first need to understand what it means for them and their business. In many cases, the old ways of thinking are still in play. But those outdated methodologies don’t enable business success in a cloud-first world. Cloud computing is a big shift from the traditional way that businesses think about IT resources. What is it about cloud computing? Why is cloud computing so popular? Here are six common reasons why organizations are turning to cloud computing services:

Cost

Cloud computing eliminates the capital expense of buying hardware and software, and then setting up and running on-site datacenters—the racks of servers, round-the-clock electricity for power and cooling, and IT experts for managing the infrastructure. It adds up fast.

Azure provides the most flexible purchase and pricing options for its cloud services. Azure is the only platform that offers an end-to-end cloud cost management and optimization solution to help customers make the most of cloud investment with tools like Azure Total Cost of Ownership (TCO) calculator, [pricing calculator](#), and [cost management](#).

Speed

Most cloud computing services are provided as self-service and on demand, so even vast amounts of computing resources can be provisioned in minutes—typically with just a few mouse clicks—giving businesses flexibility and taking the pressure off capacity planning.

Azure Cloud Services eliminates the need to manage server infrastructure and helps you build, deploy, and manage modern applications. It allows you to quickly deploy infrastructure and services to meet all your business needs. You can run Windows- and Linux-based applications in 50 Azure datacenter regions, delivered with enterprise-grade service-level agreements (SLAs).

Global scale

One benefit of cloud computing services is the ability to scale elastically. In cloud speak, that means delivering the right amount of IT resources—for example, more or less computing power, storage, and bandwidth—right when it's needed and from the right geographic location.

Extend the global reach of your organization to tap into emerging markets while providing the best, most consistent user experience. With Azure you can build, deploy, and manage modern apps at scale with a globally distributed database—without the hassles associated with hosting in your datacenter. You can deploy your apps globally for the best app experience for your users based on five well-defined consistency models:

- **Strong:** Favors data consistency. Ideal for banks, e-commerce processing, and online booking.
- **Bounded staleness:** Delivers accurate data in a reasonable timeframe, in chronological order. Works best with GPS data collecting and shipping apps.
- **Session:** Provides logical and real-time data to assist profile updates, music apps, and retail.
- **Consistent prefix:** Serves a sequential order of data to the user. Example scenarios include sports updates and social media comments.
- **Eventual:** Emphasizes availability over write order. Great for product reviews, wall posts, and receipt retrieval.

Productivity

On-site datacenters typically require a lot of “racking and stacking,” including hardware setup, software patching, and other time-consuming IT management chores. Cloud computing removes the need for many of these tasks, so IT teams can spend time achieving more important business goals.

Quickly turn ideas into solutions to get up and running fast—just bring your code. Build applications with the language of your choice, including Node.js, Java, and .NET. Work with best-in-class development tools for PC or Mac, such as Visual Studio and Visual Studio Code, to increase your productivity with features that let you focus on what matters most: writing great code. Get mobile apps into the hands of users faster by streamlining the mobile development lifecycle with Visual Studio App Center, including automated builds and testing for cross-platform, hybrid, and native apps on iOS and Android.

Performance

The biggest cloud computing services run on a worldwide network of secure datacenters, which are regularly upgraded to the latest generation of fast and efficient computing hardware. This offers several benefits over a single corporate datacenter, such as reduced network latency for applications and greater economies of scale.

Transform your business and reduce costs with an energy-efficient infrastructure spanning more than 100 highly secure facilities worldwide, linked by one of the largest networks on earth. Azure has more

global regions than any other cloud provider—offering the scale needed to bring applications closer to users around the world, preserving data residency and providing comprehensive compliance and resiliency options for customers.

Reliability

Cloud computing makes data backup, disaster recovery, and business continuity easier and less expensive since data can be mirrored at multiple redundant sites on the cloud provider's network.

One of IT's most essential functions is to ensure that corporate data is never lost and that applications stay available—despite server crashes, power outages, or natural disasters. Keep your data safe and recoverable by backing it up to Azure. Azure Backup is a simple solution that decreases your infrastructure costs while giving you enhanced security mechanisms to protect your data against ransomware. With one solution, you can protect workloads running in Azure and on-premises across Linux, Windows, VMware, and Hyper-V. Ensure business continuity by keeping your applications running in Azure. Azure Site Recovery makes it simple for you to test disaster recovery by replicating applications between Azure regions. You can also replicate on-premises VMware and Hyper-V virtual machines and physical servers to Azure to stay available if the primary site goes down. Recover workloads to the primary site when it's up and running again.

Azure case studies

Let's look at case studies in which customers benefitted by migrating their application or underlying infrastructure to Azure.

Aurora Health Care

Healthcare system transforms online services into a friendly digital experience

To transform its digital services, Aurora Health Care migrated its websites to the Microsoft Azure platform and adopted a strategy of continuous innovation.

"As a team, we're focused on high-quality solutions and speed. Choosing Azure was a very transformative decision for us."

Jamey Shiels: Vice President Digital Experience,
Aurora Health Care

[Read more about this story](#)

ExakTime

Labor management breaks free of on-premises constraints with cloud technology

With Microsoft Azure, ExakTime is moving toward streamlined agile product development, while the company's clients enjoy a more robust and easy-to-use product, full of new features.

"Now, a developer can sit down at his machine, have an idea, spin up a web service or an Azure instance, test out his idea, point it at test data, and get the concept going. In the time that it would have taken to provision just the stuff to do a test, we can actually write the functionality."

Wayne Wise: Vice President of Software Development
ExakTime

[Read more about this story](#)

Coverdell

Coverdell modernizes their infrastructure to drive record cost savings with Azure

Coverdell's decision to invest in Azure, and to unite their network of websites, applications, data, and infrastructure within this environment, led to more cost savings than the company could have ever expected. The migration to an Azure-only environment eliminated 54,000 USD in monthly costs for colocation services. With the company's new, united infrastructure alone, Coverdell expects to save an estimated 1 million USD over the next 2–3 years.

"Having access to the Azure technology stack opens the door for some scalable, easy-to-implement, and highly available solutions that are cost effective. This allows our architects to be much more creative with the solutions they provide."

Ryan Sorensen: Director of Application Development and Enterprise Architecture

Coverdell

[Read more about this story](#)

Cost management

Cloud computing represents a big shift—its business strategy is conceptual and doesn't become real until the numbers get plugged in. Several years ago, it was common to invest more financial resources into the datacenter to add more servers, networking equipment, and storage to ensure uptime and security. Today, this approach is no longer operationally or financially feasible. Financial planning for cloud adoption requires organizations to decide on whether to expand on-premises capabilities or move certain workloads and functions off-premises to cloud-delivered services.

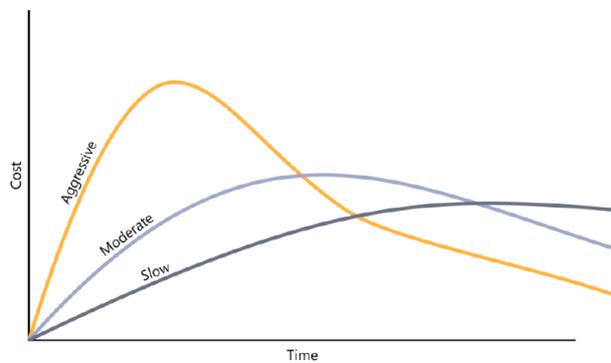
It is imperative to involve your Chief Financial Officer (CFO) and your enterprise's finance department in developing your cloud migration plan. You will need to work with them to develop cost models that compare IT operations both on-premises (in the datacenter) and in the cloud. You'll also need to build models showing how the purchase and procurement of new hardware draws down over time. You might even build models showing when and how datacenters can close.

Develop some key measurements to quantify the savings more particularly. For example, one measurement Microsoft used is called cost per operating system instance (cost/OSI). This was used to include both applications and operating systems running on bare-metal servers as well as those running in VMs as a single metric. Cost/OSI includes hardware, licensing, facilities, network, operations staff, and, in general, all the costs of running an operating system and its applications in an on-premises datacenter. You can segment systems if this is useful, such as the concept of "T-shirt sizing" with a metric for small, medium, large, and extra-large deployments.

With this metric, you now can compare the cost of running a system on-premises and in the cloud. Of course, the parameters for cost/OSI in the cloud are different and include size of the application, number of cores required, amount of storage, and estimated network traffic. And, unlike the on-premises case, servers in the cloud can be spun down when they're not needed or not used, and thus charges can be reduced or even eliminated. You should determine your cost/OSI currently as a baseline. Then, you can forecast costs for various operations in the cloud. Most cloud service providers, including Azure, provide cost-estimation tools to help you determine what your cost/OSI will be under various configurations and requirements.

You need to work with your finance department to develop several scenarios for your cloud migration, including aggressive, moderate, and slow migration plans, as shown in the figure below. An aggressive

plan might involve moving 50 percent of your workloads to the cloud in the first year, whereas a moderate plan might be 30 percent, and a slower plan might be 10 percent. Aggressive plans will potentially save you more, but this must be weighed against greater risk and higher migration costs.



The journey to the cloud is about more than just cost savings. View the enterprise's data as a valuable asset that can be made to have greater value based on what you can do with it. Add significant value by using and analyzing new types of data to discover insights on your products, customers, and processes. Experiment frequently to determine how to maximize the impact from these insights. In turn, these actions will increase control and reduce risk for a company's operation—which CFOs care about deeply. The more you can quantify the increased value of data as well as cost savings stemming from a move to the cloud, the easier it will be to get more of the highest-level decision makers to support the move.

Azure pricing tools help you manage your cloud spend with transparency and accuracy to make the most of Azure and other clouds. By giving you the tools to monitor, allocate, and optimize your cloud costs, you can accelerate future investment with confidence:

[Total Cost of Ownership \(TCO\) Calculator](#): Lower the total cost of ownership of your on-premises infrastructure with the Azure cloud platform. Use the Azure TCO calculator to estimate the cost savings you can realize by migrating your application workloads to Azure. Simply provide a brief description of your on-premises environment to get an instant report.

[Pricing calculator](#): Estimate your expected monthly bill using our pricing calculator to track your actual account usage and bill at any time using the billing portal. Set up automatic email billing alerts to be notified if your spend goes above an amount you configure.

[Cost management](#): Azure Cost Management, licensed by Microsoft subsidiary Cloudyn, is a multi-cloud cost management solution that helps you best utilize and manage Azure and other cloud resources. Collect cloud usage and billing data through application program interfaces (APIs) from Azure, Amazon Web Services (AWS), and Google Cloud Platform. With that data, gain full visibility into resource consumption and costs across cloud platforms in a single, unified view. Continuously monitor cloud consumption and cost trends. Track actual cloud spend against your budget to avoid overspending. Detect spending anomalies and usage inefficiencies. Plus, use historical data to improve your forecasting accuracy for cloud usage and expenditures.

[Achieve more at the best prices with Azure](#)

Microsoft is committed to delivering the best customer value on Azure, with a [long-standing commitment](#) to make prices on commodity services like compute, storage, and bandwidth comparable to other cloud providers. This means you get even more value from Azure. In addition to

delivering great prices, further discounting and more flexible purchasing programs help support your journey to the cloud:

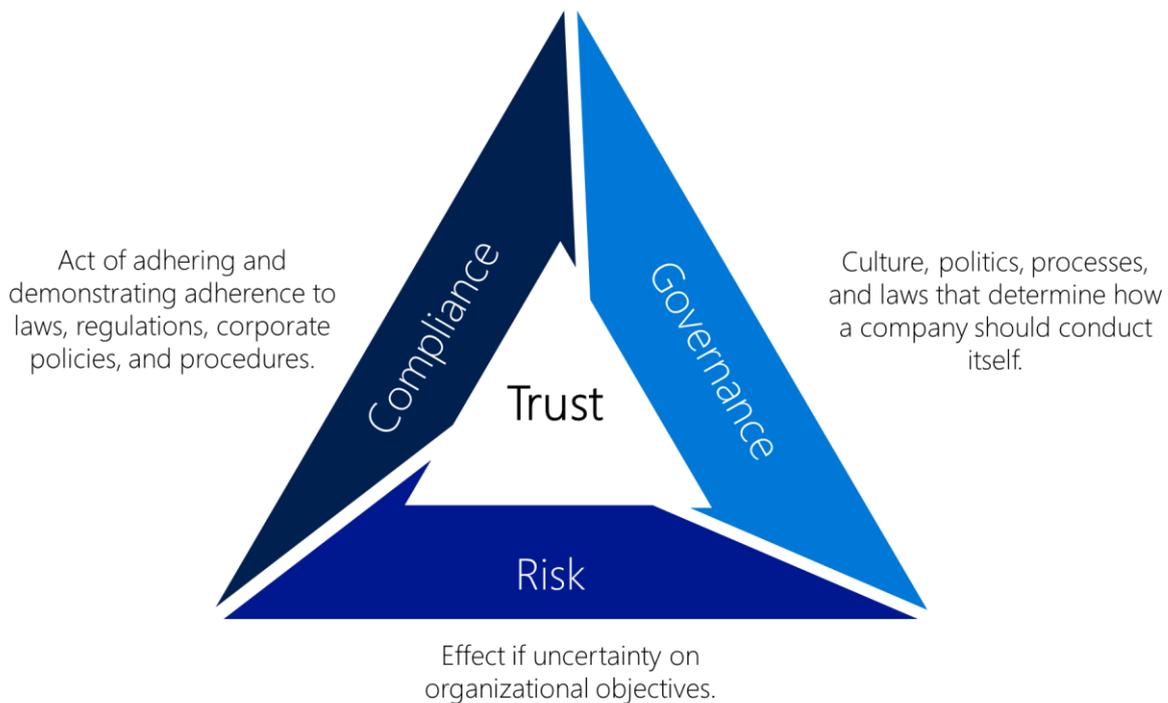
- If you're moving a significant number of workloads to the cloud and looking for great pricing with flexibility, check out the Azure Compute option. With this program, you can run any compute instance in Azure and realize discounts up to 60 percent in exchange for add-ons to your Windows Server annuity licenses.
- For developers, Microsoft provides the [Azure Free Account](#) that provides a \$200 credit to spend for the first 30 days and access to the most popular Azure services for free for 12 months. In addition, 25 products are always free.
- [Azure Hybrid Benefit for Windows Server](#) allows you to use your on-premises Windows Server licenses and run Windows virtual machines on Azure at a reduced cost. Use your on-premises Windows Server licenses with Software Assurance to save up to 49 percent on Azure. Alongside Azure Hybrid Benefit, you can [reserve virtual machines](#) in advance and enjoy cost savings of up to 80 percent on pay-as-you-go prices.

Significantly reduce costs—up to 72 percent compared to pay-as-you-go prices—with one-year or three-year terms on Windows. Azure allows you to use on-premises Windows Server licenses with Software Assurance to save big. With this benefit, for each license Microsoft covers the cost of the operating system (on up to two virtual machines!), while you pay only for base compute costs. Azure Hybrid User Benefit Calculator also helps estimate savings when using the Azure Hybrid Benefit for Windows Server licenses that include Software Assurance.

With all of the above cost calculations, organizations can save up to 49 percent on Windows Server virtual machines with the Azure Hybrid Benefit for Windows Server. Combined with the estimated cost savings from Azure Reserved Virtual Machine Instances (RIs) and the added value of the Azure Hybrid Benefit, now they are saving up to an estimated 80 percent.

Governance, compliance, and risk

Organizations have been managing governance, compliance, and risk management since the dawn of business. Every organization has a unique approach to the aspects of governance, risk management, and compliance, from the ad hoc and disorganized to the mature and aligned.



Governance, risk management, and compliance (GRC) are three facets that help to ensure that an organization meets its objectives, as detailed below:

- Governance is the combination of processes established and executed by the directors (or the board of directors) that are used to achieve goals
- Risk management is predicting, understanding, and managing risks that could otherwise hinder or prevent the organization from achieving its objectives
- Compliance refers to adhering to policies and procedures as well as laws and regulations

GRC is a discipline that aims to synchronize information and activity across governance, risk management, and compliance to operate more efficiently, facilitate effective information sharing, more effectively report activities, and avoid wasteful overlap.

The goals, therefore, of any GRC program must include the following:

- Keep risk at acceptable levels
- Maintain availability to systems and services
- Comply with relevant laws and regulation
- Protect customer data

In general, GRC is not normally a “net-new” function for the cloud; rather, it extends existing activities. GRC professionals should therefore fully understand the implications that the cloud has for their areas and extend existing practices.

Ensuring regulatory compliance

Managing regulatory compliance can be a complex task, and for multinational organizations—particularly those in heavily regulated industries such as healthcare and financial services—it can be even more challenging. Standards and regulations abound and, of course, they change frequently, making it difficult for businesses to keep abreast of all the international electronic data handling laws.

As with security controls, businesses should understand the division of responsibilities regarding regulatory compliance in the cloud. Cloud providers make an effort to ensure that their platforms and

services are compliant, but companies also need to confirm that their applications, or those supplied by third parties, are compliant.

Similarly, applications in regulated industries that use cloud services might require certification from the cloud provider. For example, a healthcare application that processes protected health information (PHI) is subject to both the Privacy Rule and the Security Rule encompassed within the Health Information Portability and Accountability Act (HIPAA). This situation would require that a healthcare business receive written assurances from the cloud provider that it will safeguard any PHI received or created.

Another important regulation is the Payment Card Industry Data Security Standard (PCI DSS), a proprietary information security standard for organizations that handle branded credit cards from the major card schemes including Visa, MasterCard, American Express, Discover, and JCB. The PCI standard is mandated by the card brands and administered by the Payment Card Industry Security Standards Council. The standard was created to increase controls around cardholder data to reduce credit-card fraud. Validation of compliance is performed annually, either by an external Qualified Security Assessor (QSA) or by a firm-specific Internal Security Assessor (ISA) who creates a Report on Compliance (ROC) for organizations handling large volumes of transactions, or by a Self-Assessment Questionnaire (SAQ) for companies.

Global	<input checked="" type="checkbox"/> CSA STAR Attestation <input checked="" type="checkbox"/> CSA STAR Certification <input checked="" type="checkbox"/> CSA STAR Self-Assessment	<input checked="" type="checkbox"/> ISO 22301 <input checked="" type="checkbox"/> ISO 27001 <input checked="" type="checkbox"/> ISO 27017	<input checked="" type="checkbox"/> ISO 27018 <input checked="" type="checkbox"/> SOC 1 Type 2 <input checked="" type="checkbox"/> SOC 2 Type 2
U.S. Government	<input checked="" type="checkbox"/> CJIS <input checked="" type="checkbox"/> DoD DISA SRG Level 2 <input checked="" type="checkbox"/> DoD DISA SRG Level 4 <input checked="" type="checkbox"/> DoD DISA SRG Level 5	<input checked="" type="checkbox"/> FedRAMP <input checked="" type="checkbox"/> FIPS 140-2 <input checked="" type="checkbox"/> High JAB P-ATO <input checked="" type="checkbox"/> IRS 1075	<input checked="" type="checkbox"/> ITAR <input checked="" type="checkbox"/> Moderate JAB P-ATO <input checked="" type="checkbox"/> Section 508 VPAT <input checked="" type="checkbox"/> SP 800-171
Industry	<input checked="" type="checkbox"/> CDSA <input checked="" type="checkbox"/> FACT UK <input checked="" type="checkbox"/> FERPA <input checked="" type="checkbox"/> FFIEC	<input checked="" type="checkbox"/> FISC Japan <input checked="" type="checkbox"/> GLBA <input checked="" type="checkbox"/> GxP 21 CFR Part 11 <input checked="" type="checkbox"/> HIPAA/HITECH <input checked="" type="checkbox"/> HITRUST	<input checked="" type="checkbox"/> IG Toolkit UK <input checked="" type="checkbox"/> MARS-E <input checked="" type="checkbox"/> MPAA <input checked="" type="checkbox"/> PCI DSS Level 1 <input checked="" type="checkbox"/> Shared Assessments
Regional	<input checked="" type="checkbox"/> Argentina PDPA <input checked="" type="checkbox"/> Australia IRAP/CCSL <input checked="" type="checkbox"/> Canada Privacy Laws <input checked="" type="checkbox"/> China DJCP <input checked="" type="checkbox"/> China GB 18030 <input checked="" type="checkbox"/> China TRUCS	<input checked="" type="checkbox"/> ENISA IAF <input checked="" type="checkbox"/> EU Model Clauses <input checked="" type="checkbox"/> EU-US Privacy Shield <input checked="" type="checkbox"/> Germany IT Grundschutz <input checked="" type="checkbox"/> India MeitY <input checked="" type="checkbox"/> Japan CS Mark Gold	<input checked="" type="checkbox"/> Japan My Number Act <input checked="" type="checkbox"/> New Zealand GCIO <input checked="" type="checkbox"/> Singapore MTCS <input checked="" type="checkbox"/> Spain DPA <input checked="" type="checkbox"/> Spain ENS <input checked="" type="checkbox"/> UK G-Cloud

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Many emerging laws, particularly those dealing with privacy and individual personally identifiable information (PII), require that businesses themselves comply and report on compliance and any breaches that might occur.

One of the most important developments in this area is the recent enactment by the European Commission of the General Data Protection Regulation (GDPR), designed to strengthen data protection for individuals within the European Union. The GDPR requires that data about individuals, such as “a name, a home address, a photo, an email address, bank details, posts on social networking websites, medical information, or a computer’s IP address,” be maintained on servers within the EU and not transferred out of it. It also requires that companies notify individuals of any data breaches, and mandates that companies have a Data Protection Officer. Other countries have, or are developing, similar types of regulations.

To help customers meet their own compliance obligations across regulated industries and markets worldwide, Azure maintains the largest compliance portfolio in the industry—both in terms of breadth

(total number of offerings), as well as depth (number of customer-facing services in assessment scope). Azure compliance offerings are grouped into four segments: globally applicable, US government, industry specific, and region/country specific.

Azure compliance offerings are based on various types of assurances, including formal certifications, attestations, validations, authorizations, and assessments produced by independent third-party auditing firms, as well as contractual amendments, self-assessments, and customer guidance documents produced by Microsoft. Each offering description in this document provides an up-to-date scope statement indicating which Azure customer-facing services are in scope for the assessment, as well as links to downloadable resources to assist customers with their own compliance obligations.

More detailed information about Azure compliance offerings is available from the [Trust Center](#). Moreover, all downloadable documentation is available to Azure customers under a nondisclosure agreement from the [Service Trust Portal](#) in the following sections:

- [Audit reports](#): Includes FedRAMP, GRC assessment, ISO, PCI DSS, and SOC reports sections
- [Data protection resources](#): Includes compliance guides, FAQ and white papers, and pen test and security assessments sections

 [How to use this guide](#)

Cloud security

Many customers indicate that cloud security is one of their top concerns. Every IT executive we talk to admits to a bit of initial discomfort when thinking about moving their IT ecosystems to the cloud. After all, when all applications and data reside in the on-premises datacenter, enterprise IT is in control. Azure helps provide a highly secure foundation, built from the ground up, to host your infrastructure, applications, and data. With an understanding of the importance of protecting customer data, the Azure focus is on helping secure the datacenters that contain your data. Microsoft has invested over a billion dollars in security, including the physical security of the Azure platform, so you can devote your time and resources to other business initiatives.

Azure platform services support the same technologies that millions of developers and IT professionals already rely on and trust. When you build on, or migrate IT assets to, a public cloud service provider, you are relying on that organization's abilities to protect your applications and data—the services and controls they provide help manage the security of your cloud-based assets. Extensive security capabilities built into the Azure platform, combined with the security tools and intelligence provided by Microsoft, help improve your organization's security posture.

Secure foundation

Maintaining infrastructure security requires you to make substantial investments and resources without clear ROI. Azure delivers state-of-the-art security, from physical datacenters to cloud infrastructure and operations, to reduce your infrastructure security cost and help safeguard your data in the cloud.

Physical datacenter security

Physical security refers to how Microsoft designs, builds, and operates datacenters in a way that strictly controls physical access to the areas where customer data is stored. Microsoft has devoted an entire division to designing, building, and operating the physical facilities that support Azure. This team is invested in maintaining state-of-the-art physical security, including:

- Operating datacenters that are protected by industry-leading security systems
- Including extensive layers of protection to help reduce the risk of unauthorized physical access to data and datacenter resources

- Ensuring that datacenters are certified to comply with the most comprehensive portfolio of internationally recognized standards and [certifications](#) of any cloud service provider

Cloud infrastructure security

One of the primary benefits of cloud computing is the concept of a shared, common infrastructure across numerous customers simultaneously, leading to economies of scale. This concept is called multi-tenancy. Microsoft works continuously to ensure that the multi-tenant architecture of Azure supports security, confidentiality, privacy, integrity, and availability standards. Azure is a multi-tenant cloud that:

- Segregates customer data, resources, and networks, with platform-level protections against threats like distributed denial of service (DDoS)
- Provides custom-built hardware with integrated security, attestation, secure boot, and continuous firmware pen testing
- Actively scans for vulnerabilities and remediates them quickly with Microsoft cybersecurity experts who practice war-game exercises and perform live-site penetration testing to Operational Security

Microsoft also provides multilayered security across physical datacenters, infrastructure, and operations in Azure. State-of-the-art security is delivered in Azure datacenters globally, with a cloud built on customized hardware, security controls integrated into hardware and firmware components, and added protections against threats such as a distributed denial of service (DDoS) attack. Additional benefits include:

- More than 3,500 global security experts across the Microsoft Cyber Defense Operations Center, Digital Crimes Unit, and other teams working together to protect the Azure infrastructure
- You control your data and access to it in Azure: any operational help from Microsoft requires your explicit approval with least-privileged access provided to complete the task
- 24/7 operation to detect and respond to any potential threats with quick notification through the security incident management team

Data governance

To ensure compliance with regulations and standards, a data governance function is essential. Since long before the cloud, data governance in IT has been a critical function. Creating and ensuring adherence to common data models, providing extensibility where needed, managing changes, ensuring regular and controlled taxonomy updates, specifying use of master and reference data, implementing data classification, and instituting formal processes around data retention and destruction: all of these activities have been included in the IT governance function for decades.

For your part, you need to know what data your applications are keeping in the cloud and know the laws of your country or region regarding data sovereignty and cross-border data movement. Potential measures you might want to implement include the following:

- Not placing any individual or customer data in the cloud
- Encrypting key PII, such as email addresses or physical addresses, prior to moving data to the cloud
- Disabling geo-replication to other geographies

Security and privacy are built right into the Azure platform, which helps you protect business and personal information by enabling you to manage user identities, credentials, and control access. Azure uses industry-standard protocols to encrypt data in transit, which means your data is secured as it travels between devices and Microsoft datacenters, as it moves within datacenters, and when it is at rest in Azure Storage. Azure data privacy and governance includes:

- Protecting data in transit and at rest, such as encryption for data, files, applications, services, communications, and drives
- Supporting and using numerous encryption mechanisms, including SSL/TLS, IPsec, and AES
- Providing configuration support for BitLocker Drive Encryption on virtual hard disks (VHDs) that contain sensitive information
- Ensuring that access to data by Azure support personnel requires your explicit permission and is granted on a “just-in-time” basis that is logged and audited, and then revoked after completing the engagement

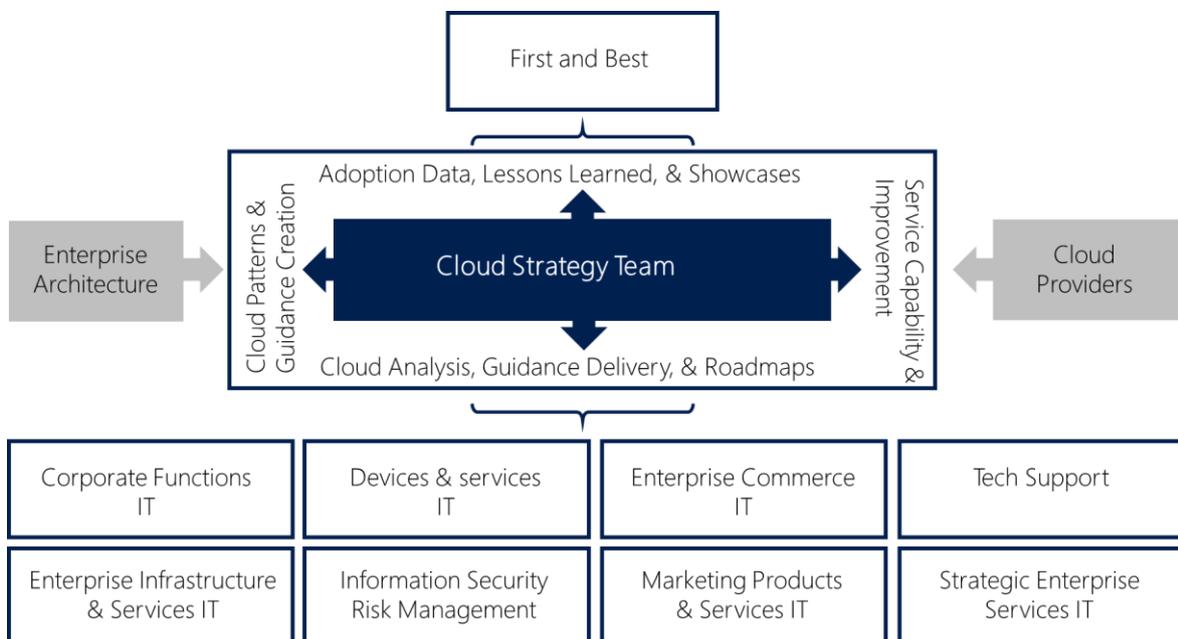
People strategy

Cloud adoption is a strategic change that requires involvement from both business decision makers and end users. People strategy is one of the important aspects of cloud adoption.

Founding strategic team

A migration journey to the cloud is a strategic decision, one that requires engaging senior members of IT and, indeed, business leaders from around the organization, to understand all aspects of the cloud and which of the many options and approaches to take. You can begin the journey with the creation of a Cloud Strategy Team (CST) consisting of business leaders, finance, IT infrastructure, and application groups. These teams can help with the cloud analysis and experimentation phase.

For instance, a Cloud Strategy Team could be driven by the CTO and consist of members of the enterprise architecture team, IT finance, senior technologists from various IT applications groups (HR, finance, and so on), and leaders from the infrastructure, security, and networking teams. The figure below shows one example of a Cloud Strategy Team.



The Cloud Strategy Team must be chartered to lead the cloud analysis and experimentation phase. To start cloud adoption analysis, the team would be responsible for reviewing business requirements and capabilities that would be required to identify possible use cases for cloud adoption. In addition, the team should be responsible either for building or facilitating building the architectures, patterns, and guidance for deployment of the re-envisioned applications or services. It should also manage

communications with key stakeholders and promote the program's success and learnings. One of the key driving functions in creating this team is to promote long-term commitment to the cloud journey. It establishes a practice for continuously evaluating and experimenting to help determine the appropriate platform and destination for each application—namely, what is moved to the most appropriate platform, such as the following questions:

- If moved to the cloud, should it be left as a simple VM for infrastructure as a service (IaaS) or redesigned for platform as a service (PaaS)?
- Could a preexisting software-as-a-service (SaaS) model replace it, saving costs?
- Or should it remain on-premises?

Among its first tasks, CST members can spend time educating themselves, ensuring that all participants are on a "level playing field." For better or worse, cloud technology comes with its own set of acronyms, so learning to speak a common language early accelerates future conversations. The team can also spend time familiarizing itself with the offerings from platform, tools, and cloud application providers.

When the team begins to draft out the strategy, members should understand that not all services or applications end up in the public cloud, for various reasons—and therefore, it is to be based on the notion of a hybrid cloud. This means that, at least for some period, certain applications remain on-premises—and for cloud transition, co-existence is required.

Translation of roles, guidance, and training

For IT staff to function as change agents supporting current and emerging cloud technologies, their buy-in for the use and integration of these technologies is needed. For this, staff require three things:

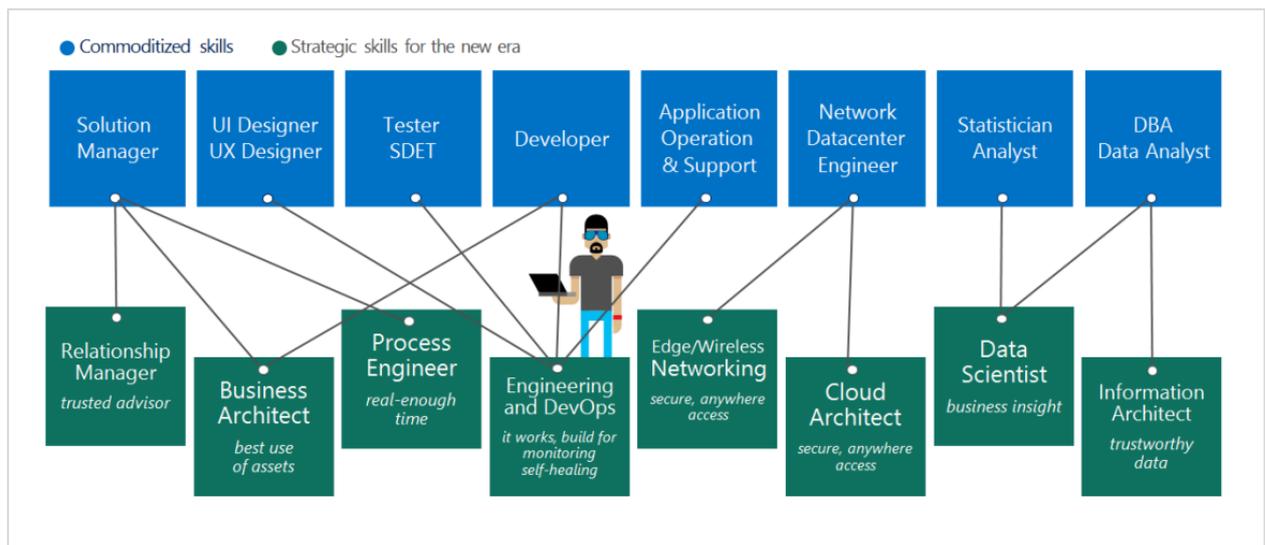
- An understanding of their roles and of any changes to their current position
- Time and resources to explore the technologies
- An understanding of the business case for the technologies

At each evolutionary phase during the history of the IT industry, the most notable industry changes are often marked by changes in staff roles. During the transition from mainframes to the client/server model, the role of the computer operator largely disappeared, replaced by the system administrator. When the age of virtualization arrived, the requirement for individuals working with physical servers diminished, replaced with a need for virtualization specialists. Similarly, as institutions shift to cloud computing, roles will likely change again. For example, datacenter specialists might be replaced with cloud financial analysts. Even in cases where IT job titles have not changed, the daily work roles have evolved significantly.

Skills readiness path

IT staff members may feel anxious about their roles and positions as they realize that a different set of skills is needed for the support of cloud solutions. But agile employees who explore and learn new cloud technologies don't need to have that fear. They can lead the adoption of cloud services and help the organization understand and embrace the associated changes.

Typical mappings of cloud IT roles include:



Microsoft and partners offer a variety of options for all audiences to develop their skills with Microsoft Azure services.

- [Microsoft Virtual Academy](#): Offers training from the people who helped build Microsoft Azure. From a basic overview to deep technical training, IT staff will learn how to leverage Microsoft Azure for their business.
- [Microsoft IT Pro Cloud Essentials](#): Provides a free annual subscription that includes cloud services, education, and support benefits. IT Pro Cloud Essentials provides IT implementers with hands-on experience, targeted educational opportunities, and access to experts in areas that matter most to increase knowledge and create a path to career advancement.
- [Microsoft IT Pro Career Center](#): Serves as a free online resource to help map your cloud career path. Learn what industry experts suggest for your cloud role and the skills to get you there. Follow a learning curriculum at your own pace to build the skills you need most to stay relevant.

We recommend turning knowledge of Microsoft Azure into official recognition with [Microsoft Azure certification training and exams](#).

Security (CISO guidelines)

Security was considered a major concern for some time, and even a showstopper, for public cloud migration. However, public cloud security has transitioned from a major concern to one of the drivers for cloud migration. The rationale behind this is the superior ability of large public cloud service providers to protect applications and the data of cloud-based assets.

We know that security is job one in the cloud, and how important it is that you find accurate and timely information about Azure security. One of the best reasons to use Azure for your applications and services is to take advantage of its wide array of security tools and capabilities. These tools and capabilities help make it possible to create secure solutions on the secure Azure platform. Security features implemented to secure the Azure platform provide the assurance that the platform is managed in a secure manner.

An organization's security professional, such as the Chief Information Security Officer (CISO), can further drill-down on how Microsoft addresses security, privacy, and compliance questions, which are addressed in four areas: Secure Platform, Privacy & Controls, Compliance, and Transparency.

Secure Platform	Privacy & Controls	Compliance	Transparency
Security Development Cycle , internal audits	Manage your data all the time	Trust Center	How Microsoft secures customer data in Azure services
Mandatory security training, background checks	Control on data location	Common Controls Hub	How Microsoft manages data location in Azure services
Penetration testing, intrusion detection, DDoS, audits & logging	Provide data access on your terms	The Cloud Services Due Diligence Checklist	Who in Microsoft can access your data on what terms
State-of-the-art datacenter , physical security, secure network	Responding to law enforcement	Compliance by service, location, and industry	How Microsoft secures customer data in Azure services
Security incident response, shared responsibility	Stringent privacy standards		Review certification for Azure services, transparency hub

Technology strategy

Your apps portfolio may include applications that your organization built, which are deployed over time and still used for core business functions. The cloud provides a comprehensive set of services with the flexibility and security to deploy, build, and manage applications through a global network of datacenters. Some applications are ready to modernize; some may require minor changes in code; and still others may need a complete redesign to make them cloud-ready. Choosing the right migration approach for different applications in your portfolio can help you extract maximum value from cloud-enabled and innovative technologies.

Why Azure?

Organizations all over the world recognize Azure as the most trusted cloud platform over other cloud providers, with truly consistent hybrid cloud that's a core part of strategy for most organizations. Don't get boxed in by a cloud service provider who is missing important parts of the hybrid solution. Hybrid cloud is all about the platform that connects your datacenter to the cloud, with common tools and technologies that bridge what you know today with where you are going. Microsoft has a deep stack of hybrid services based on trusted technologies that delivers what you need at every layer—compute, network, storage, management, identify, and data. Stay ahead with Azure by developing breakthrough apps with a comprehensive set of Azure cloud services, infrastructure, and tools.

Try the cloud you can trust

When you compare Azure cloud offerings with other cloud providers, you will find that Azure has more comprehensive compliance coverage. With more than 70 compliance offerings, Azure was the first major cloud provider to contractually commit to GDPR requirements. To protect your organization, Azure embeds security, privacy, and compliance into its development methodology and has been recognized as the most trusted cloud for US government institutions, earning a Federal Risk

and Authorization Management Program (FedRAMP) “High” status that covers 38 Azure services. In addition, Azure IP Advantage provides best-in-industry intellectual property protection, so you can focus on innovation instead of worrying about baseless lawsuits.

Maintain real hybrid consistency

On-premises datacenters have an important role to play, both today and in the future. For many organizations, integrating these two to create a hybrid cloud is essential. Microsoft understands this reality. To help you achieve it, we offer a broad range of cloud and on-premises technologies that work together in a coherent way. And unlike our competitors, we provide the flexibility to let you choose the path that’s right for you. We’re committed to providing a consistent hybrid cloud that supports the approach you pick.

Optimize your existing assets by taking a hybrid approach to the cloud. Azure offers hybrid consistency everywhere—in application development, security and management, identity management, and across the data platform. Consistency helps reduce the risk and cost of a hybrid cloud environment by enabling a common set of skills and offering portability of applications and workloads. Plus, save up to 40 percent when migrating Windows Server virtual machines to Azure using the Azure Hybrid Benefit.

Achieve global scale with 50 announced Azure regions—more than any other cloud provider. Our priority on geographic expansion means that you can choose the datacenter and region that works for you and your customers, with the performance and support you need, where you need it.

Build faster to be more productive

Rely on the only cloud provider recognized in the industry as having leading solutions in IaaS, SaaS, and PaaS—in fact, according to a Forrester Total Economic Impact study, you will be more productive and increase your ROI with Azure PaaS services. Turn your ideas into solutions faster with more than 100 services, end-to-end management experiences, and app delivery with agile development practices.

Use any development tool or language

Develop and build the way you want in Azure, with your choice of tools, applications, and frameworks, like Jenkins and Chef. As a leading open-source contributor on GitHub, Microsoft actively supports multiple open-source community projects—such as Kubernetes, Fluentd, and Helm—and has a unique partnership with Red Hat to offer coordinated, multilingual support across multiple products.

Innovate with unmatched intelligence

Build intelligent solutions at scale using cognitive APIs, bots, machine learning, and blockchain-as-a-service (BaaS) capabilities that you will only find with Azure. By pairing these capabilities with powerful GPU-based compute, you will accelerate deep learning, enable high-performance computing simulations, and conduct real-time data analytics using Nvidia GPUs in Azure.

Manage and optimize cloud spend

Optimize your cloud resources, manage departmental budgets, and allocate costs with free Azure Cost Management. Drive accountability through cost allocation and chargeback reports. Maximize resource utilization by right-sizing virtual machines and visualizing the cost-benefits of various purchasing options that Azure offers.

One Azure ecosystem

Based on working with customers and a wide partner ecosystem, Azure has a proven approach for your hybrid or cloud-based migration to reduce risk and contribute to a smooth transition. You can speed up Azure Stack initiatives by leveraging the rich Azure ecosystem:

- Azure ensures that most applications and services that are certified for Azure will work on Azure Stack. Several ISVs—including Bitnami, Docker, Kemp Technologies, Pivotal Cloud Foundry, Red Hat Enterprise Linux, and SUSE Linux—are extending their solutions to Azure Stack.
- You can opt to have Azure Stack delivered and operated as a fully managed service. Several partners—including Tieto, Yourhosting, Revera, Pulsant, and NTT—will have managed service offerings across Azure and Azure Stack shortly. These partners have been delivering managed services for Azure via the Cloud Solution Provider (Cloud Providers) program and are now extending their offerings to include hybrid solutions.
- As an example of a complete, fully managed hybrid cloud solution, Avanade is delivering an all-in-one offer that includes cloud transformation services, software, infrastructure, setup and configuration, and ongoing managed services so customers can consume Azure Stack just as they do with Azure today.
- Systems Integrators (SI) can help accelerate application modernization initiatives by building end-to-end Azure solutions for customers. They bring in-depth Azure skill sets, domain and industry knowledge, and process expertise (e.g., DevOps). Every Azure Stack cloud is an opportunity for an SI to design the solution, lead and influence system deployment, customize the included capabilities, and deliver operational activities. This includes SIs like Avanade, DXC, Dell EMC Services, InFront Consulting Group, HPE Pointnext, and PricewaterhouseCoopers (PwC).

Integrate Azure hybrid cloud consistency

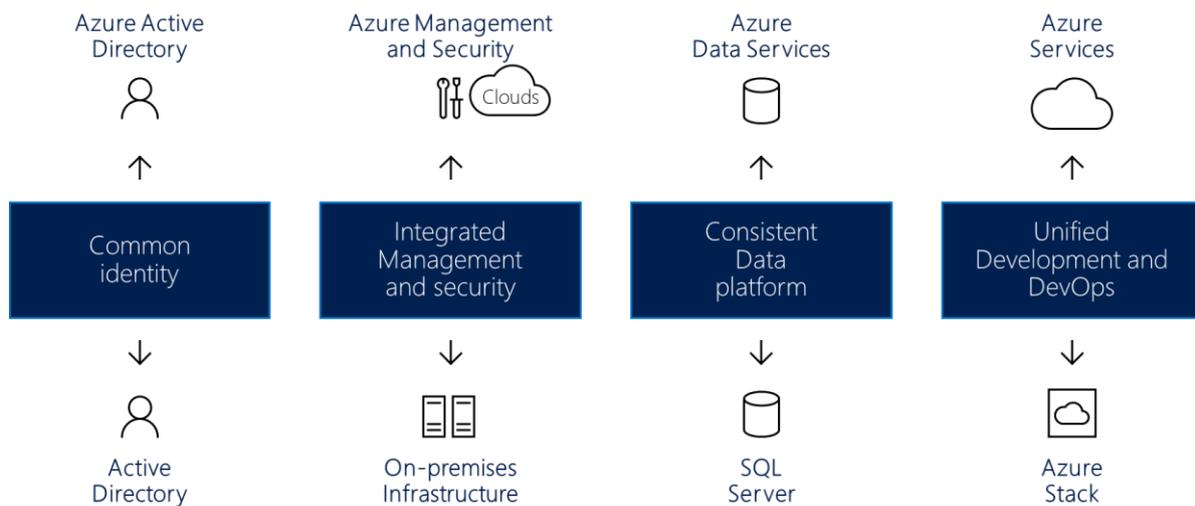
Cloud platforms offer the greatest level of flexibility when it comes to business processes, but many organizations are hesitant to make the move, preferring instead to keep full control over their most sensitive data. The problem is, on-premises servers simply don't allow for the same rate of innovation as technologies evolve. What if you could have your on-premises solution and your cloud solution, too? You absolutely can. The possibilities with a hybrid cloud model are limitless.

Using a hybrid cloud not only allows organizations to scale computing resources, it also eliminates the need to make massive capital expenditures to handle short-term spikes in demand as well as when the business needs to free up local resources for more sensitive data or applications. Organizations pay only for resources they temporarily use instead of having to purchase programs and maintain additional resources and equipment that could remain idle over long periods of time. Hybrid cloud computing is a “best of all possible worlds” platform, delivering all the benefits of cloud computing—flexibility, scalability, and cost efficiencies—with the lowest possible risk of data exposure.

Microsoft believes that a true hybrid cloud must provide four components, each of which brings significant benefits, including:

- Common identity for on-premises and cloud applications. This improves user productivity by giving your users single sign-on to all their applications.
- Integrated management and security across your hybrid cloud. This enables a cohesive way to monitor, manage, and help secure your environment, giving you increased visibility and control.
- A consistent data platform for your datacenter and the cloud. This gives you data portability, combined with seamless access to on-premises and cloud data services for deep insight into your data.

- Unified development and DevOps across the cloud and your on-premises datacenters. This lets you move applications between the two environments as needed, and it also improves developer productivity, since both places now have the same development environment.



As the figure shows, Microsoft offers hybrid cloud technologies that address all four areas. Examples of these include:

- Azure Active Directory works with your on-premises Active Directory to provide common identity for your users. Single sign-on across on-premises and in the cloud makes it simple for users to safely access the applications and assets they need. Administrators can manage security and governance controls, so users can access what they need—with flexibility to adjust those permissions without affecting the user experience.
- Azure provides integrated management and security services for both cloud and on-premises infrastructure that include an integrated set of tools for monitoring, configuring, and protecting your hybrid cloud. This end-to-end approach to management specifically addresses four real-world challenges facing organizations considering a hybrid cloud solution.
- Azure hybrid cloud provides common tools that ensure you can leverage all your data, seamlessly and efficiently. Azure data services combine with Microsoft SQL Server to create a consistent data platform. A consistent hybrid cloud model allows users to work with both operational and analytical data and provides the same services on-premises and in the cloud for data warehousing, data analysis, and data visualization.
- Microsoft Azure services in the cloud, combined with Microsoft Azure Stack on-premises, provide unified development and DevOps. Consistency across the cloud and on-premises means that your DevOps team can build applications that run in either environment and easily deploy to the right location. Templates can be reused across the hybrid cloud as well, which can further simplify DevOps processes.

Microsoft Azure Stack is a hybrid cloud solution that allows organizations to run Azure-consistent services in their datacenter, providing a simplified development, management, and security experience that is consistent with Azure public cloud services. Azure Stack is an extension of Azure, enabling you to run Azure services from your on-premises environments and then move to the Azure cloud if and when required.

Azure Stack allows you to deploy and operate both IaaS and PaaS using the same tools and offering the same experience as the Azure public cloud. Management of Azure Stack, whether through the web UI portal or through PowerShell, has a consistent look and feel for IT administrators and end users with Azure.

Azure and Azure Stack unlock new hybrid use cases for both customer-facing and internal line-of-business applications, including:

- **Edge and disconnected solutions** – Customers can address latency and connectivity requirements by processing data locally in Azure Stack and then aggregating in Azure for further analytics, with common application logic across both. Many customers are interested in this edge scenario across different contexts, including factory floors, cruise ships, and mine shafts.
- **Cloud applications that meet varied regulations** – Customers can develop and deploy applications in Azure, with full flexibility to deploy on-premises on Azure Stack to meet regulatory or policy requirements, with no code changes needed. Illustrative application examples include global audit, financial reporting, foreign exchange trading, online gaming, and expense reporting. Customers are sometimes looking to deploy different instances of the same application to Azure or Azure Stack, based on business and technical requirements. While Azure meets most requirements, Azure Stack complements the deployment approach where needed.
- **Cloud application model on-premises** – Customers can use Azure web services, containers, serverless, and microservice architectures to update and extend existing applications or build new ones. You can use consistent DevOps processes across Azure in the cloud and Azure Stack on-premises. We're seeing broad interest in application modernization, including for core mission-critical applications.

Azure Stack is offered in two deployment options, to meet your needs:

- **Azure Stack integrated systems** – Azure Stack integrated systems are offered through a partnership of Microsoft and [hardware partners](#), creating a solution that provides cloud-paced innovation balanced with simplicity in management. Because Azure Stack is offered as an integrated system of hardware and software, you are offered the right amount of flexibility and control, while still adopting innovation from the cloud. Azure Stack integrated systems range in size from 4–12 nodes and are jointly supported by the hardware partner and Microsoft. Use Azure Stack integrated systems to enable new scenarios for your production workloads.
- **Azure Stack Development Kit** – Microsoft Azure Stack Development Kit is a single-node deployment of Azure Stack, which you can use to evaluate and learn about Azure Stack. You can also use the kit as a developer environment, where you can develop tooling that are consistent with Azure. Azure Stack Development Kit is not intended to be used as a production environment.

[How to use this guide](#)

Define portfolio

How exactly do we prioritize the migration of applications to the cloud? To understand which applications you should move, when, and how, it's important to create a well-attributed catalog of applications managed by IT. Then, the relative importance of each attribute (say, business criticality or amount of system integration) can be weighted and you can build the prioritized list.

There might be many attributes, ranging from document classification types to server counts to protocols, and so forth. It is often useful to roll these up into management sets of overall attributes. As the figure below depicts, the top-level criteria include performance, architecture, financial, risk, operations, and security and compliance.

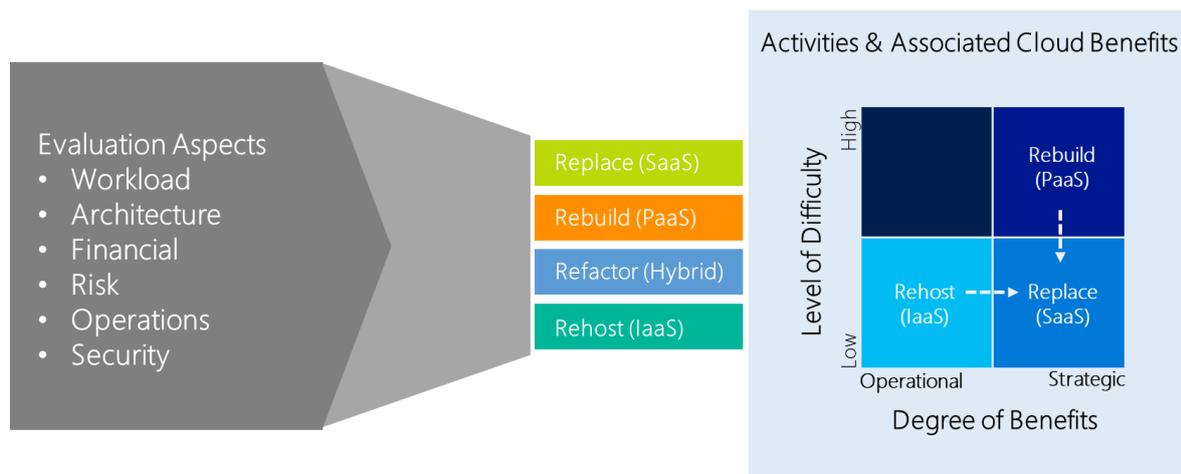
Many enterprises already have a portfolio management system in which such a list is maintained, and usually this can be used or extended for cloud purposes. Others might need to use an ad hoc tool such as a spreadsheet. Either can be effective.

It can be useful to think about application characteristics, or attributes, from two perspectives: the business (“top-down”) and technical (“bottom-up”) models. This is because the data comes from different constituencies. The top-down approach asks where each application or workload should go; the bottom-up approach describes where each can go. The sections that follow explain each, along with the attributes they capture.

Top-down portfolio analysis

So far, we have discussed the migration process as a systematic approach, examining objective and subjective metadata to determine where applications or workloads should go. This is a top-down assessment method, which provides a strategic approach, driven by planning and your detailed analysis and modernization needs.

The architecture below demonstrates how the top-down assessment first evaluates the security aspects previously mentioned, such as the categorization of data (high, medium, or low business impact), compliance, sovereignty, and security risk requirements. Then, it assesses the current complexity interface, authentication, data structure, latency requirements, and coupling and application life expectancy of the architecture. Next, top-down assessment measures the operational requirements of the application, such as service levels, integration, maintenance windows, monitoring, and insight, among others. When all of these aspects have been analyzed and taken into consideration, the result is a score that reflects the relative difficulty to migrate this application to each of the cloud platforms— IaaS, PaaS, and SaaS.



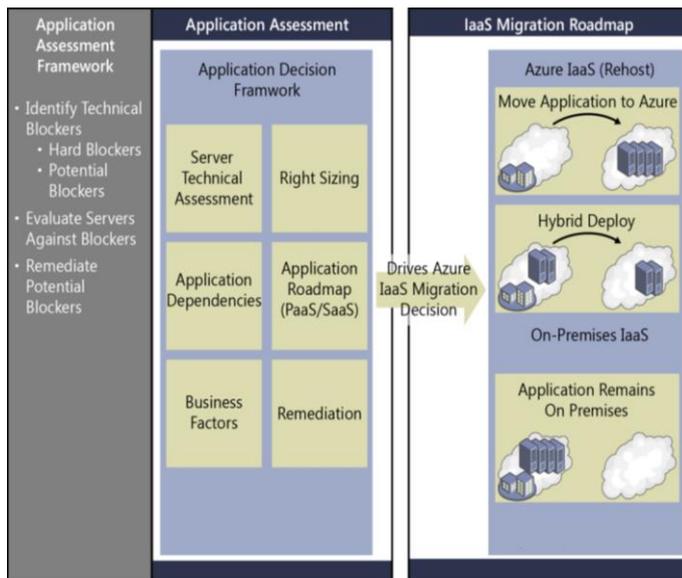
Second, the top-down assessment evaluates the financial benefits of the application, such as operational efficiencies, TCO, return on investment, or any other appropriate financial metrics. In addition, the assessment also examines the seasonality of the application (are there times of the year when demand spikes) and overall compute load. Also, it looks at the types of users it supports (casual/expert, always/occasionally logged on, etc.), and consequently the required scalability and elasticity. Finally, the assessment concludes by examining business continuity and resiliency requirements that the application might have, as well as dependencies to run the application if a disruption of service should occur.

Bottom-up portfolio analysis

There is a complementary approach that is more tactical, technical, and focused on requirements. As we mentioned, the top-down approach analyzes where an application should go; here we are asking where a particular workload can go, based on its purely technical requirements. The bottom-up approach occurs simultaneously with your top-down planning and is aimed at providing a view into

the eligibility, at a technical level, of an application to migrate. We typically can pull much of this information from a Configuration Management Database (CMDB). Enterprises use this method to provide additional insight to the top-down approach.

The type of requirements evaluated by the bottom-up assessment cover the application or service required: maximum memory, maximum number of processors (CPU cores), maximum operating system storage space, maximum data drives, network interface cards (NICs), IPv6, network load balancing, clustering, version of the operating system, version of the database (if required), domains supported, and third-party components or software packages, among others.



Each day, it seems, cloud platforms are becoming more and more capable of handling different application profiles. Servers equipped with 16 and 32 cores have become commonplace, and massive amounts of memory and storage are available. Still, you might find applications that for one technical reason or another you cannot move at this time, or that require waiting until cloud capabilities are further extended.

As part of the bottom-up planning, catalog the technical aspects of your applications, including their operating system type, version, number of processors required, memory required, storage space and number of drives needed, and so on. Knowing the size of an application’s database and its data types will help inform a decision as to whether to use, for example, a cloud-centric relational database such as Azure SQL Database, SQL Server, or Oracle in a VM, or perhaps even a NoSQL database.

Your existing integration systems will be affected by cloud migrations, at least temporarily, so you should spend time documenting the potential impact on these systems. You will need a clear understanding of which applications connect to which, if there is an order of precedence for integration operations, how much data is moved and how frequently, and what the architecture of your Extract, Transform, and Load (ETL) tools is. The complexity of your integration operations should be an important factor in prioritizing cloud migration goals.

Moreover, many cloud vendors now implement options for business continuity and disaster recovery, including failover to alternate datacenters, redundant data storage, and online backup. Understand their offerings and capabilities, and how they map to the needs of your applications.

Migrate to Azure for endless opportunities

Cloud migration path

Before selecting the cloud approach that is right for your organization, it is important to understand key concepts and models. Most important of all is the notion that computing is provided as a service, meaning that the cloud enables a set of capabilities that can be rented, used for a period of time, added on to as more are needed, and dispensed with when no longer needed. You pay for what you use and no more.

As every application is unique, there's no single set of steps to follow for modernization. Some applications are ready to modernize; some may require minor changes in code; and still others may need a complete redesign to make them cloud-ready. Choosing the right migration approach for different applications in your portfolio can help you extract maximum value from cloud-enabled and innovative technologies.

Rehost

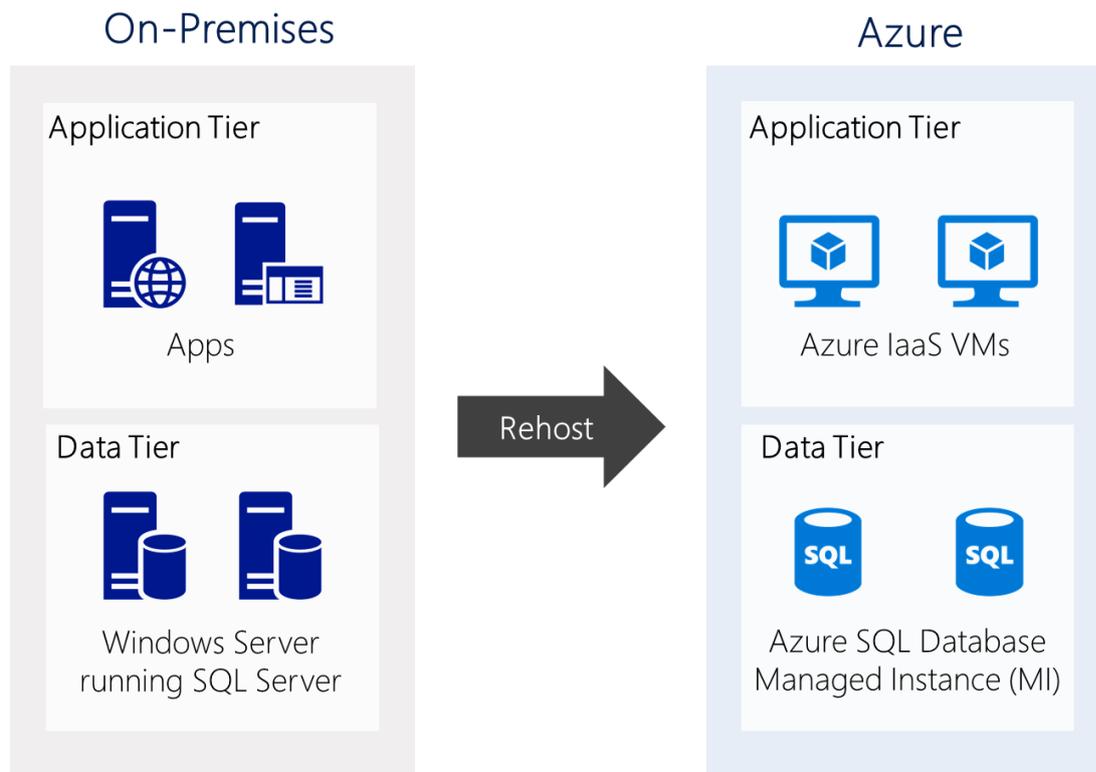
Rehosting your legacy application by migrating to the cloud can help to overcome on-premises challenges like application downtime due to hardware failure, isolated management of IT infrastructure, expensive and time-intensive procurement processes, inefficient disaster recovery, and inconsistent archiving. Rehosting can be considered a first step toward cloud adoption and is the fastest way to migrate because it doesn't require any code changes to your app. Moving to the cloud enables better scalability, reliability, and security of the underlying application infrastructure; it also significantly reduces capital investments and overall operational cost.

When to use

- You need to move applications from your datacenter to the cloud quickly
- Your apps are architected to leverage Azure IaaS scalability
- Your business requires the applications but doesn't need to change capabilities right away
- Your applications or database requirements can only be met using an Azure IaaS VM
- You need to move the application with no code changes

Often referred to as a "lift-and-shift" migration. This option doesn't require code changes, and lets you migrate your existing apps to Azure quickly. Each app is migrated as is to reap the benefits of the cloud without the risk and cost associated with code changes.

Rehost sample scenario



Refactor

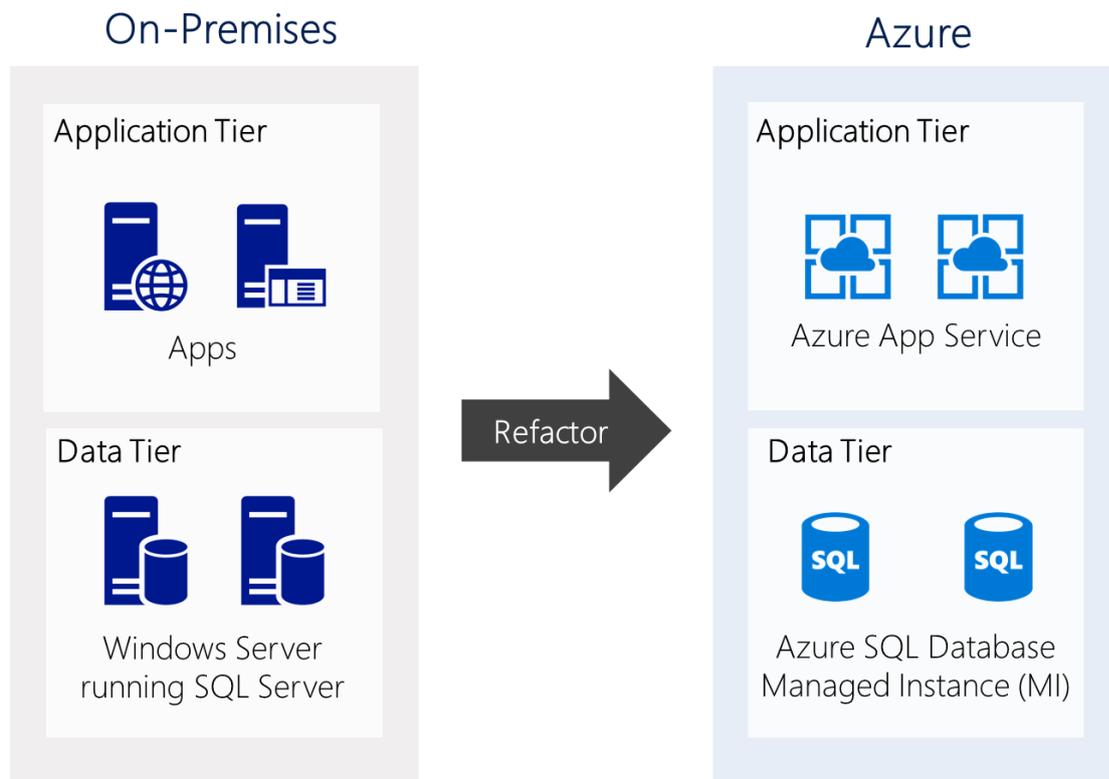
Transforming your legacy application by modernizing your application deployment architecture lets you retain your existing application code and business logic. With this approach, you can add cloud-enabled and innovation capabilities to your application with minimal code changes to leverage the benefits of cloud PaaS services. For example, you can move your existing apps to App Service (PaaS) or Azure Kubernetes Service (AKS). You can also refactor your SQL database into Azure SQL Database Managed Instance.

When to use

- You need to use an existing code base and development skills, and code portability is a concern
- Your application can be easily repackaged to work in Azure
- You want to apply innovative DevOps practices provided by Azure
- Your IT team is investing in DevOps using a container strategy for certain workloads

Often referred to as “repackaging,” refactoring requires minimal changes to apps so that they can connect to [Azure PaaS](#) and use cloud offerings. For example, you could migrate existing apps to Azure App Service or Azure Kubernetes Service (AKS). Or, you could refactor relational and non-relational databases into options such as Azure SQL Database Managed Instance, Azure Database for MySQL, Azure Database for PostgreSQL, and Azure Cosmos DB.

Refactor sample scenario



Rearchitect

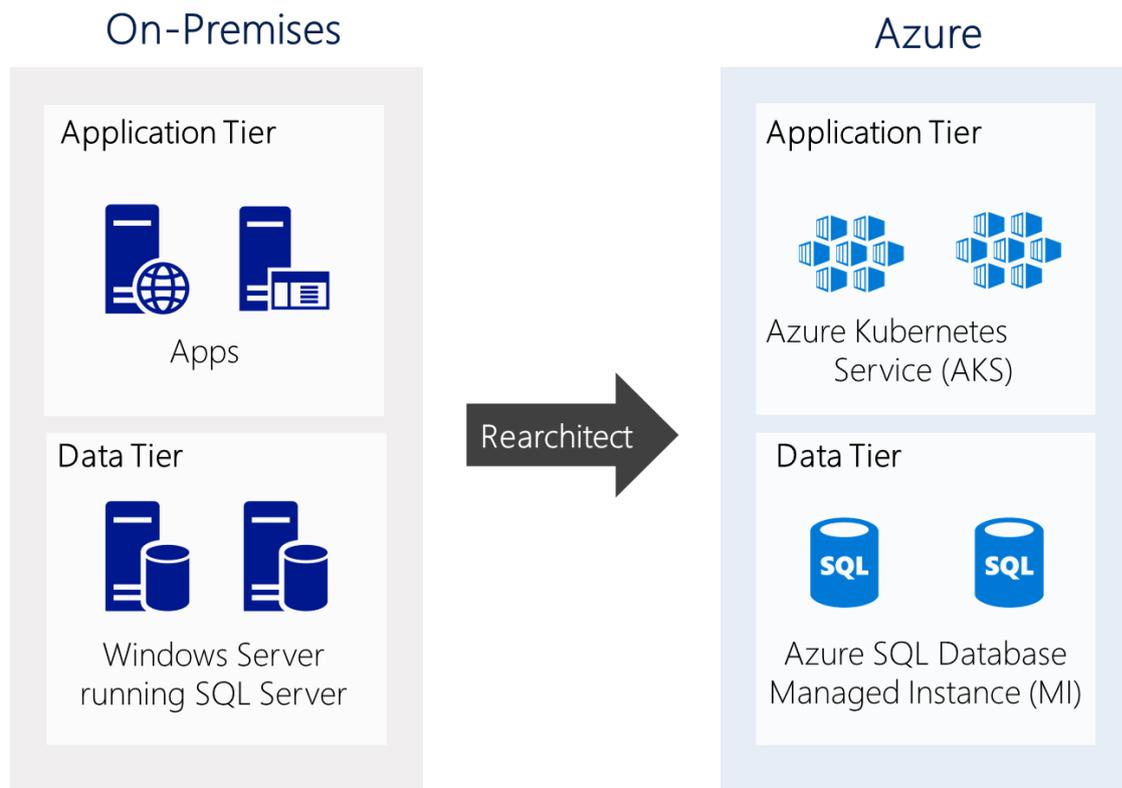
Rearchitecting is to modify or extend the existing application's code base to optimize it for cloud platform and better scalability. Rearchitecting is a good time to break apart a monolithic application into a set of loosely coupled modules or functions that integrate to build a complete app. With this approach, you can group different application functionalities into modules that can then be scaled up or down and tested, deployed, and managed independently. If any code breaks, only that module or function is affected; the rest of the application remains available. And when a module or function no longer meets current business requirements, you can swap it out for a better option.

When to use

- Your application needs a major revision to incorporate new capabilities or to work more effectively on a cloud platform
- You want to make use of existing application investments
- You want to meet scalability requirements in a cost-effective way
- You want to minimize use of virtual machines
- You want to apply innovative DevOps practices provided by Azure

Rearchitecting for migration is about modifying and extending app functionality and code base to optimize app architecture for cloud scalability. For example, you could break down a monolithic application into a group of microservices that work together and scale easily. Or, you could rearchitect relational and non-relational databases to fully managed database-as-a-service (DBaaS) solutions, such as Azure SQL Database Managed Instance, Azure Database for MySQL, Azure Database for PostgreSQL, and Azure Cosmos DB.

Rearchitect sample scenario



Rebuild

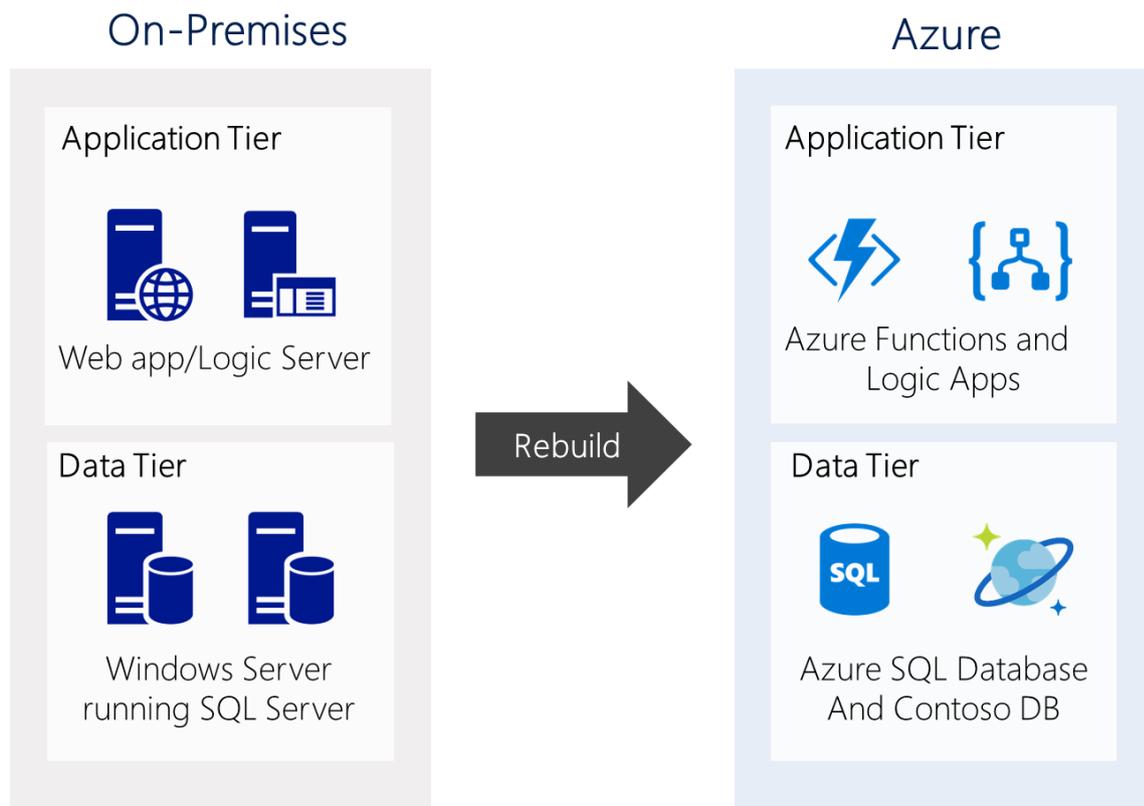
When building greenfield applications in this Rebuild phase, consider cloud native technologies to leverage the high productivity with PaaS along with rapid application development. Internet of Things (IoT) and Blockchain are great examples of born-in-the cloud applications.

When to use

- You want rapid development, and the existing application is limiting in terms of functionality and lifespan
- You're ready to build new applications using cloud-native technologies
- You want to build innovative apps taking advantage of advancements in AI, blockchain, and IoT
- You want to expedite your business innovation
- You want to apply innovative DevOps practices provided by Azure

Rebuild takes things a step further by rebuilding an app from scratch using Azure cloud technologies. For example, you could build green field applications with cloud-native technologies like serverless, Azure AI, Azure SQL Database Managed Instance, and Azure Cosmos DB.

Rebuild sample scenario



Cloud security and compliance

Security is integrated into every aspect of Azure—offering unique security advantages derived from global security intelligence, sophisticated customer-facing controls, and a secure, hardened infrastructure. This powerful combination helps protect your applications and data, support your compliance efforts, and provide cost-effective security for organizations of all sizes.

Built-in security controls

It's hard to maintain a strong security posture when security controls are not intuitive and need to be configured separately. Azure includes built-in security controls across a breadth of services that help you protect data and workloads quickly and manage risk across hybrid environments. Integrated partner solutions let you easily transition existing protections to the cloud.

Identity-based access controls

Identity is becoming the new boundary layer for security, taking over that role from the traditional network-centric perspective. Network perimeters have become increasingly porous, and that perimeter defense cannot be as effective as it was before the explosion of bring your own device (BYOD) and cloud applications. Azure identity management and access control enable seamless, secure access to all your apps. Use an identity and access management solution you can trust, with integration across cloud and on-premises directories, including:

- Authorized access to resources with role-based access, multi-factor authentication, and single sign-on
- Quick mitigation of user identities suspected of compromise
- Just-in-time, just-enough access granted on a task-by-task basis to limit exposure of over-privileged admin credentials
- Extended user identity and access to policies across multiple environments through Azure Active Directory

Controlled network access

Network control includes the configuration, management, and securing of network elements such as virtual networking, load balancing, DNS, and gateways. The controls provide a means for services to communicate and interoperate. Azure includes a robust and secure networking infrastructure to support your application and service connectivity requirements. Network connectivity is possible between resources located in Azure, between on-premises and Azure hosted resources, and to and from the internet and Azure. Network control also offers the following features:

- Users can establish secure connections to and within Azure using virtual networks, network security groups, VPN, and ExpressRoute
- Firewall and anti-malware protects hosts from malicious network traffic
- Services like Web Application Firewall and Azure DDoS Protection safeguard and ensure app availability

Safeguards for your virtual machines running in a production environment

Using the cloud takes some of the security burden off your shoulders. For example, Microsoft provides physical security for Azure datacenters and helps protect the cloud platform against infrastructure threats such as a DDoS attack. Given that Microsoft has thousands of cybersecurity specialists working on security every day, the resources brought to bear against attackers are considerable. In fact, while organizations once worried about whether the cloud was secure, most now understand that given the level of investment that vendors such as Microsoft make in people and specialized infrastructure, the cloud is actually more secure than most on-premises datacenters.

But you can't entirely outsource the security of your resources—you still have an important role to play. For production VMs, defining just the basics isn't enough to do this. You also need to apply three patterns consistently to every VM you create, including:

- **Secure VMs.** Security should be everybody's number-one priority, and doing it effectively requires several things. You must assess your security state, protect against security threats, and then detect and respond rapidly to threats that occur.
- **Protect VM contents.** Setting up regular automatic backups is essential to protect against user errors. This isn't enough, though; you must also make sure that your backups are safe from ransomware attacks and available when you need them.
- **Monitor VMs and applications.** This pattern encompasses several tasks, including getting insight into the health of your VMs, understanding interactions among them, and establishing ways to monitor the applications these VMs run. All of these are essential to keep your applications running around the clock.

Safeguards for data in transit and at rest

One of the keys to data protection in the cloud is accounting for the possible states in which your data may occur, and what controls are available for each state. For the purpose of Azure data security and encryption best practices, recommendations focus on the following data states:

- Data encryption controls are built into services from virtual machines to storage and SQL Database
- As data moves between clouds and customers, it can be protected using industry-standard encryption protocols
- Azure Key Vault enables users to safeguard and control cryptographic keys and other secrets used by cloud apps and services
- Azure Information Protection will help classify, label, and protect your sensitive data in apps

Simplified security management

Security monitoring refers to having a proactive strategy that audits your resources to identify systems that do not meet organizational standards or best practices. Azure Security Center provides unified security management and advanced threat protection across hybrid cloud workloads. With Security

Center, you can apply security policies across your workloads, limit your exposure to threats, and detect and respond to attacks, including:

- Unified view of security across all on-premises and cloud workloads with Azure Security Center
- Continuous monitoring and security assessments to ensure compliance and remediate any vulnerabilities
- Interactive tools and contextual threat intelligence for streamlined investigation
- Extensive logging and integration with existing security information and event management (SIEMs) to simplify the SOC experience

Partner solutions enabled in the cloud

Azure Security Center offers integration with various third-party security solutions that provide a unified view for alerting and monitoring of your Azure and non-Azure workloads. For integrated partner solutions, Security Center scans Azure resources and provides recommendations to install the solution while automating deployment. In addition to these features, auto discovery is available for partner solutions that have already been deployed in the subscription. Azure has a vibrant partner ecosystem, so it's easy to integrate trusted cloud security vendors. The Azure Marketplace includes partner solutions across areas like antimalware, networking security, encryption, monitoring and alerting, application security, authentication, and more—making it easier to apply consistent security across hybrid environments.

Security guidance and tools

To help you overcome your compliance management challenges and fulfill your responsibilities of meeting regulatory requirements—as well as conduct self-service audits and risk assessments of your use of its enterprise cloud services—Microsoft introduced the [Service Trust Portal](#) and [Compliance Manager](#). They are designed to help organizations meet complex compliance obligations and improve your data protection capabilities when choosing and using Microsoft Cloud services.

Service Trust Portal (STP) is your go-to website that provides in-depth information and tools you can leverage to help meet your needs for using Microsoft Cloud services, including Azure, Office 365, Dynamics 365, and Windows. STP is a one-stop shop for security, regulatory, compliance, and privacy information related to the Microsoft Cloud, where we publish the information and resources you need to perform self-service risk assessments of our cloud services and tools to help you track regulatory compliance activities within our cloud, including:

- **Compliance Manager:** Compliance Manager, a workflow-based risk assessment tool in the Microsoft Service Trust Portal, enables you to track, assign, and verify your organization's regulatory compliance activities related to Microsoft Cloud services, such as Office 365, Dynamics 365 and Azure. You can find more details in the next section.
- **Trust documents:** Currently there are three categories of guides that provide you with abundant resources to assess Microsoft Cloud; learn about Microsoft operations in security, compliance, and privacy; and help you act on improving your data protection capabilities. These include:
 - **Audit reports:** These audit reports allow you to stay current on the latest privacy, security, and compliance-related information for Microsoft Cloud services. This includes ISO, SOC, FedRAMP and other audit reports, bridge letters, and materials related to independent third-party audits of Microsoft Cloud services such as Azure, Office 365, Dynamics 365, and others.
 - **Data protection guides:** Data protection guides provide information about how Microsoft Cloud services protect your data, and how you can manage cloud data security and compliance for your organization. This includes deep-dive white papers that provide details on how Microsoft designs and operates cloud services, FAQs,

reports of end-of-year security assessments, penetration test results, and guidance to help you conduct risk assessment and improve your data protection capabilities.

- **Azure Security and Compliance Blueprint:** These blueprints provide resources to assist you in building and launching cloud-powered applications that help you comply with stringent regulations and standards. With more certifications than any other cloud provider, you can have confidence deploying your critical workloads to Azure, with blueprints that include:
 - Industry-specific overview and guidance
 - Customer responsibilities matrix
 - Reference architectures with threat models
 - Control implementation matrices
 - Automation to deploy reference architectures
 - Privacy resources – Documentation for Data Protection Impact Assessments, Data Subject Requests (DSRs), and Data Breach Notification is provided to incorporate into your own accountability program in support of the General Data Protection Regulation (GDPR).
 - **Get started with GDPR:** Microsoft products and services help organizations meet GDPR requirements while collecting or processing personal data. STP is designed to give you information about the capabilities in Microsoft services that you can use to address specific requirements of the GDPR. The documentation can help your GDPR accountability and your understanding of technical and organizational measures. Documentation for Data Protection Impact Assessments, Data Subject Requests (DSRs), and Data Breach Notification is provided to incorporate into your own accountability program in support of the GDPR.
 - **Data Subject Requests:** The GDPR grants individuals (or data subjects) certain rights in connection with the processing of their personal data. This includes the right to correct inaccurate data, erase data, or restrict its processing, as well as receive their data and fulfill a request to transmit their data to another controller.
 - **Data Breach:** The GDPR mandates notification requirements for data controllers and processors in the event of a breach of personal data. STP provides you with information about how Microsoft tries to prevent breaches in the first place, how Microsoft detects a breach, and how Microsoft will respond in the event of a breach and notify you as a data controller.
 - **Data Protection Impact Assessment:** Microsoft helps controllers complete GDPR Data Protection Impact Assessments. The GDPR provides an in-exhaustive list of cases in which DPIAs must be carried out, such as automated processing for the purposes of profiling and similar activities; processing on a large scale of special categories of personal data, and systematic monitoring of a publicly accessible area on a large scale.
- **Other resources:** In addition to tools guidance discussed in the above sections, STP also provides other resources including regional compliance, additional resources for the Security and Compliance Center, and frequently asked questions about the Service Trust Portal, Compliance Manager, and privacy/GDPR.
 - **Regional compliance:** STP provides numerous compliance documents and guidance for Microsoft online services to meet compliance requirements for different regions including Czech Republic, Poland, and Romania.

Unique intelligent insights

As the volume and complexity of security signals grow, determining if those signals are credible threats, and then acting, takes far too long. Microsoft offers an unparalleled breadth of security intelligence delivered at cloud scale to help quickly detect and remediate threats.

Azure threat intelligence

By using the threat intelligence option available in Security Center, IT administrators can identify security threats against the environment. For example, they can identify whether a particular computer is part of a botnet. Computers can become nodes in a botnet when attackers illicitly install malware that secretly connects the computer to the command and control. Threat intelligence can also identify potential threats coming from underground communication channels, such as the dark web.

To build this threat intelligence, Security Center uses data that comes from multiple sources within Microsoft. Security Center uses this to [identify potential threats](#) against your environment. The Threat intelligence pane is composed of three major options:

- Detected threat types
- Threat origin
- Threat intelligence map

Machine learning in Azure Security Center

Azure Security Center deeply analyzes a wealth of data from a variety of Microsoft and partner solutions to help you achieve greater security. To make use of all this data, the company leverages data science and machine learning in particular for threat prevention, detection, and eventually investigation.

Broadly, Azure Machine Learning helps achieve two outcomes:

Next-generation detection

Attackers are increasingly automated and sophisticated. They use data science too. They reverse-engineer protections and build systems that support mutations in behavior. They masquerade their activities as noise, and learn quickly from mistakes. Machine learning helps us respond to these developments.

Simplified security management

Making effective security decisions is not easy. It requires security experience and expertise. While some large organizations have such experts on staff, many companies don't. Azure Machine Learning enables customers to benefit from the wisdom of other organizations when making security decisions.

Behavioral analytics

Behavioral analytics is a technique that analyzes and compares data to a collection of known patterns. However, these patterns are not simple signatures. They are determined through complex machine learning algorithms that are applied to massive data sets. They are also determined through careful analysis of malicious behaviors by expert analysts. Azure Security Center can use behavioral analytics to identify compromised resources based on analysis of virtual machine logs, virtual network device logs, fabric logs, crash dumps, and other sources.

Method to Azure migration

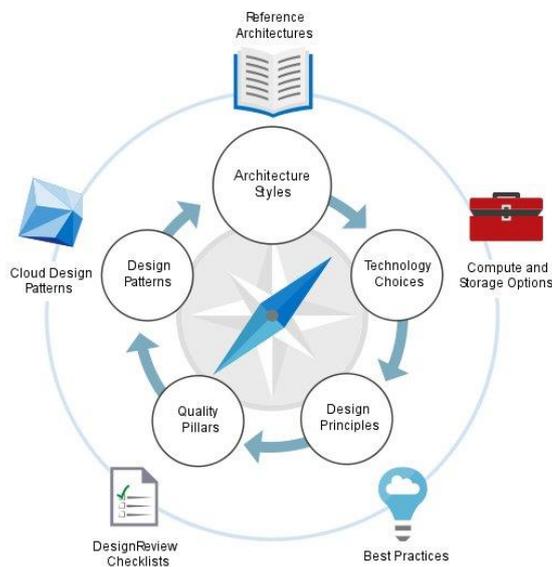
What happens after you have completed working on your business and IT roadmap strategies, and your app portfolio and migration plan are in place? Now it's time to step forward with the onboarding process for your cloud adoption journey, where you will perform the actual migration of your apps from on-premises or another cloud to Azure. To proceed further in your cloud adoption journey, you have three options for onboarding:

- **Guided self-service:** Migrate yourself, with help from Microsoft
- **Microsoft FastTrack for Azure:** Use the Microsoft FastTrack program for Azure
- **Solutions partner:** Get connected with Microsoft Cloud Solution Partners (CSPs)

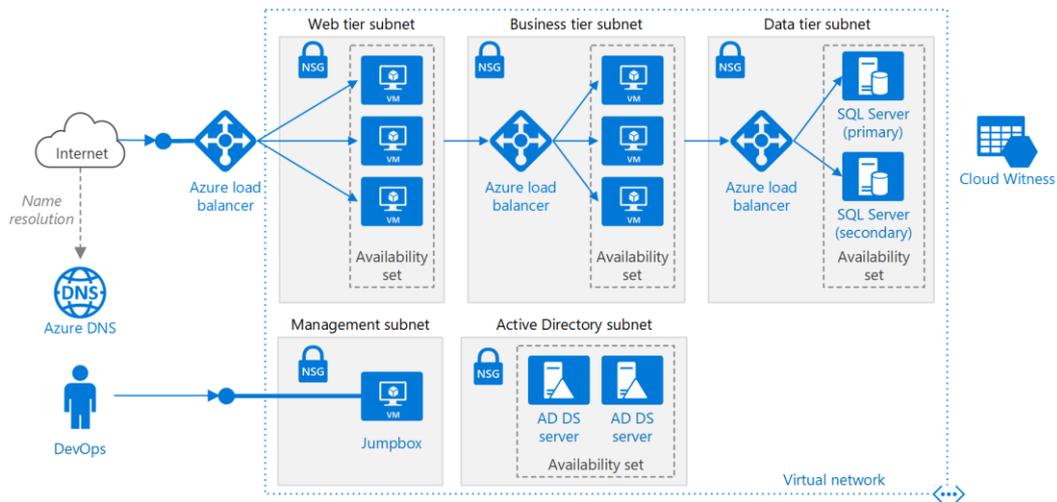
Guided self-service

If your organization is planning Azure migration on its own, Microsoft is always there to assist you throughout your migration journey. To help fast-track your migration to Azure, Microsoft and its partners have developed an extensive set of architectures, guides, tools, and services to reduce risk and speed migration of virtual machines, applications, and databases. These tools and services support a broad selection of operating systems, programming languages, frameworks, and databases.

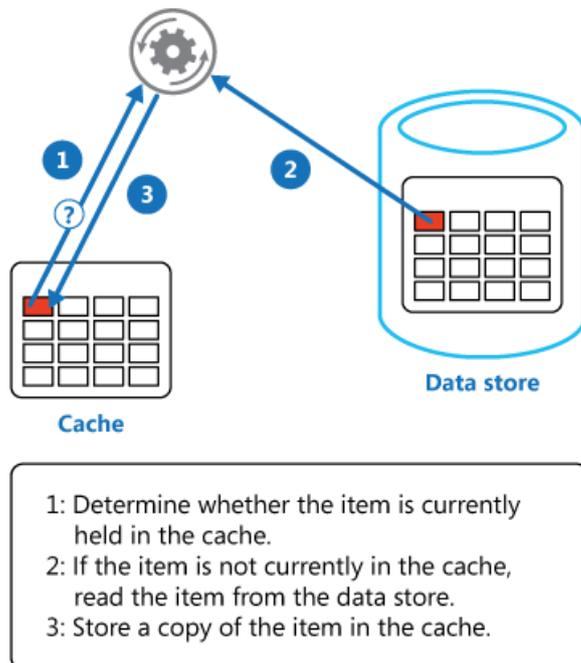
- **Assessment and migration tools:** Azure allows you to leverage a wide range of tools to be used in different phases for your cloud transformation, including assessing your existing infrastructure. For more details on the tool, you can refer to the Assess section in the Migration chapter below.
- **Architectural guide:** This [guide presents](#) a structured approach for designing applications on Azure that are scalable, resilient, and highly available. It is based on proven practices that Microsoft has prepared from different customer engagements. It is organized as a series of steps, from architecture and design to implementation. For each step, supporting guidance will help you with the design of your application architecture.



- **Reference solution architectures:** Reference architectures are arranged by scenario, with related architectures grouped together. Each architecture includes recommended practices, along with considerations for scalability, availability, manageability, and security. Most also include a deployable solution. The example reference architecture below shows how to deploy VMs and a virtual network for an N-tier application, using SQL Server on Windows as the data tier.



- More reference architectures can be found [here](#).
- **Cloud design patterns:** Azure provides a number of useful cloud design patterns for building reliable, scalable, secure applications in the cloud. Each pattern describes the problem that the pattern addresses, considerations for applying the pattern, and an example based on Azure. Most of the patterns include code samples or snippets that show how to implement the pattern on Azure. However, most of the patterns are relevant to any distributed system, whether hosted on Azure or on other cloud platforms. The following is an example cloud design pattern for Cache-Aside under Data Management to show how to load data on demand into a cache from a data store.



- More cloud design patterns can be found [here](#).

Most migration projects can be divided into three phases: Assess, Migration, and Modernization. Follow the [Migration](#) and [Modernization](#) sections of this chapter to understand more about the phases in detail.

Microsoft FastTrack for Azure

[FastTrack for Azure](#)ⁱ provides direct assistance from Azure engineers, working hand in hand with partners, to help customers build Azure solutions quickly and confidently. FastTrack brings best practices and tools from real customer experiences to guide customers from setup, configuration, and development to production of Azure solutions, including:

- Development and test
- Backup and archive
- Disaster recovery
- App modernization
- App lift and shift
- Digital marketing
- E-commerce
- Data warehouse
- Database migration
- SAP on Azure
- RedHat on Azure*
- Intelligent Apps*
- IoT*
- High-performance computing*

*Available in Q2 of 2018

During a typical FastTrack for Azure engagement, Microsoft will help you define the business vision to plan and develop Azure solutions successfully. The team will assess your architectural needs and provide guidance, design principles, tools, and resources to help you build, deploy, and manage your Azure solutions. They will match you with skilled partners for deployment services on request and will periodically check in to ensure deployment is on track and help remove blockers.

The main phases of a typical FastTrack for Azure engagement are:

- **Discovery:** Identify key stakeholders, understand the goal or vision for problems you are solving, and assess architectural needs
- **Solution enablement:** Learn design principles for building applications, review architecture of applications and solutions, and receive guidance and tools to drive proof of concept (PoC) work through to production
- **Continuous partnership:** Azure engineers and/or program managers will check in periodically to ensure your deployment is on track and help remove blockers for you (in-house resources) or for your Azure partner

Azure Solutions Partner

Microsoft certified solution providers specialize in providing up-to-date, Microsoft technology-based customer solutions all over the world. Optimize your business in the cloud with help from an experienced partner.

Get the help you need from partners with ready-made or custom Azure solutions and partners who can help deploy and manage those solutions for your business:

- [Find a Cloud Solutions Partner](#) – A certified CSP can help you take full advantage of the cloud by assessing your business goals for cloud adoption, identifying the right cloud solution that meets your business needs and helps your business become more agile and efficient.
- [Find a Managed Service Partner](#) – Azure Managed Service Partner (MSP) helps you transition to Azure by guiding you in all aspects of the cloud journey. From consulting to migrations and operations management, cloud MSPs show customers all the benefits that come with cloud

adoption. They also act as a one-stop shop for common support, provisioning, and billing experience—all with a flexible pay-as-you-go (PAYG) business model.

Capacity planning and efficiency

Capacity planning is a critical concern for any organization. Accurate capacity planning can ensure optimized utilization of your underlying infrastructure and allows you to pay only for the resources you are using. The [Azure Site Recovery Capacity Planner tool](#) helps you figure out your capacity requirements for protecting Hyper-V VMs, VMware VMs, and Windows/Linux physical servers with Azure Site Recovery. It provides guidelines across the following areas:

- VM eligibility assessment, based on the number of disks, disk size, IOPS, churn, and a few VM characteristics
- Network bandwidth need versus RPO assessment
- Azure infrastructure requirements
- On-premises infrastructure requirements
- Initial replication batching guidance
- Estimated total disaster recovery cost to Azure

Before starting planning

Before you begin Azure Site Recovery capacity planning, ensure that the following tasks are complete:

- Discovery of source (on-premises) infrastructure details
- Planning, assessment, and cloud suitability steps for all on-premises applications, including selecting the applications that are best suited for Azure migration
- Azure Network Mapping setup to support the workload or application migration

Capacity planner modes

The Azure Site Recovery Capacity Planner is a macro-enabled Microsoft Excel workbook. You can run it in either of two modes:

- Quick planning: Run the tool in this mode to get network and server projections based on an average number of VMs, disks, storage, and change rate. For this planning mode, you will need to provide an overall average of your source environment resources, including variables such as the total number of VMs, total number of disks, average disk size, compression, and retention.
- Detailed planning: Run the tool in this mode and provide details of each workload at a VM level. Analyze VM compatibility, and get network and server projections. For this planning mode, you will need to provide information for each VM, including the number of disks attached to a VM, total VM storage, VM capacity utilization, and daily churn. You'll also need to provide general information about retention, compression, etc.

Regardless of which planner type you use, the final assessment report consists of two sections: input where you provide information about your existing source infrastructure, and output where Azure Site Recovery Capacity Planner tool displays its recommendations for better capacity management.

To understand more about this tool, let's take an example where you will opt for Quick Planner and provide an overall average of your existing infrastructure resources. Based on those resources, you will receive recommendations for the resources you need for seamless disaster recovery.

Input

The input section summarizes data from the source infrastructure, based on the details provided, and includes the following types of information:

- Total number of virtual machines
- Average number of VHDs per virtual machine
- Average size of VHD (in GBs)

- Average utilization per disk (percent)
- Average daily data change rate (percent)
- Retention in days
- Number of hours in which initial replication for the batch of virtual machines should complete
- Number of virtual machines per initial replication batch

INPUTS	
Infra Inputs source	Manual
Select your scenario	VMware/Physical to Azure
Total number of virtual machines	2
Average number of VHDs per virtual machine	2
Average size of VHD (in GBs)	500
Average utilization per disk (%)	35%
Total data to be replicated (in GBs)	700
Churn Inputs	
Average daily data change rate (%)	5%
Amount of data changed per day (in GBs)	35
Compression	0%
Amount of data Xfered per day (in GBs)	35
Retention Inputs	
Retention in days	3
Initial Replication Inputs	
Number of hours in which initial replication for the batch of virtual machines should complete	16
Number of virtual machines per initial replication batch	3

Output

The output sections will display the network bandwidth requirements, Azure storage account components, and Azure Site Recovery infrastructure components that are required to run infrastructure on Azure with seamless disaster recovery. These planner modes provide the following types of information as an outcome report:

- Bandwidth required for delta replication (MB/sec). Network bandwidth for delta replication is calculated on the average daily data change rate.
- Bandwidth required for initial replication (MB/sec). Network bandwidth for initial replication is calculated on the initial replication values you put in.
- Storage required (in GBs), or the total Azure storage required.
- Total IOPS on standard storage accounts is calculated based on 8K IOPS unit size on the total standard storage accounts. For the Quick Planner, the number is calculated based on all the source VM disks and daily data change rate. For the Detailed Planner, the number is calculated based on the total number of VMs that are mapped to standard Azure VMs, including the data change rate on those VMs.
- Number of standard storage accounts provides the total number of standard storage accounts needed to protect the VMs. Note that a standard storage account can hold up to 20,000 IOPS across all the VMs in standard storage, with a maximum of 500 IOPS supported per disk.
- Number of blob disks required indicates the number of disks that will be created on Azure storage.
- Number of premium storage accounts required provides the total number of premium storage accounts needed to protect the VMs. Note that a source VM with high IOPS (greater than 20,000) needs a premium storage account. A premium storage account can hold up to 80,000 IOPS.
- Total IOPS on premium storage is calculated based on 256K IOPS unit size on the total premium storage accounts. For the Quick Planner, the number is calculated based on all the

source VMs disks and daily data change rate. For the Detailed Planner, the number is calculated based on the total number of VMs that are mapped to premium Azure VM (DS and GS series) and the data change rate on those VMs.

- Number of configuration servers required shows how many configuration servers are required for the deployment.
- Number of additional process servers required shows whether additional process servers are needed in addition to the process server that is configured on the configuration server by default.
- 100 percent additional storage on the source shows whether additional storage is required in the source location.

OUTPUT	
Network Bandwidth requirements	
Bandwidth required for delta replication (in Megabits/sec)	10 Mbps
Bandwidth required for initial replication (In Megabits/sec)	100 Mbps
Bandwidth refers to dedicated bandwidth for replication.	
Azure requirements	
Storage required (in GBs)	781.6666667
Total IOPS on standard storage accounts	342
Number of standard storage accounts required	1
Number of Blob disks required	4
Number of premium storage accounts required	0
Total IOPS on premium storage accounts	0
Other Infra requirements	
Number of Configuration Servers required	1
Number of additional Process Servers required	0
100% additional storage on the Source	NA

[Source Link 1](#); [Source Link 2](#)

Begin onboarding

Migrating to the cloud doesn't have to be difficult. But many organizations struggle to get started—to get deep visibility into the environment and the tight interdependencies among applications, workloads, and data. Without that visibility, it can be difficult to plan the path forward. To help organizations build confidence with Azure and achieve faster adoption, Microsoft has defined Azure migration and modernization processes to provide guidance and tools that help effortlessly migrate workloads to Azure.

Each migration approach has different benefits and reasons for using it. You can choose a single approach when you migrate apps to the cloud, or you can select certain components from multiple approaches. Individual applications aren't limited to a single approach or maturity state. The following table describes the main benefits of, and reasons for choosing, each migration or modernization approach for your application.

Cloud infrastructure-ready	Cloud DevOps-ready	Cloud-optimized
Lift and shift		Modernize/refactor/rewrite
Application compute target		
Applications deployed to VMs in Azure	Containerized monolithic or N-Tier apps deployed to VMs, Azure Service Fabric, or Azure Container Service (i.e., Kubernetes)	Containerized microservices or regular applications based on PaaS on Azure App Service, Azure Service Fabric, Azure Container Service (i.e., Kubernetes)
Data target		
SQL or any relational database on a VM	Azure SQL Database Managed Instance	Azure SQL Database, Azure Cosmos DB, or other NoSQL
Advantages		
<ul style="list-style-type: none"> • No re-architecting, no new code • Least effort for quick migration • Least-common denominator supported in Azure • Basic availability guarantees • After moving to the cloud, it's easier to modernize even more 	<ul style="list-style-type: none"> • No re-architecting, no new code • Containers offer small incremental effort over VMs • Improved deployment and DevOps agility to release because of containers • Increased density and lower deployment costs • Portability of apps and dependencies • Azure Container Service (or Kubernetes) and Azure Service Fabric, provides high availability and orchestration • Nodes/VM patching in Service Fabric • Flexibility of host targets: Azure VMs or VM scale sets, Azure Container Service (or Kubernetes), Service Fabric, and future container-based choices 	<ul style="list-style-type: none"> • Architect for the cloud, refactor, new code needed • Microservices cloud-native approaches <ul style="list-style-type: none"> • Fully managed services • New web apps, monolithic, N-Tier, cloud-resilient, and cloud-optimized • Automatic patching • Optimized for scale • Optimized for autonomous agility by subsystem • Built on deployment and DevOps • Enhanced DevOps, like slots and deployment strategies • PaaS and orchestrator targets: Azure App Service, Azure Container Service (or Kubernetes), Azure Service Fabric, and future container-based PaaS
Challenges		
<ul style="list-style-type: none"> • Smaller cloud value, other than shift in operating expense or closing datacenters • Very little is managed: No OS or middleware patching; might require immutable infrastructure solutions, like Terraform, Spinnaker, or Puppet 	<ul style="list-style-type: none"> • Containerizing is an additional step in the learning curve 	<ul style="list-style-type: none"> • Might require significant code refactoring or rewriting (increased time and budget)

Migration

Migration can be intimidating—migrating your environment to the cloud or upgrading to the latest platform requires thorough planning, deep knowledge, and careful attention to detail. By breaking down the migration process into three steps—Assess, Migrate, and Optimize—you can solve the most pressing migration challenges and deliver the reliability, performance, and security your business stakeholders expect.



Assess

This phase of migration will help your decision making as you begin your migration journey. Microsoft recommends establishing your migration priorities and business objectives, so you can continually track to those as you discover more about your environment. Automated migration tools will then provide additional insight into your environment and dependencies to help create a cloud migration plan. There will be a requirement to run a technical and financial assessment to figure out whether their on-premises workloads are suitable for migration to Azure. This includes assessing machine and database compatibility for migration, and estimating capacity and costs for running resources in Azure.

Assess

Your organization likely runs hundreds—maybe thousands—of applications across a range of servers. While your current management tools may provide a good representation of these, to kick-start any migration, you need an inventory mechanism that can feed data into subsequent steps. Using cloud migration assessment tools, compile an inventory of the physical and virtual servers in your environment. This data can include profile information and performance metrics about your applications. At the end of this step, you'll have a complete inventory of servers with metadata for each, allowing you to build your cloud migration plan.

Map on-premises applications

Using information from your discovery, map your servers to represent your on-premises applications. This will help you identify dependencies or communication between servers so you can include all necessary application components in your cloud migration plan—both to help reduce risks and ensure a smooth migration. Group your servers logically to represent the applications, and then select the best migration strategy for each application based on its requirements and migration objectives.

Evaluate

With your application groups mapped, evaluate how best to move each on-premises application. The evaluation also gives you a snapshot of compatibility for each current application you want to run in Azure, and the estimated cost to run it. Cloud migration assessment tools can help you evaluate paths for migration. These tools provide insights, such as recommended Azure resources and migration strategies, for your application servers.

[Know your assessment tools](#)

Inspect your on-premises environment, whether physical or virtual, and review a checklist and detailed report on steps you need to take to move your environment to Azure.

Microsoft Assessment and Planning (MAP) Toolkit

MAP is an agentless, automated, multi-product planning and assessment tool for quicker and easier desktop, server, and cloud migrations. MAP provides detailed readiness assessment reports and executive proposals with extensive hardware and software information, as well as actionable recommendations to help organizations accelerate their IT infrastructure planning process and gather more detail on assets that reside within their current environment. MAP also provides server utilization data for Hyper-V server virtualization planning, identifying server placements, and performing virtualization candidate assessments. It collects and organizes system resources and device information from a single networked computer. Assessment tools often require users to first deploy software agents on all computers to be inventoried, but this tool does not. MAP uses technologies already available in your IT environment to perform inventory and assessments.

- [Download the Microsoft Assessment and Planning Toolkit](#)

Microsoft Data Migration Assistant (DMA)

DMA assesses and detects compatibility issues that can impact database functionality in Azure. It also assesses feature parity between your SQL Server source and target, and recommends performance and reliability improvements for your target environment. Additionally, it discovers new features in the target SQL Server platform that the database can benefit from after an upgrade. These are described as feature recommendations and organized in categories such as performance, security, and storage. DMA doesn't only provide assessment for database migration from SQL Server to Azure SQL Server database, but also provides assessment for SQL Server to Azure SQL Database Managed Instance and Oracle to Azure SQL Database.

- [Download the Data Migration Assistant](#)

Database Migration Guide

The Database Migration Guide is for enterprise customers, partners, and business decision makers who are interested in moving to the Microsoft Modern Data Platform: for example, migrating from Oracle to SQL Server or to Azure Data Services. Hosted on the Microsoft web, the Database Migration Guide is designed to make it easy for organizations to move their data to the Microsoft Modern Data Platform. The goals of the guide are to address content gaps by providing comprehensive, step-by-step tips for performing migrations and improve the discoverability of the guidance, tools, software, and programs that are available to assist customers with performing these migrations.

The guide serves as a single point of entry for users, providing a guided migration experience, with details on how to migrate from a specific source platform to a specific target platform. The guide informs and educates users, and it recommends specific courses of action based on the selected migration scenario. Prescriptive guidance also includes pointers to the following:

- Documentation (best practices, customer case studies, MSDN articles, blog postings, white papers, videos, presentation decks, training, etc.)
- Tools or services to assist with migrations
- Recommended partners
- Associated customer programs
- Cost estimations and return-on-investment analysis
- [Download the Azure Database Migration Guide](#)

Azure Migrate

The Azure Migrate service helps you assess on-premises machines for migration to Azure. It assesses the migration suitability of the machines and provides sizing recommendations for Azure VMs based on the performance history of on-premises VMs. It also gives you estimated costs for running on-premises machines in Azure. You can visualize dependencies of on-premises machines to create groups of machines that you will assess and migrate together, as well as:

- Discover information about your VMware virtual machines, including CPU and memory utilization, disk details, and networks. Group machines for migration assessment with higher confidence by setting up dependency visualization to view dependencies of a single VM or a group of VMs.
- Get advice on right-sizing your cloud resources to proceed with confidence and better control your migration costs based on efficient utilization. If Azure Migrate identifies specific VMs as problematic, follow step-by-step guidance for overcoming obstacles to help keep your migration on track.
- After running a cloud assessment with Azure Migrate, begin migrating your on-premises VMs to Azure using services including Azure Site Recovery and Database Migration Service. Visit the [Azure Migration Center](#) to learn more and to find discovery and data migration software tools from our partners.
- Learn more about [Azure Migrate](#).

Service Map

Service Map, part of Azure Log Analytics, is used by Azure Migrate to show dependencies between machines you want to migrate. Service Map automatically builds a common reference map of dependencies across your servers, processes, and third-party services. Service Map discovers failed network connections that your managed systems are attempting to make, helping you identify potential server misconfiguration, service outage, and network issues. Service Map can currently be used for 180 days without incurring charges.

The output of the assess phase is typically a list of the items you've discovered, ranked according to business impact and value, with business-critical resources at the top and lower-value legacy workloads at the bottom. Tiering your findings enables you to prioritize migration operations. You will need a thorough understanding of the applications you are migrating, their underlying architectural dependencies and business requirements, and the post-migration benefits that stakeholders expect.

[Source Link 1](#); [Source Link 2](#); [Source Link 3](#)

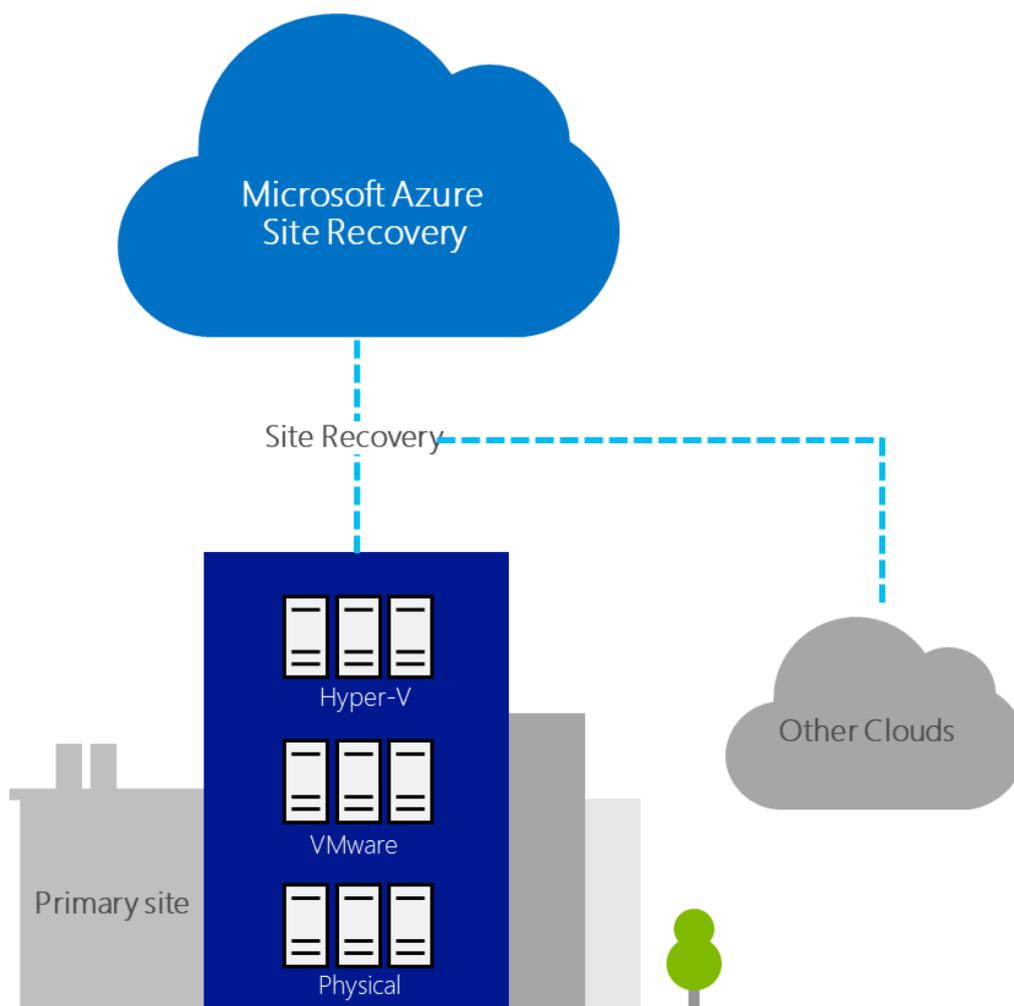
Migrate

In this phase, we guide your cloud migration via four widely adopted approaches including Rehost, Refactor, Rearchitect, and Rebuild. Learn about these paths to decide the right mix for your applications. For example, you could choose to rehost or "lift and shift" less-strategic apps with no code changes, and rearchitect others that are more business critical, decomposing them into services.

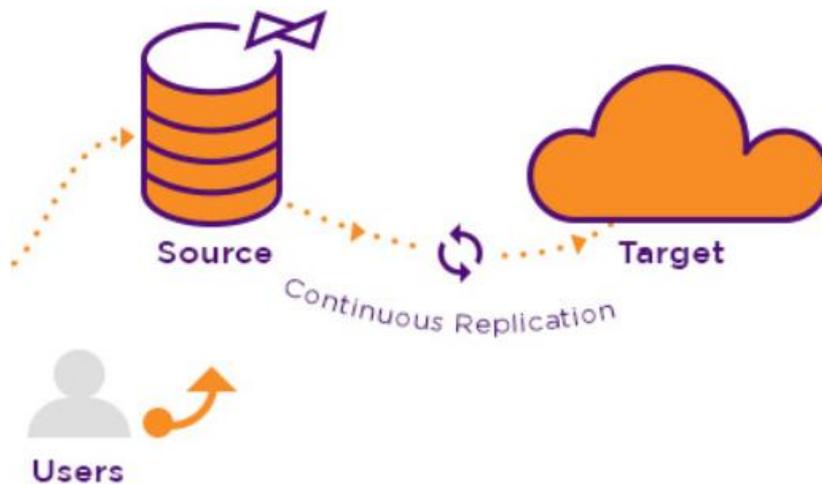
Before any migration, you will want to ensure primary systems are safe and will continue to run without issues. Any downtime disrupts users or customers, and costs time and money. Migration is not as simple as turning off the virtual machines on-premises and copying them across to Azure. Migration tools must take into account asynchronous or synchronous replication to ensure live systems can be copied to Azure with no downtime. Most of all, systems must be kept in lock-step with on-premises counterparts. You might want to test migrated resources in isolated partitions in Azure, to ensure applications work as expected.

To move virtual machines, workloads, and applications from on-premises into Azure requires tools such as Azure Site Recovery (ASR), or third-party tools such as CloudEndure. Any tool usage will be based on project goals and environment specifics. For example, you could use any of the following:

- **Azure Site Recovery:** Azure Site Recovery orchestrates and manages disaster recovery for Azure VMs, on-premises VMs, and physical servers. You can also use Site Recovery to manage migration of machines on-premises and other cloud providers to Azure. Replicate on-premises machines to Azure, or Azure VMs to a secondary region. Then you fail the VM over from the primary site to the secondary, and complete the migration process. With Azure Site Recovery, you can achieve various migration scenarios:
 - **Migrate from on-premises to Azure:** Migrate on-premises VMware VMs, Hyper-V VMs, and physical servers to Azure. To do this, complete almost the same steps as you would for full disaster recovery. Simply don't fail machines back from Azure to the on-premises site.
 - **Migrate between Azure regions:** Migrate Azure VMs from one Azure region to another. After the migration is complete, configure disaster recovery for the Azure VMs now in the secondary region to which you migrated.
 - **Migrate from other cloud to Azure:** You can migrate your compute instances provisioned on other cloud providers to Azure VMs. Site Recovery treats those instances as physical servers for migration purposes.



- Once you have assessed on-premises/cloud infrastructure for migration, Azure Site Recovery contributes to your migration strategy by replicating on-premises machines. With the following easy steps, you can set up migration of on-premises VMs, physical servers, and cloud VM instances to Azure:
 - Verify prerequisites
 - Prepare Azure resources
 - Prepare on-premises VM or cloud instances for migration
 - Deploy a configuration server
 - Enable replication for VMs
 - Test failover to make sure everything's working
 - Run a one-time failover to Azure
- Know more: [Azure Site Recovery](#)
- **Azure Database Migration Service:** This service helps reduce the complexity of your cloud migration by using a single comprehensive service instead of multiple tools. Azure Database Migration Service is designed as a seamless, end-to-end solution for moving on-premises SQL Server databases to the cloud. The Azure Database Migration Service is a fully managed service designed to enable seamless migrations from multiple database sources to Azure Data platforms with minimal downtime. It integrates some of the functionality of existing tools and services, providing customers with a comprehensive, highly available solution. The service uses the [Data Migration Assistant](#) to generate assessment reports that provide recommendations to guide you through the changes required prior to performing a migration. It's up to you to perform any remediation required. When you are ready to begin the migration process, the Azure Database Migration Service performs all of the associated steps. You can fire and forget your migration projects with peace of mind, knowing that the process takes advantage of best practices as determined by Microsoft.
- Learn more: [Azure Database Migration Service](#)
- **CloudEndure:** When you need a wider range of supported virtual machines to migrate to Azure, CloudEndure uses replication to migrate virtual machines with no impact to the original source machine (like ASR). CloudEndure is also a solid choice if you want to use an independent tool. CloudEndure enables migration of even the most complex workloads to Azure without downtime, disruption, or data loss. Through continuous, block-level replication, automated machine conversion, and application stack orchestration, CloudEndure simplifies the migration process and reduces the potential for human error. Whether you are migrating to or across Azure, CloudEndure Live Migration gives you the flexibility and security you need to succeed in today's fast-paced digital ecosystem. CloudEndure's Live Migration solution has been selected as a choice migration vendor in the newly launched [Azure Migration Center](#).
- Learn more: [CloudEndure Live Migration to Azure](#)



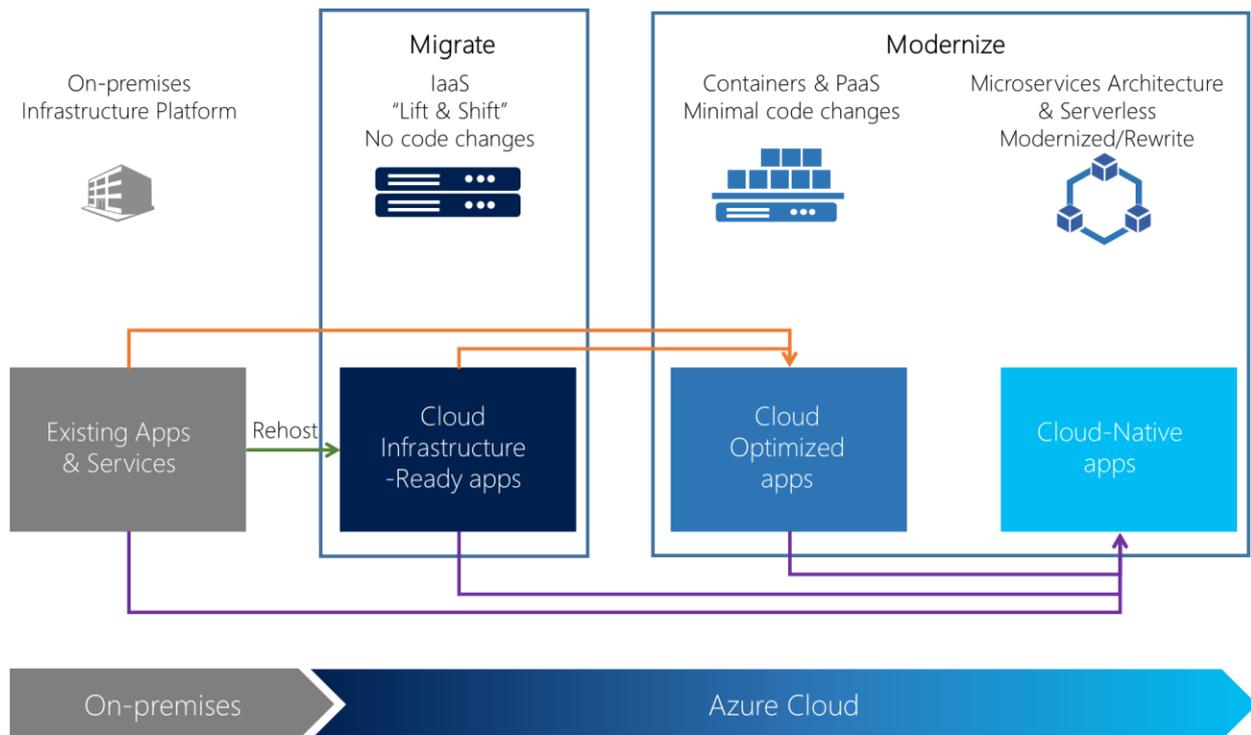
For the migrate phase, you will use proven tools such as Azure Site Recovery to seamlessly rehost virtual machines, and Azure Database Migration Service to move databases to Azure. Depending on your approach, you might also refactor apps using container services, or rebuild or rearchitect using Azure services such as App Service and Functions. For your data, you can either migrate to an Azure SQL Database managed instance, or modernize with the Azure CosmosDB globally distributed database service. If you want to upgrade on-premises, explore the latest version of Windows Server, with capabilities that can help you get cloud and DevOps ready.

[Source Link 1](#); [Source Link 2](#); [Source Link 3](#)

Modernization

After onboarding your business application to the cloud, the next step is to modernize your workloads. Application modernization is a journey to transform your business applications to make them future-ready. Based on your application portfolio and whether you have already identified your applications to modernize or after onboarding your application to Azure, you may be planning to take the next step to modernize your applications. Azure Cloud Services enables your business applications to innovate quickly and deliver faster time-to-value and a wide range of future-ready cloud services. Azure services give you flexibility to modernize business applications whether opting for application optimization or building cloud-native applications based on the application nature.

The following architecture shows a possible cloud migration approach you can take when you move existing applications to the cloud.



Each migration approach has different benefits and reasons for using it. You can choose a single approach when you migrate apps to the cloud or choose certain components from multiple approaches. Individual applications aren't limited to a single approach or maturity state. For instance, a common hybrid approach would have certain on-premises components plus other components in the cloud.

Cloud-optimized applications

A cloud-optimized application is an approach to building and managing applications that takes advantage of the cloud computing model, while using a combination of containers, managed cloud infrastructure, resilient application techniques, monitoring, continuous delivery, and DevOps—all without the need to re-architect and recode your existing applications.

Modernizing your legacy application by rearchitecting allows you to rapidly and repeatedly deliver reliable applications to your customers. You gain essential agility and reliability by deferring much of the operational complexity of your app to the platform.

At this level and still without re-architecting or altering significant code, you can gain even more benefits from running your app in the cloud with modern technologies like containers and additional cloud managed services. You improve the agility of your applications to ship faster by refining your enterprise development operations (DevOps) processes. You achieve this by using technologies like Windows Containers, which is based on Docker Engine. Containers remove the friction that's caused by application dependencies when you deploy in multiple stages. In this maturity model you can deploy containers on IaaS or PaaS while using additional cloud managed services related to databases, cache as a service, monitoring, and continuous integration/continuous deployment (CI/CD) pipelines.

The following list describes the tools, technologies, and solutions that are recognized as requirements for cloud-optimized apps. You can adopt cloud-optimized elements selectively or gradually, depending on your priorities.

- **Cloud infrastructure:** The infrastructure that provides the compute platform, operating system, network, and storage. Azure IaaS services are positioned at this level.
- **Runtime:** This layer provides the environment for the application to run. If you are using containers, this layer usually is based on Docker Engine, running either on Linux hosts or on Windows hosts.
- **Managed cloud:** When you choose a managed cloud option, you can avoid the expense and complexity of managing and supporting the underlying infrastructure, VMs, OS patches, and networking configuration. If you choose to migrate by using IaaS, you are responsible for all of these tasks, and for associated costs. In a managed cloud option, you manage only the applications and services that you develop. The cloud service provider typically manages everything else. Examples of managed cloud services in Azure include Azure SQL Database, Azure Redis Cache, Azure Cosmos DB, Azure Storage, Azure Database for MySQL, Azure Database for PostgreSQL, Azure Active Directory, and managed compute services like VM scale sets, Azure Service Fabric, Azure App Service, and Azure Kubernetes Service.
- **Application development:** You can choose from many languages when you build applications that run in containers. You can opt among different languages to develop container-based apps including .NET, Node.js, Python, Spring/Java, or GoLang.
- **Monitoring, telemetry, logging, and auditing:** The ability to monitor and audit applications and containers that are running in the cloud is critical for any cloud-optimized application. Azure Application Insights helps you get rich performance monitoring, powerful alerting, and easy-to-consume dashboards to help ensure your applications are available and performing as you expect.
- **Provisioning:** Automation tools help you provision the infrastructure and deploy an application to multiple environments (production, testing, and staging). You can use tools like Chef and Puppet to manage an application's configuration and environment. This layer also can be implemented by using simpler and more direct approaches. For example, you can deploy directly by using Azure command-line interface (Azure CLI) tooling, and then use the continuous deployment and release management pipelines in Visual Studio Team Services.
- **Application lifecycle:** Visual Studio Team Services and other tools, like Jenkins, are build automation servers that help you implement CI/CD pipelines, including release management.

[Source 1](#); [Source 2](#); [Source 3](#)

Cloud-native applications

Cloud-native applications are ones that are either redesigned specifically for a cloud computing architecture or natively created app for cloud to take advantage of cloud computing frameworks, which are composed of loosely coupled cloud services. Such applications are ones that have a high degree of uptime and are highly available, from wherever there's an internet connection. These applications are extremely scalable.

Cloud-native is a more advanced or mature state for large and mission-critical applications. Cloud-native applications usually require architecture and design that are created from scratch instead of by modernizing existing applications. The key difference between a cloud-native application and a simpler cloud-optimized web app is the recommendation to use microservices architectures in a cloud-native approach. Cloud-optimized apps can also be monolithic web apps or N-tier apps.

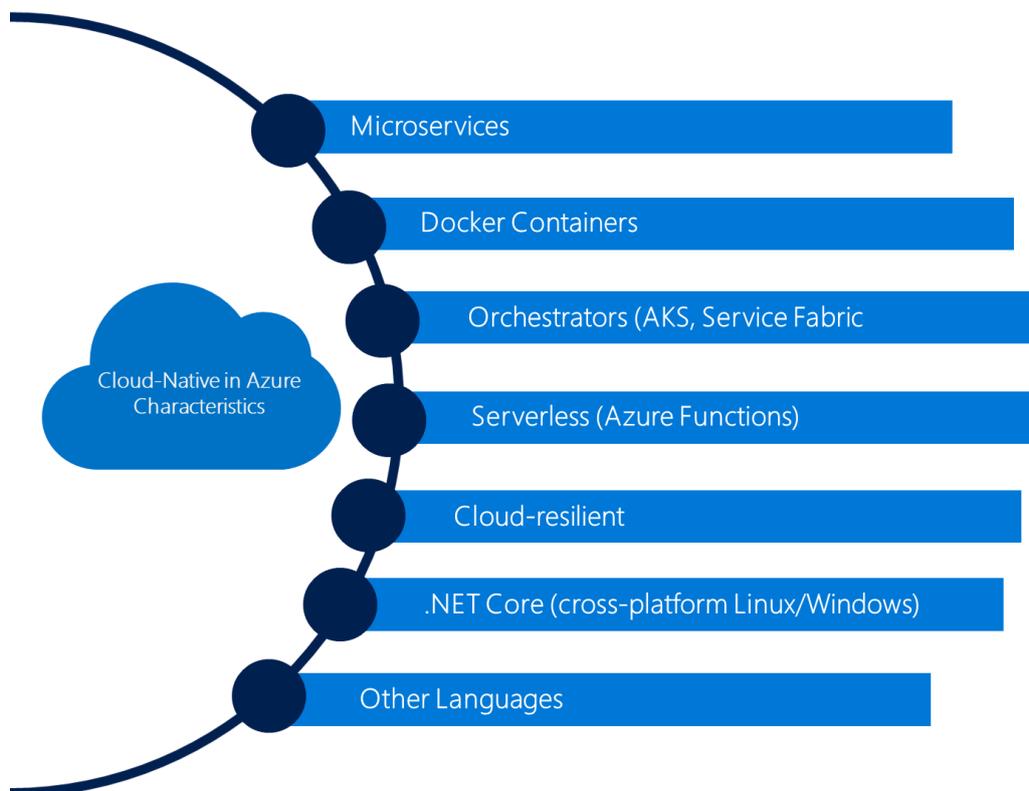
The [Twelve-Factor App](#) (a collection of patterns that are closely related to microservices approaches) is also considered a requirement for cloud-native application architectures. The [Cloud Native Computing Foundation \(CNCF\)](#) is a primary promoter of cloud-native principles. Microsoft is a [member of the CNCF](#). For a sample definition and more information about the characteristics of cloud-native applications, see the Gartner article [How to architect and design cloud-native applications](#).

The most important factor to consider if you migrate a full application to the [cloud-native](#) model is that you must rearchitect to a microservices-based architecture. This clearly requires a significant investment in development because of the large refactoring process involved. This option usually is chosen for mission-critical applications that need new levels of scalability and long-term agility. But, you could start moving toward a cloud-native model by adding microservices for just a few new scenarios, and eventually refactor the application fully as microservices. This is an incremental approach that is the best option for some scenarios.

The cloud-native modernization maturity level usually requires new development investments. Moving to this level typically is driven by business need to modernize applications as much as possible to drastically improve scale in large applications by creating autonomous subsystems (microservices) that can be deployed and scale independently from other areas of the application while lowering costs in the long term and increase evolution agility of those autonomous app's parts which provide significant competitive advantages. Azure offers a comprehensive set of cloud platform services that makes it easy to navigate architectural approaches and design patterns for building modern apps.

In addition, serverless architecture, a popular choice for cloud-native applications, includes:

- Event-driven functions—without the need to explicitly provision or manage infrastructure—with Azure Functions
- Globally distributed, multi-model databases with Azure Cosmos DB
- Highly available and redundant storage with Azure Storage
- More than 200 out-of-the-box connectors using Logic Apps to integrate apps, data, systems, and services



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simpler cloud-optimized web app is the recommendation to use microservices architectures in a cloud-native approach. Cloud-optimized apps can also be monolithic web apps or N-tier apps.

These architectural approaches face very important challenges and complexities but can be greatly simplified by using cloud PaaS and orchestrators like Azure App Services, Azure Container Services, Azure Kubernetes Service (AKS) (managed Kubernetes), Azure Service Fabric, Azure Functions and more, for a serverless approach. All these approaches (like microservices and serverless) typically require you to architect for the cloud and write new code—code that is adapted to specific PaaS platforms, or code that aligns with specific architectures, like microservices.

You can also extend basic modern web apps and cloud-native apps by adding other services, like artificial intelligence (AI), machine learning (ML), and IoT. You might use any of these services to extend any of the possible Cloud-Optimized approaches.

[Source 1](#); [Source 2](#)

Operations

Cloud migration significantly impacts the daily operations of an IT department, broadening the scope of IT operations as organizations plan to move to the cloud and also following the transition. Cloud adoption creates new management challenges for IT teams. Instead of utilizing disjointed solutions for individual IT operations, organizations may want to take advantage of cloud-scale infrastructure to simplify deployment through unified IT management as a service. Management capabilities such as monitoring, backup, automation, and so forth are delivered as a service from the cloud that connects all of the servers in all environments (on-premises, Azure, and other clouds), allowing IT staff to centrally manage operations.

To get more insights about IT operations transformation, let’s review the following operations tasks to see how they would change in the cloud-centric world:

Task	On-premises function	Cloud function
Health monitoring	Use various tools such as Microsoft System Center to monitor applications and provide Root Cause Analysis (RCA) of failures	Gain visibility into the health and performance of your apps, infrastructure, and data in Azure with cloud monitoring tools such as Azure Monitor, Log Analytics, and Application Insights
Security operations (SecOps)	Use Security Information and Event Management (SIEM) tools to analyze events; ensure event logs are audited regularly	Use products like Azure Security Center to prevent, detect, and respond to threats
Data backup	Use on-premises tools such as Microsoft System Center Data Protection Manager (DPM) to create disk- or tape-based data backups	Protect your business data with an Azure backup, a cloud-based as a service, and take advantage of automatic storage management, unlimited scaling, data encryption, application consistent backup and many more capabilities

Task	On-premises function	Cloud function
Scalability	Add and provision additional hardware instances (servers) in the datacenter; ensure proper operation and network connectivity	Configure scale up/out options to automatically respond to spikes by enabling scale, reliability, and resiliency
Business continuity/disaster recovery testing	Use custom scripts to failover to alternate datacenters	Turn on tools such as Azure Site Recovery to perform script-driven orderly failover and recovery of applications and storage
Network configuration and optimization	Use various tools to analyze and optimize network performance discover router loops, and so on	Ensure hybrid network connections such as V-Nets and MPLS routers (“ExpressRoute”) are appropriately tuned and load balanced
Identity provisioning and De-provisioning	Maintain user directory, for example, Active Directory; ensure appropriate user access to resources; enable/enforce single sign-on (SSO)	Extend directory to cloud and possibly utilize alternate forms of authentication for specific applications and resources

This list is neither exhaustive nor conclusive; rather, it is illustrative of the types of issues an operations staff will want to address.

The operations staff, in addition, typically maintains a Configuration Management Database (CMDB) for all of its hardware assets. There is much in the CMDB that is relevant for the cloud migration process. As we will discuss later, the CMDB can provide information such as the size of servers required for a given application, the typical number of VM instances, what storage is being used, and so on. This information, in combination with the portfolio management system, will provide the raw data used to prioritize application migration

Optimize

The final phase for migration is optimize your business-critical workloads. You can use Azure security and management resources to govern, secure, and monitor your business workloads in Azure. You can begin using these services during your migration and, with Azure hybrid support, continue using many of them for a consistent experience across your hybrid cloud. In general, these resources help you run a secure and well-managed environment while using products available in the Azure portal.

Manage costs to invest with confidence

Make the most of your cloud investment with Azure Cost Management licensed by Cloudyn, a Microsoft subsidiary, this solution lets you manage your cloud spend with transparency and accuracy—giving you the tools to monitor, allocate, and trim your cloud costs so you can accelerate future cloud investments.

Monitor usage and spending

Monitoring your usage and spending is critically important for cloud infrastructures because organizations pay for the resources they consume over time. When usage exceeds agreement thresholds, unexpected cost overages can quickly occur. Cost Management Reports help you monitor spending to analyze and track cloud usage, costs, and trends. Using Over Time reports, you can detect anomalies that differ from normal trends. Inefficiencies in your cloud deployment are visible in optimization reports. You can also notice inefficiencies in cost-analysis reports.

Manage costs

Historical data can help manage costs when you analyze usage and costs over time to identify trends. Trends are then used to forecast future spending. Cost Management also includes useful projected cost reports. Cost allocation manages costs by analyzing your costs based on your tagging policy. And, you use cost allocation for showback/chargeback to show resource utilization and associated costs to influence consumption behaviors or charge tenant customers. Access control helps manage costs by ensuring that users and teams access only the cost management data that they need. Alerting helps manage costs by notifying you automatically when unusual spending or overspending occurs. Alerts can also notify other stakeholders automatically for spending anomalies and overspending risks. Various reports support alerts based on budget and cost thresholds. However, alerts are not currently supported for cloud providers partner accounts or subscriptions.

Improve efficiency

You can determine optimal VM usage and identify idle VMs or remove idle VMs and unattached disks with Cost Management. Using information in Sizing Optimization and Inefficiency reports, you can create a plan to down-size or remove idle VMs. However, optimization reports are not currently supported for cloud providers partner accounts or subscriptions.

Enable industry-leading security

Rely on the Azure Security Center for unified security management and advanced threat protection across your hybrid cloud workloads. The Security Center gives you full visibility into and control over the security of your cloud applications in Azure. Quickly detect and take action to respond to threats, and reduce your exposure by enabling adaptive threat protection. The built-in dashboard provides instant insights into security alerts and vulnerabilities that require attention. Azure Security Center can help you with many functions.

- **Centralized policy management:** Ensure compliance with company or regulatory security requirements by centrally managing security policies across all your hybrid cloud workloads.
- **Continuous security assessment:** Monitor the security of machines, networks, storage and data services, and applications to discover potential security issues.
- **Actionable recommendations:** Remediate security vulnerabilities before they can be exploited by attackers with prioritized and actionable security recommendations.
- **Advanced cloud defenses:** Reduce threats with just in time access to management ports and whitelisting to control applications running on your VMs.
- **Prioritized alerts and incidents:** Focus on the most critical threats first with prioritized security alerts and incidents.
- **Integrated security solutions:** Collect, search, and analyze security data from a variety of sources, including connected partner solutions.

Monitor your cloud health

Monitoring is the act of collecting and analyzing data to determine the performance, health, and availability of your business application and the resources that it depends on. Azure includes multiple services that individually perform a specific role or task in the monitoring space. Together, these services deliver a comprehensive solution for collecting, analyzing, and acting on telemetry from your application and the Azure resources that support them. Gain visibility into the health and performance

of your apps, infrastructure, and data in Azure with cloud monitoring tools such as Azure Monitor, Log Analytics, and Application Insights. Use these cloud monitoring tools to take action and integrate with your service management solutions:

- **Core monitoring:** Core monitoring provides fundamental, required monitoring across Azure resources. These services require minimal configuration and collect core telemetry that the premium monitoring services use.
- **Deep application and infrastructure monitoring:** Azure services provide rich capabilities for collecting and analyzing monitoring data at a deeper level. These services build on core monitoring and take advantage of common functionality in Azure. They provide powerful analytics with collected data to give you unique insights into your applications and infrastructure.

Ensure high availability and scalability

To provide redundancy and improved performance, applications are typically distributed across multiple instances. Customers may access your application through a load balancer that distributes requests to one of the application instances. If you need to perform maintenance or update an application instance, your customers must be distributed to another available application instance.

Azure virtual machine scale sets provide high availability to your applications, and allow you to centrally manage, configure, and update a large number of VMs. With virtual machine scale sets, you can build large-scale services for areas such as compute, big data, and container workloads. Azure virtual machine scale sets provide the management capabilities for applications that run across many VMs, automatic scaling of resources, and load balancing of traffic. Scale sets provide the following key benefits:

- **Easy to create and manage multiple VMs:** When you have many VMs that run your application, it's important to maintain a consistent configuration across your environment. For reliable performance of your application, the VM size, disk configuration, and application installs should match across all VMs.
- **Provides high availability and application resiliency:** Scale sets are used to run multiple instances of your application. If one of these VM instances has a problem, customers continue to access your application through one of the other VM instances with minimal interruption.
- **Allows your application to automatically scale as resource demand changes:** Customer demand for your application may change throughout the day or week. To match customer demand, scale sets can automatically increase the number of VM instances as application demand increases, then reduce the number of VM instances as demand decreases.
- **Works at large-scale:** Scale sets support up to 1,000 VM instances. If you create and upload your own custom VM images, the limit is 300 VM instances.

Protect your data in the cloud

To ensure maximum business availability from any kind of disaster, organizations want to avoid costly business disruptions, meet compliance goals, and protect their data against ransomware and human errors by backing up your apps in Azure. Azure Backup deploys easily and is a cost-efficient solution for your backup needs. Because it's built-in, you can set up your cloud backup in a few simple steps. Pay only for what you use, and restore data with no additional costs. Azure Backup is the Azure-based service you can use to back up (or protect) and restore your data in the Microsoft Cloud. Azure Backup replaces your existing on-premises or off-site backup solution with a cloud-based solution that is reliable, secure, and cost-competitive.

Azure Backup provides the following benefits:

- **Automatic storage management:** Hybrid environments often require heterogeneous storage - some on-premises and some in the cloud. With Azure Backup, there is no cost for using on-premises storage devices. Azure Backup automatically allocates and manages backup storage, and it uses a pay-as-you-use model.
- **Unlimited scaling:** Azure Backup uses the underlying power and unlimited scale of the Azure cloud to deliver high-availability without maintenance or monitoring overhead. You can set up alerts to provide information about events, but you don't need to worry about high-availability for your data in the cloud.
- **Multiple storage options:** An aspect of high-availability is storage replication. Azure Backup offers two types of replication: locally redundant storage and geo-redundant storage.
- **Unlimited data transfer:** Azure Backup does not limit the amount of inbound or outbound data you transfer. Azure Backup also does not charge for the data that is transferred. However, if you use the Azure Import/Export service to import large amounts of data, there is a cost associated with inbound data.
- **Data encryption:** Data encryption allows for secure transmission and storage of your data in the public cloud. You store the encryption passphrase locally, and it is never transmitted or stored in Azure. If it is necessary to restore any of the data, only you have encryption passphrase, or key.
- **Application-consistent backup:** An application-consistent backup means a recovery point has all required data to restore the backup copy. Azure Backup provides application-consistent backups, which ensure additional fixes are not required to restore the data. Restoring application-consistent data reduces the restoration time, allowing you to quickly return to a running state.
- **Long-term retention:** You can use Recovery Services vaults for short-term and long-term data retention. Azure doesn't limit the length of time data can remain in a Recovery Services vault. You can keep data in a vault for as long as you like. Azure Backup has a limit of 9999 recovery points per protected instance. See the Backup and retention section in this article for an explanation of how this limit may impact your backup needs.

[Source Link 1](#); [Source Link 2](#); [Source Link 3](#); [Source Link 4](#); [Source Link 5](#)

Appendix: next steps

Call to action

Visit the following links to learn more about the cloud operating model and Azure:

- Cloud Operating Model [<Placeholder – Publicly accessible link for COM overview/introduction>](#)
- [Azure Migration Center](#)
- [Get started with Azure](#)
- [Azure migration partners](#)
- [Training to build expertise in Azure](#)

Hero solutions for infrastructure migration

Apps and infrastructure migration and modernization

Windows Server on Azure

Organizations are running a lot of business on Windows Server today: mission-critical apps, Active Directory, Domain Name Servers, not to mention virtual machines and storage. For more than 20 years, in fact, Windows Server has been the operating system of choice for enterprise workloads. Migrating your Windows Server to Azure is the recommended approach to ensure that you are

effectively leveraging the flexibility and reliability of the Azure cloud. Spend less time running infrastructure, and gain flexibility and efficiency when you run your Windows Server workloads on Azure. Apps running on Windows Server on-premises can be categorized as custom apps or line-of-business (LOB) applications, developed in house. Packaged apps include Microsoft Exchange and SharePoint, or workloads running on Remote Desktop.

1. Custom apps migration to Azure

For organizations, the line-of-business (LOB) applications they have developed for internal use are the most critical part of the IT infrastructure. These applications may be conceptually simple or complex; they may be large or small; and they may have been developed by large teams or a small group trying to solve a business problem. Many LOB applications are old, poorly understood, and lightly maintained, especially if the original developers have moved on to other roles or retired. Often these legacy LOB applications are the most critical of the critical, since keeping them running as code and support systems age gets increasingly difficult. Microsoft tools and technologies can help you modernize, protect, and improve these applications with Azure.

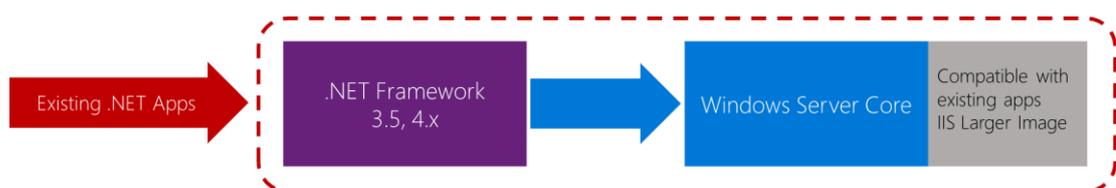
Sandbox and container approach

You can begin by setting up an Azure sandbox environment to test what happens when you migrate a non-production instance of your application—this gives you a safe, controlled environment. An excellent way to build a sandbox environment to test these applications is by putting it into a container, and then moving the container to Azure. Azure helps you modernize these applications faster with containers, and you can use serverless to add additional functionality while keeping your production codebase “clean.”

Containers are a way to wrap up an application into its own isolated package. In its container, the application is not affected by applications or processes that exist outside of the container. Everything the application depends on to run successfully as a process is inside the container. Wherever the container might move, the requirements of the application will always be met, in terms of direct dependencies, because it is bundled with everything that it needs to run (library dependencies, runtimes, and so on).

Example

Let’s take an example of custom app created using the .NET Framework, a traditional ASP.NET web application that does not use .NET Core, which is newer and runs cross platform on Linux, Windows, and MacOS. The main dependency in the .NET Framework is Windows. It also has secondary dependencies, like IIS, and System.Web in traditional ASP.NET. A .NET Framework application must run on Windows, period. You can containerize this existing .NET Framework application using Windows Containers. Windows Containers offer ways to modernize existing .NET Framework applications that are running on Windows-through containerization. Ultimately, Windows Containers gets you the benefits that you are looking for by using containers agility, portability, and better control.



2. Packaged apps (SQL Server, SharePoint, Dynamics)

Azure provides the best options to migrate your packaged application, which can be deployed as cloud only or hybrid using on-premises datacenter and hosted in Azure infrastructure services. Whether it's for development, testing, staging, production, or disaster recovery

purposes, Azure is a perfect home for your packaged applications in the cloud. You can rapidly deploy the packaged application and scale it up or down as needed. Set up development or test environments, or scale out your production deployments by adding more resources. You can also use Azure Marketplace for ready-to-deploy images to simplify deployment and configuration—reducing the time to deploy complex applications from days to hours.

Example

You can host your SharePoint Server 2016 farms on Azure. These applications have been battle-tested to perform well on Azure. Use your existing licenses with license mobility and the Azure Hybrid Use Benefit, and get first-class, first-party support across Azure, SharePoint, and SQL Server. Running your SharePoint Server 2016 farms on Azure ensures that your solution is running on the same cloud framework that hosts Office 365 and Microsoft Dynamics 365.

Linux on Azure

Azure Linux Virtual Machines provides on-demand, high-scale, secure, virtualized infrastructure using Red Hat, Ubuntu, or the Linux distribution of your choice. Azure supports running many popular Linux distributions provided and maintained by a number of partners. You can find distributions such as Red Hat Enterprise, CentOS, SUSE Linux Enterprise, Debian, Ubuntu, CoreOS, RancherOS, FreeBSD, and more in the Azure Marketplace. Microsoft actively works with various Linux communities to add even more flavors to the [Azure-endorsed Linux Distros](#) list.

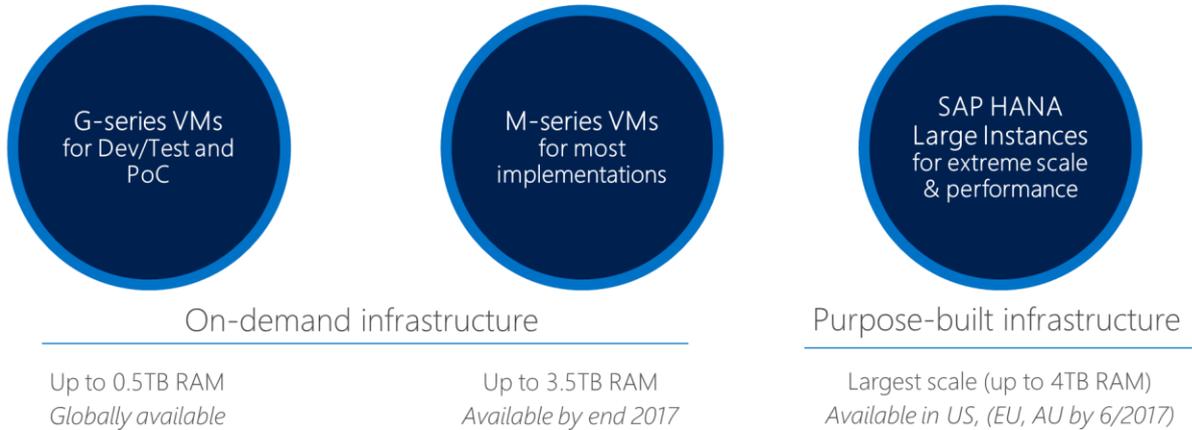
If your preferred Linux distro of choice is not currently present in the gallery, you can "Bring your own Linux" VM by [creating and uploading a Linux VHD in Azure](#). Azure Virtual Machines allow you to deploy a wide range of computing solutions in an agile way. You can deploy virtually any workload and any language on nearly any operating system: Windows, Linux, or a custom-created one from any one of the growing list of partners.

SAP on Azure

Azure is a SAP-ready cloud partner that runs reliably on your mission-critical SAP workloads and scenarios on a scalable, compliant, and enterprise-proven platform, while providing flexibility and cost savings. With the expanded partnership between Microsoft and SAP, you can run SAP applications across dev/test and production scenarios in Azure, and be fully supported. From SAP NetWeaver to SAP S4/HANA, SAP BI, Linux to Windows, and SAP HANA to SQL, Microsoft has you covered. Besides hosting SAP NetWeaver scenarios with the different DBMS on Azure, you can host other SAP workload scenarios, like SAP BI on Azure.

Azure has native Azure Virtual Machines offers that are ever growing in size of CPU and memory resources to cover SAP workloads that leverage SAP HANA. Azure for SAP HANA is a unique offer that sets Azure apart from the competition. In order to enable hosting more memory/CPU resources, demanding SAP scenarios that involve SAP HANA, Azure offers the usage of customer-dedicated, bare-metal hardware for the purpose of running SAP HANA deployments that require up to 20 TB (60 TB scale-out) of memory for S/4HANA or other SAP HANA workloads. This unique Azure solution of SAP HANA on Azure (large instances) allows you to run SAP HANA on the dedicated bare-metal hardware with the SAP application layer or workload middleware layer hosted in native Azure Virtual Machines.

SAP HANA options on Azure

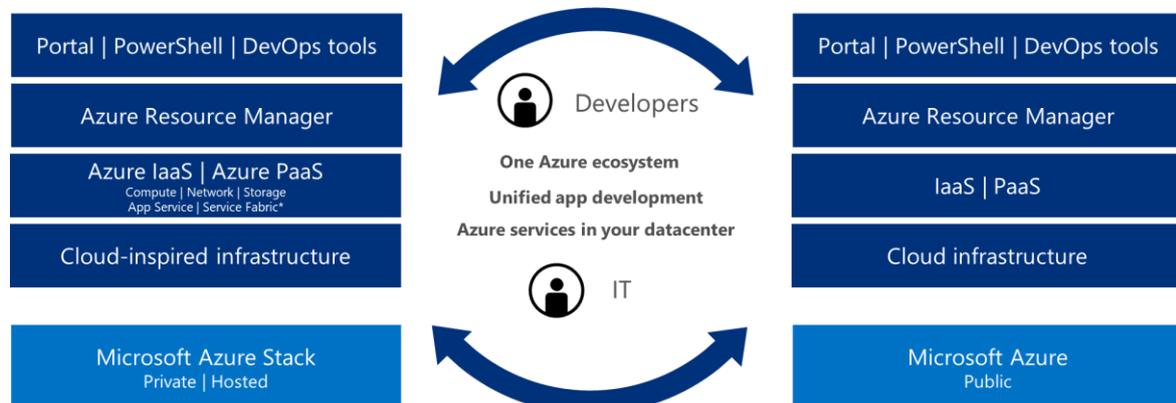


Azure Stack

Azure recognizes that even with all the advantages that the cloud provides in terms of speed and flexibility, minimized costs, performance, and reliability, many organizations are going to need to run on-premises datacenters for some time to come. In response to cloud adoption barriers, Azure provides a hybrid cloud strategy that builds bridges between your on-premises datacenters and the Azure public cloud. Azure Stack is an extension of Azure, bringing the agility and fast-paced innovation of cloud computing to on-premises environments. Organizations can now build modern applications across hybrid cloud environments, balancing the right amount of flexibility and control. Developers can build applications using a consistent set of Azure services and DevOps processes and tools, and then collaborate with operations to deploy to the location that best meets the business, technical, and regulatory requirements. Developers can speed new cloud application development by building on application components from the Azure Marketplace, including open-source tools and technologies.

Microsoft's hybrid cloud platform

Power of Azure in your datacenter



Azure and Azure Stack unlock new hybrid use cases for both customer-facing and internal LOB applications:

- **Edge and disconnected solutions:** Customers can address latency and connectivity requirements by processing data locally in Azure Stack and then aggregating in Azure for

further analytics, with common application logic across both. There is much customer interest in this edge scenario across different contexts, including factory floors, cruise ships, and mine shafts.

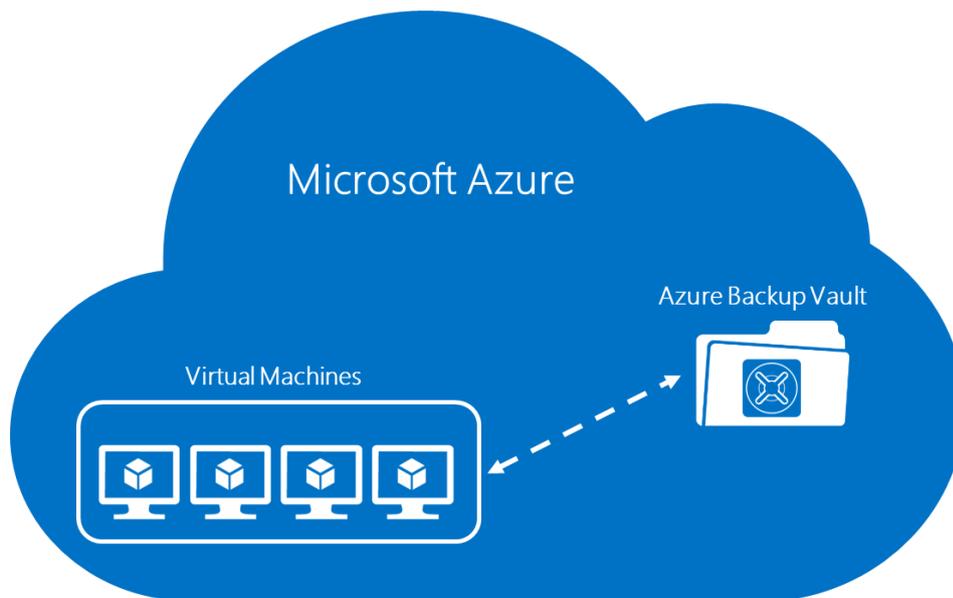
- **Cloud applications that meet varied regulations:** Customers can develop and deploy applications in Azure, with full flexibility to deploy on-premises on Azure Stack to meet regulatory or policy requirements, with no code changes needed. Illustrative application examples include global audit, financial reporting, foreign exchange trading, online gaming, and expense reporting. Many customers are looking to deploy different instances of the same application to Azure or Azure Stack, based on business and technical requirements. While Azure meets most requirements, Azure Stack complements the deployment approach where needed.
- **Cloud application model on-premises:** Customers can use Azure web services, containers, serverless, and microservice architectures to update and extend existing applications or build new ones. You can use consistent DevOps processes across Azure in the cloud and Azure Stack on-premises. Broad interest exists in application modernization, including for core mission-critical applications.

Business continuity and disaster recovery

Even a minor outage can put you at a competitive disadvantage. One of the essential functions of an organization's IT is to ensure that corporate data is never lost and that applications stay available—despite server crashes, power outages, or natural disasters. Business and technology owners must determine how much functionality is required during a disaster. This level of functionality can take a few forms: completely unavailable, partially available via reduced functionality or delayed processing, or fully available. As an organization you can adopt a business continuity and disaster recovery (BCDR) strategy that keeps your data safe, and your apps and workloads up and running, when planned and unplanned outages occur.

Azure Recovery Services contributes to your BCDR strategy in many ways.

Azure Backup: The first step in preventing data loss in Azure is to back up your data. Use Azure Backup to protect data for on-premises servers, virtual machines, virtualized workloads, SQL Server, SharePoint Server, and more. Azure Backup is the Azure-based service you can use to back up (or protect) and restore your data in the Microsoft Cloud. Azure Backup replaces your existing on-premises or off-site backup solution with a cloud-based solution that is reliable, secure, and cost-competitive. Azure Backup offers multiple components that you download and deploy on the appropriate computer, server, or in the cloud. The component, or agent, that you deploy depends on what you want to protect. All Azure Backup components (no matter whether you're protecting data on-premises or in the cloud) can be used to back up data to a Recovery Services vault in Azure.



Site Recovery service: Site Recovery helps ensure business continuity by keeping business apps and workloads running during outages. Site Recovery replicates workloads running on physical and VMs from a primary site to a secondary location. When an outage occurs at your primary site, you fail over to a secondary location and access apps from there. After the primary location is running again, you can fail back to it. Azure Site Recovery makes it simple for you to test disaster recovery by replicating applications between Azure regions. You can also replicate on-premises VMware and Hyper-V virtual machines and physical servers to Azure to stay available if the primary site goes down. Recover workloads to the primary site when it's up and running again.

Security and management

Initially, public cloud migrations were driven by cost savings and agility to innovate. Security was considered a major concern for some time, and even a showstopper, for public cloud migration. However, public cloud security has transitioned from a major concern to one of the drivers for cloud migration. The rationale behind this is the superior ability of large public cloud service providers to protect applications and the data of cloud-based assets.

The Azure infrastructure is designed from facility to applications for hosting millions of customers simultaneously, and it provides a trustworthy foundation upon which businesses can meet their security needs. In addition, Azure provides you with a wide array of configurable security options, and the ability to control them, so that you can customize security for the unique requirements of your deployments to meet your IT control policies and adhere to external regulations.

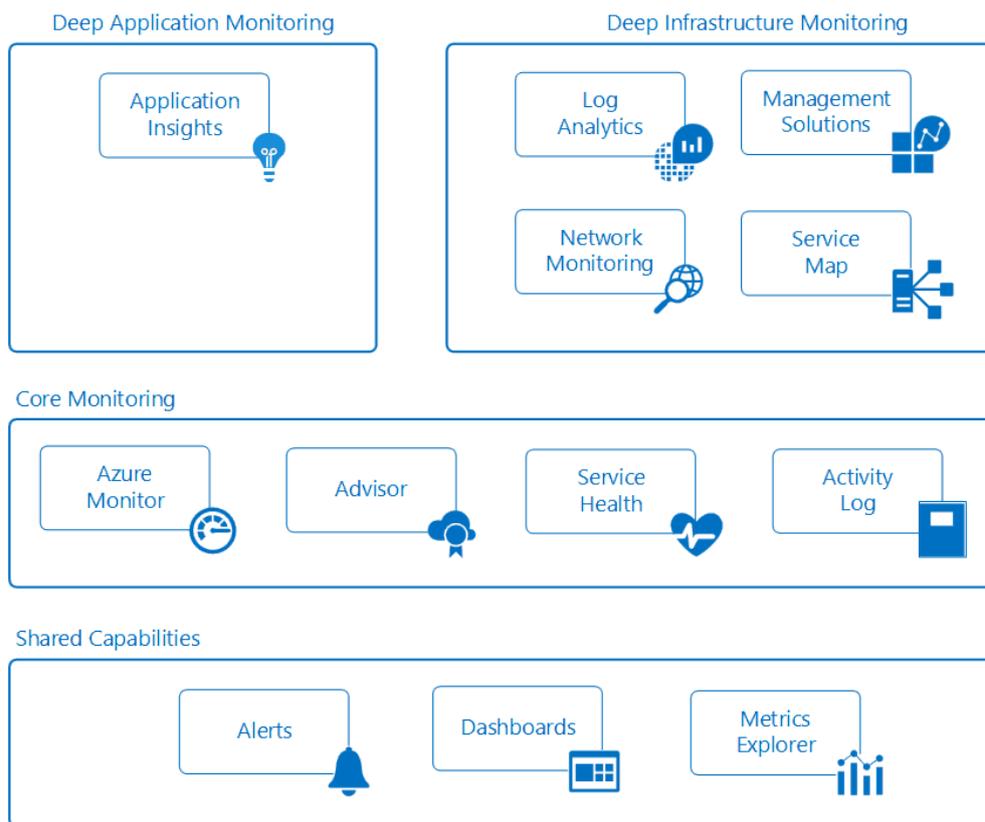
Azure Security Center: Azure Security Center makes Azure the only public cloud platform to offer continuous security-health monitoring. It provides unified security management and advanced threat protection across hybrid cloud workloads. With Security Center, you can apply security policies across your workloads, limit your exposure to threats, and detect and respond to attacks. This includes:

- **Centralized policy management:** Ensure compliance with company or regulatory security requirements by centrally managing security policies across all your hybrid cloud workloads.
- **Continuous security assessment:** Monitor the security of machines, networks, storage and data services, and applications to discover potential security issues.
- **Actionable recommendations:** Remediate security vulnerabilities before they can be exploited by attackers with prioritized and actionable security recommendations.

- **Advanced cloud defenses:** Reduce threats with just-in-time access to management ports and whitelisting to control applications running on your VMs.
- **Prioritize alerts and incidents:** Focus on the most critical threats first with prioritized security alerts and incidents.
- **Integrate security solutions:** Collect, search, and analyze security data from a variety of sources, including connected partner solutions.
- **Use Azure Monitoring:** Monitoring is the act of collecting and analyzing data to determine the performance, health, and availability of your business application and the resources that it depends on. An effective monitoring strategy helps you understand the detailed operation of the components of your application. It also helps increase your uptime by proactively notifying you of critical issues so that you can resolve them before they become problems.

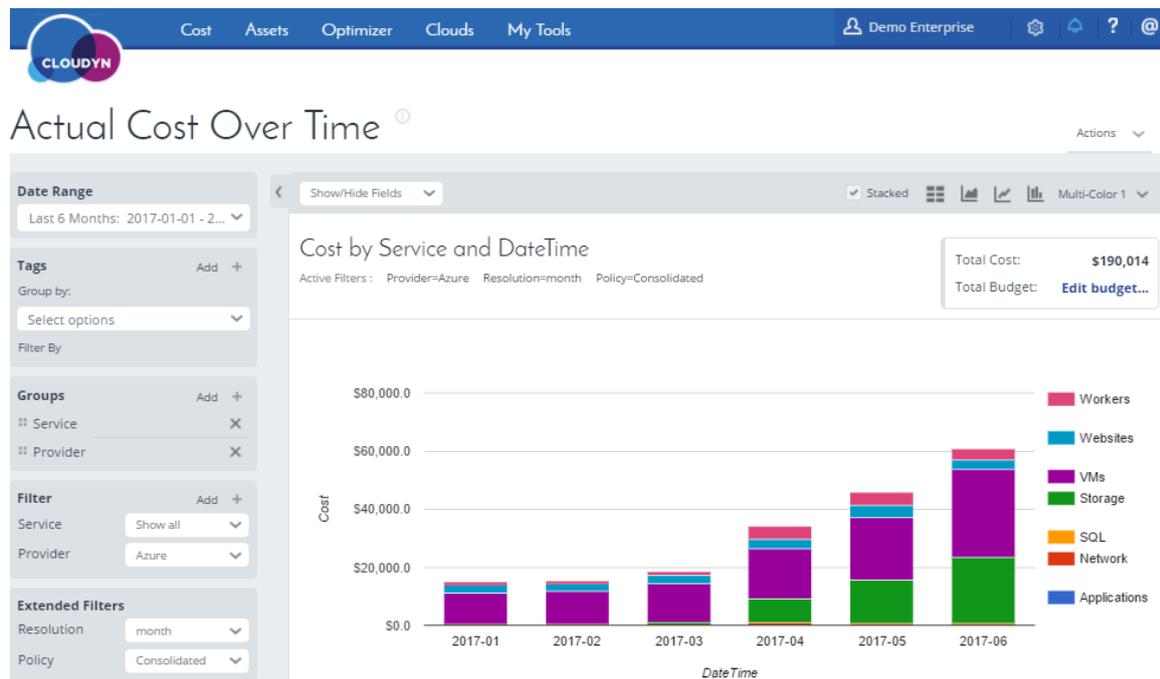
Azure includes multiple services that individually perform a specific role or task in the monitoring space. Together, these services deliver a comprehensive solution for collecting, analyzing, and acting on telemetry from your application and the Azure resources that support them. They can also work to monitor critical on-premises resources in order to provide a hybrid monitoring environment. Understanding the tools and data that are available is the first step in developing a complete monitoring strategy for your application.

The following diagram shows a conceptual view of the components that work together to provide monitoring of Azure resources.



Azure Cost Management, licensed by Cloudyn (a Microsoft subsidiary), allows you to track cloud usage and expenditures for your Azure resources and other cloud providers, including AWS and Google. Easy-to-understand dashboard reports help with cost allocation and showbacks/chargebacks as well. Cost Management helps optimize your cloud spending by identifying underutilized resources that you can then manage and adjust. Monitoring your usage and spending is critically important for

cloud infrastructures because organizations pay for the resources they consume over time. When usage exceeds agreement thresholds, unexpected cost overages can quickly occur.



High-performance compute

Organizations have large-scale computing needs. These big compute workloads include engineering design and analysis, financial risk calculations, image rendering, complex modeling, Monte Carlo simulations, and more. Use the Azure cloud to efficiently run compute-intensive Linux and Windows workloads, from parallel batch jobs to traditional HPC simulations. Run your HPC and batch workloads on Azure infrastructure, with your choice of compute services, grid managers, Marketplace solutions, and vendor-hosted (SaaS) applications. Azure provides flexible solutions to distribute work and scale to thousands of VMs or cores, and then scale down when you need fewer resources. You can also extend your on-premises high-performance computing (HPC) cluster to the cloud when you need more capacity or run work entirely in Azure. Scale easily and take advantage of advanced networking features such as RDMA to run true HPC applications using MPI to get the results you want, when you need them. Azure provides on-demand compute resources that enable you to run large parallel and batch compute jobs in the cloud, including:

- High-performance computing VMs:** Azure H-series virtual machines are the latest in high performance computing VMs. They are designed to deliver cutting-edge performance for complex engineering and scientific workloads like computational fluid dynamics, molecular modeling, crash simulations, seismic exploration, and weather forecasting simulations. These 8 and 16 vCPU VMs are built on the Intel Haswell E5-2667 V3 processor technology, featuring DDR4 memory and SSD-based temporary storage. In addition to substantial CPU power, the H-series offers diverse options for low-latency RDMA networking using FDR InfiniBand and several memory configurations to support memory-intensive computational requirements. Enterprise customers burst their HPC jobs to Azure for additional compute power, helping to solve complex design of experiments (DOE), optimizations, and other critical projects. H-series virtual machines provide on demand compute capacity to deliver great performance: running a variety of applications, helping businesses around the world reducing their product development cycle, and bringing products to market faster.
- Azure Batch:** Use Batch to run large-scale parallel and HPC applications efficiently in the cloud. Define Azure compute resources to execute your applications in parallel or at scale, without manually configuring or managing infrastructure. Schedule compute-intensive tasks,

and dynamically add or remove compute resources based on your requirements. Azure Batch provides job scheduling and auto-scaling of compute resources as a platform service, making it easy to run large-scale parallel and HPC applications in the cloud. By using the Batch SDKs and Batch service, you can configure one or more applications to run on demand or on a schedule across a pool of VMs. Describe how the data should be distributed, what parameters to use for each task, and the command line to get started. Azure Batch handles both scale and scheduling, managing the execution as a whole.

- **Azure CycleCloud:** The CycleCloud software suite is the leading cloud orchestration, provisioning, and data management platform for big compute, big data, and large technical computing applications running on any public, private, or internal environment. It's designed to enable enterprise IT organizations to provide secure and flexible cloud HPC and big compute environments to their end users. With dynamic scaling of clusters, the business can get the resources it needs at the right time and the right price. CycleCloud's automated configuration enables IT to focus on providing service to business users.
- **Azure Avere:** Avere uses an innovative combination of file system and caching technologies to support performance requirements for customers who run large-scale compute workloads. Avere solutions ensure storage performance keeps pace with workload demand by enabling enterprises to derive greater performance from existing storage infrastructure, as well as to take advantage of cloud-based resources to expand the capacity and throughput of HPC platforms. Avere Systems technology boosts workflows by accelerating data access and making that access available to more concurrent requests. Building a global HPC platform on Avere technology can enable enterprises to rapidly scale from a hundred to tens of thousands of cores and beyond—without sacrificing performance or exceeding budget and staffing limits.
- **Azure Cray:** Microsoft and Cray are working together to bring customers the right combination of extreme performance, scalability, and elasticity. Customers can get dedicated Cray XC or CS series supercomputers in Azure to run HPC and AI applications alongside their other cloud workloads directly on the Azure network. The Cray systems easily integrate with Azure Virtual Machines, Azure Data Lake storage, the Microsoft AI platform, and Azure Machine Learning services for rich workflows and collaboration. All of this is provided in the cloud with the most datacenters worldwide, the most compliance certifications, and dedicated regions for government agencies and their partners. Only this partnership with Microsoft and Cray allows customers to run a broad array of hybrid workflows in the cloud, and be fully supported by the experts in enterprise cloud and HPC.

Hero solutions for modernization

App modernization

[App modernization using App Service](#)

Modernize your LOB applications to meet today's IT challenges and your rapidly changing business needs. Technology transformation starts with cloud technology and enables faster development, higher productivity, reduced costs, and more secure applications throughout your organization.

Azure Web Apps enables you to modernize your apps where you can build and host web applications in the programming language of your choice without managing infrastructure. It offers auto-scaling and high availability, supports both Windows and Linux, and enables automated deployments from GitHub, Visual Studio Team Services, or any Git repo. Azure App Service Web Apps (or just Web Apps) is a service for hosting web applications, REST APIs, and mobile back ends. You can develop in your favorite language, be it .NET, .NET Core, Java, Ruby, Node.js, PHP, or Python. Applications run and scale with ease on Windows-based environments.

Web Apps not only adds the power of Microsoft Azure to your application, such as security, load balancing, autoscaling, and automated management. You can also take advantage of its DevOps

capabilities, such as continuous deployment from VSTS, GitHub, Docker Hub, and other sources, as well as package management, staging environments, custom domain, and SSL certificates.

[App modernization using AKS](#)

Containers make it easy for you to continuously build and deploy applications. By orchestrating the deployment of those containers using Kubernetes in Azure Container Service, you can achieve replicable, manageable clusters of containers.

Azure Kubernetes Service (AKS) manages your hosted Kubernetes environment, making it quick and easy to deploy and manage containerized applications without container orchestration expertise. It also eliminates the burden of ongoing operations and maintenance by provisioning, upgrading, and scaling resources on demand, without taking your applications offline. AKS reduces the complexity and operational overhead of managing Kubernetes by offloading much of that responsibility to Azure. As a hosted Kubernetes service, Azure handles critical tasks like health monitoring and maintenance for you.

[App modernization and microservices using Service Fabric](#)

You should think about architecting cloud-native applications when you are targeting large and complex applications with multiple independent development teams working on different microservices that can be developed and deployed autonomously. Also, granularized and independent scalability per microservice typically requires you to architect for the cloud and write new code—code adapted to specific PaaS platforms, or code that aligns with specific architectures like microservices.

Service Fabric enables you to build and manage scalable and reliable applications composed of microservices that run at high density on a shared pool of machines, referred to as a cluster. It provides a sophisticated, lightweight runtime to build distributed, scalable, stateless, and stateful microservices running in containers. It also provides comprehensive application management capabilities to provision, deploy, monitor, upgrade/patch, and delete deployed applications including containerized services. Service Fabric also addresses the significant challenges in developing and managing cloud-native applications. Developers and administrators can avoid complex infrastructure problems and focus on implementing mission-critical, demanding workloads that are scalable, reliable, and manageable. Service Fabric represents the next-generation platform for building and managing these enterprise-class, tier-1, cloud-scale applications running in containers.

[Azure Pivotal Cloud Foundry](#)

Accelerate your technology transformation. Streamline application development cycles, and build and operate cloud-native, enterprise Java apps with a comprehensive, continuous-delivery platform. A cloud-native platform based on open-source technology, Pivotal Cloud Foundry (PCF) enables you to deliver new experiences to your customers, rapidly and repeatedly. You can use any language or runtime, and leverage various backing services (such as MySQL, RabbitMQ and Redis), to defer much of the operational complexity to the platform.

Cloud Foundry is an open-source PaaS for building, deploying, and operating 12-factor applications developed in various languages and frameworks. There are two forms of Cloud Foundry available to run on Azure: open-source Cloud Foundry (OSS CF) and Pivotal Cloud Foundry (PCF). OSS CF is an entirely open-source version of Cloud Foundry managed by the Cloud Foundry Foundation. Pivotal Cloud Foundry is an enterprise distribution of Cloud Foundry from Pivotal Software Inc.

[App modernization with OpenShift](#)

Red Hat OpenShift is a container application platform that brings Docker and Kubernetes to the enterprise. Regardless of your applications architecture, OpenShift lets you easily and quickly build, develop, and deploy in nearly any infrastructure, public or private. Whether it's on-premises, in a public cloud, or hosted, you have an award-winning platform to get your next big idea to market ahead of your competition.

OpenShift on Azure is jointly engineered, operated, and supported by both Red Hat and Microsoft. As a fully managed service, it will be kept up to date, with a single unified bill, integrated support experience, and in all respects a native Azure service. OpenShift on Azure makes it easier to set up and use with native Azure integration and leverage the same Kubernetes technology that powers Azure Kubernetes Service.

[Cloud-native apps](#)

[Cloud-native applications](#) are designed specifically for a cloud computing architecture. These applications take advantage of cloud computing frameworks, which are composed of loosely coupled cloud services. Such applications are ones that have a high degree of uptime and are highly available, from wherever there's an internet connection. These applications are also extremely scalable.

[Event-driven apps](#)

Most modern applications are built using events—whether it is reacting to changes coming from IoT devices, responding to user clicks on mobile apps, or initiating business processes from customer requests. Azure Event Grid enables efficient management and handling of these events.

[Azure Event Grid](#) is a fully managed service that supports the routing of events by utilizing a publisher-subscriber model. At its core, Event Grid is an event routing service that manages the routing and delivery of events from numerous sources and subscribers. You can use filters to route specific events to different endpoints, multicast to multiple endpoints, and make sure your events are reliably delivered. Event Grid also has built-in support for custom and third-party events.

[Gaming](#)

Modern games require more powerful development tools, global and flexible multiplayer support, and new revenue models as compared to gaming development a few years ago. Today's games have evolved from instructional tools to a new class of interactive entertainment. By adopting cloud technologies, you experience quick turnaround to develop, test, and launch game apps to meet the needs of the growing number of game users and ever-changing business requirements. With cloud, now you can build a game upfront, and then continuously deliver new experiences while monetizing at the same time.

Azure is a leader in cloud computing and provides choice and flexibility to adopt cloud for your game app and its backend services. Azure can help build games faster, launch with confidence and globally, and monetize intelligently. And it's not for the future, it's happening right now. The Hitman franchise, owned by IO Interactive (IOI), released the latest version of Hitman in the form of the world's first episodic AAA game in April 2016. With the help of Azure, developers were able to focus more on thinking about new, interactive features to make a serviced game like Hitman even better, instead of worrying about underlying infrastructure and services. IO Interactive has also been taking advantage of continuous delivery and monetization, recently announcing a new Challenger Pack for Hitman as well as 10 new player-curated Featured Contracts that players can purchase. From fresh upstarts to the biggest names in the industry, [Azure powers games](#) that get results.

DevOps

DevOps brings together people, processes, and technology, automating software delivery to provide continuous value to your users. With [Azure DevOps solutions](#), deliver software faster and more reliably—no matter how big your IT department or what tools you are using. With Azure DevOps you can enable automation with:

- **Continuous integration (CI):** Take advantage of continuous integration to improve software development quality and speed. When you use Visual Studio Team Services or Jenkins to build apps in the cloud and deploy to Azure, each time you commit code, it is automatically built and tested—so bugs are detected faster.
- **Continuous delivery (CD):** Ensure that code and infrastructure are always in a production-deployable state, with continuous delivery. By combining continuous integration and infrastructure as code (IaC), you achieve identical deployments and the confidence you need to manually deploy to production at any time.
- **Continuous deployment with CI/CD:** With continuous deployment, you can automate the entire process from code commit to production if your CI/CD tests are successful. Using CI/CD practices, paired with monitoring tools, you can safely deliver features to your customers as soon as they are ready.

Modern business intelligence

Businesses are increasingly monitoring and tracking data about what it takes to keep themselves running. They collect and maintain increasingly available data, such as transaction and sales data stored in data warehouses, server log files tracking visitors, data from sensors tracking delays on factory floors, IT data logs, and data on their competitors and industrial sectors. Data-driven decision making—orienting business decisions around data—drives major IT initiatives across all business sectors.

Collecting the information is only the first step. A great deal of research has investigated the process by which people work with data: how they ask questions about it, make sense of it, and communicate with it. A critical part of this chain is information visualization tools. Visualization provides a powerful way to make sense of data. By mapping data attributes to visual properties such as position, size, shape, and color, visualization designers leverage perceptual skills to help users discern and interpret patterns in data.

Business intelligence (BI) is the practice of interpreting and visualizing data to make useful, business-oriented decisions. BI tasks occur in offices, universities, and datacenters, and provide data-oriented lifeblood to research and business organizations worldwide. BI systems must often appeal to broad audiences, from knowledge workers to CEOs to stockholders. They must allow for rapid analysis for decision making, developing insights, and communicating the results of those insights. Gain deeper insight into your data to stay in the know and spot trends as they happen. With BI solutions and tools, your entire organization can understand and quickly act on data.

Self-service BI

Most business users in an organization require access to self-service tools to prepare data for analysis. Such self-service BI solutions can transform business users from data consumers to active data analysts, reducing the time and complexity of data gathering and preparation, and shifting the monopoly on data extraction, processing, and visualization from IT to a model of data analysis across the organization.

Power BI is a complete self-service data analysis tool available right now, enabling all users to make smart decisions with data. Connect with ease to internal data sources and external data services, such as Microsoft Dynamics, Salesforce, and QuickBooks. Process data with drag-and-drop gestures. Use

natural language to query datasets and create compelling visualizations. And share your reports with colleagues using content packs. Power BI is at the forefront of tools that help cultivate and strengthen data-savvy knowledge workers.

[On-premises BI modernization](#)

Do you want an on-premises solution for reporting today? And the flexibility to move to the cloud tomorrow? Power BI Report Server is the on-premises solution you can use today. Power BI Report Server gives your users access to data and insights, and the enterprise-reporting capabilities of SQL Server Reporting Services—all in a modern, on-premises solution. You can visually explore data and quickly discover patterns to make better, faster decisions. At the same time, generate the precisely formatted reports your business needs. You'll also be able to confidently scale to thousands of users because Power BI Report Server is based on a proven, enterprise-grade platform. Power BI Report Server is built on the proven SQL Server Reporting Services technology, and includes all Reporting Services capabilities, including operational (RDL) reports.

[Build modern applications with intelligence](#)

From developers to executives, tools for analysis empower your customers to make better-informed decisions. Regardless of the business objective of your application, you must provide confidence in data-driven decision making to your customers. But access to analytics doesn't guarantee the value of insight. Too often, a lack of contextual tools prevents users from taking full advantage, especially where it relates to everyday tasks that must be performed quickly and accurately.

Power BI Embedded simplifies Power BI capabilities by helping you quickly add stunning visuals, reports, and dashboards to your apps. Similar to apps built on Microsoft Azure, use services like Machine Learning and IoT. By enabling easy-to-navigate data exploration in their apps, you can make quick, informed decisions in context.

[Artificial intelligence](#)

Computing advances have created intelligent machines that complement human reasoning to augment and enrich our experience and competencies. Artificial intelligence (AI) will define the next generation of software solutions. Human-like capabilities such as understanding natural language, speech, vision, and making inferences from knowledge will extend software beyond the app. Vast amounts of data, faster processing power, and increasingly smarter algorithms are powering AI applications and associated use cases across consumer, finance, healthcare, manufacturing, transportation and logistics, and government sectors around the world—enabling smarter and intelligent applications to speak, listen, and make decisions in unprecedented ways. As AI technologies and deployments sweep through virtually every industry, a wide range of use cases are beginning to illustrate potential business opportunities, and inspire changes to existing business processes leading to newer business models.

Modern AI applications live at the intersection of cloud computing, data platforms, and AI tools. The cloud provides a powerful foundation for elastic compute and storage, while supporting special-purpose hardware such as graphics processing units (GPUs) that accelerate demanding calculations. It also enables connectivity, identity, application monitoring, and the Internet of Things (IoT). Data platforms in the cloud can ingest and integrate massive volumes of data, use databases and data lakes to transform and analyze the data, and build real-time data-driven applications. Layered upon these capabilities are AI tools and algorithms that help developers build models from the data for targeted intelligent scenarios, and deploy them in a hosted AI application.

At Microsoft, researchers in artificial intelligence are harnessing the explosion of digital data and computational power with advanced algorithms to enable collaborative and natural interactions

between people and machines that extend the human ability to sense, learn, and understand. The research infuses computers, materials, and systems with the ability to reason, communicate, and perform with human-like skill and agility. Deep investments by Microsoft in the field are advancing the state of the art in machine intelligence and perception, enabling computers to understand what they see, communicate in natural language, answer complex questions, and interact with their environment. In addition, the company's researchers are thought leaders on the ethics and societal impacts of intelligent technologies. The Microsoft AI platform offers a comprehensive set of flexible AI services, enterprise-grade AI infrastructure, and modern AI tools for developers and data scientists to create applications of the future.

Intelligent apps

Build intelligent apps faster using the tools and technologies of your choice and AI that is already built in. Building intelligent apps using Azure is easy, because no other platform brings analytics and native AI to your data wherever it lives and in the languages you use. Take advantage of a rich set of cognitive APIs to easily build new experiences into your apps for human-like intelligence. Use your team's existing skill sets, and tools you know and love, to build intelligent apps and deploy without a change in code. Build once, deploy anywhere: in the cloud, on premises, and to edge devices, with the confidence of global distribution to more datacenters than any other provider. Choose your favorite technologies, including open source. Azure supports a range of deployment options, popular stacks and languages, and a comprehensive set of data engines. Capitalize on this flexibility, plus the performance, scale, and security delivered by Microsoft technologies to build apps for any scenario.

Intelligent agents (bots)

A bot is an app that users interact with in a conversational way using text, graphics (cards), or speech. It may be a simple question-and-answer dialog, or a sophisticated bot that allows people to interact with services in an intelligent manner using pattern matching, state tracking, and AI techniques well integrated with existing business services.

Azure Bot Service provides an integrated environment that is purpose-built for bot development, enabling you to build, connect, test, deploy, and manage intelligent bots, all from one place. Bot Service provides tools to build, test, deploy, and manage intelligent bots all in one place. Through the modular and extensible framework provided by the SDK, developers can leverage templates to create bots that provide speech, language understanding, question and answer, and more.

Machine learning

Machine learning is a data science technique that allows computers to use existing data to forecast future behaviors, outcomes, and trends. Using machine learning, computers learn without being explicitly programmed. Forecasts or predictions from machine learning can make apps and devices smarter. When you shop online, machine learning helps recommend other products you might like based on what you've purchased. When your credit card is swiped, machine learning compares the transaction to a database of transactions and helps detect fraud. When your robot vacuum cleaner vacuums a room, machine learning helps it decide whether the job is done.

Azure Machine Learning is an integrated, end-to-end data science and advanced analytics solution. It enables data scientists to prepare data, develop experiments, and deploy models at cloud scale. Machine Learning opens massive possibilities for predictive analytics, AI, and real-time applications. The platform of choice for building these applications has been Apache Spark. With a massive community at thousands of enterprises worldwide, Spark makes it possible to run powerful analytics algorithms at scale and in real time to drive business insights. However, managing and deploying

Spark at scale has remained challenging, especially for enterprise use cases with large numbers of users and strong security requirements.

Databricks provided an end-to-end, managed Apache Spark platform optimized for the cloud. Featuring one-click deployment, autoscaling, and an optimized Databricks Runtime that can improve the performance of Spark jobs in the cloud by 10-100x, Databricks makes it simple and cost efficient to run large-scale Spark workloads. Moreover, Databricks includes an interactive notebook environment, monitoring tools, and security controls that make it easy to leverage Spark in enterprises with thousands of users. Azure Databricks has gone one step beyond the base Databricks platform by integrating closely with Azure services through collaboration between Databricks and Microsoft. Azure Databricks is an Apache Spark-based analytics platform optimized for the Microsoft Azure cloud services platform. Designed with the founders of Apache Spark, Databricks is integrated with Azure to provide one-click setup, streamlined workflows, and an interactive workspace that enables collaboration between data scientists, data engineers, and business analysts.

Internet of Things

IoT is about using data from connected “things” to better understand business operations and making smarter decisions based on that knowledge. An IoT solution involves equipping any type of physical device, such as factory equipment, display kiosks, fleets, and even agricultural fields and public water supplies, with the ability to collect and transmit data—making them IoT-enabled, or “smart.” By analyzing the data that connected things generate, organizations can find opportunities for improvement and new sources of value. At a minimum, basic reporting and analysis is critical—without it, IoT data amounts to little more than a lot of noise. More and more objects and devices are made with built-in sensors and Wi-Fi capabilities. At the same time, the internet is getting more sophisticated and technology costs are going down, making IoT more accessible than ever.

Azure IoT simplifies IoT and helps you get started quickly and easily. With the most comprehensive IoT portfolio—spanning solutions, platform services, and industry-leading edge technologies—you can create operational efficiencies, new revenue streams, and better customer experiences. When you connect your business with IoT, the opportunities are endless. Accelerate your IoT journey with fully managed and industry-specific IoT solutions, or build a customized IoT application that enables fine-grain control. Either way, Azure IoT offers powerful and secure IoT solutions that will meet your needs today and into the future.

IoT Central

Azure IoT Central is a fully managed SaaS solution that makes it easy to connect, monitor, and manage your IoT assets at scale. Azure IoT Central simplifies the initial setup of your IoT solution and reduces the management burden, operational costs, and overhead of a typical IoT project. You can bring your connected product vision to life by:

- Deriving new insights from connected devices to enable better products and experiences for your customers
- Creating new business opportunities for your organization

IoT Hub

IoT Hub is a managed service, hosted in the cloud, that acts as a central message hub for bi-directional communication between your IoT application and the devices it manages. You can use Azure IoT Hub to build IoT solutions with reliable and secure communications between millions of IoT devices and a cloud-hosted solution backend. You can connect virtually any device to IoT Hub.

IoT Hub supports communications both from the device to the cloud and from the cloud to the device. IoT Hub supports multiple messaging patterns such as device-to-cloud telemetry, file upload

from devices, and request-reply methods to control your devices from the cloud. IoT Hub monitoring helps you maintain the health of your solution by tracking events such as device creation, device failures, and device connections. IoT Hub's capabilities help you build scalable, full-featured IoT solutions such as managing industrial equipment used in manufacturing, tracking valuable assets in healthcare, and monitoring office building usage.

IoT Edge

Azure IoT Edge moves cloud analytics and custom business logic to devices so that your organization can focus on business insights instead of data management. Enable your solution to truly scale by configuring your IoT software, deploying it to devices via standard containers, and monitoring it all from the cloud. Analytics drives business value in IoT solutions, but not all analytics needs to be in the cloud. If you want a device to respond to emergencies as quickly as possible, you can perform anomaly detection on the device itself. Similarly, if you want to reduce bandwidth costs and avoid transferring terabytes of raw data, you can perform data cleaning and aggregation locally—and then send the insights to the cloud.

ⁱFastTrack for Azure is now available to eligible customers who satisfy the following criteria:

- Be located in one of these countries (English-only):
 - United States
 - Canada
 - Australia
 - United Kingdom
 - New Zealand
 - Western Europe*

*FastTrack for Azure is available as English-only in these Western European countries: Austria, Belgium, Denmark, Finland, Ireland, Italy, Luxembourg, Netherlands, Nordics, Norway, Portugal, Spain, Sweden, and Switzerland

- Have an identified Azure project estimated to consume a minimum of 5,000 USD per month (or local currency equivalent) of Azure services
- Have an active, paid Azure subscription
- Not be directly supported by a Microsoft Cloud Solution Architect
- Be ready to build and deploy a FastTrack-supported Azure solution