Microsoft

Cloud migration essentials

A guide to migrating servers and virtual machines

Contents

Introduction

In the past few years cloud adoption has increased significantly, as it provides considerable value over traditional datacenters—achieving greater scalability, cost efficiency, and improved performance.[1]

Many organizations are now looking to quickly take advantage of this value by migrating their existing applications and workloads. But cloud migration requires careful planning and strategy. One of the keys to cloud success is to determine the optimal platform and priorities for running business applications. Once considered optional, these applications are now central to infrastructure decisions and achieving company goals.

To enable successful migration, 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 the initial technical plans and business justification, ensure your workloads will run as expected, and perform the migration with limited impact on the business.

If you're an IT manager running on-premises applications and servers, this guide is designed to help you start their migration to the cloud.

In this guide, you'll discover:

✔ Preliminary steps to consider when looking at migration

☁ Various approaches for rehosting, refactoring, and revising your workloads for the cloud

⚙ Tools you can use to accelerate your migration project

Migrating to the cloud does not have to be difficult. With the right tools and processes, your migration project can be fast and friction free. Learn how methods such as lift and shift rapidly move you to the cloud—reducing cost immediately and enabling you to focus on future cloud modernization. Dive into assess, migration, and optimization methods to help along the way, and start to evaluate next steps in your continuing adoption of cloud resources.

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[1] By migrating to the cloud, you can save more than 80 percent over the total cost of running a traditional solution on-premises. (Migrating VMware to Microsoft Azure: Total cost of ownership guidance, November 2017. Retrieved from: https://azure.microsoft.com/mediahandler/files/resourcefiles/vmware-to-azure-migration-tco-guidance/VMware_to_Azure_migration_TCO_guidance.pdf)

> **"**One of our big objectives was to eliminate $3 million in capital costs over about three years, and to reduce our operating costs by approximately the same amount. At the same time, we wanted to improve our quality of service. With Azure, we're confident that we'll meet those goals.**"**
>
> **Jim Slattery, Chief Financial Officer, Capstone Mining**[2]

Why migrate now?

At first glance migration may seem like a technical decision, but at its core this is a business decision. Ultimately, it begs a fundamental question: what's driving your business to migrate to the cloud, and why now?

The benefits of cloud are universal—reduced running costs, faster modernization capabilities, and increased security. But often, specific initiators first kick off the discussion within an organization, including:

Operational efficiencies and reduction of operating expenses. Due to the reduction in hardware support, increased manageability, and efficiency of process, you can save an average of 20 to 30 percent on virtual-machine (VM) resource configuration alone.[3]

Decreased time to market/release. By reducing management overhead and freeing up budget, you can focus more time and effort on rapid software and solution development. Faster deployment of infrastructure as a service (IaaS) and platform as a service (PaaS) will enable your business to release faster and more often.

Support for scalability requirements that are more cost effective. When you have to plan for peak usage through on-premises systems, most of the time you're left with servers that are running at less than 20 percent utilization. The cloud releases organizations from this model, enabling a scale-when-you-need-it approach.

Renewal of datacenter or hardware leasing. If you're currently extending your budget on renewing hardware or paying for datacenter locations for hosting, this is the perfect time to look toward cloud migration. The cloud can make these necessities a thing of the past by enabling a cloud vendor to host these services for you.

Renewal of licensing. Nearly everyone has an annual licensing agreement with their major IT providers. These too require ample budget to ensure your virtualization and OS platform are sufficiently covered. The cloud can help you here, providing a pay-as-you-go offering to reduce this cost.

Application development and modernization. If you're in the software business, your resources are probably spread thin. And using on-premises platforms is likely not enabling you to adopt modern services. The cloud provides an integrated platform for modern development, where development teams can increase speed by up to 33 percent.[4]

Ultimately, by migrating your current environment to the cloud, you're putting yourself in a better position to accelerate your business. By reducing costs and making management more efficient, a cloud platform can immediately impact your IT group's ability to invest back into core strategic projects, increasing security and reliability while advancing application development.

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[2] Read the customer story:
https://customers.microsoft.com/story/capstone-mining
[3] VM sizing calculations are based on the Microsoft Azure TCO Calculator, which is available at: https://www.tco.microsoft.com/
[4] "The Shift to SaaS: A high-value opportunity for ISVs." Keystone Strategy. June 2017. Retrieved from: https://content.microsoft.com/Global/FileLib/PDF/EN-CNTNT-Keystone_Shift_to_SaaS_June_2017-en-us_updated.pdf

How do you approach cloud migration?

Sometimes cloud migration can be simple, with only a few decision points. However, your case may be more complex, depending on how many servers and virtual machines you use.

Your migration could require you to run parallel and iterative migration processes as you progressively move your applications and workloads to the cloud.

Whether your migration is simple or complex, it's helpful to think of the basic elements of the process. Migration can be boiled down to three main phases, as illustrated in the model below.

PaaS

SaaS

Lift and shift

Cloud optimization

Existing on-premises apps

App modernization

IaaS

PaaS

SaaS

Rearchitect

Rebuild

Refactor

IaaS   Rehost

Replace
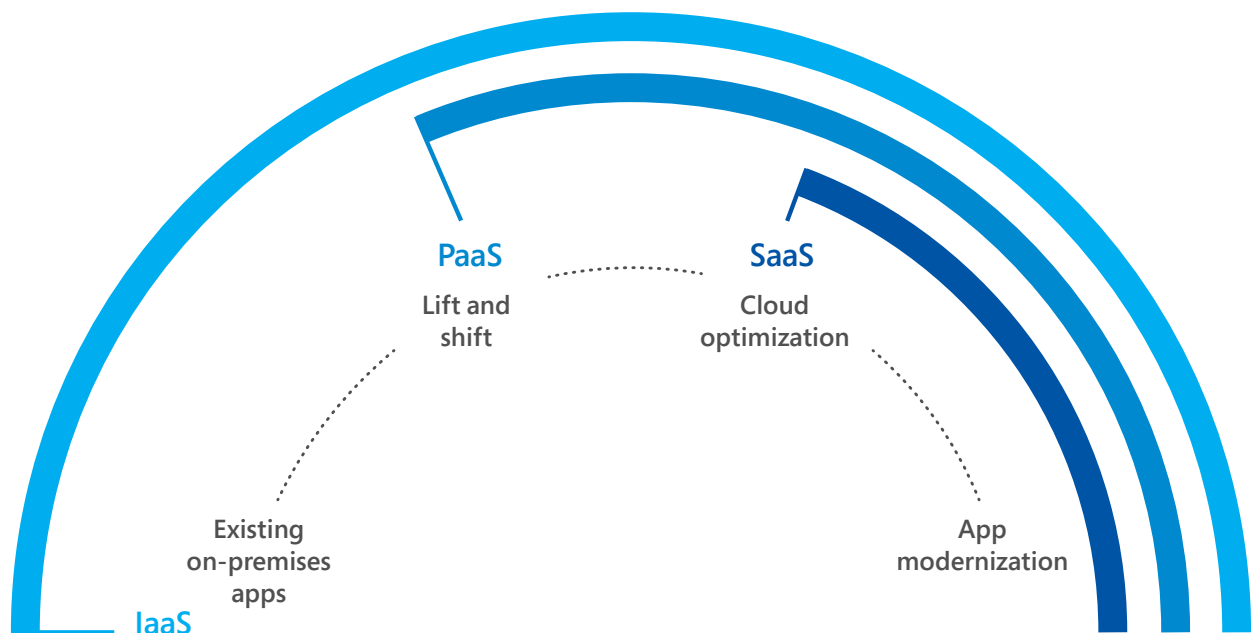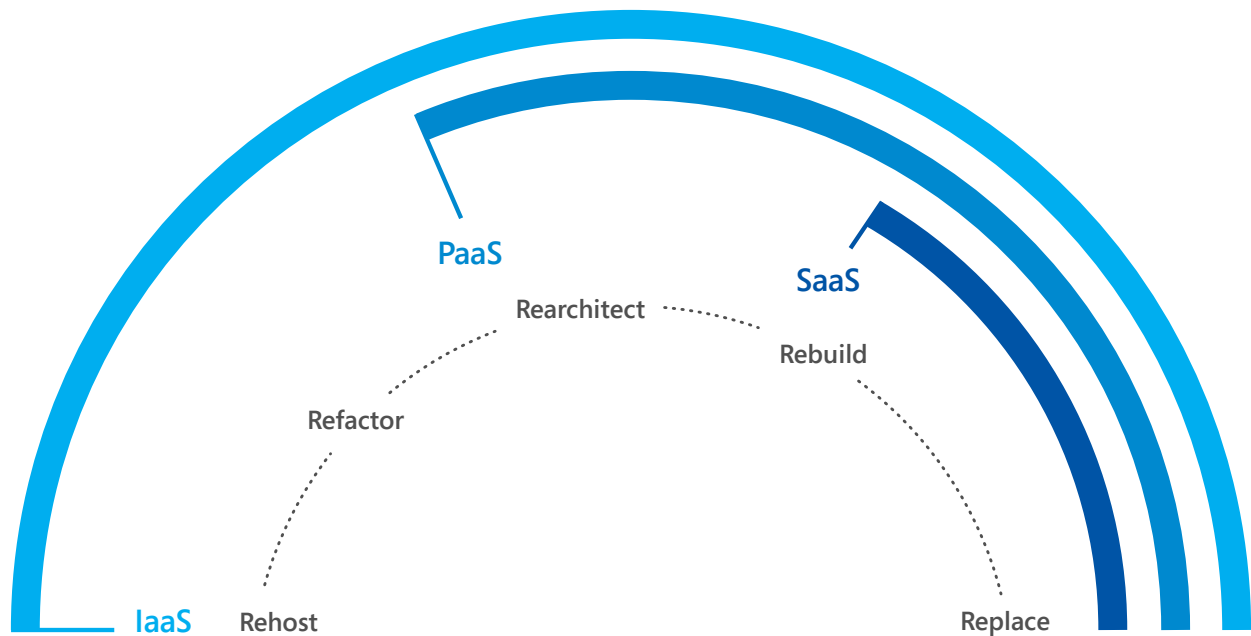
Rehost. Also referred to as "lift and shift," this stage entails migrating your physical servers and virtual machines as-is to the cloud. By simply shifting your current server environment straight to IaaS, you reap the benefits of cost savings, security, and increased reliability.

In the new rehosted cloud model, hardware and operating systems you previously managed yourself are now managed by the cloud provider. All other aspects of the workload or application remain the same. This is the most popular migration approach, as it lets organizations move quickly, with little risk or impact, and receive immediate benefits. It also allows customers to see lower total cost of ownership (TCO) faster, enabling investment back into the migration process to evolve through the model.

	Managed by customer
App data	
Code	
App configuration	
App platform	
Containers	

Remains same

	Managed by cloud provider
OS	
Hardware	

Figure A[5]

[5] "Five Options for Migrating Applications to the Cloud: Rehost, Refactor, Revise, Rebuild or Replace." Jeff Woods. Gartner: The Future of IT Conference. October 2011. https://gartnerinfo.com/futureofit2011/MEX38L_A2%20mex38l_a2.pdf

Refactor. Also known as "repackage," this stage involves using additional cloud provider services to optimize the cost, reliability, and performance by refactoring your applications. In lift and shift, you were only taking advantage of the provider-managed hardware and OS, but in this model you also take advantage of cloud services to drive down cost.

You continue to utilize your current application as-is, with some minor application code or configuration changes, and connect your application to new infrastructure services such as containers, database, and identity management systems. By employing modernized services in this scenario, you can lower cost and management.

App data	
Code	Managed by customer
App configuration	
App platform	
Containers	Managed by cloud provider
OS	
Hardware	

Updated (applies to App data, Code, App configuration)
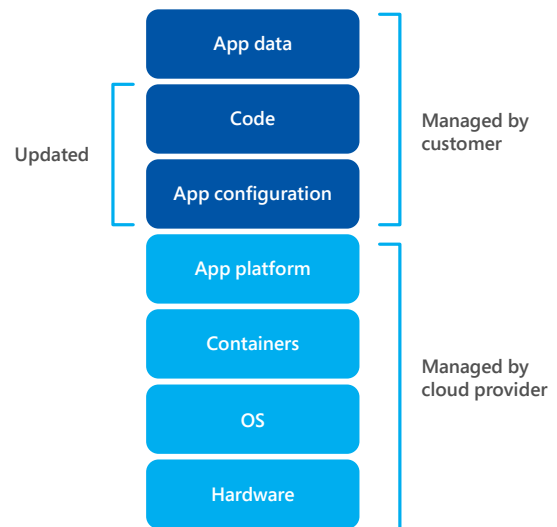
Figure B[5]

Rearchitect. This is also known as "redesigning" an application to modernize it—that is, to transform it with a modular architecture. Rearchitecting is modifying or extending an existing application's code base to optimize it for a cloud platform and for better scalability.

Cloud provider services can be used directly as backend services of modern apps, which are highly scalable and reliable. This is likely the most time-consuming way to migrate an app to the cloud because it requires app code changes. One example of rearchitecting would be decomposing a monolithic application into microservices that work together and readily scale on Azure. Another example would be rearchitecting a SQL Server database to make it a fully managed Azure SQL Database.

App data	
Code	Managed by customer
App configuration	
App platform	
Containers	Managed by cloud provider
OS	
Hardware	

New / Updated (applies to App data, Code, App configuration)
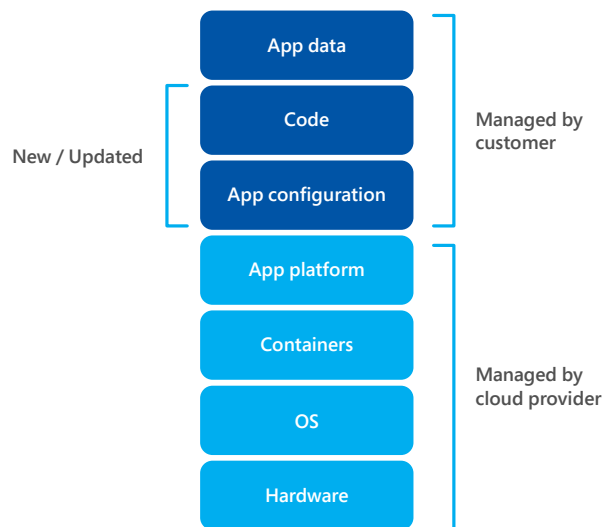
Figure C[5]

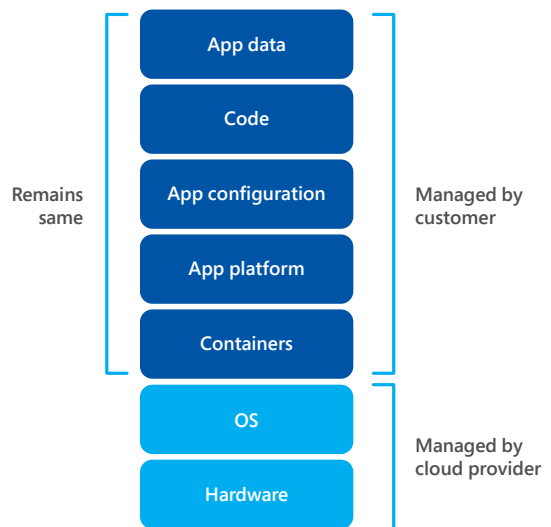[5] "Five Options for Migrating Applications to the Cloud: Rehost, Refactor, Revise, Rebuild or Replace." Jeff Woods. Gartner: The Future of IT Conference. October 2011. https://gartnerinfo.com/futureofit2011/MEX38L_A2%20mex38l_a2.pdf

Rebuild. Revise the existing application by aggressively adopting PaaS or even software as a service (SaaS) services and architecture. The process encompasses major revisions to add new functionality or to rearchitect the application for the cloud.

An example of this stage would be code redesign to decompose the original application into smaller chunks, and then deploy using modern cloud provider services.

Remains same		Managed by customer
	App data	
	Code	
	App configuration	
	App platform	
	Containers	
	OS	Managed by cloud provider
	Hardware	
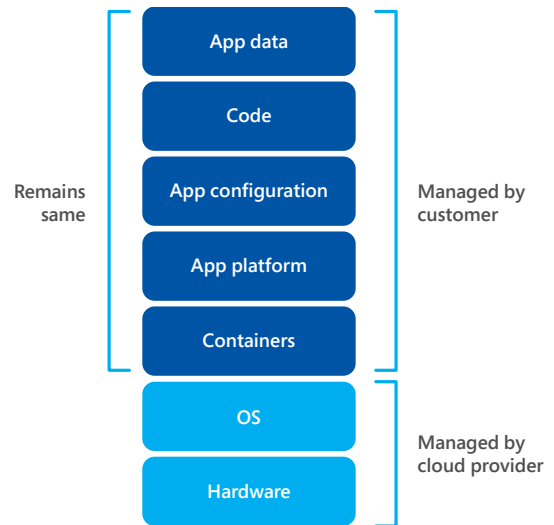
Replace. This refers to moving or discarding an existing application and replacing it with commercial software delivered as a service, or SaaS. SaaS provides a complete software solution that you purchase on a pay-as-you-go basis from a cloud service provider.

When you choose this option, all underlying infrastructure, middleware, app software, and app data are managed by service providers and located in their datacenters. The service provider manages the hardware and software and, with the appropriate service agreement, will ensure the availability and security of the app—and your data as well. SaaS allows your organization to get quickly up and running with an app at minimal upfront cost. Typically, you migrate existing data to the SaaS environment. Application data import/export is achieved with an API or configuration/admin console.

Transform		Managed by cloud provider
	App data	
	Code	
	App configuration	
	App platform	
	Containers	
	OS	
	Hardware	
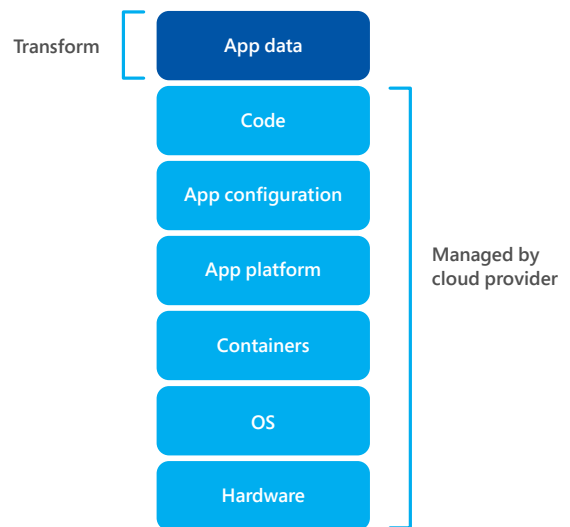
Lift and shift is the most common (and easiest) first step, enabling you to move quickly to the cloud. Through process discovery efforts, you can easily map the next best steps for each workload based on goals, effort, and complexity. An advantage of this approach is that it enables you to sustain parallel migration efforts. And, as your IaaS projects continue, you can easily start modernizing certain applications to PaaS and even SaaS options.

While the migration evolution model shows a potential step-by-step journey for moving workloads from on-premises to the cloud, the model also suggests that workloads could start at different pivot points. Where you begin depends upon the complexity of the workload and, ultimately, what you want out of it. For example, if you have a simple web application hosted in Windows

Server Internet Information Server (IIS), connected to a database, then it may make sense to proceed directly to the cloud optimization stage. In this case, you could migrate that application using Azure App Service and Azure SQL Database. To do this, you'd need to have a deep understanding of the application, including its complexity and dependencies.

No matter which option you choose, you need a solution that provides a smooth and easy cloud adoption, so you can migrate at your own pace. This requires a cloud provider (and core partners) who can deliver a comprehensive set of tools, methods, and offers for helping with migration and reducing risk. Most of all, this solution should offer a simple process that's easy to follow.

With these goals in mind, Microsoft recommends a simple three-step migration process for moving to the cloud:

Assess. Identify and inventory your on-premises resources, such as applications and workloads, to plan where your Azure migration should start.
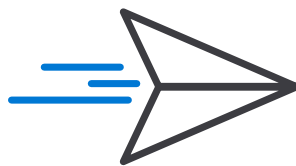
Migrate. Migrate smarter and faster with flexible, powerful tools, while ensuring minimal business impact.

Optimize. Fine-tune your resources to strengthen security, improve performance, and maximize return on investment (ROI).

With this straightforward framework, you get a proven approach to migration. This process provides a clear picture of your entire application and workload portfolio, the best way to configure your applications and workloads to achieve migration, convenient tools to ensure low-impact transfer, and ongoing performance and cost optimization.

But before migration begins, how do you ensure that your virtual datacenter in the cloud is ready to receive your workloads? As you're planning to run your most critical applications there, you want to be confident that your cloud foundation is solid. If you already have workloads or DevTest running on the cloud, then you may have an environment and connectivity ready to go. However, if you're new to the cloud or only have a basic setup there, then you'll need to perform a few steps before migration.

Before you migrate

Prior to migration, you essentially need to build a virtual datacenter in your cloud, including connectivity, networking, storage, and identity— elements comparable to your on-premises environment.

By building this virtual datacenter, you can ensure that your applications will continue to support the business after migration, without surprises.

Building this in the cloud is a streamlined process, as you can leverage components available there for fast assembly and configuration. Many excellent tools as well as guidance can help accelerate this step, but below are some of the basics—and why they're important to migration.

Identity

As with your on-premises environment, you need a way for users to be identified and authenticated to ensure secure access to your new cloud resources. In most cases, this means running Azure Active Directory or a similar solution. You could simply extend your on-premises identity to the cloud to support the migrated workloads. However, many cloud providers have built-in identity solutions provided as a service. These can also integrate with your on-premises identity systems to enable single sign-on for user convenience. As your workloads will now be stored within the cloud, you'll also want seamless access for users between your existing on-premises systems and the systems you've migrated.

To ensure a harmonious user experience—while supporting your expected growth into more advanced cloud services—a good investment would be a cloud-based identity management solution connected to your on-premises environment.
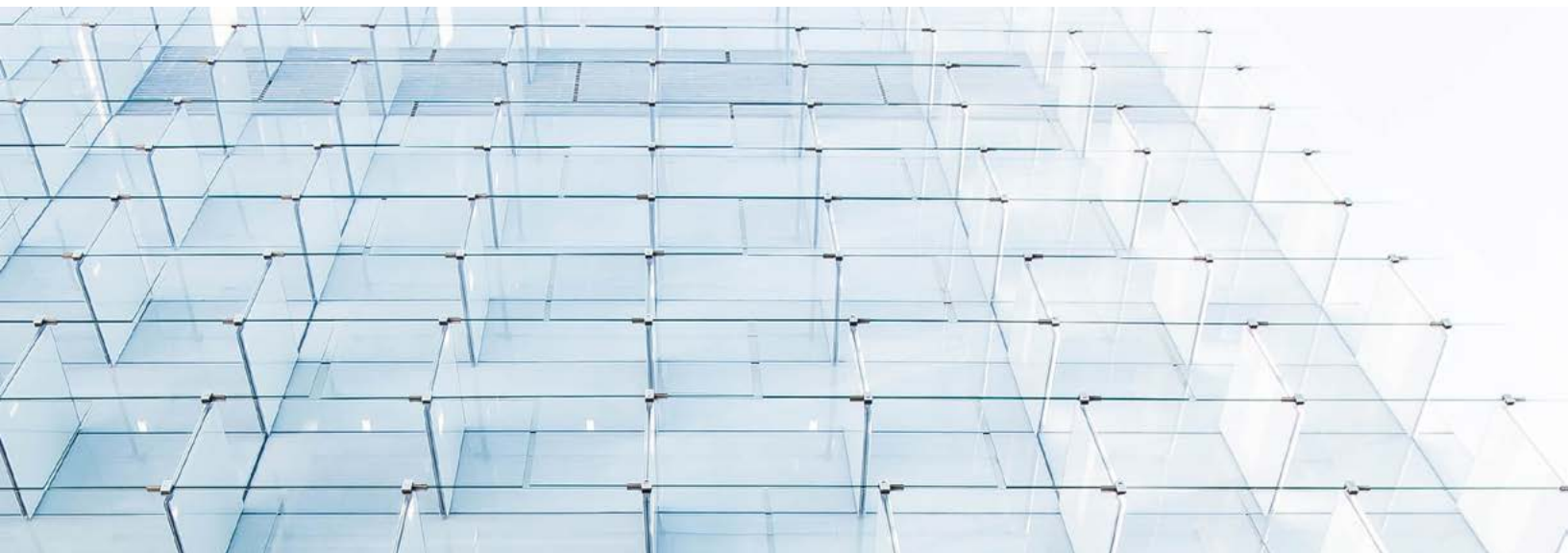
Storage

Another necessity in your cloud is a storage platform that will meet the expected performance needs of your migrated workloads. On-premises, this platform is usually through network attached storage (NAS) or storage area network (SAN) systems. In the cloud, virtual storage is often through blobs or page blobs, depending on the type of data being stored.

Fortunately, you can choose among many storage types to guarantee reliable performance, including performance and access levels, backup, geographical replication, and disaster recovery. Working with a virtual storage platform means you also have a finer degree of control and configuration. You can easily configure exact storage requirements for each workload as needed, without having to worry about physical architecture. Azure even offers managed storage, which takes the pain out of storage configuration. It requires you to enter just a few details before acquiring up to thousands of secure, reliable, and available disks for your migration project.

Networking

Networks are crucial. They are the figurative backbone of the datacenter. Moving to the cloud requires a new way of networking, since you're no longer reliant on physical topology. In fact, you can now overcome physical boundaries with a single subnet, which simplifies networking communication.

When moving applications from on-premises to the cloud, you may want to keep them in the same networking subnets and even IP address ranges to ensure a seamless migration. Virtual networking can support this and merge with your on-premises physical networking architecture, as needed. This ensures that your applications can continue to use the network topology they were built upon, further easing migration.

Connectivity

During migration, you will move vast amounts of data. However, you'll still be moving data even after the bulk of your critical workloads are hosted in the cloud. As such, you should consider a more dedicated connectivity option to help with the data transfer and ultimate end-user experience.

You may currently have virtual networks set up, possibly using Internet or site-to-site VPNs to connect to your cloud environment. While this works well for smaller deployments, you'll need a new approach to run an entire enterprise both during and after migration.

Azure ExpressRoute, for example, is a compelling tool to use for this. It ensures both performance and security—especially in the initial heavy lifting of virtual machines to Azure, which involves considerable data flowing across the wires. ExpressRoute enables a faster, private connection to Azure.

Azure Data Box is another option for migrating large amounts of data—when you're limited by time, network availability, or cost. Data Box is a physical device that you connect to your network. You load your data to it by using standard NAS protocols. Then you simply send it to Microsoft through a delivery transport service. Your data will then be securely loaded into your Azure environment.

Readiness

While many core management skills can migrate to the cloud, there are some key differences. You'll need to get up to speed on new skills. However, training takes time away from performing core duties, can be costly, and, frequently, doesn't properly build on what you already know.

Azure Essentials can help solve these problems by means of unique learning paths focused on job roles. This readiness tool offers simple online training in bite-sized pieces, practical labs, and assessments to test your knowledge. It's the fastest way for your team to grow their skills, and, best of all, it's free.

Beginning your migration

Now it's time to begin your migration journey to the cloud. This e-book focuses on a migration process where you would be moving the bulk of your applications and workloads running in virtual machines to IaaS (and plan to modernize after that has been performed). The environment in this scenario is set up in Azure with Azure Active Directory (linked to on-premises AD) for identity management, with managed disks ready to receive the data and virtual networks deployed.
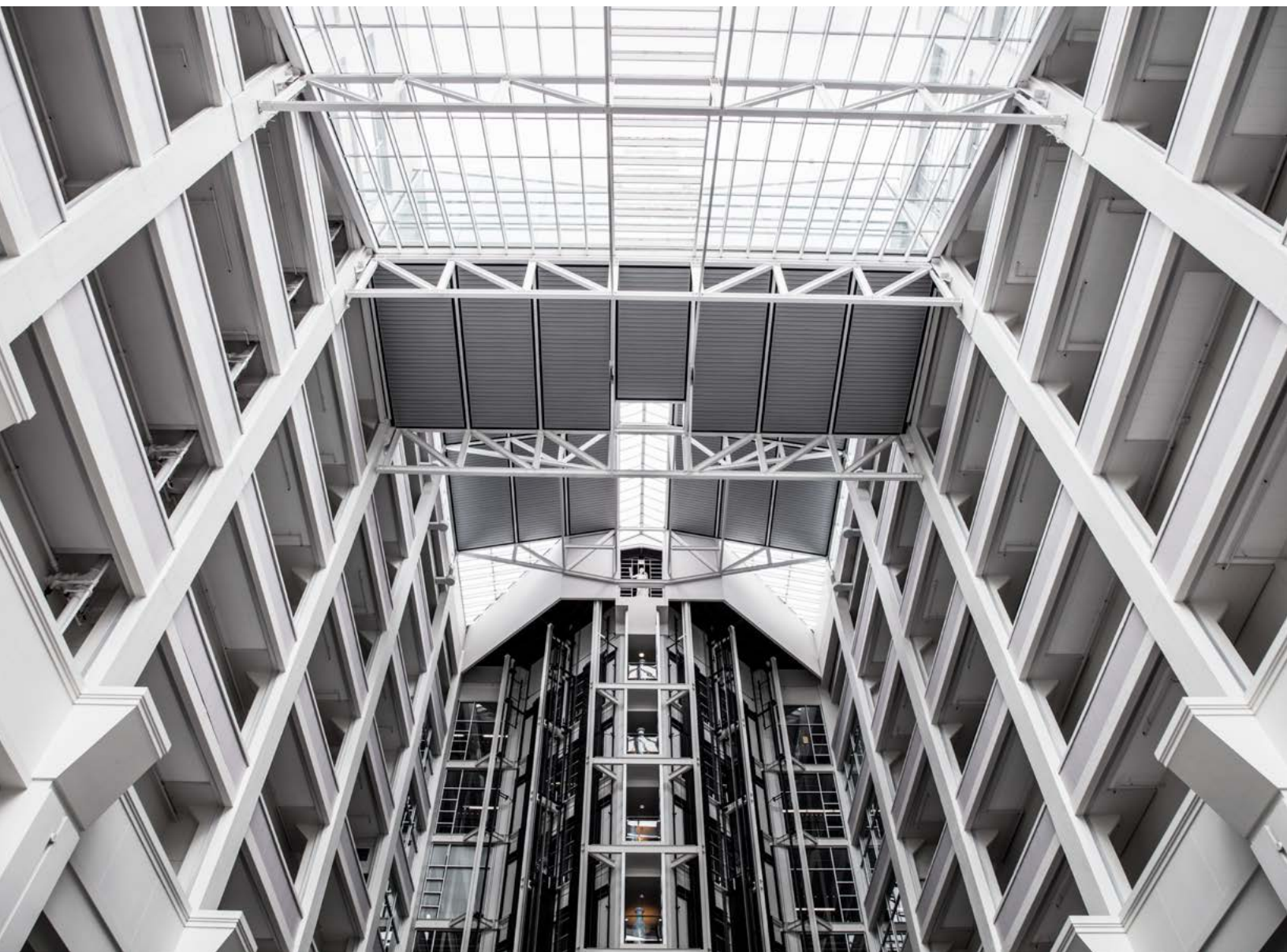
Assess

In migrating to the cloud, you first need to get a better understanding of your applications, how many servers and/or virtual machines you have, and how you'll need to plan to move them to the cloud.

Uncertainties about the total savings and perceived complexity can get in the way of taking this step. Many organizations have come to realize that moving existing workloads to Azure can yield significant benefits. Justifying the investment requires confidence that you'll save a significant amount on operational costs, and that your current workloads will work as expected in the cloud.

Many workloads can run immediately on Azure without modification, while other workloads that have operational and application dependencies in an on-premises environment require further analysis and planning. If your applications are made up of multiple servers or virtual machines, then consolidated planning must be done to identify these and shift them to the cloud. This is not a manual process, and you'll need intelligent planning tools to do it. Similarly, getting accurate cost comparisons can be challenging when you're estimating the load and cloud VM series type. Without automated analysis to map on-premises capacity to VM instance, your estimations may fall short—causing performance issues. Or your estimations may go too far—stretching your budget.

"We don't want to be in the datacenter business; we're in the thread business. We plan to move 90 percent of our global datacenter infrastructure into Azure, and we're at about 75 percent now. The only things we'll leave on-site are a few domain controllers and file/print servers."

Richard Cammish, Chief Information Officer, Dillon Gage[6]

[6] Read the customer story: https://customers.microsoft.com/en-us/story-precious-metals-dealer-ups-it-reliability-trims-costs

Assess in four steps

Technical and business planning for migration comes down to four straightforward steps:

| Assessment of on-premises applications and servers | Identification of application and server dependencies | Configuration analysis | Cost planning |
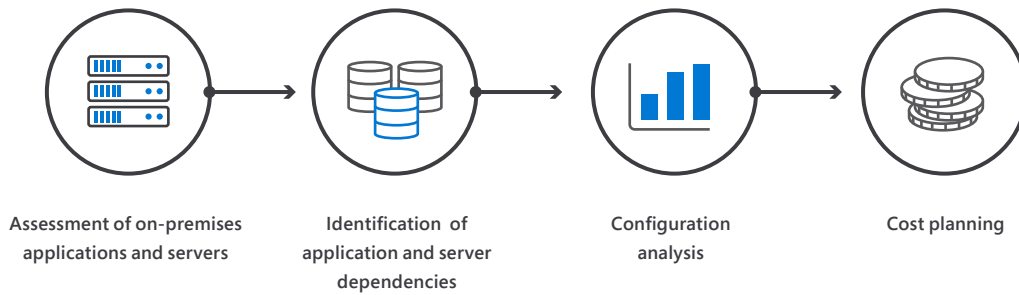
Assessment of on-premises applications and servers

It's likely that your organization runs hundreds—if not thousands—of servers and virtual machines. While your current management tools may represent these clearly, to kick-start any migration you'll need an assessment mechanism that can feed data into subsequent steps.

Discovering servers and virtual machines is usually a straightforward process. It relies on interaction directly with the endpoint (using an agent) or managing hypervisor (such as vSphere or Hyper-V).

Ultimately, the goal of the assess phase is to collect server and application information, including type, configuration, usage, and applications that may be running.

Identification of application and server dependencies

Once discovery is complete, you'll need to map any dependencies or communication between your servers (and applications). This is critical because when migrating an application, you need to know all the servers and processes the app is using.

Many tools provide server dependency mapping but don't extend to application dependencies. To ensure a full picture of all communication between workloads, you need a tool that will do both. This will allow you to create visual maps of all your applications and workloads, which enables their interaction as a single entity for costing, configuration analysis, and eventually migration.

Configuration analysis

The assess process enables you to ensure that each workload will function on your cloud platform. Through the collected analysis, assessment tools will be able to provide metrics on the compatibility of the workload in the cloud. For example, is the workload OS supported? Or are there specific hardware dependencies that may not be replicated in a cloud environment (such as running a UEFI boot, which is larger than a 4 TB data disk size)? Configuration analysis should tell you which workloads

will migrate with no modifications, modifications, which workloads might require basic modifications to comply, and which workloads are not compatible in their current formation, as well as provide guidelines to remediate potential issues or recommend configuration changes.

Cost planning

The final step of the assess phase is collecting resource usage reporting (such as CPU, memory, and storage). This is important, as on-premises virtual machines are often over-provisioned but actually utilized under 20 percent. If you were to take the physical configuration of your on-premises server and map this to an IaaS VM series type, you would likely find that you were paying for more performance and scale than you need.

Since the cloud is costed as a usage model, you should ensure your choice meets both performance and economic targets. The goal in any cloud model is to drive your virtual machines to at least 90 percent utilization, while making sure you meet performance and reliability goals. Through historic resource analysis, intelligent cost analysis tools can determine the actual usage of your workload and suggest the best cloud IaaS VM series to use.

Tools for assessment

Many tools in the Azure ecosystem enable you to tackle these needs simultaneously. As part of the Azure subscription for all customers, Microsoft offers Azure Migrate to provide automation for the assess phase. Azure Migrate is a great fit for customers who have virtualized servers in VMware. Customers with servers in other environments should leverage assessment tools from the Azure migration partner ecosystem. These tools can also help you with usage characteristics like CPU, memory, and storage to equivalent Azure environments, giving you the technical and business reporting needed to continue your migration plans. Using these tools will help you maximize the benefits of moving to Azure, as well as identify where programs such as Azure Hybrid Benefit best fit into your migration to save further budget. With Azure Hybrid Benefit, you can utilize your on-premises Windows Server licenses with Software Assurance when migrating and save up to 40 percent in Azure VM runtime costs.[7]

For further information on these tools, explore the following resources:

Azure Migrate. Take advantage of discovery, assessment, guidance, insight, and mechanisms for cloud migration through this free integrated Azure service.
› Learn more about Azure Migrate

Azure migration partners. Accelerate your migration with experienced assessment partners, who provide many options for your unique environments.

› Learn more about Azure migration technology partners

Azure Hybrid Benefit. Use your on-premises Windows Server licenses with Software Assurance to save big on Azure. With this benefit, for each license Microsoft will cover the cost of the OS (on up to two virtual machines!), while you pay only for base compute costs.
› Learn more about Azure Hybrid Benefit

Azure for Windows Server apps.
Save up to 82 percent on the pay-as-you-go price of running Windows Server apps in Azure Virtual Machines when you combine the Azure Hybrid Benefit for Windows Server with the upcoming Reserved Virtual Machine Instance offering.
› Learn more about running Windows Server apps on Azure

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[7] Azure Hybrid Benefit. Retrieved from:
https://azure.microsoft.com/pricing/hybrid-benefit/

04

Migrate

Once you have completed your discovery and assessment, it's time to prepare for the next step: cloud migration.

This is where, after you have landed on your migration goals and gathered all requirements and constraints, you can choose the best method of migration.

Earlier in this e-book, we overviewed the migration evolution model that showed workloads progressing through phases of lift and shift, cloud optimization, and eventually app modernization.

During the migration effort, you'll determine the approach that best meets your requirements. This is best addressed per application. Essentially, in this phase, you're physically moving your workloads and applications (including their data) to the cloud and planning to retire the on-premises versions. Every organization will have a different approach and mixture of using rehosting, refactoring, rearchitecting, or rebuilding for their applications.

This e-book focuses on the rehost approach, moving applications running on traditional servers and virtual machines to Azure IaaS. In many cases, organizations will start with lift and shift to drive rapid migration and early cost savings. Lift and shift involves no change in your app or workload framework or architecture; it simply means exchanging hardware and OS management with the cloud environment. This approach requires confidence regarding two key issues. Can your workload be easily migrated, without too many manual steps? Will your workload function as expected in the cloud? As such, several decision points come into play based on what's being moved, and especially how (or if) you want to access it while the migration is taking place.

The lift-and-shift method most often employed for server or VM migration is **real-time replication**, due to its flexibility and capability in staged migration. Real-time replication allows the workload to remain online and accessible during the migration. And, as you'll see in the next section, modern tools enable the system to cleanly migrate real-time data even when the system is actively being used.
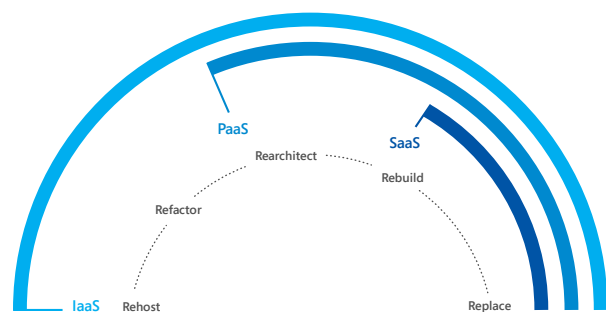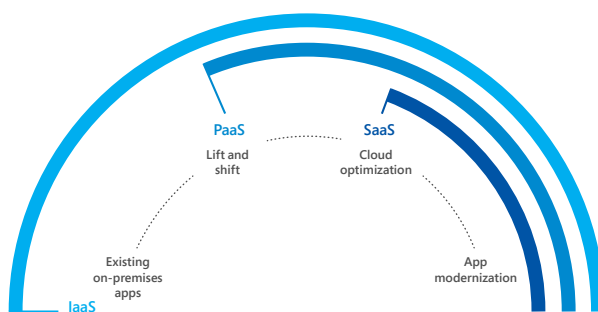
Real-time replication

Real-time replication involves setting up a copy of the workload in the cloud and allowing asynchronous replication to keep the copy and the workload in sync. This means that while you're building and executing your migration plans, any data or server updates are synced between the copies.

This model also enables groups of virtual machines to be connected, as in a multi-tiered application or workload. This is important when testing and the final migration cut-over begins. When the system is aware of the connections and dependencies between virtual machines, you can create plans to ensure the VMs are bought up in the correct order when starting. For example, with a simple web app, your database source needs to be available before the application runtime begins.

Using your assessment plans as a guide—and your migration tool of choice—you can configure each VM to replicate to the correct VM instance in your cloud provider. This is also the point when you should define the storage and network connections that you set up initially in the environment creation. Most tools have a mechanism to define the replication timeframe (usually from 30 seconds to 15 minutes). This will be based on your network capability and latency.
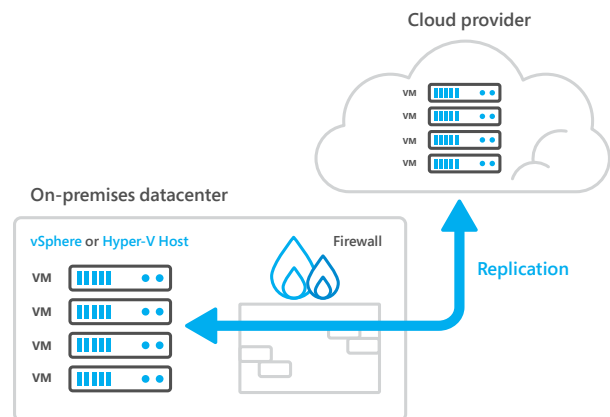
Many tools also support application-aware replication automatically. Microsoft applications (such as SharePoint, Dynamics, SQL Server, and Active Directory) and apps from other vendors (including Oracle, SAP, IBM, and Red Hat) can be migrated with application-aware replication, which ensures the source data consistency before replication. Initial replication is also bandwidth intensive, and mechanisms discussed earlier—like ExpressRoute and Data Box—can assist with this. It's something to consider when planning your migration timeline.

Testing

Testing is integral to ensuring system health before final cut-over. Many migration tools include options to start up your set of VMs in an isolated environment, which allows you to mimic the production environment in the cloud. This means you can fully test the application without affecting either the on-premises or cloud production versions. Once replication is complete, simply start your application or workloads using the isolated environment option, while taking time to test your start-up script or runbook for any errors. When you're fully satisfied that both function as expected, it's time to perform the final cut-over.

Migration tools can also do the final launch in your cloud and turn off the on-premises version. In some cases, you may have to update some DNS records for the new cloud-based workloads. However, if you migrated to use DNS in the cloud as part of your initial environment setup, this may happen automatically.

> "To expand globally, we can simply clone the infrastructure that we have running in our US Microsoft Azure datacenter to Azure datacenters in Asia and elsewhere."

Tom Grounds, Chief Information Officer, Coats[8]

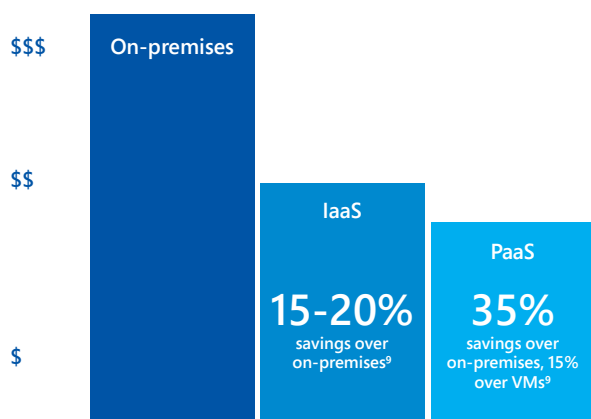## Taking further advantage of your cloud provider to drive application innovation

As you migrate your existing virtual machines in Azure, this is also the perfect time to continue on the path to application modernization. To do this, you can take advantage of your cloud provider, delivering even further cost savings and flexibility.

As you may remember from the migration evolution model, cloud optimization is the next logical step following lift and shift, or "rehosting," for your workloads, as you'll find many of them can take advantage of PaaS services.

The PaaS services of immediate interest are containers, app services, and database services. Why look at cloud optimization so soon after migrating? The answer is simple. Now that you have done all the hard work in assessing, analyzing, and migrating to the cloud, you've made it easier to take the step to PaaS. Plus, you can get more cost benefits through reduced management and operating expense reduction.

A clear place to start is containerization. Containerization provides an OS-level virtualization method used to deploy and run distributed applications without launching an entire VM for each app. With containerization, you get immediate savings on operational expenditure due to a reduced footprint in the cloud. Remember that the smaller your footprint, the more economical it is. Containerization rapidly moves compatible apps to containers (out of large VMs) with no code changes. It immediately provides you with the benefit of running multiple apps with no affect on the end user experience.

The next consideration in optimization is moving to specific PaaS services. There are a lot of options to choose from, but two to start with are app services and database

	On-premises		
$$$			
$$		IaaS	
			PaaS
		15-20% savings over on-premises[9]	**35%** savings over on-premises, 15% over VMs[9]
$			

services due to the ease of the migration activity. In many cases, web and mobile applications can migrate to App Service with little refactoring effort.

By moving to PaaS for your suitable apps and databases, you're significantly lowering costs by reducing your footprint and management requirements. You can save an additional 15–20 percent or more by migrating workloads and applications to PaaS, over and above the savings you are making today with IaaS.

It's important to note that there will be an initial investment of time, effort, and budget to move to more advanced PaaS services. In some cases, you'll have a

[8] Read the customer story: https://customers.microsoft.com/story/coats
[9] Based on the Microsoft Azure Cost Calculator. Retrieved from: https://www.tco.microsoft.com/

simple migration where the application is "cloud ready," but in others configuration changes and code updates may be required. Fortunately, there are tools available that enable you to analyze the code and determine the effort required to move to App Service.

For your databases, this is a straightforward process. Azure provides options for database PaaS services, including Azure SQL Database, where you are hosting the data on a full database as a service (DBaaS) platform. Azure SQL Database enables you to host database data in a service, reducing your database management costs, but has some limitations compared to a full SQL Server deployment. If your applications need functionality that may not be available in Azure SQL Database, then SQL Database Managed Instance is recommended. Azure SQL Database Managed Instance provides the full platform experience of SQL Server, but with the underlying OS and SQL service fully managed by Azure.

Tools for migration

As the migration of servers and virtual machines is different for everyone, multiple tools are available to support your needs. These range from the Microsoft-provided Azure Site Recovery (ASR) to third-party tools. Third-party tools are valuable alternatives when you have specific needs not covered by ASR. For example, while there are some OS types ASR can't migrate, various partner tools can support these efforts.

Database migration is uniquely supported by the Azure Database Migration Service (DMS). By using the DMS migration workflow, you will be able to move your on-premises databases to Microsoft Cloud. DMS enables schema and data migrations from SQL Server to Azure, including SQL Server on virtual machines and Azure SQL Database.

Alternatively, you may have other specific needs, like rapid migration (migrating over a hundred VMs per day), where normal replication may not be sufficient. In this case, tools can assist in migrating the run-time to Azure first while leaving the storage on-premises. Then, over time, the storage is replicated. Many options can meet your unique migration needs. Learn more at Azure Migration Center.

For further information on these tools, explore the following resources:

Azure Site Recovery. Migrate physical servers or VMs from on-premises to Azure, or support custom replication timing, isolated testing, and final migration cut-over. You can replicate and migrate your VMs to Azure using right-sizing recommendations for migration as part of the assessment phase, and take advantage of Azure Hybrid Benefit when the initial replication occurs (as a configuration option). This tool saves you time, as you don't need to retroactively go back and perform these tasks for each VM.
› Learn more about Azure Site Recovery

Azure Database Migration Service. Migrate your existing application database to Azure as a VM, Azure Managed Instance, or directly to Azure SQL Database.
› Learn more about the Azure Database Migration Service

Azure migration partners. Accelerate your migration to Azure with partners offering technology solutions and the expertise to help.
› Learn more about Azure migration technology partners

05

Optimize

Once you've implemented your cloud migration strategy, you'll want to ensure that you're successfully taking advantage of the cloud's performance, scalability, and cost-saving benefits.

This will enable you to only pay for the services and resources you use, achieve a greater ROI, and receive additional savings by taking advantage of the latest cloud capabilities. This is also the best time to start looking at new services for modernizing your application, migrating to PaaS and even SaaS, where applicable.

On-premises tools are not built for cloud scale and agility. Plus, they're simply not aligned with the new usage models enabled by the cloud. Continual optimization is a critical third step in your migration journey. Optimization targets two main areas—ensuring peak performance and continual cost efficiency.

Once you migrate, you'll also want to make sure to keep your virtual machine continuously secure, protect your data, and monitor your cloud health. And that's easy to do with Azure—once you get an understanding of the full suite of controls and capabilities available to you.

Secure cloud resources

Ensuring strong security for your cloud-based resources is a shared responsibility between you and your cloud provider. Azure is built with a foundation of trust and security, compliance, privacy, and transparency. The Azure platform provides a secure foundation to host your infrastructure with built-in security controls and capabilities to help you further protect your data and applications.

Azure Security Center provides unified security management and advanced threat protection across hybrid cloud workloads. The Security Center enables you to take advantage of several capabilities, including:

› **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.

Protecting data

Azure ensures workloads and data are fully backed up and protected from disasters, while providing encryption of stored data for internal and customer security. Azure can also automatically encrypt your stored data—while allowing full accessibility to all applications and users.

› **Virtual machine disk encryption**. Azure Disk Encryption enables encryption of Windows and Linux Azure Virtual Machine disks. Azure Disk Encryption uses the industry standard BitLocker feature of Windows and the dm-crypt feature of Linux to provide volume encryption for the OS and the data disks. The solution is integrated with Azure Key Vault to help you control and manage the disk encryption keys and secrets in your key vault subscription, while ensuring that all data in the virtual machine disks are encrypted at rest in your Azure storage.

› **Virtual machine backup**. Azure Backup is a scalable solution that protects your application data with zero capital investment and minimal operating costs. Application errors can corrupt your data, and human errors can introduce bugs into your applications. With Azure Backup, your virtual machines running Windows and Linux are protected.

› **Azure Site Recovery**. An important part of your organization's business continuity and disaster recovery (BCDR) strategy is figuring out how to keep corporate workloads and apps up and running when planned and unplanned outages occur. Azure Site Recovery helps orchestrate replication, failover, and recovery of workloads and apps so that they are available from a secondary location if your primary location goes down.

Monitoring cloud health

As with any system, monitoring is important to drive both proactive and reactive analysis. Azure provides many monitoring services targeted at applications, workloads, and core service health to ensure you have full visibility into your current system status—plus, access to important data when working with a break-fix situation. In Azure, you can use either basic or premium monitoring services.

Basic monitoring provides fundamental, required monitoring across Azure resources. These services need minimal configuration and collect core telemetry that the premium monitoring services use.

› **Azure Monitor**. Azure Monitor enables basic monitoring for Azure services by allowing the collection of metrics, activity logs, and diagnostic logs. For example, the activity log tells you when new resources are created or modified. Metrics are available that provide performance statistics for different resources, and even the operating system, inside a virtual machine. You can view this data with one of the explorers in the Azure portal, send it to Azure Log Analytics for trending and detailed analysis, or create alert rules to proactively get notifications of critical issues.

› **Service Health**. It's important to be aware of any issues with Azure services concerning any dependent applications. Azure Service Health identifies issues with Azure services that might affect your application. Service Health also helps you plan for scheduled maintenance.

› **Azure Advisor**. Azure Advisor constantly monitors your resource configuration and usage telemetry. It then gives you personalized recommendations based on best practices. Following these recommendations helps you improve the performance, security, and availability of the resources that support your applications.

Premium monitoring services build on basic monitoring and provide powerful analytics with collected data to give you unique insights into your applications and infrastructure. Plus, they present you with data in the context of scenarios that are targeted to different audiences.

› **Application Insights** enables you to monitor the availability, performance, and usage of your application, whether it's hosted in the cloud or on-premises. By instrumenting your migrated or rearchitected application to work with Application Insights, you can quickly identify and diagnose errors without waiting for a user to report them. With the information that you collect, you can make informed choices on your application's maintenance and improvements. Application Insights stores its data in a common repository where it can take advantage of shared functionality such as alerts, dashboards, and deep analysis with the Log Analytics query language.

› **Service Map** provides insight into your IaaS environment by analyzing virtual machines with their different processes and dependencies on other computers and external processes. It integrates events, performance data, and management solutions in Log Analytics. You can then view this data in the context of each computer and its relation to the rest of your environment.

› **Network Watcher** provides scenario-based monitoring and diagnostics for different network scenarios in Azure. It stores data in Azure metrics and diagnostics for further analysis.

Many premium management solutions are packaged sets of logic that provide insights for an application or service. They rely on log analytics to store and analyze the monitoring data that they collect. **Azure Log Analytics** enables deeper visibility into your hybrid IT environment and allows you to diagnose performance issues from an advanced analytics portal in one click.

Azure Log Analytics enables you to:

› **Analyze data**. In Log Analytics, you can leverage log searches by constructing queries to analyze the collected data, using pre-existing dashboards that you can customize with graphical views of your most valuable searches. Once you have a defined collection of operational data from your Azure virtual machines and activity logs, you can perform powerful searches.

› **Visualize data**. Log Analytics dashboards can visualize all your saved log searches, giving you the ability to find, correlate, and share IT operational data in your organization.

› **Alert data**. Alerts in Log Analytics identify important information in your repository. They are created by alert rules that automatically run log searches at regular intervals and match certain criteria. With Alert Action, you can perform advanced actions with alerts, such as create an email notification, launch an automation runbook, or create an incident record in your ITSM incident management system.

Continual cost efficiency and optimization

Performance monitoring can help you achieve beneficial cost optimization. In the initial assessment, you performed right-sizing for your on-premises workload based on a point in time. Once those workloads are moved to Azure, their usage may change. For example, if you move a moderately used app from on-premises to Azure, the initial assessment phase may recommend for the middle-tier VM a D2v3 instance (2 vCPU and 8 GB RAM). However, after six months, the use of that application might decline, so you'd want to downsize to a lower VM instance to reduce costs.

Azure Cost Management shows you usage and costs so that you can track trends, detect inefficiencies, and create alerts. All usage and cost data are displayed in intuitive dashboards and reports. With built-in cost management, you can continually monitor for CPU and memory usage, enabling recommendations for virtual-machine instances that can be further right-sized. These services can also help you monitor for over-utilized VMs and up-size as needed to ensure performance service level agreements (SLAs). Plus, these services can help you discover under-utilized VMs for potential downsizing. For example, Azure cost optimization can provide a regular view of your current virtual-machine total utilization.

With a quick glance, you can determine the number of virtual machines that are consistently under-utilized (that is, running below 90 percent). Then, with the Azure cost optimization sizing opportunities, you can find recommendations for which VMs should be actioned, as well as the suggested instance change (including potential annual savings).

As you continue to utilize your new IaaS environment, targeting maximum cost savings through Azure Reserved VM Instances (RI) becomes attractive. Reporting available in Azure Cost Management can recommend the workloads that would benefit from RIs, maximizing your TCO.

Tools for optimization

For further information on optimization tools, explore the following resources:

Security with Azure Security Center. With Security Center, you can apply security policies across your workloads, limit your exposure to threats, and detect and respond to attacks.
› Learn more about the Azure Security Center

Azure Cost Management. Get detailed visibility into the resource costs of running systems on Azure through this service that is tightly integrated with Azure operations.
› Learn more about Azure Cost Management

Azure Log Analytics. This service centralizes log data from multiple systems in a single data store.
› Learn more about Azure Log Analytics

Monitoring in Azure. Get detailed, up-to-date performance and utilization data, access to the activity log that tracks every API call, and diagnostic logs that help you debug issues in your Azure resources. Management solutions are available from Microsoft and partners to provide monitoring for various Azure and third-party services.
› Learn more about Azure Monitoring

Azure migration partners. Accelerate your migration with experienced assessment partners, who provide many options for your unique environments.
› Learn more about Azure migration technology partners

Summary

No matter why your organization is looking to move to the cloud, you shouldn't be put off by its seeming complexity.

As you've learned in this e-book, breaking a migration down into elemental steps will contribute to a more successful migration. You can start this process with a few applications, and then expand to further applications in your environment.

First, you need a clear plan that takes into careful consideration your servers, VMs, and workloads—and what's required for these to function in the cloud. Along with this assessment, determine your true resource usage and analyze any configuration dependencies for your workloads. Then, when you go forward with migration, ensure that your workloads in the cloud are in sync with your on-premises system in real time. Along with this, you want to test the health of your system, so that your final cut-over is smooth. Lastly, continue your cloud journey by ensuring peak performance and cost efficiency through cloud optimization.

The benefits of migration will be immediately apparent in your time and budget savings. The cloud will allow you to be more agile and, in many cases, respond to business needs faster. The cloud may even lower your TCO by as much as 84 percent, freeing you to take that massive savings and invest it back into your business to drive modernization faster. Plus, you can explore PaaS and SaaS options, decreasing your TCO even more while expanding your IT capability.

Whether you're in the early stages of migration assessment, or just starting to plan your approach, keep in mind that migration can be easier with a trusted provider like Microsoft. Through integrated tools, a strong partner ecosystem, and rich guidance, you can tread a well-forged path to minimize risk and impact to your business.

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[10] "Migrating VMware to Microsoft Azure: Total cost of ownership guidance." Microsoft. November 2017. Retrieved from: https://azure.microsoft.com/mediahandler/files/resourcefiles/vmware-to-azure-migration-tco-guidance/VMware_to_Azure_migration_TCO_guidance.pdf

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To learn more about options to meet your unique migration needs, visit the Azure Migration Center

Additional resources

Azure Migration Guide for Windows Server

Choosing your database migration path to Azure