What is Cloud Computing?

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cloud com·put·ing

noun

the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer.

On-Premise

- You own the servers
- You hire the IT people
- You pay or rent the real-estate
- You take all the risk

Cloud Providers

- Someone else owns the servers
- Someone else hires the IT people
- Someone else pays or rents the real-estate
- You are responsible for your configuring cloud services and code, someone else takes care of the rest.

The Evolution of Cloud Hosting

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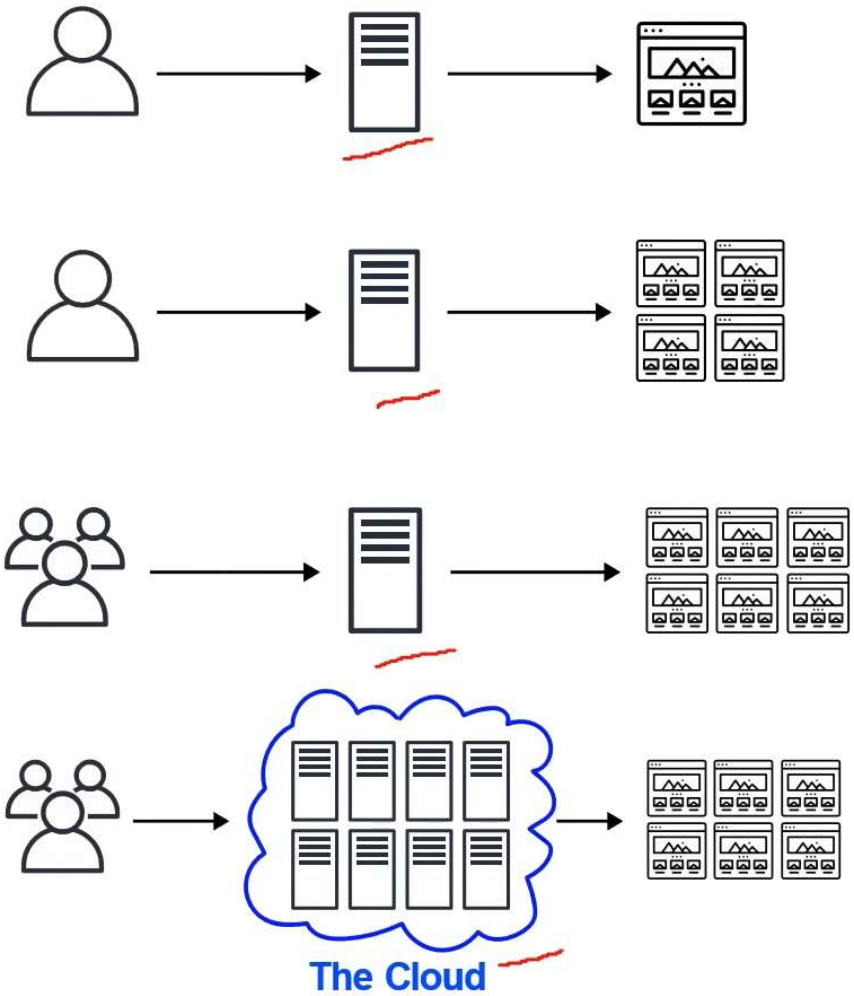

Dedicated Server

One physical machine dedicated **to single a business**.
Runs a single web-app/site.
Very Expensive, High Maintenance, *High Security

Virtual Private Server (VPS)

One physical machine dedicated **to a single business**.
The physical machine is virtualized **into sub-machines**
Runs multiple web-apps/sites
Better Utilization and Isolation of Resources

Shared Hosting

One physical machine, shared by **hundred of businesses**
Relies on most tenants under-utilizing their resources.
Very Cheap, Limited functionality, Poor Isolation

Cloud Hosting

Multiple physical machines that act as one system.
The system is abstracted into multiple **cloud services**
Flexible, Scalable, Secure, Cost-Effective, High Configurability

Common Cloud Services

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A cloud provider **can have hundreds of cloud services** that are grouped various types of services. The four most common types of cloud services for Infrastructure as a Service (IaaS) would be:

Compute
Imagine having a virtual computer that can run application, programs and code.

Networking
Image having the a virtual network being able to define internet connections or network isolations

Storage
Imagine having a virtual hard-drive that can store files

Databases
Imagine a virtual database for storing reporting data or a database for general purpose web-application

The term “Cloud Computing” can be used to refer to all categories, even though it has “compute” in the name.

What is Microsoft?

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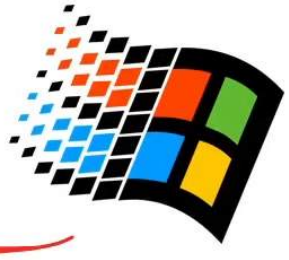
Microsoft

An American multinational computer technology corporation headquartered **in Redmond, Washington**

Microsoft makes software, phones, tablets, game consoles, cloud services, a search engine and more!

Microsoft has been around since the late 1970s and is well known for their **Operation System**.



What is Azure?

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Microsoft calls their cloud provider service

Microsoft Azure

Commonly referred to just **Azure**

Azure literally means **"bright blue color of the cloudless sky"**

Cloud Service Providers can be initialized as **CSPs**

☁ Benefits of Cloud Computing

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Cost-effective	You **pay for what you consume**, **no up-front cost**. Pay-as-you-go (PAYG) thousands of customers sharing the cost of the resources
Global	Launch workloads **anywhere in the world**, Just choose a region
Secure	Cloud provider takes care of physical security. **Cloud services can by secure by default** or you have the ability to configure access down to granular level.
Reliable	data backup, disaster recovery, and data replication, and fault tolerance
Scalable	Increase or decrease resources and services based on demand
Elastic	**Automate** scaling during spikes and drop in demand
Current	The underlying hardware and managed software is patched, upgraded and replaced by the cloud provider without interruption to you.

Types of Cloud Computing

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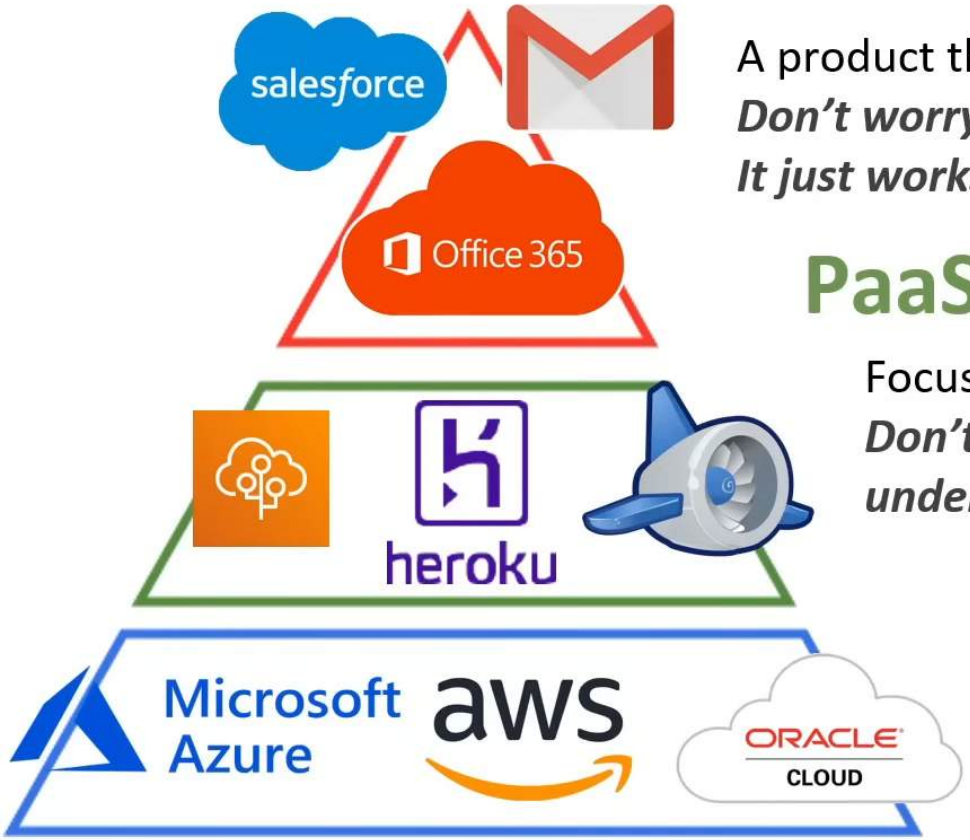

SaaS Software as a Service **For Customers**

A product that is run and managed by the service provider
Don't worry about how the service is maintained.
It just works and remains available.

PaaS Platform as a Service **For Developers**

Focus on the deployment and management of your apps.
Don't worry about, provisioning, configuring or understanding the hardware or OS.

IaaS Infrastructure as a Service **For Admins**

The basic building blocks for cloud IT. Provides access to networking features, computers and data storage space.
Don't worry about IT staff, data centers and hardware.

Types of Cloud Computing Responsibilities

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On-Premise	Infrastructure as a Service	Platform as a Service	Software as a Service
Applications	Applications	Applications	Applications
Data	Data	Data	Data
Runtime	Runtime	Runtime	Runtime
Middleware	Middleware	Middleware	Middleware
OS	OS	OS	OS
Virtualization	Virtualization	Virtualization	Virtualization
Servers	Servers	Servers	Servers
Storage	Storage	Storage	Storage
Networking	Networking	Networking	Networking

Legend: Customer is Responsible | CSP is Responsible

Azure's Deployment Models

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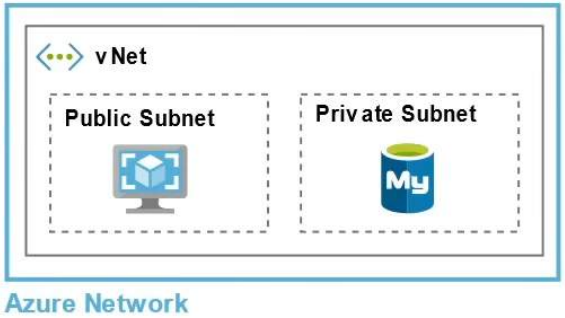
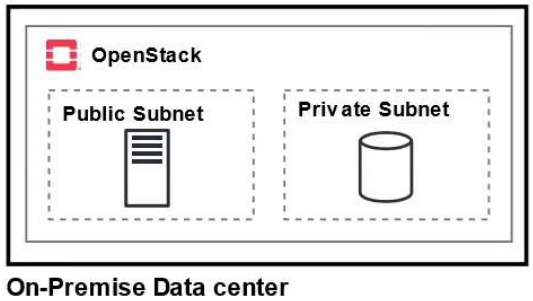
Public Cloud

Everything built on the Cloud Provider
Also known as: Cloud-Native



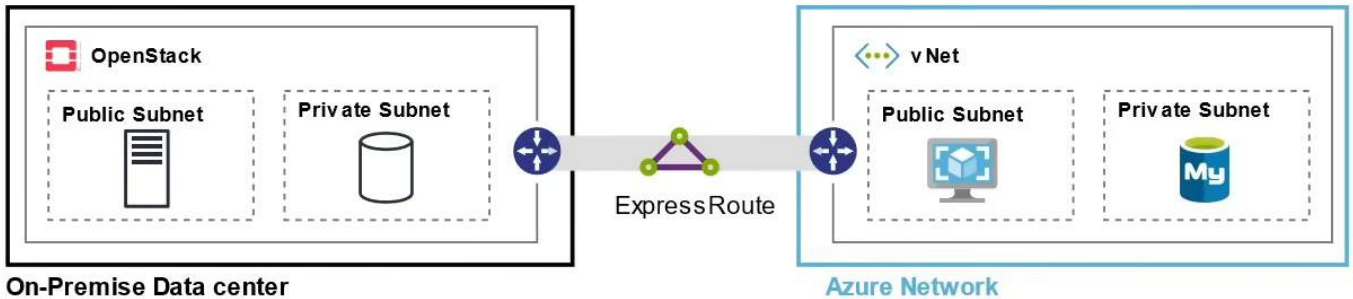
Private Cloud

Everything built on company's datacenters
Also known as **On-Premise**
The cloud could be **OpenStack**



Hybrid

Using both **On-Premise** and
A **Cloud Service Provider**



Azure's Deployment Models

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	Cost	Security	Level of Configuration	Technical Knowledge
Public Cloud	👍 Most cost-effective	👍 Security Controls by Default 👎 Might not meet security requirements	👎 Limited based on what the Cloud Service Provider exposes to you.	👍 You don't need in-depth knowledge of underlying infrastructure
Private Cloud	👎 Most expensive	👎 no guarantee its secure 👍 can meet any security compliance requirement if you put in the work.	👍 You can configure the infrastructure however you like.	👎 You need to know in-depth how to configure all levels of your infrastructure
Hybrid	👍👎 Could be more cost-effective based on what you offload to the cloud.	👎 you now have to secure your connection to the cloud 👍 can meet all security requirements	👍 You get the best of both worlds.	👎 You need to know in-depth how to configure all levels of your infrastructure and know the CSPs services.

Deployment Models

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Cross-Cloud

Using **Multiple Cloud Providers**

Aka multi-cloud, hybrid-cloud

Total Cost of Ownership (TCO)

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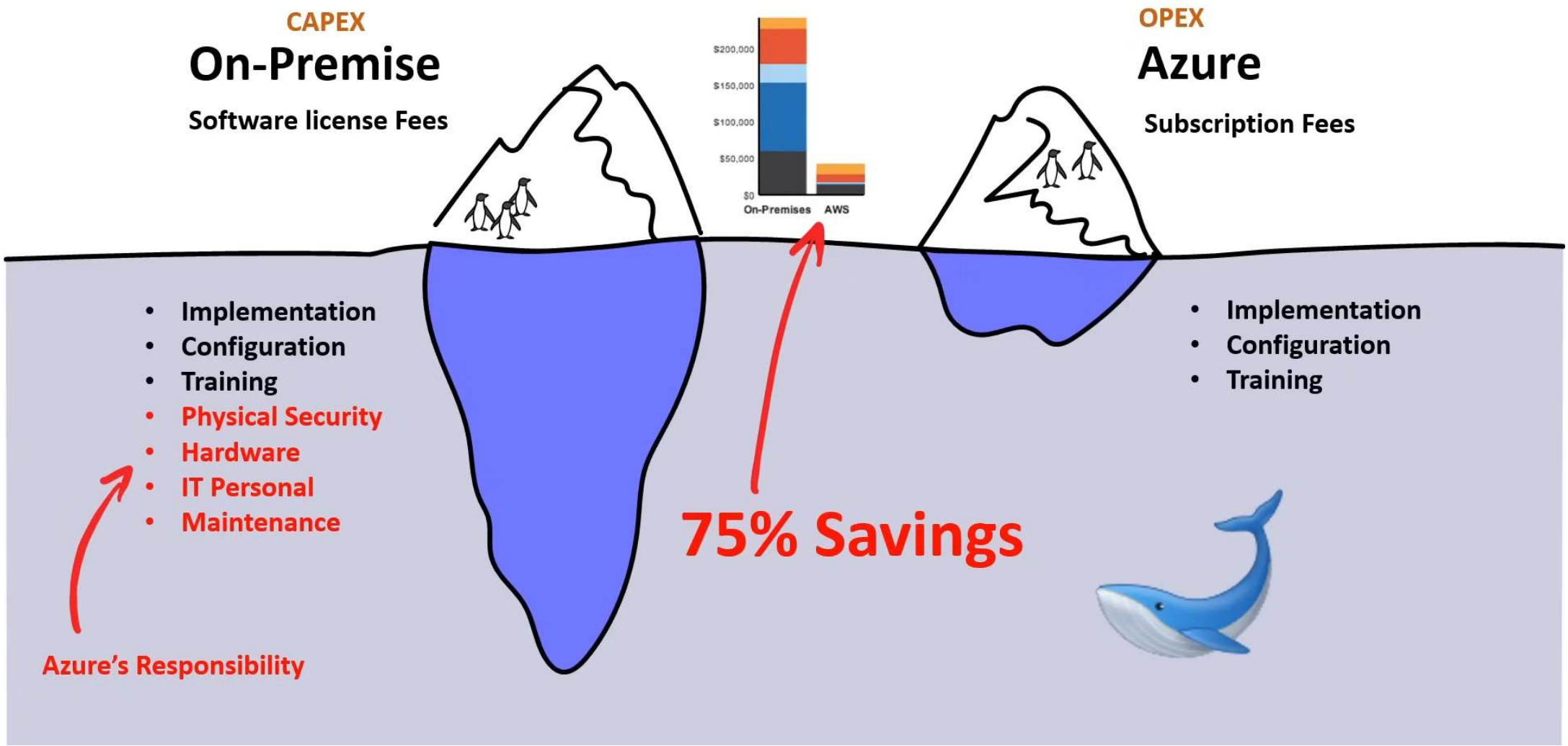

Capital vs Operational Expenditure

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Capital Expenditure (CAPEX)

Spending money upfront on **physical infrastructure**
Deducting that expense from your tax bill over time.

- Server Costs (computers)
- Storage Costs (hard drives)
- Network Costs (Routers, Cables, Switches)
- Backup and Archive Costs
- Disaster Recovery Costs
- Datacenter Costs (Rent, Cooling, Physical Security)
- Technical Personal

With Capital Expenses **you have to guess upfront** what you plan to spend

Operational Expenditure (OPEX)

The costs associated with an on-premises datacenter that has shifted the cost to the service provider. The customer only has to be concerned with non-physical costs.

- Leasing Software and Customizing features
- Training Employees in Cloud Services
- Paying for Cloud Support
- Billing based on cloud metrics eg.
  - compute usage
  - storage usage

With Operation Expenses you can try a product or service **without investing in equipment**

Cloud Architecture Terminologies

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What is a Solutions Architect?
A role in a technical organization that architects a technical solution using multiple systems via researching, documentation, experimentation.

What is a Cloud Architect?
A solutions architect that is focused solely on architecting technical solutions using cloud services.

A cloud architect need to understand the following terms and factor them into their designed architecture based on the business requirements.

- **Availability** - Your ability to ensure a service remains available eg. **Highly Available (HA)**
- **Scalability** – Your ability to grow rapidly or unimpeded
- **Elasticity** – Your ability to shrink and grow to meet the demand
- **Fault Tolerance** – Your ability to prevent a failure
- **Disaster Recovery** - Your ability to recover from a failure eg. **Highly Durable (DR)**

A Solutions Architect needs to always consider the following business factors:

- (Security) How secure is this solution?
- (Cost) How much is this going to cost?

High Availability

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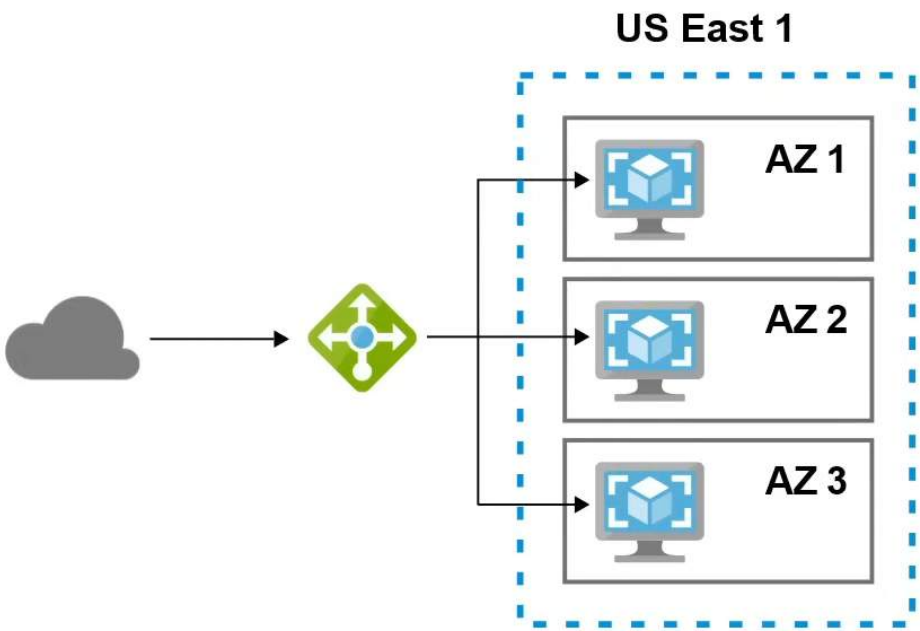
Your ability for your service to **remain available** by ensuring there is ***no single point of failure** and/or ensure a certain level of performance



Azure Load Balancer

A load balancer allows you to evenly distribute traffic to multiple servers in one or datacenter. If a datacenter or server becomes unavailable (unhealthy) the load balancer will route the traffic to only available datacenters with servers.

Running your workload across multiple **Availability Zones** ensures that if 1 or 2 **AZs** become unavailable your service / applications remains available.

High Scalability

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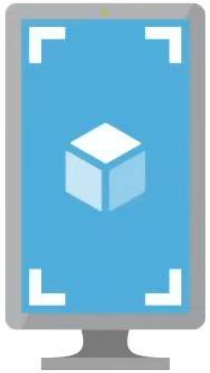
Your ability to **increase your capacity** based on the increasing demand of traffic, memory and computing power



Vertical Scaling

Scaling **Up**

Upgrade to a bigger server

Horizonal Scaling

Scaling **Out**

Add more servers of the same size

High Elasticity

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Your ability to **automatically** increase or decrease your capacity based on the current demand of traffic, memory and computing power

Azure VM Scale Sets
Automatically increase or decrease in response to demand or a defined schedule.

SQL Server Stretch Database
Dynamically stretch warm and cold transactional data from Microsoft SQL Server 2016 to Microsoft Azure

Horizonal Scaling
Scaling **Out** — Add more servers of the same size
Scaling **In** — Removing more servers of the same size

Vertical Scaling is generally hard for traditional architecture so you'll usually only see horizontal scaling described with Elasticity.

Highly Fault Tolerant

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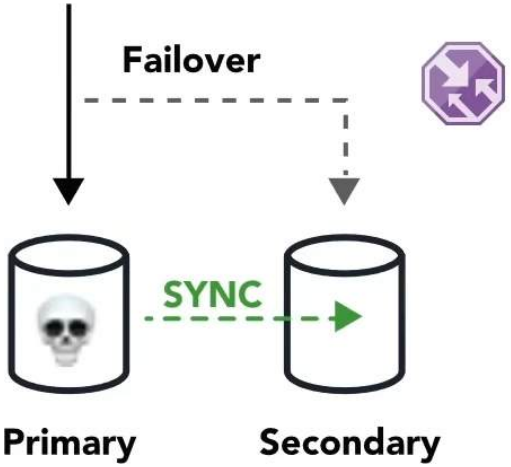
Your ability for your service to ensure there is no
no single point of failure. Preventing the chance of failure

Fail-overs is when you have a plan to shift traffic to a redundant system in case the primary system fails



You can use **Azure Traffic Manager** Which is a DNS-based traffic balancer To fail-over from a failing primary system to a stand-by secondary system.

A common example is having a copy (secondary) of your database where all ongoing changes are synced. The secondary system is not in-use until a fail over occurs and it becomes the primary database.

High Durability

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Your ability to **recover** from a disaster and to prevent **the loss** of data
Solutions that recover from a disaster is known as **Disaster Recovery (DR)**

- Do you have a backup?
- How fast can you restore that backup?
- Does your backup still work?
- How do you ensure current live data is not corrupt?

Business Continuity Plan (BCP)

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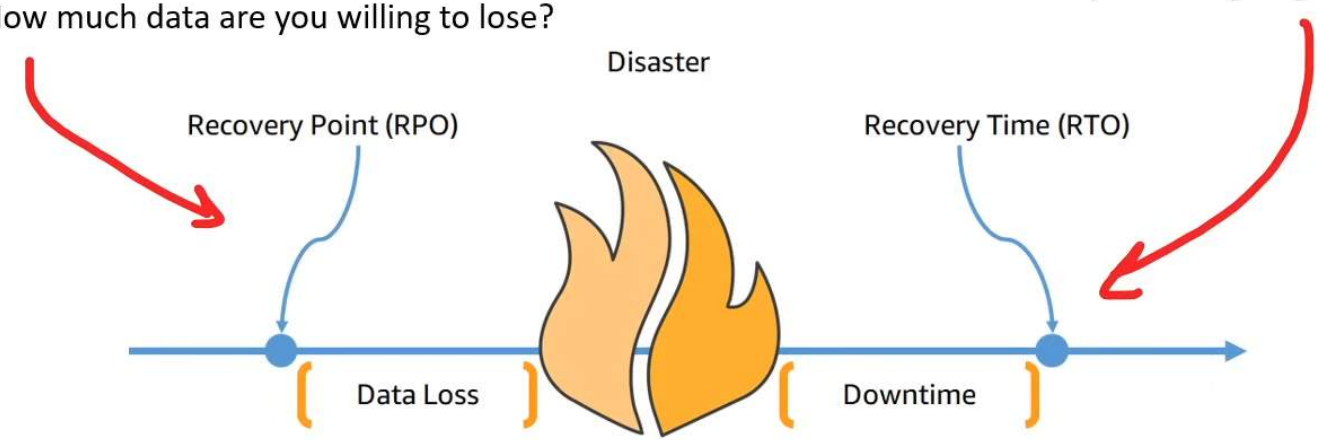
A **business continuity plan** (BCP) is a document that outlines how a business will continue operating **during an unplanned disruption in services**

Recovery Point Objective (RPO)
the maximum acceptable amount of data loss after an unplanned data-loss incident, expressed as an amount of time

How much data are you willing to lose?

Recovery Time Objective (RTO)
the maximum amount of downtime your business can tolerate without incurring a significant financial loss

How much time are you willing to go down?



Disaster Recovery Options

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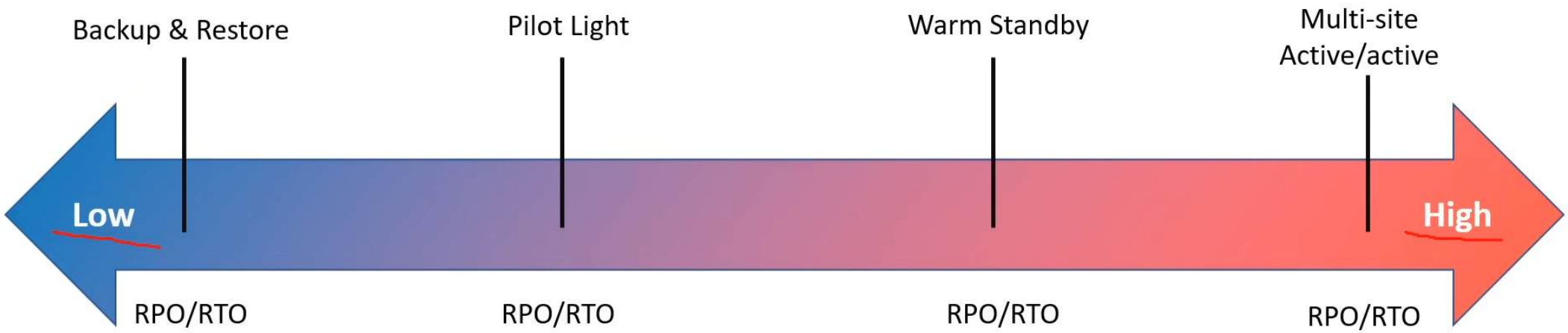
There are multiple options for recovery that trade cost vs time to recover.



RPO/RTO
Hours

You backup your data and restore it to new infrastructure

- Lower priority use cases
- Restore data after event
- Deploy resources after event
- Cost $

RPO/RTO
10mins

Data is replicated to another region with the minimal services running

- Less stringent RTO &RPO
- Core Services
- Start & and scale resources after event
- Cost $$

RPO/RTO
Minutes

Scaled down copy of your infrastructure running ready to scale up

- Business Critical Services
- Scale resources after event
- Cost $$$

RPO/RTO
Real-time

Scaled up copy of your infrastructure in another region

- Zero downtime
- Nero zero loss
- Mission Critical Services
- Cost $$$$

The Evolution of Computing

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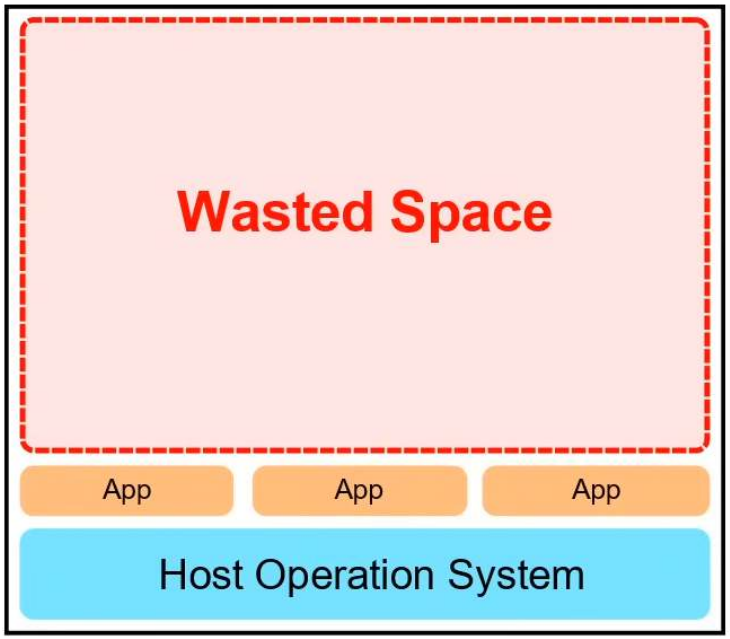
***Dedicated** 👉 VMs 👉 Containers 👉 Functions



physical server

- A physical server **wholly utilized by a single customer**.
- You have to guess your capacity, you'll overpay for an underutilized server
- Upgrading beyond your capacity will be slow and expensive
- You are limited by your Operating System
- Multiple apps can result in conflicts in resource sharing
- You have a ***guarantee of security, privacy and full utility of underlying resources**

The Evolution of Computing

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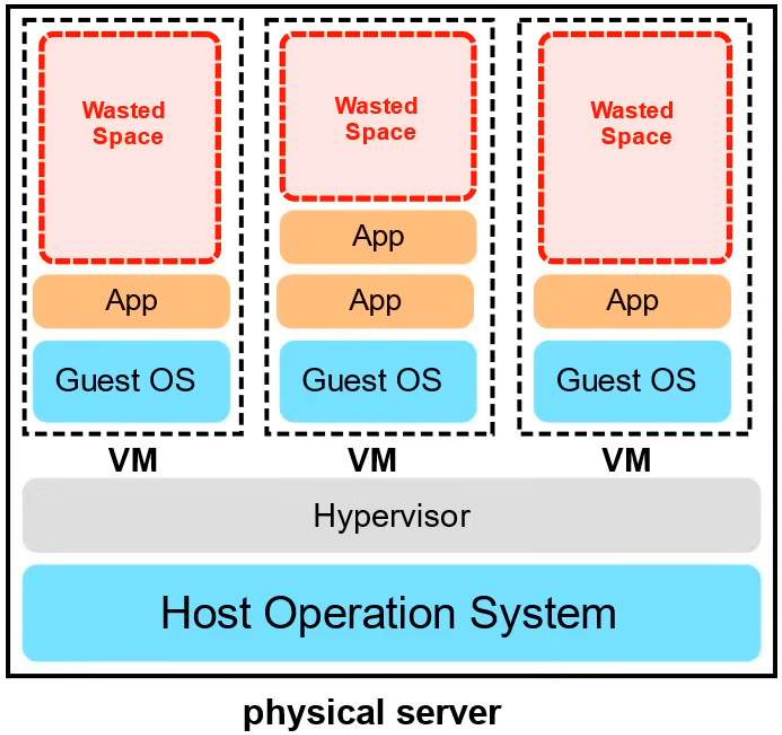
*Dedicated 👉 **VMs** 👉 Containers 👉 Functions



- You can run **multiple Virtual Machines on one machine**.
- **Hypervisor** is the software layer that lets you the VMs
- A physical server shared by multiple customers
- You are pay for a fraction of the server
- You'll overpay for an underutilized Virtual Machine
- You are limited by your Guest Operating System
- Multiple apps on a single Virtual Machine can result in conflicts in resource sharing

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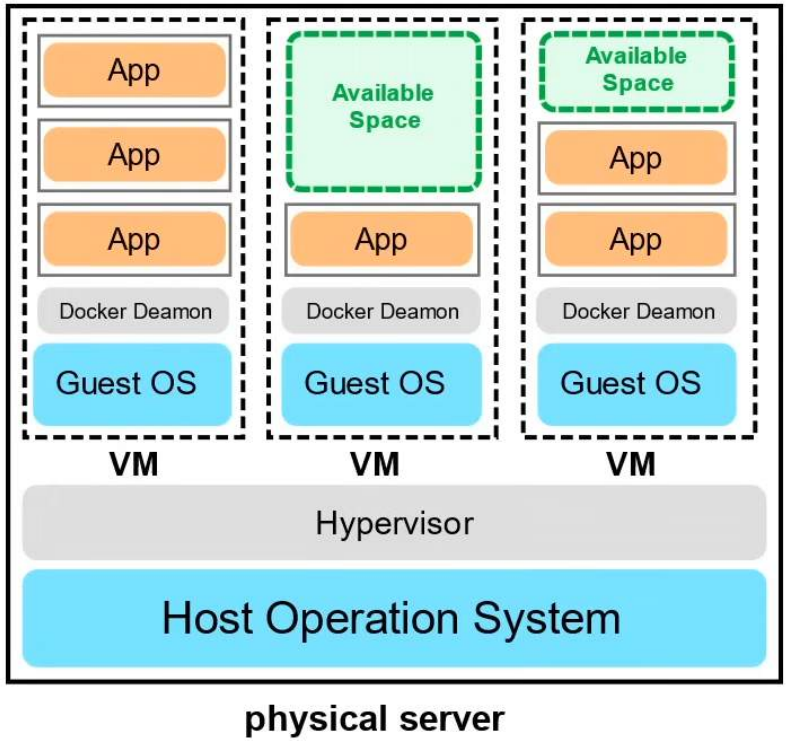
*Dedicated 👉 VMs 👉 **Containers** 👉 Functions



- Virtual Machine running multiple containers
- **Docker Deamon** is the name of the software layer that lets you run multiple containers.
- You can maximum the utilize the available capacity which is more cost-effective
- Your containers share the same underlying OS so containers are more efficient than multiple VMs
- Multiple apps can run side by side without being limited to the same OS requirements and will not cause conflicts during resource sharing

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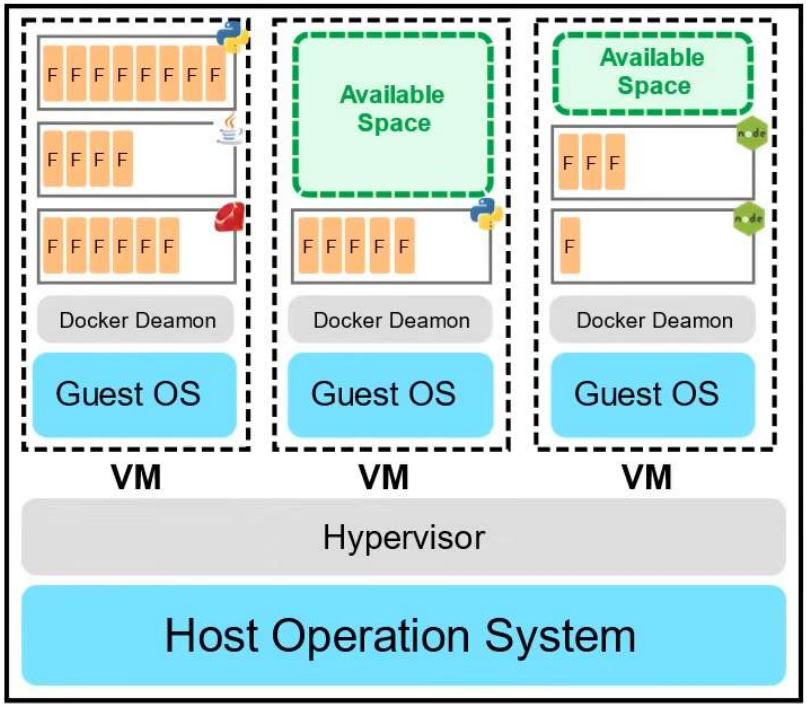
*Dedicated 👉 VMs 👉 Containers 👉 **Functions**



physical server

- A managed VMs running managed containers.
- Known as **Serverless Compute**
- You upload a piece of code choose the amount of memory and duration.
- Only responsible for code and data, nothing else
- Very cost-effective, only pay for the time code is running, VMs only run when there is code to be executed
- Cold Starts is a side-effect of this setup

Global Infrastructure – Regions and Geographies

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A **region** is a grouping of multiple datacenters (Availability Zones)

Azure has **58 Regions** available across **140 Countries**

A **Geography** is discreet market of two or more regions that preserves **data residency** and **compliance boundaries**.

Azure Geographies

- United States
- Azure Government (US)
- Canada
- Brazil
- Mexico

Imagine you are in Canada and **you want a guarantee that data will remain within Canada**. You would want to use Canada Azure Geographies

Global Infrastructure – Regions and Geographies

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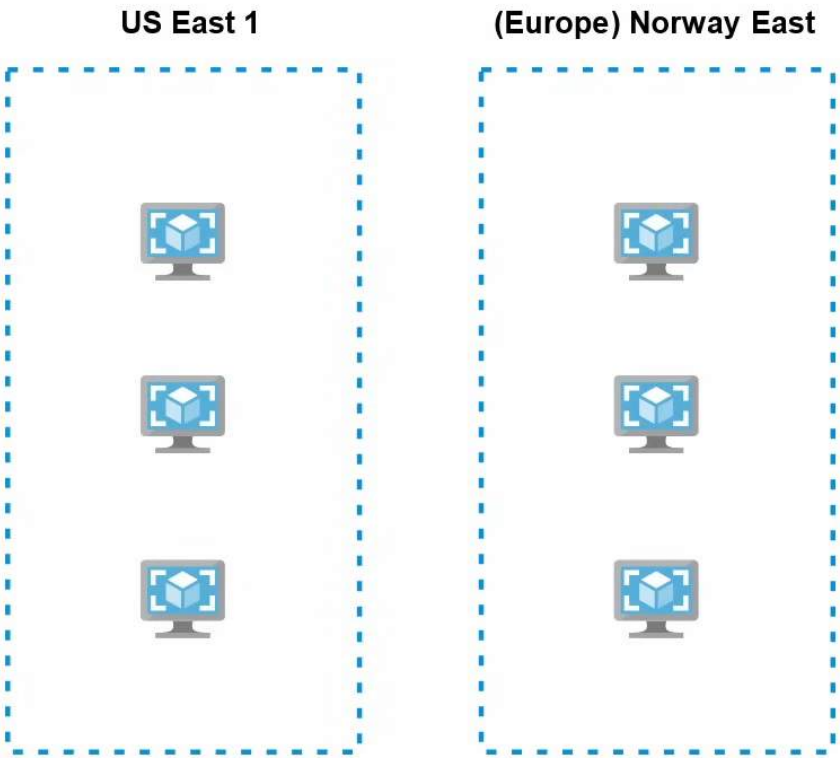
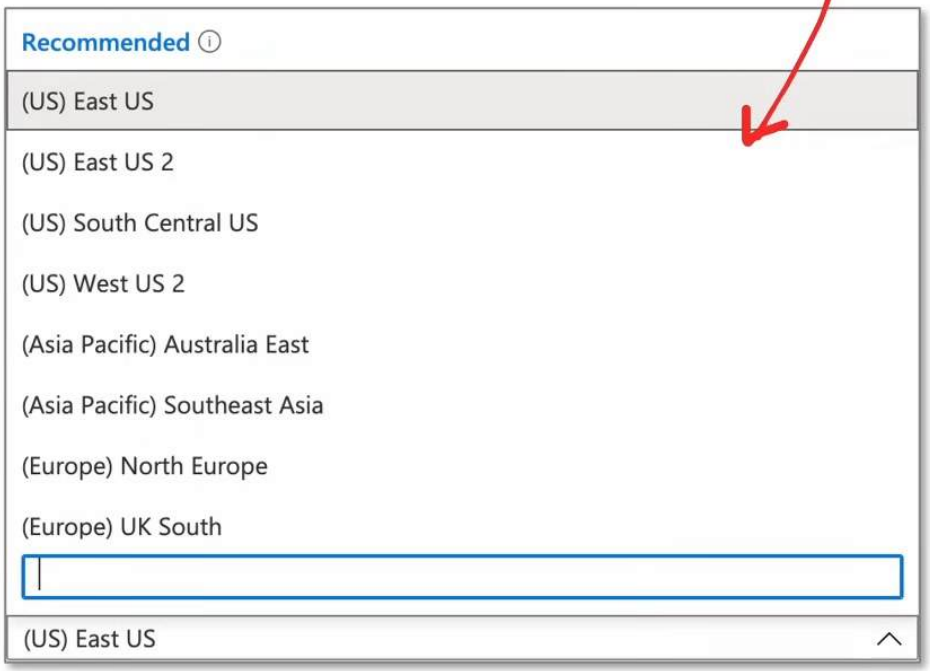


You choose the region when you launch a new cloud resource



Global Infrastructure – Paired Regions

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Each region is paired with another region **300 miles** away.

Only one region is updated at a time to ensure no outages

Some Azure Services rely on Paired Regions for **Disaster Recovery**

Eg. **Azure Geo-redundant Storage (GRS)** replicates data to a secondary region automatically, ensuring that data is durable even in the event that the primary region isn't recoverable.

Canada	Canada Central	Canada East
North America	East US	West US
Germany	Germany Central	Germany Northeast

Global Infrastructure – Region Types and Service Availability

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Not all Azure cloud services are available in every Region.

Recommended region

A region that provides the broadest range of service capabilities and is **designed to support Availability Zones** now, or in the future.

Alternate (other) region

A region that extends Azure's footprint within a data residency boundary where a recommended region also exists. **Not designed to support AZs.**
These Regions are label as **Other** in the Azure Portal

General availability (GA) is when a service is considered ready to be used publicly by everyone.

Azure Cloud services are grouped into **three** categories.
Their category determines when cloud services become available:

1. **Foundational.** When GA, immediately or in 12 months in Recommended and Alternate Regions
2. **Mainstream** When GA immediately or in 12 months in Recommended Regions
   May become available in Alternate Regions based on customer demand
3. **Specialized.** Available in Recommended or Alternate Region based on customer demand.

Global Infrastructure – Special Regions

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Azure has specialized regions to meet **compliance or legal reasons**

- US DoD Central
- US Gov Virginia
- US Gov Iowa

***Three Azure Government secret locations undisclosed**

- China East
- China North

*** Available through a unique partnership between Microsoft and 21Vianet. Microsoft does not directly maintain the datacenters.**

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Global Infrastructure – AZs

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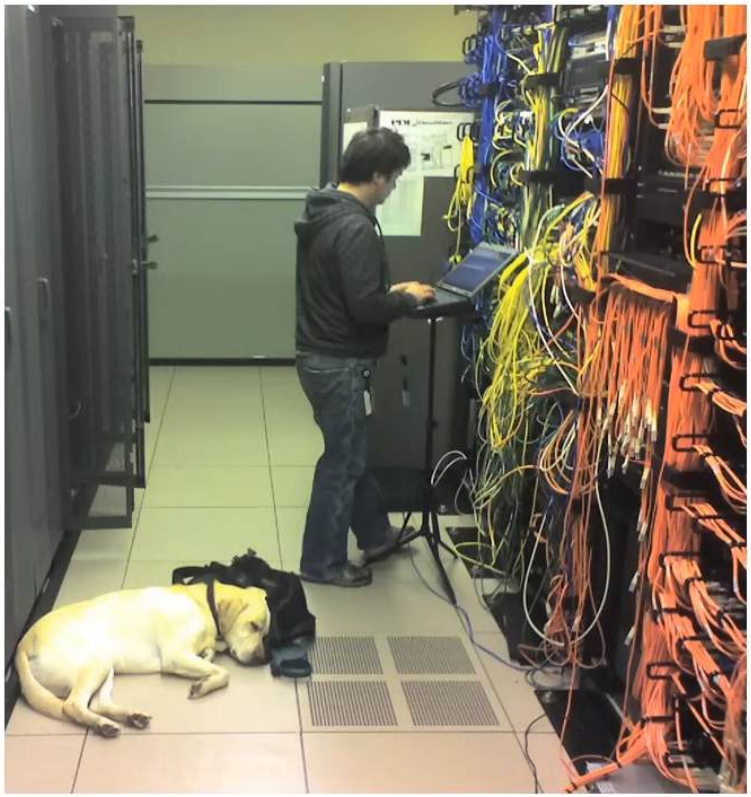
An **Availability Zone** (AZ) is physical location made up of one or more datacenter.

A datacenter is a secured building that contains hundreds of thousands of computers.

A region will ***generally** contain **3 Availability Zones**

Datacenters within a region will be isolate from each other (so different buildings). But they will be close enough to provide low-latency.

Its common practice to run workloads in at least 3 AZs to ensure services remain available in case one or two datacenters fail. (High Availability)



Global Infrastructure – AZs

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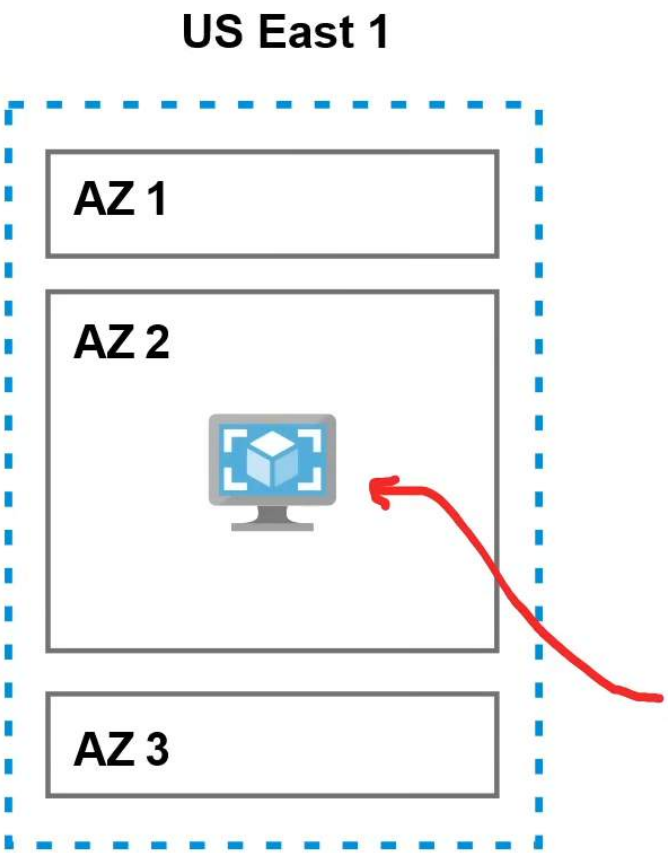
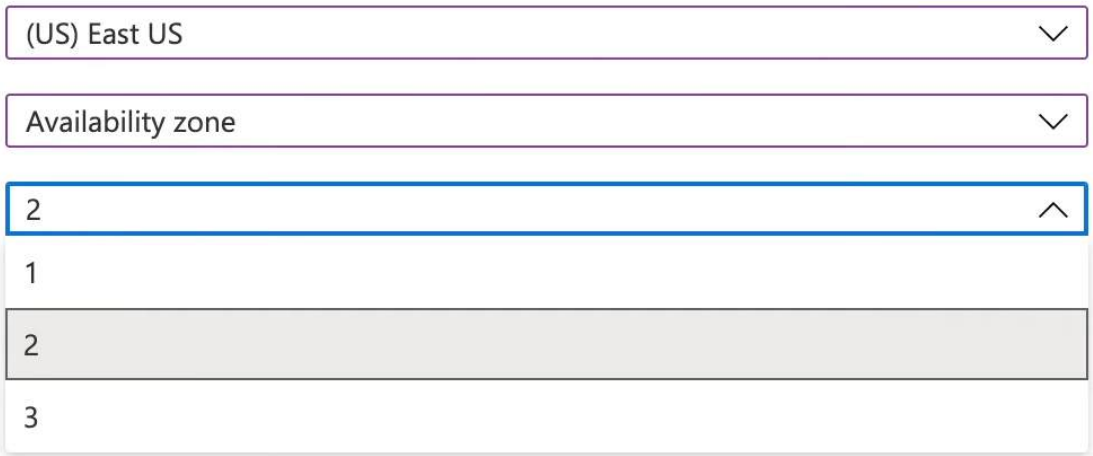


If you region has multiple AZs you choose a number. Choosing 2 means AZ-2 not that you have chosen a quantity Of 2 AZs.



Global Infrastructure – AZ Supported Regions

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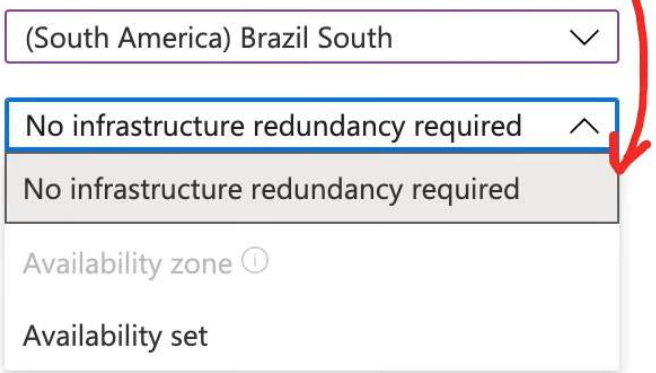
Not Every Region has support for Availability Zones
These regions are known as **Alternate** or **Other**
Recommended Regions are suppose to have at least 3 AZs.

The following Regions
have a minimum of 3 AZs

- Central US
- East US 2
- West US 2
- West Europe
- France Central
- North Europe
- Southeast Asia

You don't choose an AZ.



(South America) Brazil South

Global Infrastructure – Fault and Update Domains

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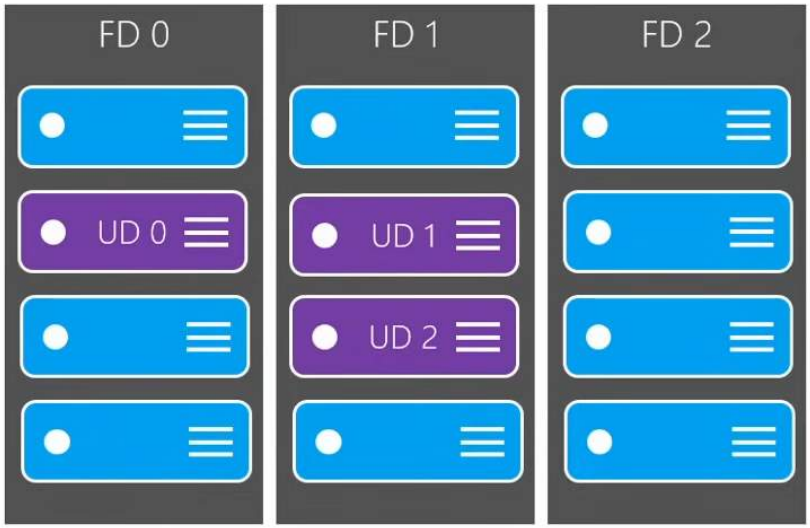
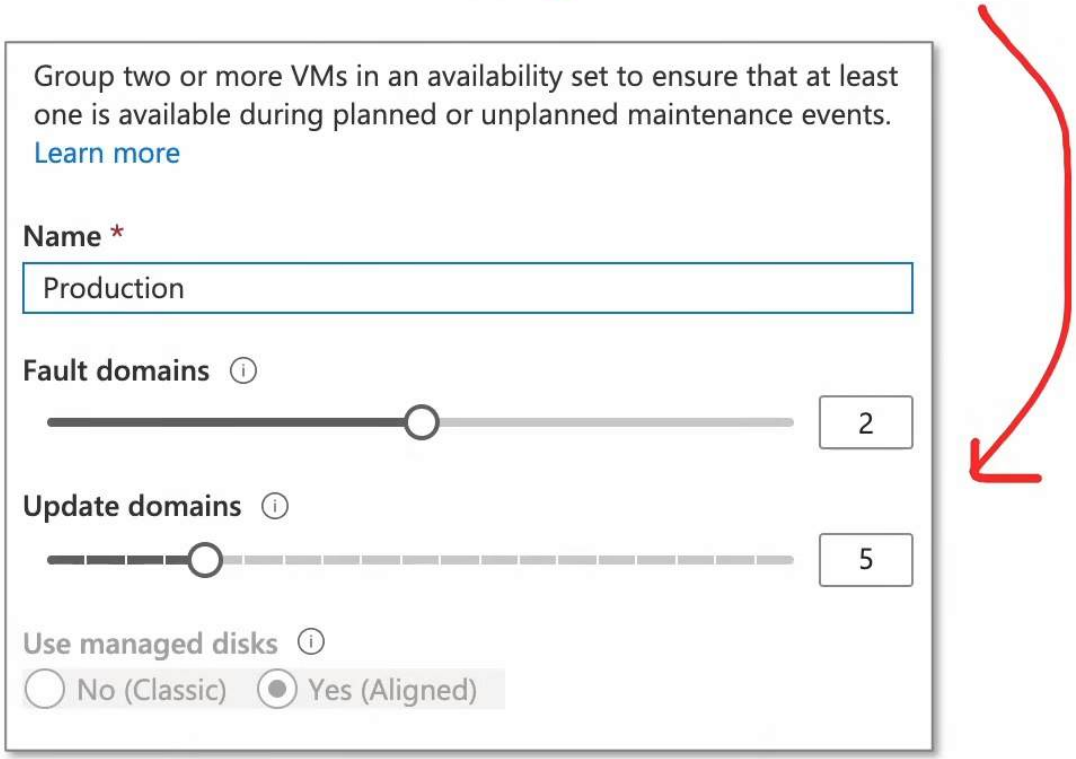
Each Virtual Machine in an Availability Set is assigned a Fault Domain and Update Domain.



Creating a Availability Set.
Choosing the amount of domains



Computing Services

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Azure Virtual Machines
Windows or Linux virtual machines (VMs). The most common type of compute.
You choose your OS, Memory, CPU, Storage. You share hardware with other customers

Azure Container Instances
Docker as a Service Run containerized apps on Azure without provisioning servers or VMs

Azure Kubernetes Service (AKS)
Kubernetes as a Service. Easy to deploy, manage and scale containerized applications.
Uses the open source Kubernetes (K8) software.

Azure Service Fabric
Tier-1 Enterprise Containers as a Service
Distributed systems platform. Runs in Azure or on-premises.
Easy to package, deploy, and manage scalable and reliable **microservices**.

Azure Functions
Event-driven, serverless compute (functions) run code without without provisioning or managing servers.
You pay only for the compute time you consume.

Azure Batch
Plans, schedules and executes your batch computer workloads across running 100+ jobs in parallel.
Use Spot VMs to save money (previously used Low-priority VMs to save on compute)

Introduction to Azure VMs

Azure Virtual Machines (VMs) is a highly configurable server.
Virtualization let you run a server ***without* having to buy and maintain the physical hardware** that runs it

Virtual Machines still require maintenance such as:

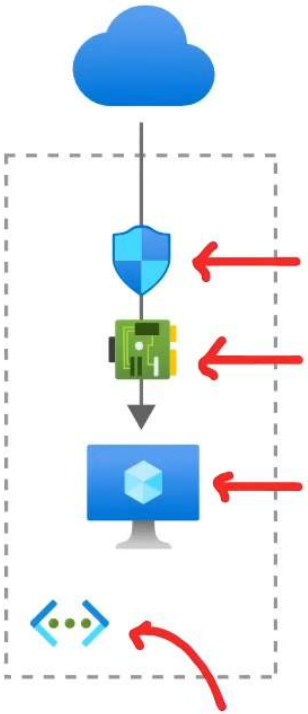
- applying OS system patches
- Installing and configuring packages

Some things you should know:

- The **size** of the virtual machine is determined by the Image
  - The image defines the combination of vCPUs, Memory and Storage Capacity
- The current limit on a per subscription basis is **20 VMs per region**.
- Azure VMs are billed at an **hourly rate**
- A single instance VMs has an availability of 99.9% (when all storage disks are premium)
- Two instances deployed in Availability Set will give you 99.95% availability
- You can attach multiple Managed Disk to your Azure VMs

Introduction to Azure VMs

When you ***launch*** an Azure Virtual Machine other networking components will be either created or associated to your Virtual Machine.



Network Security Group (NSG) — attached to the NIC, virtual firewall with rules around ports and protocols

Network Interface (NIC) — a device that handle ip protocols and network communication

Virtual Machine instance — The actual running server

Public IP Address — The address that you will use publicly access your VM

Virtual Network (VNet) — The network where your VM will reside

Resource	Type	Status	Operation details
MyNewVirtualMachine	Microsoft.Compute/virtualMachines	OK	Operation details
mynewvirtualmachine839	Microsoft.Network/networkInterfaces	Created	Operation details
MyNewVirtualMachine_group-vnet	Microsoft.Network/virtualNetworks	OK	Operation details
MyNewVirtualMachine-nsg	Microsoft.Network/networkSecurityGroups	OK	Operation details
MyNewVirtualMachine-ip	Microsoft.Network/publicIpAddresses	OK	Operation details

Azure VMs – Operation Systems

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What is an Operation System (OS)?
The OS is the program that manages all other programs in a computer.
The most commonly known operations systems are Windows ,macOS, and Linux

When you launch a Virtual Machine you need to choose an Image which has a specific Operation System.

Microsoft works closely with partners to ensure the images available are updated and optimized for an Azure runtime. Most of these images can be found in the **Azure Marketplace**

- SUSE Linux Enterprise Server
- Red Hat Enterprise Linux
- Ubuntu Server
- Debian
- FreeBSD
- Azure Marketplace - Flatcar Container Linux
- RancherOS
- Bitnami Library for Azure
- Mesosphere DC/OS on Azure
- Docker images
- CloudBees Jenkins Platform

You can **Bring Your Own Linux** by creating a Linux Virtual Hard Disk (VHD)

(Hyper-V virtual hard disk (VHDX) format isn't supported in Azure, only fixed VHD)

Azure Scale Sets

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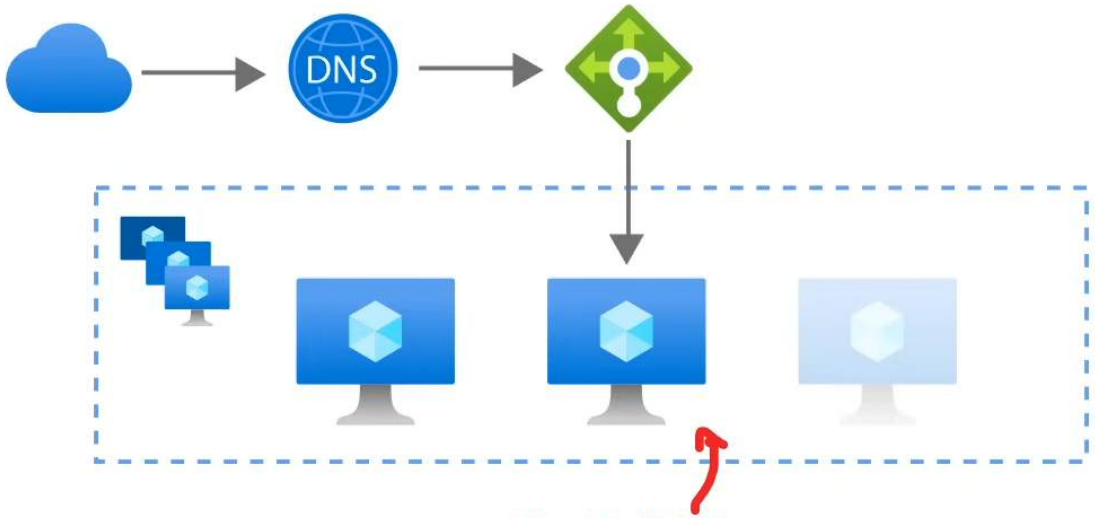
Azure Scale Sets allows you to **automatically** **increase** or **decrease** your VM capacity.

- Create Scaling Policies to automatically add or remove based on Host Metrics
- Create Health checks and set a Repair Policy to replace unhealthy instances
- Associate A Load Balancer to distribute VMs across AZs
- You can scale to 100s or even 1000s of VMs using scale sets



A Scale Set is a group **of** **identical VMs** (same Image and size)

Azure Scale Sets - Load Balancer

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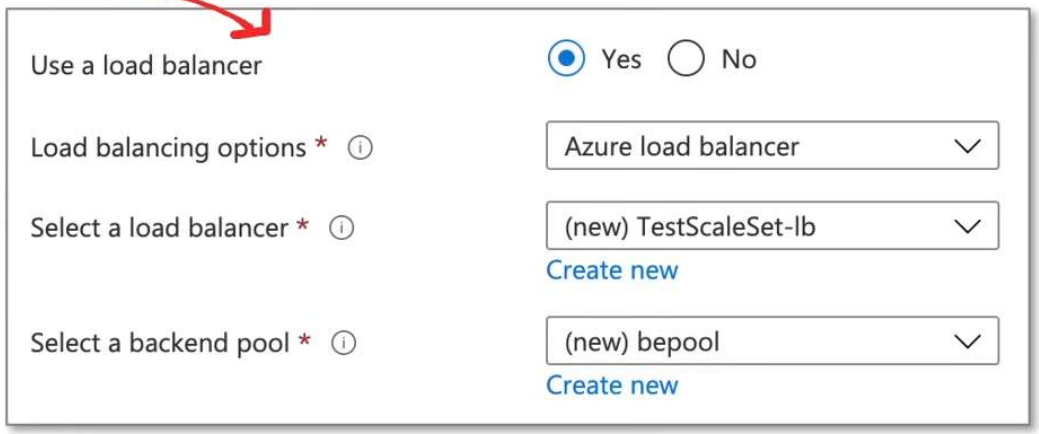
A Load Balancer can be **associated** with a Scale Set.
This will allow you to:

- evenly distribute your VMs across multiple Availability Zones to make your application Highly Available.
- Use Load Balancer probe checks for more robust Health checks



You have the choice between 2 different load balancers:

1. **Application Gateway** is an **HTTP/HTTPS** web traffic load balancer with URL-based routing, SSL termination, session persistence, and web application firewall.
2. **Azure Load Balancer** supports all **TCP/UDP** network traffic, port-forwarding, and outbound flows.

Azure Scale Sets – Scaling Policy

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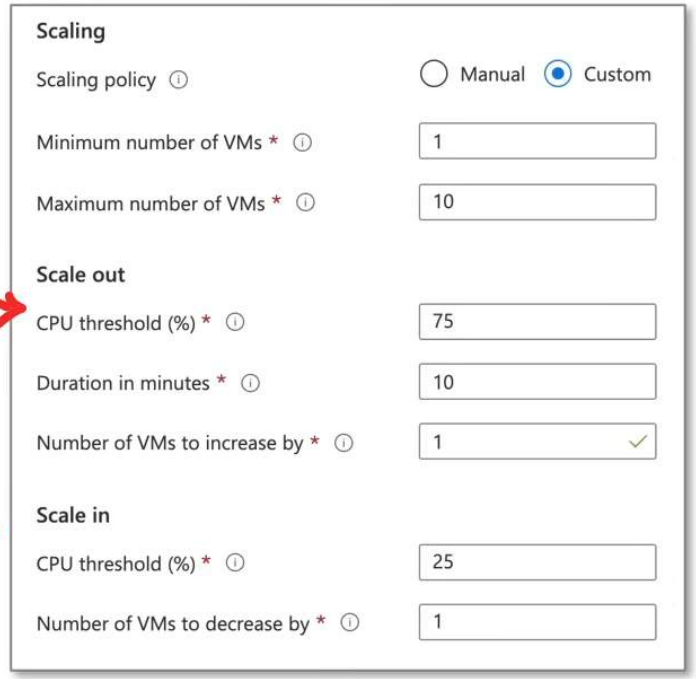
A Scaling Policy determine when a VMs should be added or removed to meet current capacity requirements

Scale Out
When a instance should be **added** to the Scale Set to **increase** capacity
eg. When CPU Threshold (%) greater than X for Y minutes add X servers

Scale In
When a instance should be **removed** to the Scale Set to **decrease** capacity
eg. When CPU Threshold (%) less than X for Y minutes add X servers



When you are creating a Scale Set you have very limited options for your Scaling Policy

Azure Scale Sets – Scaling Policy

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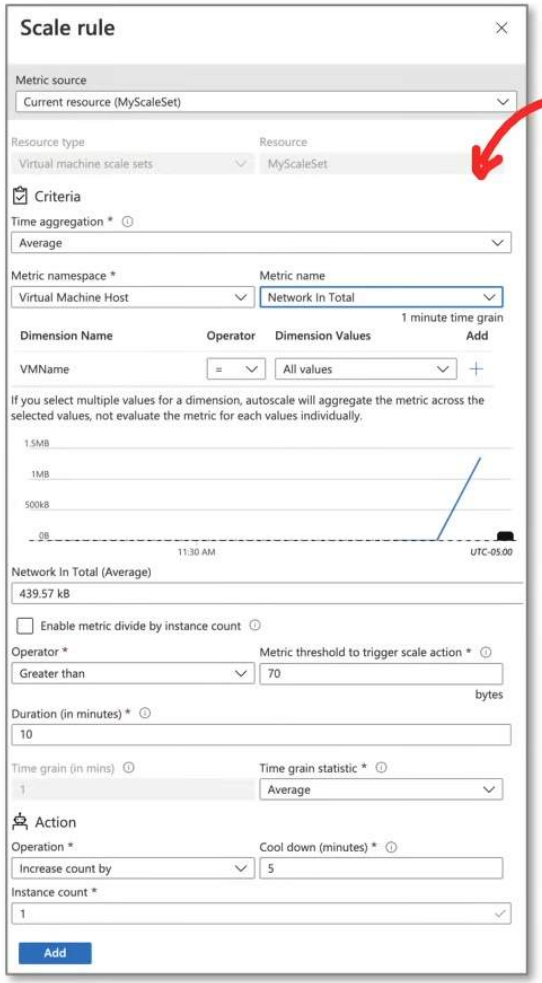

After you create your ScaleSet you have a-lot more options available to configure the rules of your Scaling Policy

Built-in Host-based metrics:
- Percentage CPU
- Network In
- Network Out
- Disk Read Bytes
- Disk Write Bytes
- Disk Read Operations/Sec
- Disk Write Operations/Sec
- CPU Credits Remaining
- CPU Credits Consumed

Aggerates
- Average
- Minimum
- Maximum
- Total
- Last
- Count

Operators
- Greater than
- Greater than or equal to
- Less than
- Less than or equal to
- Equal to
- Not equal to

Actions

Increase count by **X**
Increase percent by **X%**
Increase count to **X**
Decrease count by **X**
Decrease percent by **X%**
Decrease count to **X**

If you want more metrics there are 2 ways to collect more information:

1. **App Insights** installs a small instrumentation package in your application that monitors the app and sends telemetry to Azure.
   - When you want application metrics: Page load performance, Session counts
2. **Azure Diagnostic extension** is an agent that runs inside a VM instance. It monitors and saves performance metrics to Azure storage so you can collect more detailed information
   - When you want more detailed Host-based metrics

Azure Scale Sets – Scaling Policy

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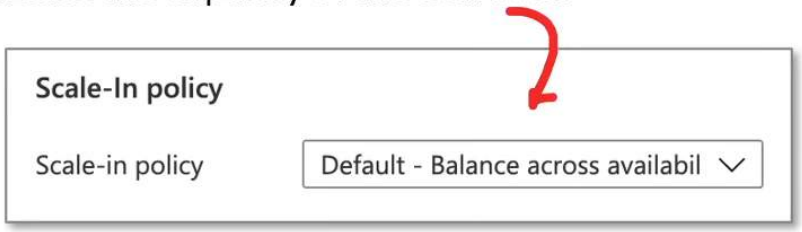
Scale-In Policy is how determines what VM is removed (deleted) to decrease the capacity of the Scale Set



Default
- Delete the VM with the highest Instance ID
- Balanced across Availability Zones (AZs) and Fault Domains (ADs)

Newest VM
- Delete the newest created VM
- Balanced across Availability Zones (AZs)

Oldest VM
- Delete the oldest VM
- Balanced across Availability Zones (AZs)

Update Policy determine how VM instances are brought up-to-date with the latest scale set model

Automatic
- Increasing with start upgrading immediately in random order

Manual
- Existing instances must be manually upgraded

Rolling
- Upgrades roll out in batches with optional pause

Automatic OS upgrades can be enabled helps to ease update management by safely and automatically upgrading the OS disk for all instances

Azure Scale Sets - Health Monitoring

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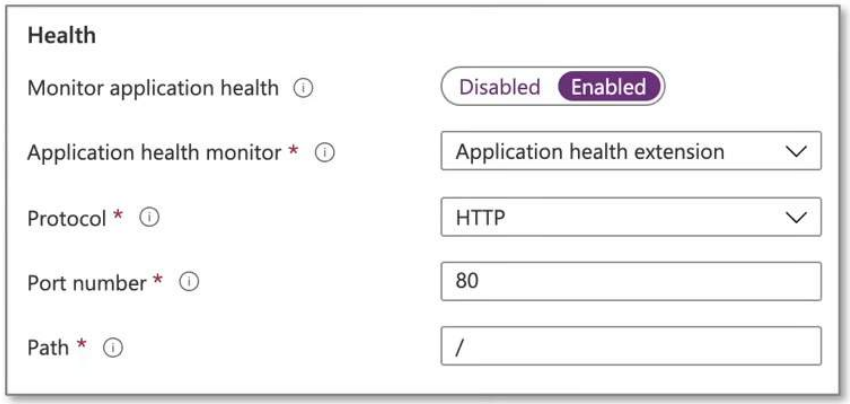
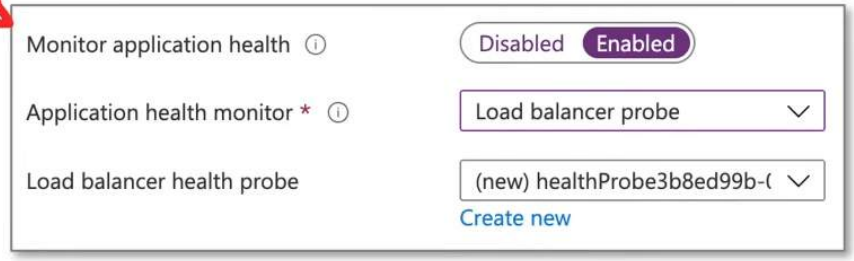
Health monitoring can be enabled to determine if you server is **healthy** or **unhealthy**.



There are 2 modes of health monitoring:

1. Application health extension
   - Ping an HTTP request to a specific path and except a status 200
2. Load Balancer Probe
   - Allow you to check based on TCP, UDP or HTTP requests.



Automatic repair policy

If an instance is found to be unhealthy the delete it and launch a new instance

Azure Virtual Desktop

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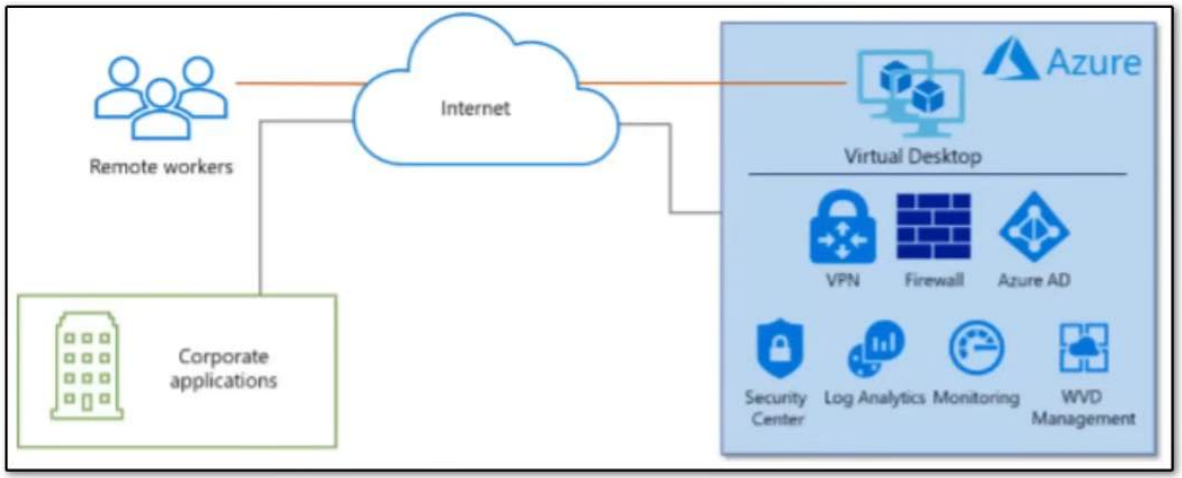
Azure Virtual Desktop on Microsoft Azure is a **desktop and app virtualization** service that runs on the cloud.

Azure Virtual Desktop works across devices, like **Windows, Mac, iOS, Android, and Linux**, with apps that you can use to access remote desktops and apps.
You can use most modern browsers to access Azure Virtual Desktop-hosted experiences.

Use Azure Virtual Desktop for specific needs like when **security** is a concern because all data is saved on the server and cannot be left on the device of a user.



Azure Virtual Desktop – Advantages

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Enable secure and productive remote work on any device

- Azure Virtual Desktop provides full Windows 10 and Windows Server desktop and application virtualization on any personal device.
- Seamless integration with **Microsoft 365 Apps for enterprise** and **Microsoft Teams**

Reduce costs of licensing and infrastructure

- Use eligible **Windows** or **Microsoft 365 licenses** to access Windows Virtual Desktop and pay only for what you use.

Protect against outages to stay productive

- Help keep your team running during outages by leveraging built-in **Azure Site Recovery** and **Azure Backup** technologies.

Simplify IT management

- Windows Virtual Desktop manages the virtual desktop infrastructure for you, so you can focus on users, apps, and OS images instead of hardware and maintenance.

Keep application and user data secure

- Easily apply the right access controls to users and devices with Azure Active Directory Conditional Access.

Introduction to Azure App Service

Azure App Service is an **HTTP-based service** for hosting web applications, REST APIs, and mobile back ends.

You can choose your **programming language** and either a **Windows** and **Linux** environment

It is a Platform as Service, so it's the **Heroku equivalent for Azure**.

Azure App Service takes care of the following underlying infrastructure

- Security patches for OS and languages
- Load balancing
- Autoscaling
- Automated manager

When you create your app you have to choose a unique name since it becomes a fully qualified domain

deep-space-nine ✓

.azurewebsites.net

Azure App Service makes it easy to implement common Integrations and features such as:

- Azure DevOps (For deployments)
- Github Integration
- Docker Hub Integration
- Package Management
- Easy to setup staging environments
- Custom Domains
- Attaching TLS/SSL Certificates

You pay based on an Azure App Service Plan:

- **Shared Tier** — Free, Shared (Linux not supported)
- **Dedicated Tier** — Basic, Standard, Premium, PremiumV2, PremiumV3
- **Isolated Tier**

Azure App Services can also run docker single or multi-containers

Azure App Service – Runtimes

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What is a Runtime Environment?

A runtime software/instructions that are executed *while* your program is running.

A runtime generally means what **programming language** and **libraries** and **framework** you are using.

A runtime for Azure App Services will be a pre-defined **container** that has your programming language and commonly used library for that language installed.

With Azure App Services you choose a runtime.

- .NET
- .NET Core
- Java
- Ruby
- Node.js
- PHP
- Python

Azure App Services will have generally multiple latest versions of of a programming language eg. Ruby 2.6, 2.7

Its common to for a cloud provider to stop supporting older versions so you keep current and forces customer to keep good security practices by having latest patches

Azure App Service – Custom Container

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Azure App Service allows you defined **custom containers** for **Windows or Linux**
You might want to create your own custom container to use a different runtime or bundle in a packages or software

Create your own **Docker** Container on your local environment

Push the Docker container to **Azure Container Registry**

Deploy your Container Image to **App Service**

Azure App Service – Deployment Slots

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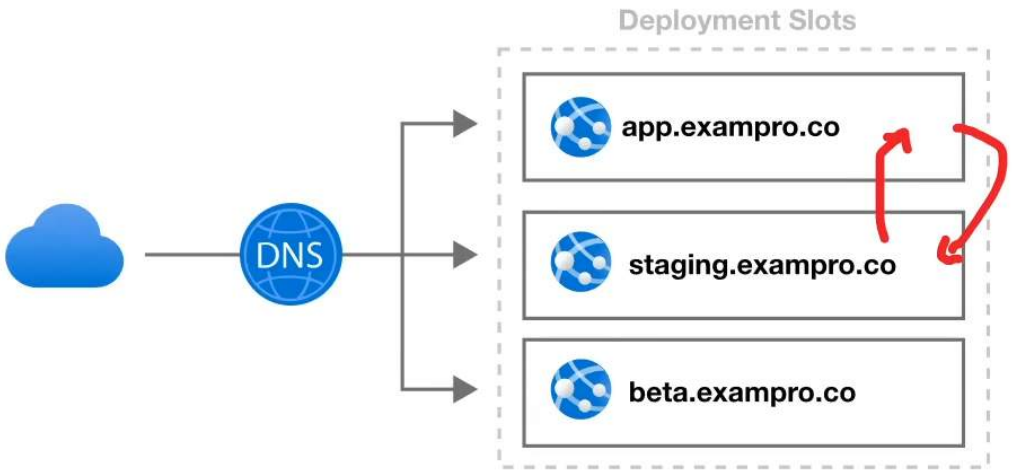
Deployments Slots allow you to create **different environments** of your web-application associated to a different hostname. This is useful when need a staging, or QA environment.

Think of it as a way to quickly clone your production environment for other uses.



You can also **Swap environments** This could be how you perform a Blue/Green deploy.

You can promote our staging to production by swapping, if something goes wrong you could swap them back.

Azure App Service – App Service Environment

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App Service Environment (ASE) is an Azure App Service feature that provides a **fully isolated and dedicated environment** for securely running App Service apps at high scale

This allow you to host:

- Windows web apps
- Linux web apps
- Docker containers
- Mobile apps
- Functions

App Service environments (ASEs) are appropriate for application workloads that require:

- Very high scale
- Isolation and secure network access.
- High memory utilization

Customers can create multiple ASEs within a single Azure region or across multiple Azure regions making ASEs ideal for **horizontally scaling stateless application tiers** in support of **high requests per second (RPS) workloads**.

- ASE comes with its own pricing tier (Isolated Tier)
- ASEs can be used to configure security architecture
- Apps running on ASEs can have their access gated by upstream devices, such as web application firewalls (WAFs)
- App Service Environments can be deployed into Availability Zones (AZ) using zone pinning.

There are **2 deployment types** for an App Service environment (ASE):

1. External ASE
2. ILB ASE

Azure App Service – App Service Environment

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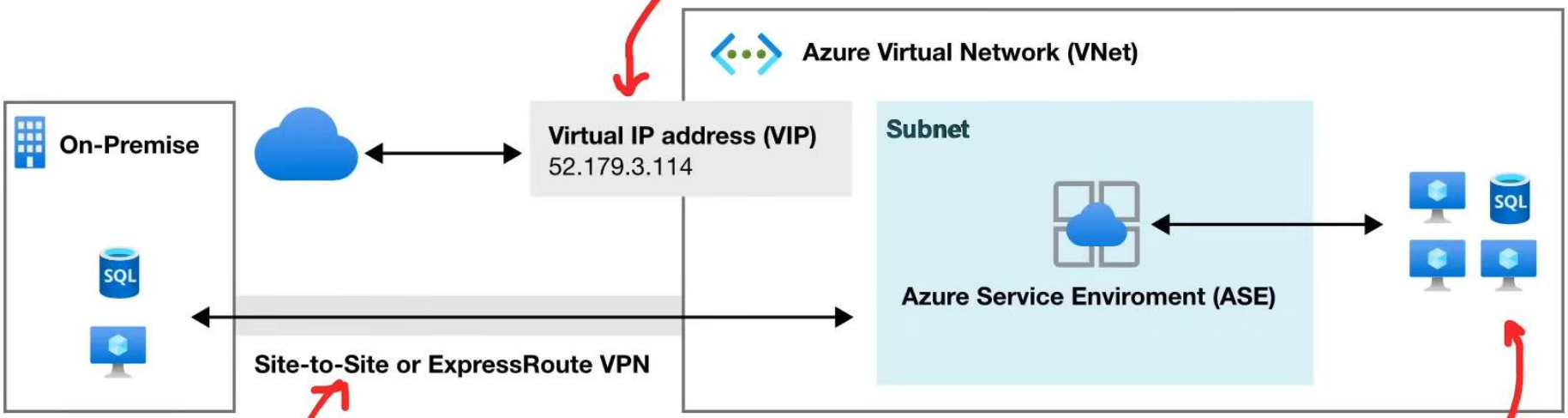
External ASE exposes the ASE-hosted apps on an **internet-accessible IP address**.



Because the ASE is within the VNet, it can also access resources within the VNet without any additional configuration.

If the VNet is connected to your on-premises network, apps in your ASE also have access to resources there without additional configuration.

Azure App Service – App Service Environment

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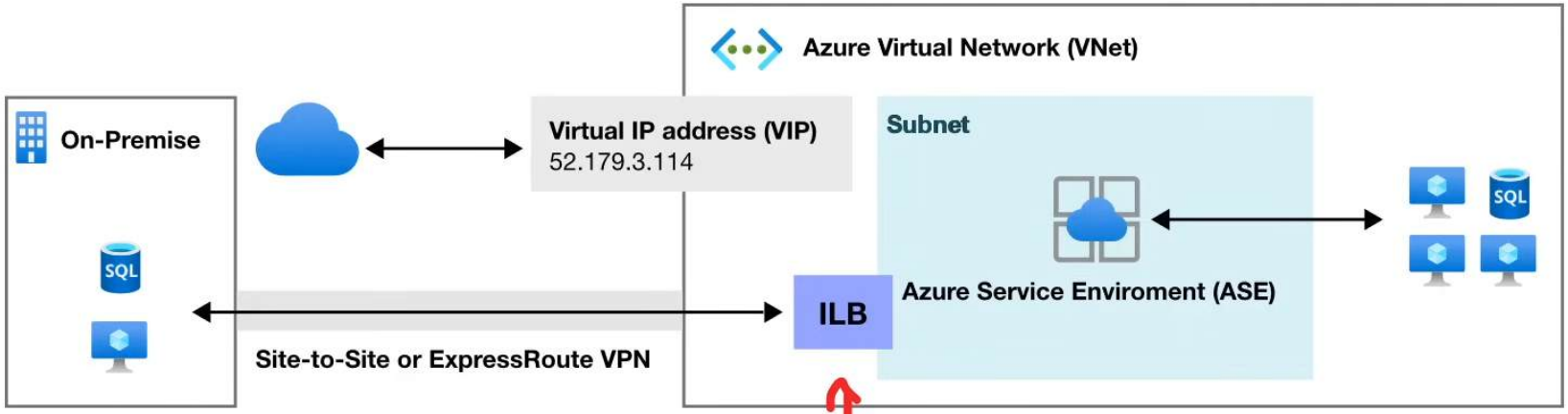

ILB ASE exposes the ASE-hosted apps on an IP address inside your VNet.
The internal endpoint is an **internal load balancer (ILB)**

Azure App Service Plan

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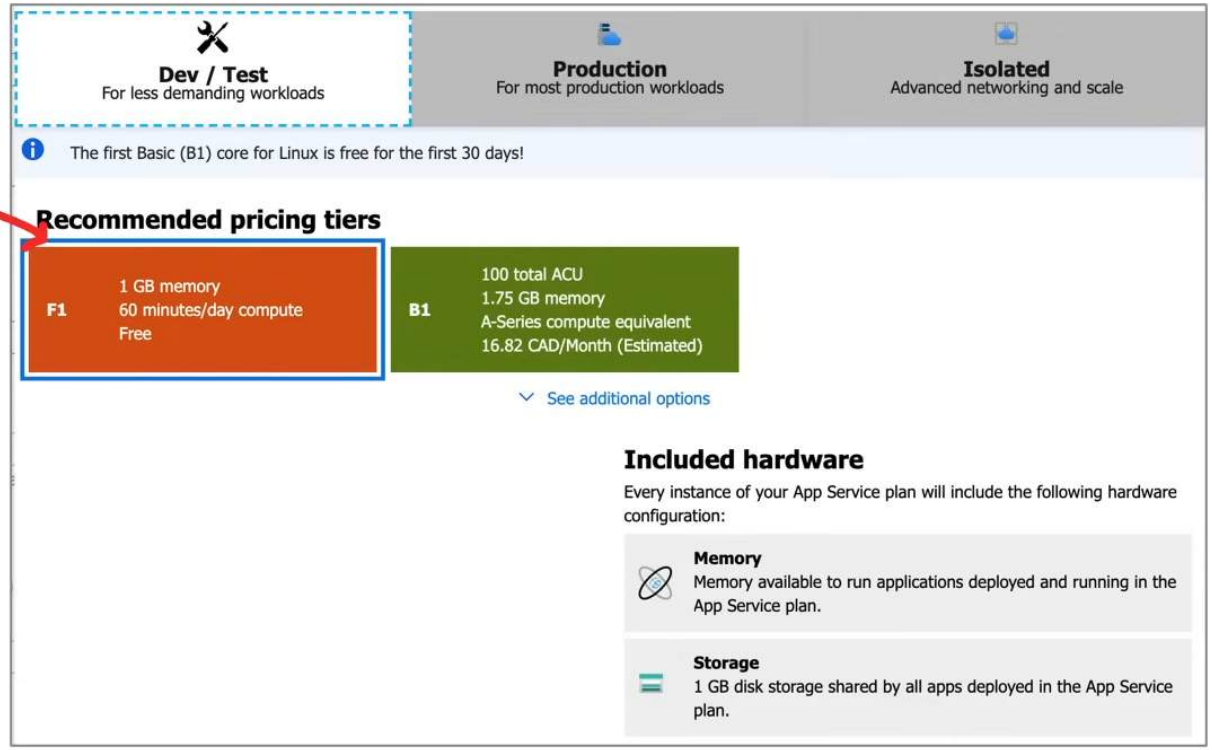
Azure App Service Plan defines **how you pay and what resources are available** to you.
There are **3 pricing tiers** for App Service Plan:

Shared Tiers
There are **2 shared:** Free, Shared

Free Tier provides:
- 1 GB of disk space
- up to 10 apps on a single shared instance
- No SLA for availability
- Each app has a compute quota of 60 minutes per day

Shared Tier provides
- up to 100 apps on a single shared instance
- No SLA for availability
- Each app has a compute quota of 240 minutes per day

Shared Tiers does not support Linux-based instances



Azure App Service Plan

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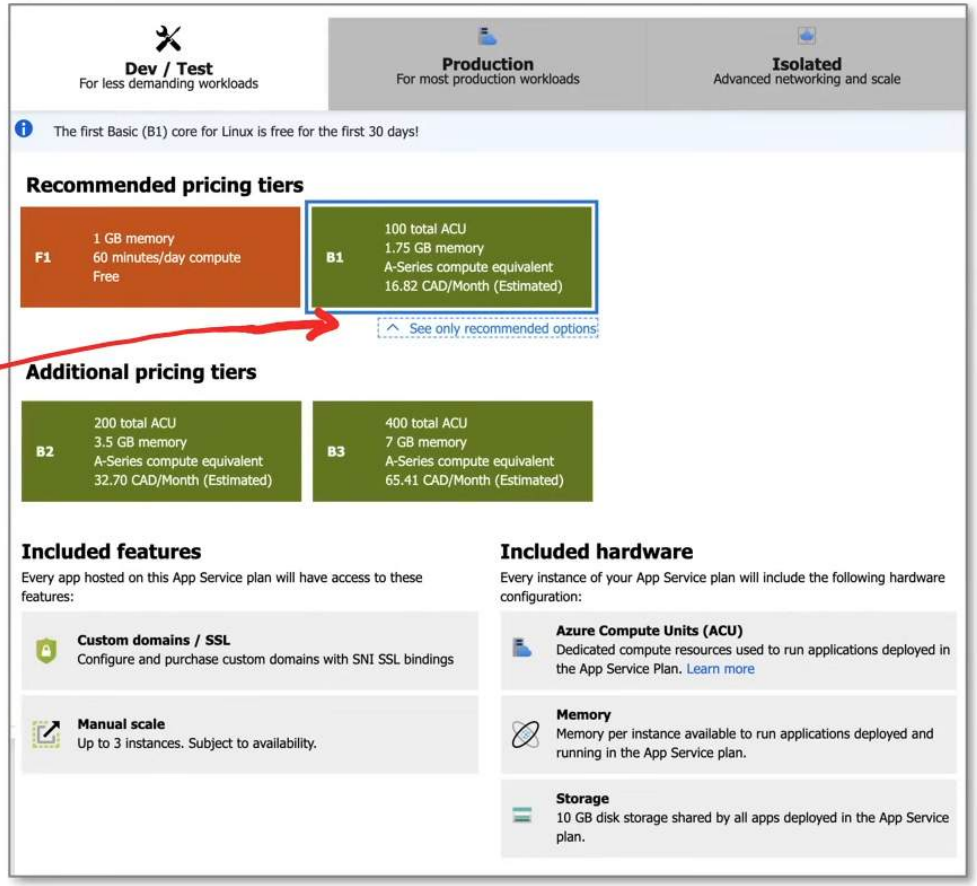
Azure App Service Plan defines **how you pay and what resources are available** to you.
There are **3 pricing tiers** for App Service Plan:

Dedicated Tiers
Basic, Standard, Premium, PremiumV2, PremiumV3

Basic

- More disk space
- Unlimited apps
- 3 levels in this tier that offer varying amounts of compute power, memory, and disk storage



Azure App Service Plan

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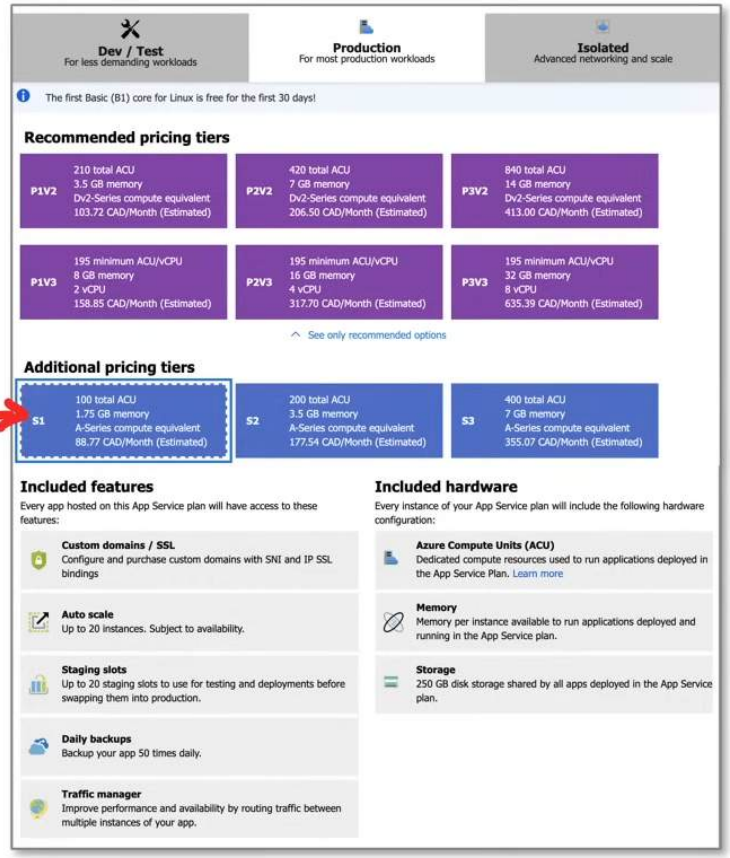
Azure App Service Plan defines **how you pay and what resources are available** to you.
There are **3 pricing tiers** for App Service Plan:

Dedicated Tiers
Basic, Standard, Premium, PremiumV2, PremiumV3

Basic
- More disk space
- Unlimited apps
- 3 levels in this tier that offer varying amounts of compute power, memory, and disk storage

Standard
- scale out to three dedicated instances
- SLA of 99.95% availability
- 3 levels in this tier that offer varying amounts of compute power, memory, and disk storage



Azure App Service Plan

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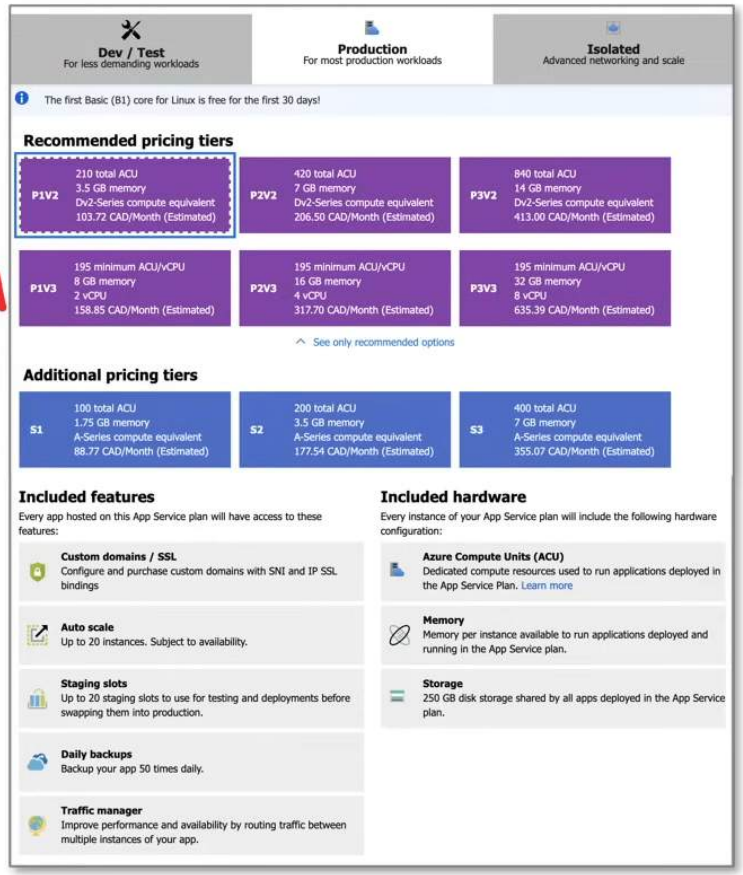
Azure App Service Plan defines **how you pay and what resources are available** to you.
There are **3 pricing tiers** for App Service Plan:

Dedicated Tiers
Basic, Standard, Premium, PremiumV2, PremiumV3

Basic
- More disk space
- Unlimited apps
- 3 levels in this tier that offer varying amounts of compute power, memory, and disk storage

Standard
- scale out to three dedicated instances
- SLA of 99.95% availability
- 3 levels in this tier that offer varying amounts of compute power, memory, and disk storage

Premium
- scale to 10 dedicated instances
- availability SLA of 99.95%
- multiple levels of hardware



Azure App Service Plan

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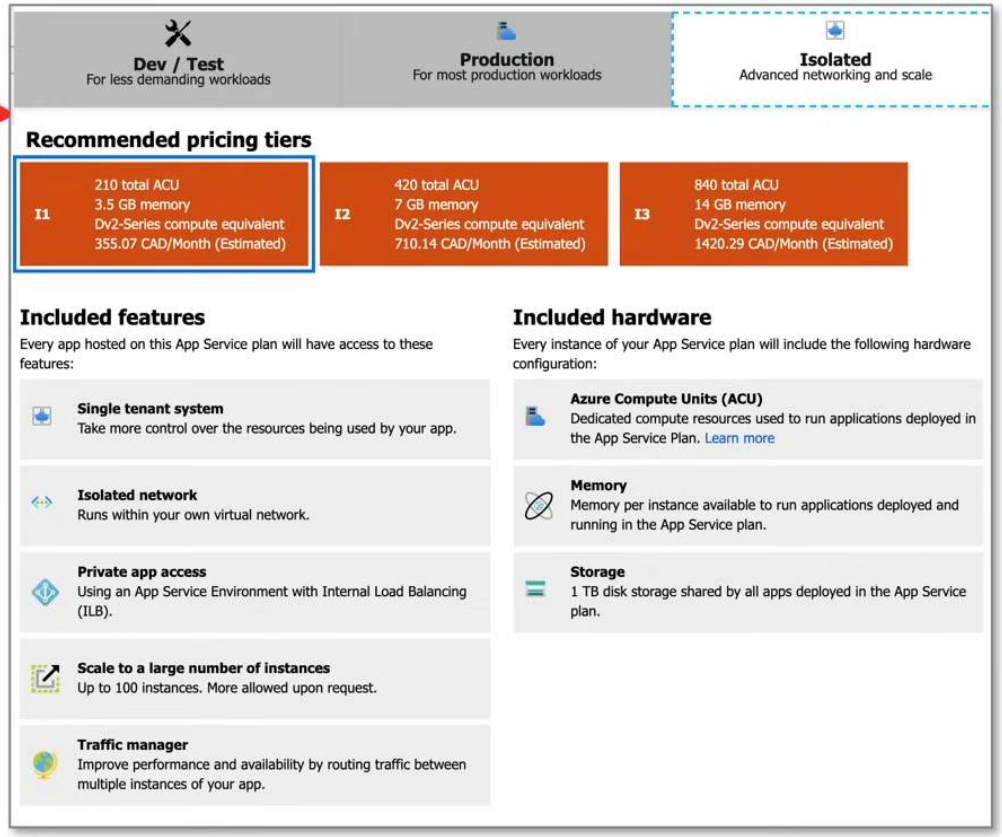
Azure App Service Plan defines **how you pay and what resources are available** to you.
There are **3 pricing tiers** for App Service Plan:

Isolated Tier

- dedicated Azure virtual network
- Full network and compute isolation
- scale out to 100 instances
- availability SLA of 99.95%



Introduction to ACI

Azure Container Instances (ACIs) allow you to **launch containers** without the need to worry about configuring or managing the underlying virtual machine

Azure Container Instances is designed for isolate containers:
- simple applications
- task automation
- build jobs

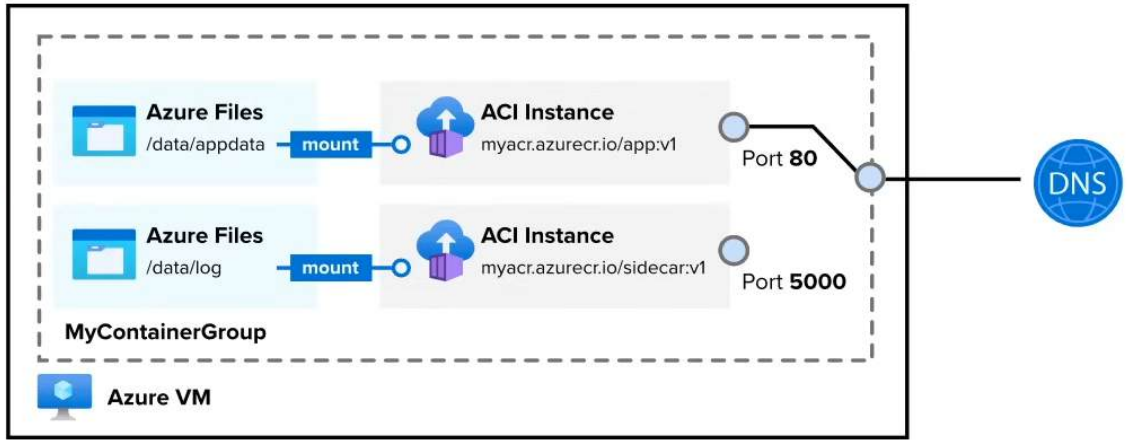
- Containers can be provisioned **within seconds** where VMs can take several minutes
- Containers are **billed per second** where VMs are billed per hour (greater savings)
- Containers have **granular and custom sizing of vCPUs, Memory and GPUs** where VMs sizes are predetermined
- ACI can deploy both **Windows** and **Linux** containers
- You can **persist storage with Azure Files** for your ACI containers
- ACIs are accessed via a fully qualified domain name (FQDN) eg *customlabel.azureregion*.azurecontainer.io.

Azure provides Quickstart images to start launching example applications but you can also **source** containers from:
- Azure Container Registry
- Docker Hub
- Privately Hosted Container Registry

Introduction to ACI

Container Groups are collection of containers that get scheduled on the same host machine.
The containers in a container group share:

- lifecycle
- Resources
- local network
- storage volumes



Container Groups** are similar to a **Kubernetes pod

Multi-container groups **currently support only Linux** containers.

There are two ways to deploy a multi-container group:

- **Resource Manager Template (ARM template)** — when you need to deploy additional Azure service resources
- **YAML File** — when your deployment includes only container instances.

Container Restart Policies

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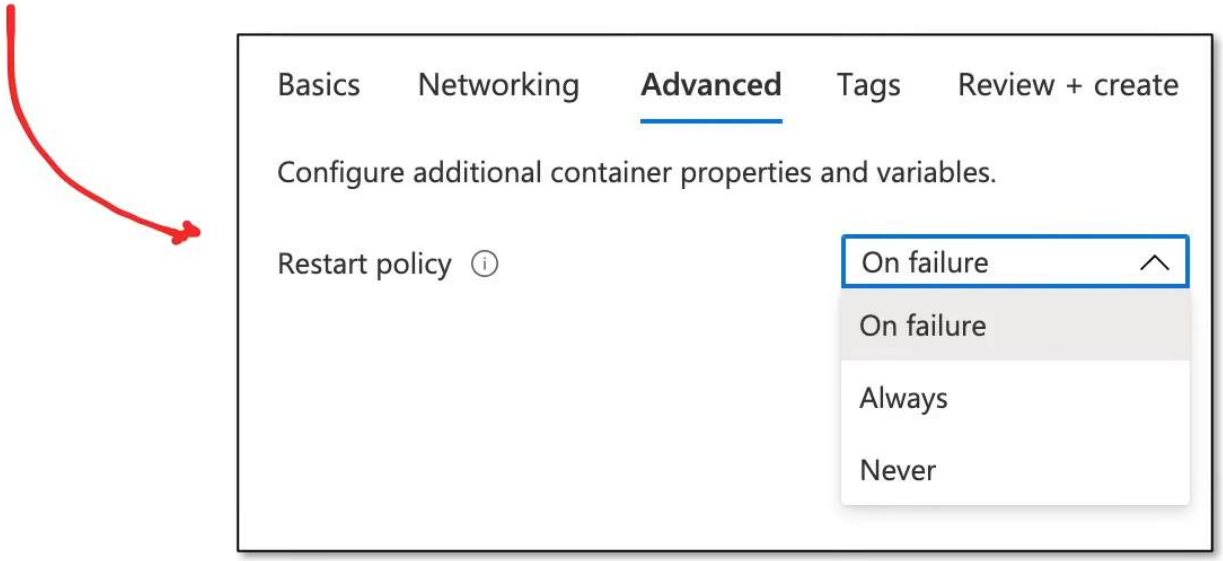
A container restart policy specifies what a container should do when their process has completed. Azure Container Instances has 3 restart-policy options:

- **Always** (default) Containers are **always restarted**. Suited for long running tasks eg. **web-servers**
- **Never** Containers **run one time only**. Suited for one off tasks. eg. **background jobs**
- **OnFailure** Containers that encounter an error



Container Environment Variables

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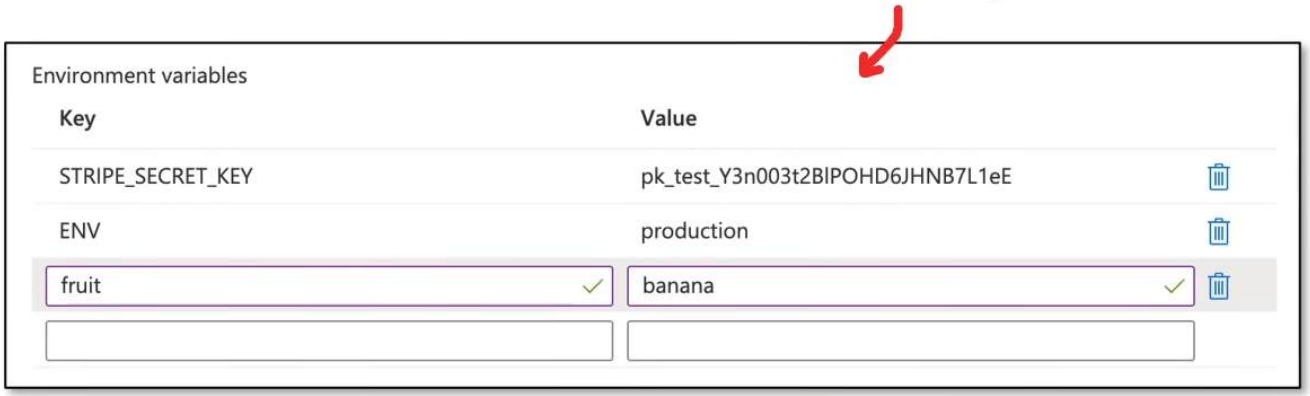
Environment variables (Env Vars) allow you to pass configuration details to your containers.
Environment variables can be set via the **Azure Portal**, CLI or PowerShell



Secured Environment Variables

By default Environment Variables are store in plaintext.
If you need to secure your environment variables you can use the **--secure-environment-variables** flag

```
az container create \
  --resource-group aci-resource-group \
  --name aci-demo-secure \
  --image exampro/rails:backend \
  --ip-address Public \
  --location eastus \
  --secure-environment-variables \
    STRIPE_SECRET_KEY=$STRIPE_SECRET_KEY
```

Container Persistent Storage

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Azure Containers are **stateless** by default.
When a container crashes or stops all state is loss.
To persist state you need to **mount** an external volume

You can mount **the following external volumes**:

- Azure Files (file share)
- Secret volume
- Empty Directory
- Cloud git repo

To mount a file volume you need do this via PowerShell or CLI and specify the **details** to mount the drive

```
az container create \
  --resource-group exampro-resource-group \
  --name my-app \
  --image exampro/web-app \
  --location eastus \
  --ports 80 \
  --ip-address Public \
  --azure-file-volume-account-name $STORAGE_ACCOUNT_NAME \
  --azure-file-volume-account-key $STORAGE_KEY \
  --azure-file-volume-share-name my-fileshare \
  --azure-file-volume-mount-path /aci/logs/
```

Azure Virtual Network (VNet)

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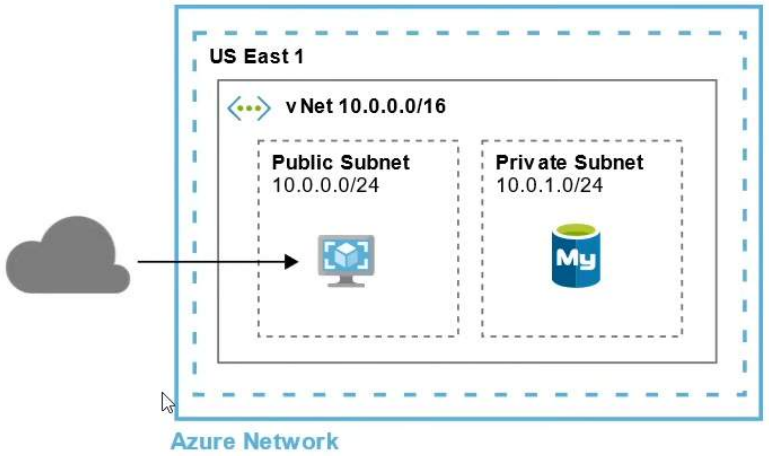
Virtual Network (vNet) is a logically isolated section of the Azure Network where you launch your Azure resources.



Azure DNS — manage your own DNS domain

Virtual Network (vNET) — logically isolated section of Azure network

- Address spaces
- Route Tables
- Subnets

Network Security Groups A virtual firewall at the subnet or NIC level

ExpressRoute A 50 Mbps-10 Gbps connection between on-premise to VNET

Virtual WAN a centralized network to route different network connections

Virtual Network Gateway - A site-to-site VPN connection between an VNet and local networks

Network Interfaces virtual network device to allow your VMs to communicate using IP protocols

VNeT Peering

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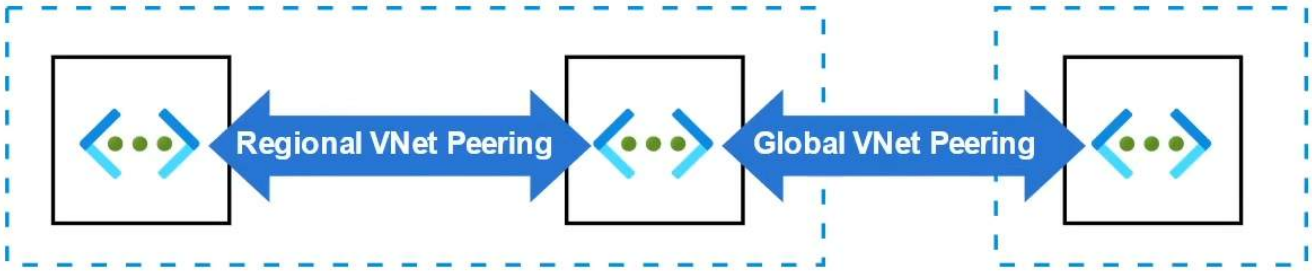
VNET peering is when you connect multiple VNet so they act as one network.



There are 2 types of VNet Peering:

1. **Regional VNet Peering** When you peer two VNets from the same region
2. **Global VNet peering** When you peer two VNets from two different regions

Network Interfaces

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What is a Network Interface?

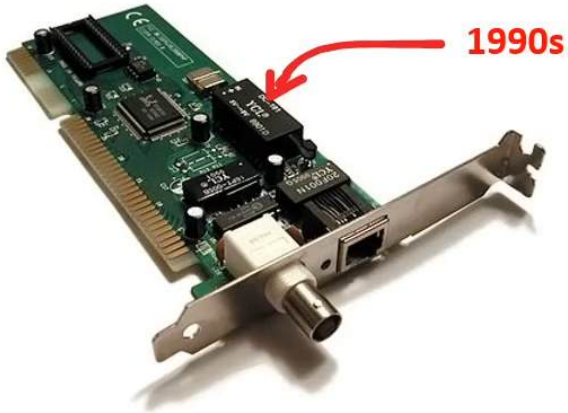
Software or hardware interface between two pieces of equipment or protocol layers in a computer network.

A Network Interface Controller (NIC)

A **computer hardware component** that connects a computer to a computer network.

Also known as:

- network interface card
- network adapter
- LAN adapter
- physical network interface

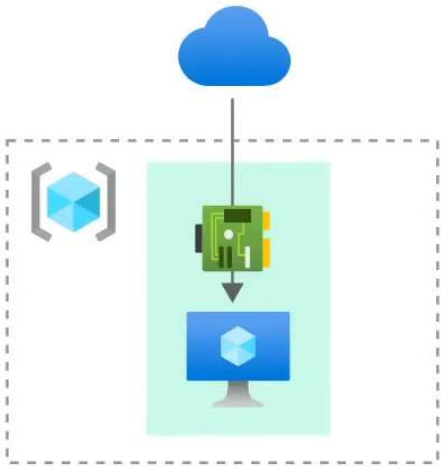


1990s Ethernet Interface Controller card

NICs are devices for both the:

- Data Link Layer (Layer 2)
- Physical Layer (Layer 1)

NICs communicate using **Internet Protocol (IP)**



Azure Network Interfaces (NICs)

Azure Network Interfaces are attached to Azure VM instance.

Without an NIC, An Azure VM instance would have no way to communicate.

An Azure VM instance has to have an NIC and can have multiple NICs.

VNeT – Subnets

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What is a Subnet?

A subnet is **a logical division of an address space**. Subnets help you **define different kinds of workloads** and allows you to apply virtual isolation within your network. When you launch an Azure resource you choose the subnet you want to launch within and an IP from that subnet is assigned to your resource

Associating a Route Table

A subnet needs a Route Table so it can access

Public vs Private Subnet

Public and Private subnet describes whether a subnet is reachable from the internet or not.
Azure **has no concept of private and public subnets** and its up to you to configure our subnets to have ensure they do no reach the internet by ensuring they have no route via the their route table to the Internet Gateway

Associating Network Security Gateways (NSG)

You can associate an NSG to protect traffic entering and leaving your subnet by applying security rules that can Allow or deny access based on IP address, port and protocol.

Gateway Subnet

Azure has a special type of Gateway Subnet that is used by **Azure Virtual Network Gateway** and that service Launches specialized VMs into that subnet.

Azure DNS

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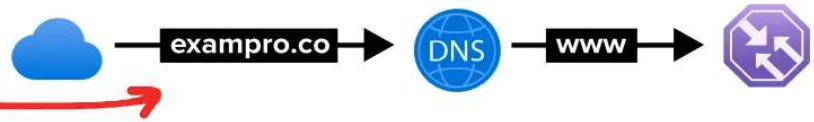
What is a Domain Name System (DNS)?

It is a service that is responsible for **translating (or resolving) a service name** to its IP address.

Azure DNS is a **hosting service** for **DNS domains** that provides name resolution by using Microsoft Azure infrastructure



Public DNS Internet-facing

- Allows you to manage domains for internet accessible domains
  - Pointing your domain to your website
  - Setting records to prove you own the domain
  - Records to connect you domain to your email server

Private DNS Internal-facing

- Allow you to use your own custom domains instead of the Azure provided domains
  - Many Azure Services use fully qualified domain name (FQDN) to identify services on the network.
    - eg. Azure Storage Accounts FQDN: **http://storageaccount.file.core.windows.net/**

You **can't use** Azure DNS **to buy a domain** name.

You can purchase a domain in App Services or a third-party provider and have Azure DNS manage

Virtual Network Gateways

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What is a (Virtual Private Network) VPN?

A VPN **extends a private network across a public network** and enables users **to send and receive data across shared or public networks** as if their computing devices were directly connected to the private network.

What is a Virtual Network Gateway?

- A **virtual network gateway** is the software **VPN** device for your Azure virtual network.
- When you deploy a virtual network gateway it will deploy two or specialized VMs in specific subnet you need to create called a "gateway subnet"
- These deployed VMs contain routing tables and run specific gateway services.
- You will choose a **Gateway Type** and that will determine if it's a VPN Gateway or an ExpressRoute Gateway

Azure ExpressRoute

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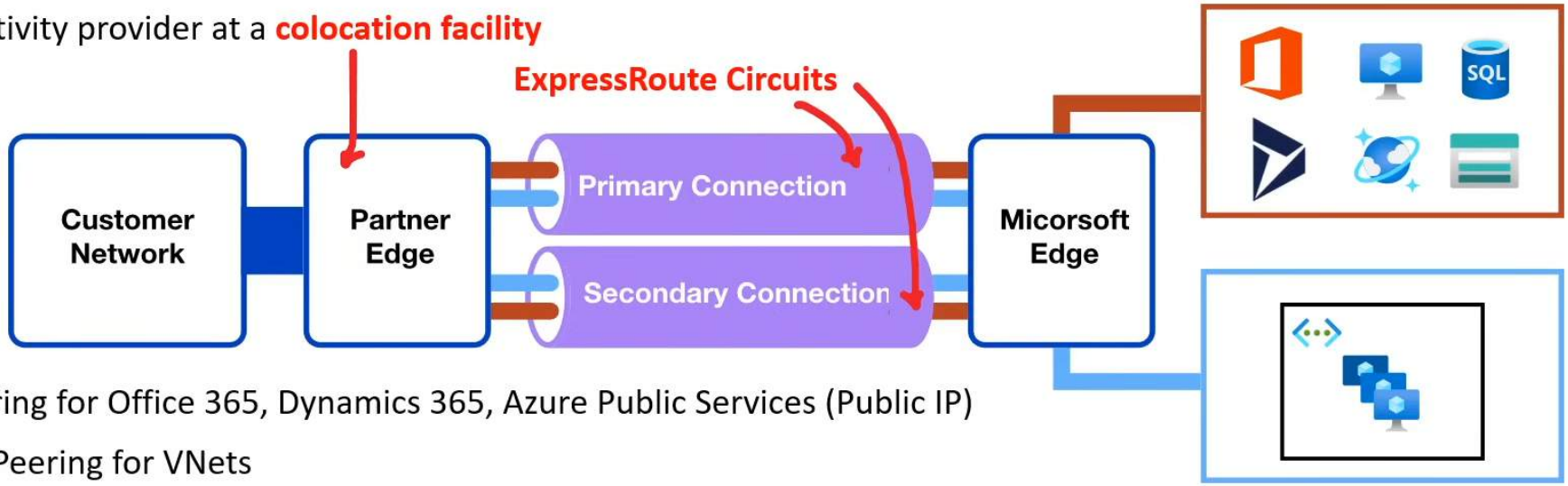
Azure ExpressRoutes creates **private connections** between Azure datacenters and infrastructure on your premises or in a colocation environment

Connectivity can be from an:

- any-to-any (IP VPN) network
- a point-to-point Ethernet network
- virtual cross-connection

through a connectivity provider at a **colocation facility**

ExpressRoute connections don't go over the public Internet and as a result can offer: **more reliability**, **faster speeds**, **consistent latencies**, **higher security**



Microsoft Peering for Office 365, Dynamics 365, Azure Public Services (Public IP)

Azure Private Peering for VNets

ExpressRoute Direct allows for **greater bandwidth connections** from 50 Mbps to 10Gbps. Ideal where for hybrid solutions with massive amounts of data or where latency matters.

Private Links

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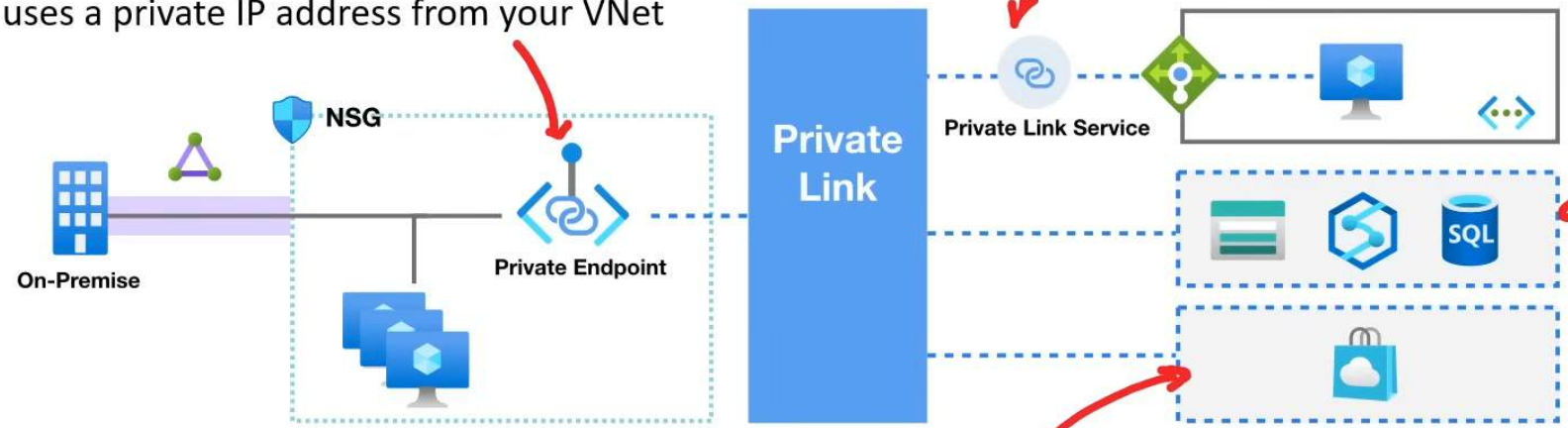
Azure Private Links allows you to **establish secure connections** between Azure resources so traffic **remains within the Azure Network**

Private Link Endpoint is an **Network Interface** that connects you privately and securely to a service powered by Azure Private Link. Private Endpoint uses a private IP address from your VNet

Private Link Service allows you to connect your own workload to Private Link. You need an **Azure Standard Internal Load Balancer** and associate it with the Link Service



Third-Party provides can be powered by Private Link

Many Azure services by default work with Private Link eg. Azure Storage, CosmoDB, SQL

Storage Services

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Azure Blob Storage
Object Serverless Storage. Store very large files and large amounts of unstructured files.
Pay for what you store, unlimited storage, no-resizing volumes, filesystem protocols.

Azure Disk Storage
A virtual volume. Choose SSD or HDD, encryption by default, attach volume to VMs

Azure File Storage
A shared volume that you can access and manage like a file server. eg SMB

***Azure Queue Storage**
Messaging Queue A data store for queuing and reliably delivering messages between applications

***Azure Table Storage**
Wide-Column NoSQL Database A NoSQL store that hosts unstructured data independent of any schema

Azure Data Box / Azure Databox Heavy
A rugged briefcase computer and storage designed to move terabytes or petabytes of data

Azure Archive Storage
Long term cold storage for when you need to hold onto files for years on the cheapest storage options

Azure Data Lake Storage
A centralized repository that allows you to store all your structured and unstructured data at any scale.

Introduction to Storage Accounts

Azure Storage offers **several types of storage** accounts.

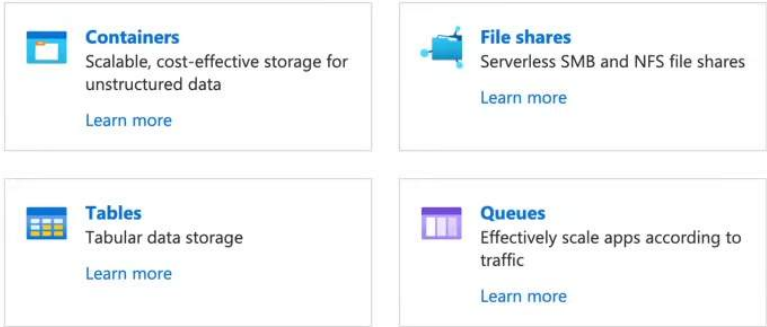
Each with **different features** and **their own pricing models**

- General-purpose v1 (legacy)
- General-purpose v2
- BlobStorage (legacy)
- BlockBlobStorage
- FileStorage

Storage type and **Account Kind** means the same thing

Storage accounts vary with the following features:

Supported Services (What can I put in this storage account?)
Blob, File, Queue, Table, **Disk**, and Data Lake Gen2



Performance Tiers (how fast will my read and writes be?)
Standard and Premium

Access Tiers (how often do I need quick access to files?)
Hot, Cool, Archive

Replication (How many redundant copies should be made and where?)
LRS, GRS, RA-GRS, ZRS, GZRS, RA-GZRS

Deployment model (Who should deploy the supported services?)
Resource Manager, Classic

Introduction to Storage Accounts

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Type	Service	Performance Tiers	Access Tiers	Replication	Deployment Models
General-purpose V2	Blob, File, Queue, Table, Disk, Data Lake Gen 2	Standard, Premium	Hot, Cool, Archive	LRS, GRS, RA-GRS, ZRS, GZRS, RA-GZRS	Resource Manager
General-purpose V1	Blob, File, Queue, Table, Disk	Standard, Premium	N/A	LRS, GRS, RA-GRS	Resource Manager **Classic**
BlockBlobStorage	Blob (block, append)	Premium	N/A	LRS, ZRS	Resource Manager
FileStorage	File	Premium	N/A	LRS, ZRS	Resource Manager
BlobStorage	Blob (Block, append)	Standard	Hot, Cool, Archive	LRS, GRS, RA-GRS	Resource Manager

Core Storage Services

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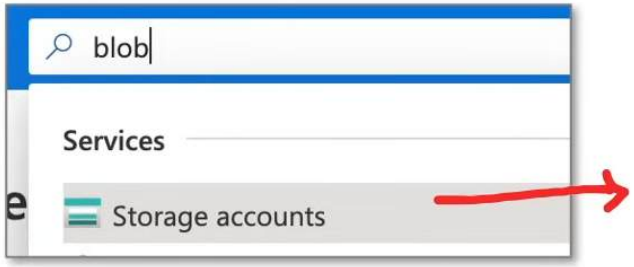
Azure has **5 core storage** services

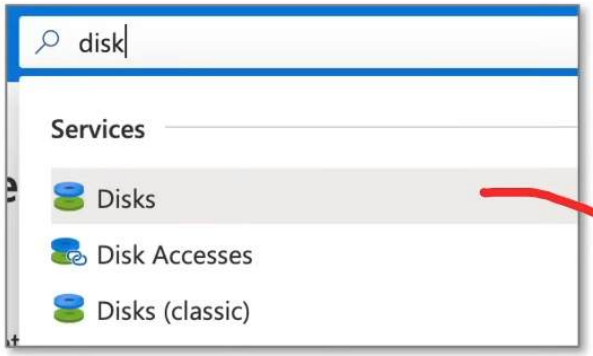


Azure Blob
A massively scalable **object store** for text and binary data.
Also includes support for big data analytics through Data Lake Storage Gen2

Azure Files
Managed **file shares** for cloud or on-premises deployments

Azure Queues
A **NoSQL store** for schemaless storage of structured data.

Azure Tables
A **messaging store** for reliable messaging between application components



Azure Disks
Block-level storage volumes for Azure VMs

Performance Tiers (Blob Storage)

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There are **2 types** of performance tiers for storage accounts: Standard and Premium

IOPS stands for Input/Output Operations Per Second
The higher the IOPS the faster a drive can read and write

Premium Performance

- Stored on Solid State Drives **(SSDs)**
- Optimize for low-latency
- Higher throughput
- Use cases:
  - Interactive workloads
  - Analytics
  - AI or ML
  - Data transformation

An SSD **has no moving parts** and data is distributed randomly. This is why it can read and write so fast.

Standard Performance

- Stored on Hard Disk Drives **(HDDs)**
- Varied performance based on access tier (Hot, Cool, Archive)

  Use cases:
  - Backup and disaster recovery
  - Media content
  - Bulk data processing

An HDD **has moving parts**, an arm that needs to read and write data sequential to a disk. It is very good a writing or reading large amounts of data that is close together

Access Tiers (Blob Storage)

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There are **3 types** of access tiers for **Standard storage**: Cool, Hot and Archive

Hot

- Data that's accessed frequently.
- Highest storage cost, lowest access cost

Use Case

- Data that's in active use or expected to be accessed frequently.
- Data that's staged for processing and eventual migration to the cool access tier

Cool

- Data that's infrequently accessed and stored for at least 30 days.
- Lower storage cost, higher access cost

Use Case

- Short-term backup and disaster recovery datasets
- Older media content not viewed frequently anymore but is expected to be available immediately when accessed
- Large data sets that need to be stored cost effectively while more data is being gathered for future processing.

Archive

- Data that's rarely accessed and stored for at least 180 days
- Lowest storage cost, highest access cost

Use Case

- Long-term backup, secondary backup, and archival datasets
- Original (raw) data that must be preserved, even after it has been processed into final usable form.
- Compliance and archival data that needs to be stored for a long time and is hardly ever accessed.

Access Tiers (Blob Storage)

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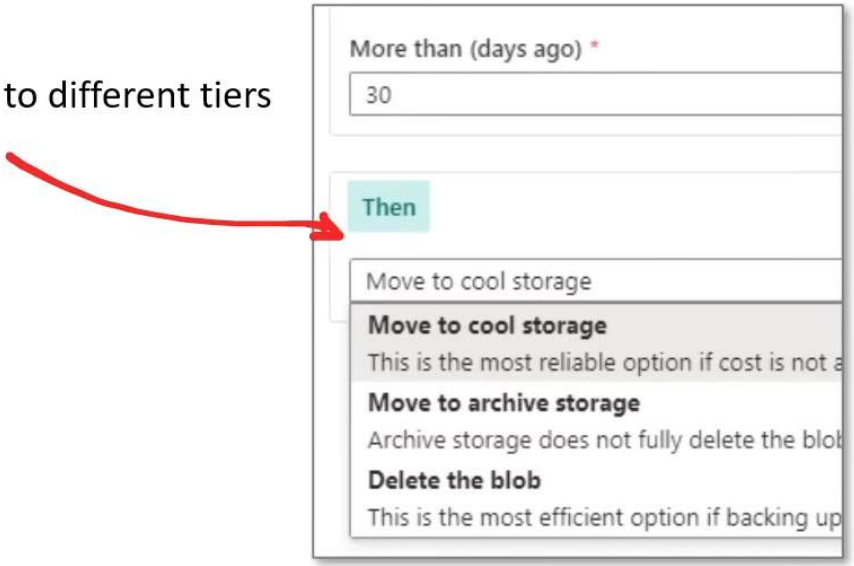
Account Level Tiering
Any blob that doesn't have an explicitly assigned tier infers the tier from the Storage Account access tier setting.

Blob-Level Tiering
You can upload a blob to the tier of your choice.
Changing tiers happens instantly with the exception from moving out of archive

Rehydrating a Blob
When moving a blob out of archive into another tier it can take several hours. This is known as **"rehydrating"**

Blob Lifecycle Management
You can create rule-based policies to transition data to different tiers
Eg. After 30 days move to cool storage



Access Tiers (Blob Storage)

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When a blob is uploaded or moved to another tier
It's charged at the new tier's rate **immediately** upon tier change.

When moving from a **cooler tier:**
The operation is billed as a **write operation** to the destination tier.
Where the write operation (per 10,000) and data write (per GB) charges of the destination tier apply.

When moving from a **hotter tier**
The operation is billed as a read from the source tier
Where the **read operation** (per 10,000) and data retrieval (per GB) charges of the source tier apply
Early deletion charges for any blob moved out of the cool or archive tier may apply as well

Cool and archive early deletion
Any blob that is moved into the cool tier (GPv2 accounts only) is subject to a cool early deletion period of 30 days.
Any blob that is moved into the archive tier is subject to an archive early deletion period of 180 days. This charge is prorated.

Replication and Data Redundancy

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When you create a Storage Account you need to choose a **Replication Type**

Replication ⓘ Geo-redundant storage (GRS)

Replication stores multiple copies of your data so that it is **protected from**:

- planned events
- transient hardware failures
- network or power outages
- massive natural disasters

The greater level of redundancy the more expensive the cost of replication

$

Primary Region Redundancy

- Locally Redundant Storage (LRS)
- Zone-redundant storage (ZRS)

Disaster Recovery and Failovers

$$

Secondary Region Redundancy

- Geo redundant storage (GRS)
- Geo-zone-redundant storage (GZRS)

Disaster Recovery and Failovers

$$$

Secondary Region **Redundancy with Read Access**

- Read-access geo-redundant storage (RA- GRS)
- Read-access geo-redundant storage (RA-GZRS)

Read Replicas

Replication and Data Redundancy

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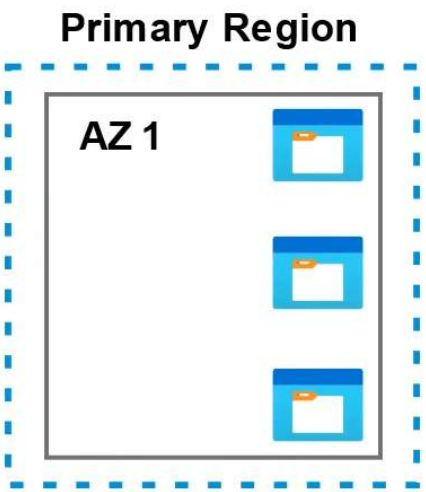
Redundancy in the Primary Region

- Data is replicated **3 times** in the primary region
- There are **two options** for storing in the primary region

Locally Redundant Storage **(LRS)**

- Copies data **synchronously** in primary region
- 99.999999999% (11 nines) durability
- **Cheapest option**



Zone-redundant storage **(ZRS)**

- Copies data **synchronously across 3 AZs** in primary region
- 99.9999999999% (12 9's) durability

Replication and Data Redundancy

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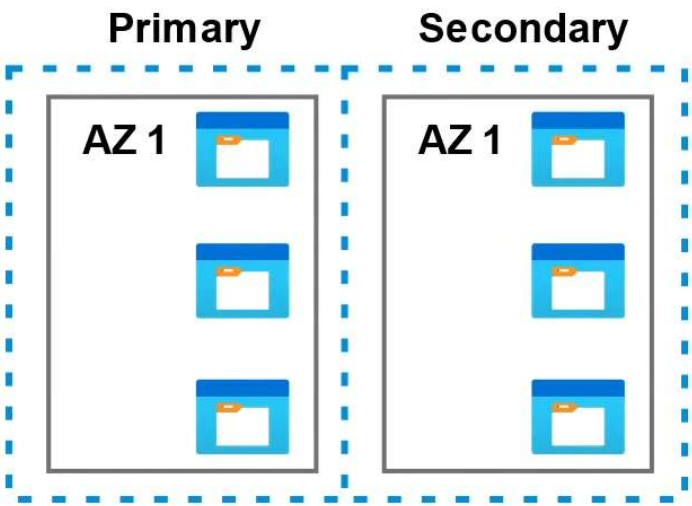
Redundancy in the Secondary Region

- Replicate to a secondary region in case of primary regional disaster
- The secondary region is determined based on your primary's pair region
- Secondary region isn't available for read or write access (except in event of failover)

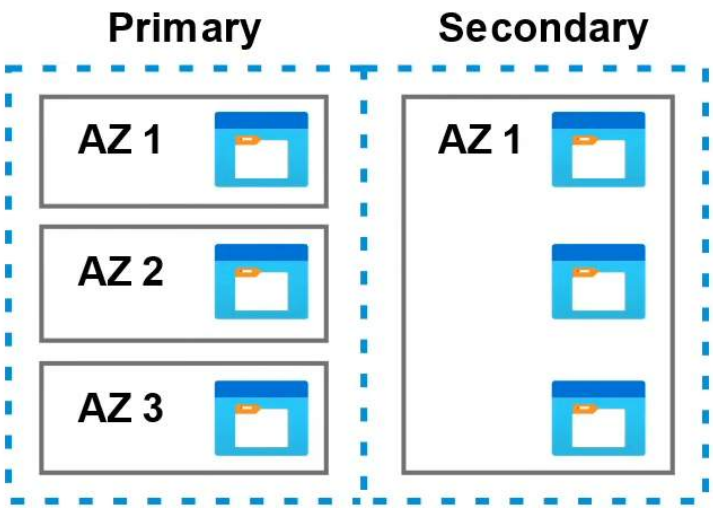
Geo Redundant Storage **(GRS)**

- Copies data **synchronously** in primary region
- Copies data **asynchronously** to another region
- 99.99999999999999% (16 9's) of durability



Geo-Zone-redundant storage **(GZRS)**

- Copies data **synchronously across 3 AZs** in a physical region
- Copies data **asynchronously** to another region
- 99.99999999999999% (16 9's) of durability



Replication and Data Redundancy

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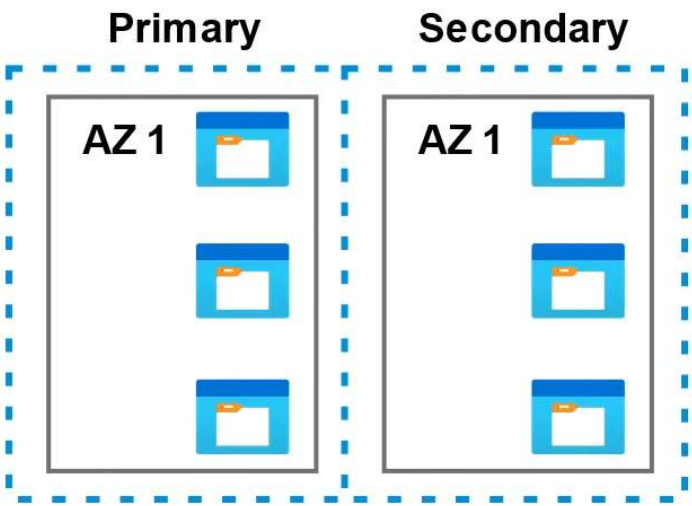
Redundancy in the Secondary Region with Read Access

- Data is replicated **synchronously** to primary region
- Your data will be "in-sync" with your primary and you'll have **read access**.

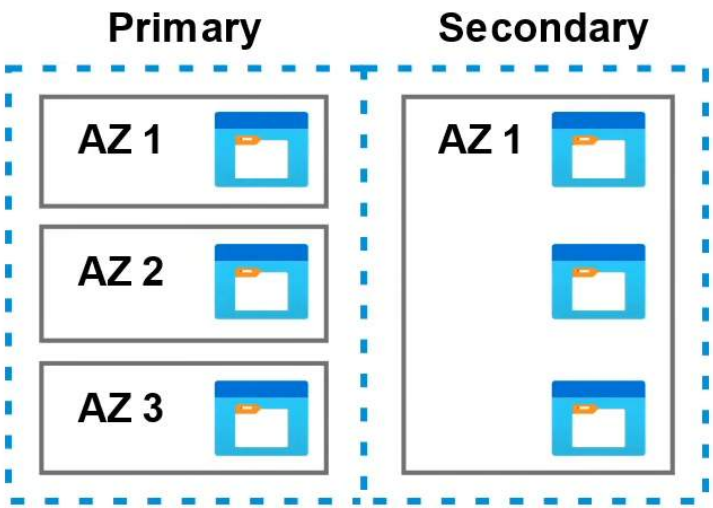
Read-Access Geo Redundant Storage **(RA-GRS)**

- Copies data **synchronously** in primary region
- Copies data **synchronously** to another region
- 99.99999999999999% (16 9's) of durability



Read-Access Geo-Zone-redundant storage **(RA-GZRS)**

- Copies data **synchronously across 3 AZs** in a physical region
- Copies data **synchronously** to another region
- 99.99999999999999% (16 9's) of durability



Azure Blob

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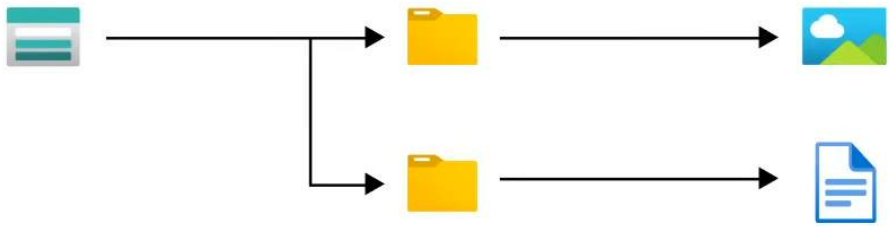
Blob storage is a **object-store** that is optimized for **storing massive amounts of unstructured data**.
Unstructured data is data that doesn't adhere to a particular data model or definition, such as text or binary data.

Azure Blobs are composed of the components:



Storage Account | Containers | Blobs

a unique namespace in Azure for your data
http://**mystorageaccount**.blob.core.windows.net

similar to a folder in a file system

The actual data being stored

Azure Blob

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Azure Storage supports **3 types** of blobs:

1. **Block blobs**
   - store text and binary data
   - made up of blocks of data that can be managed individually
   - store up to about 4.75 TiB of data

2. **Append blobs**
   - Optimized for append operations
   - ideal for scenarios such as logging data from virtual machine

3. **Page blobs**
   - store random access files up to 8 TB in size.
   - store virtual hard drive (VHD) files and serve as disks for Azure virtual machine

AZCopy

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AZCopy is a **command-line utility** that you can use to copy blobs or files to or from a storage account.

1. Its an executable file you download

Download AzCopy

First, download the AzCopy V10 executable executable file, so there's nothing to install.

- Windows 64-bit (zip)
- Windows 32-bit (zip)
- Linux x86-64 (tar)
- macOS (zip)

2. You will need to have the level of authorization via attached roles:

To download
- Storage Blob Data Reader

To upload:
- Storage Blob Data Contributor
- Storage Blob Data Owner

3. You gain access either via:

1. Azure Active Directory (AD)
2. Shared Access Signature (SAS)

```
~: azcopy login
To sign in, use a web browser to open the
page https://microsoft.com/devicelogin and
enter the code E9B7JJK6P to authentic
```

4. Use the Copy command to upload and download

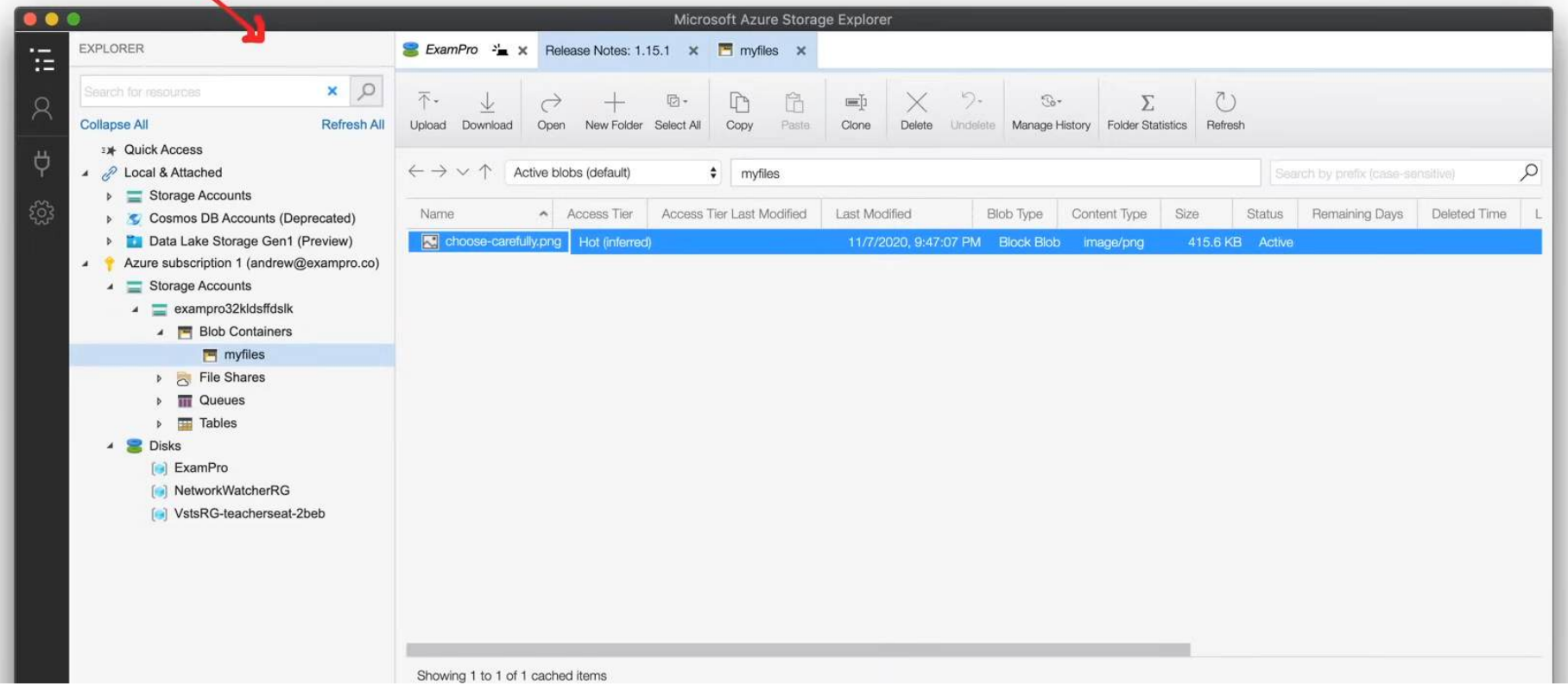
```
azcopy copy \
'C:\StarTrek\jodri.txt' \
'https://enterprise.blob.core.windows.net/mycontainer/jodri.txt'
```

```
azcopy copy \
'https://enterprise.blob.core.windows.net/mycontainer/jodri.txt' \
'C:\StarTrek\jodri.txt'
```

Azure Storage Explorer

Cheat sheets, Practice Exams and Flash cards 👉 www.exampro.co/az-900

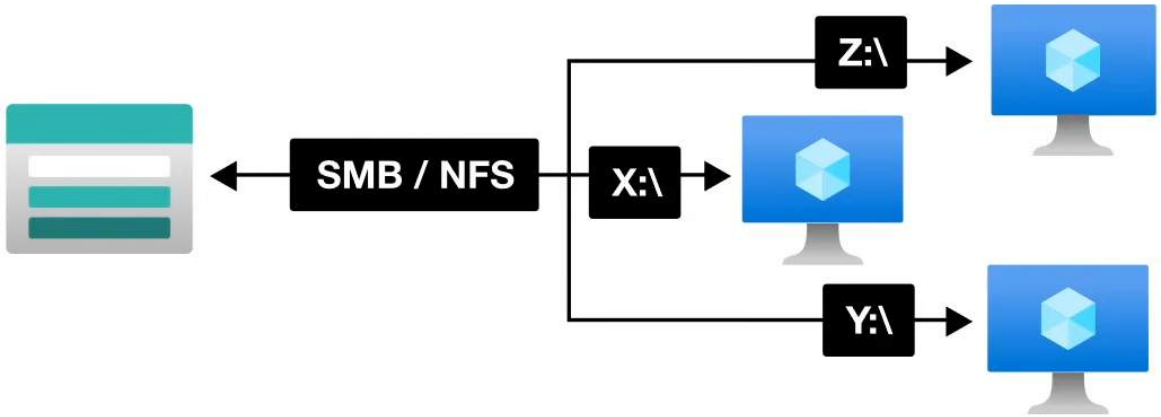
A **standalone app** that makes it easy to work with Azure Storage data on Windows, macOS, and Linux.
You can create Blob containers, upload files, create snapshots of Disk, and more!



Azure Files

Cheat sheets, Practice Exams and Flash cards 👉 www.exampro.co/az-900

Azure Files is a fully managed **file share** in the cloud.
A file share is a **centralized server for storage** that allows **multiple connections**.
It like having one big shared drive that everyone (Virtual Machines) can work on at the same time.



To connect to the file share a **network protocol** is used:

- Server Message Block (SMB)
- Network File System (NFS)

When a connection is established the file share's filesystem will be accessible in the specific directory within your own directory tree. This is knowing as **mounting**

Azure Files – Use Cases

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Use Cases

- Completely **replace or supplement** on-premises file servers Network Attach Storage (NAS) devices
- **Lift-and-Shift** your on-premise storage to the cloud via Classic Lift or Hybrid Lift
  - "Lift-and-Shift" means when you move workloads without rearchitecting, eg. importing local VMs to the cloud
  - Classic Lift — where both the application and its data are moved to Azure
  - Hybrid Lift — where the application data is moved to Azure Files, and the application continues to run on-premises
- **Simplify cloud development**
  - Shared application settings — Multiple VMs and developer workstations need to access the same config files.
  - Diagnostic share — All VMs log to the file share, developers can mount and debug all logs in a centralized place
  - Dev/Test/Debug — Quickly share tools for developer needed for local environments
- **Containerization**
  - You can use Azure Files to persist volumes for stateful containers

Why use Azure files instead of setting up your own File Share server?

- **Shared Access** — Already setup to work with standard networking protocols SMB and NFS
- **Fully managed** — Its kept up to date with security patches, designed to scale
- **Scripting and Tooling** — You can automate the management and creation of file shared with Azure API and PowerShell
- **Resiliency** — Build to be durable and always working

Azure Cloud Adoption Framework

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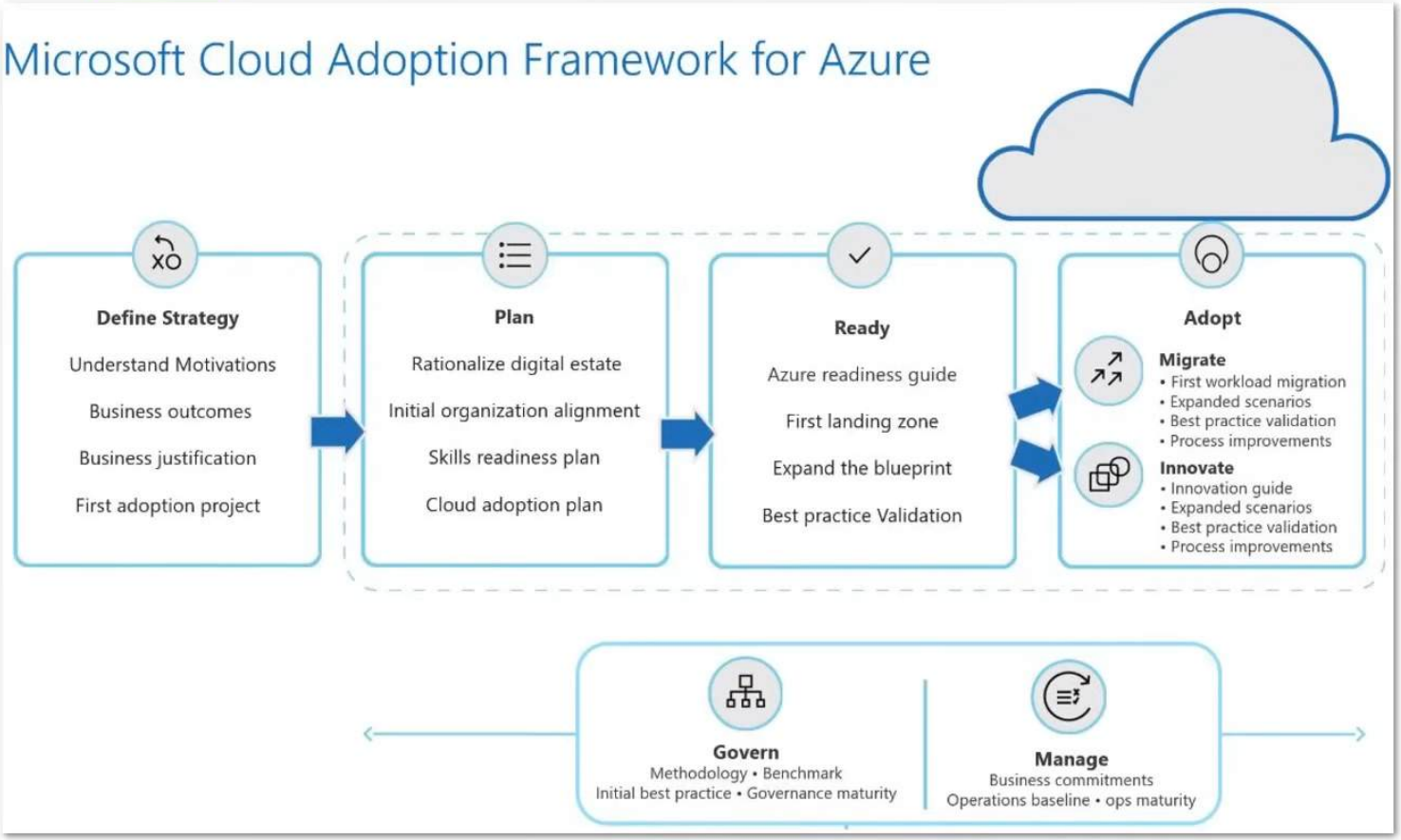
Cloud Adoption Framework is a whitepaper that is a **step-by-step process** to help organizations plan and migrate their workloads to Azure



Azure Cloud Adoption Framework

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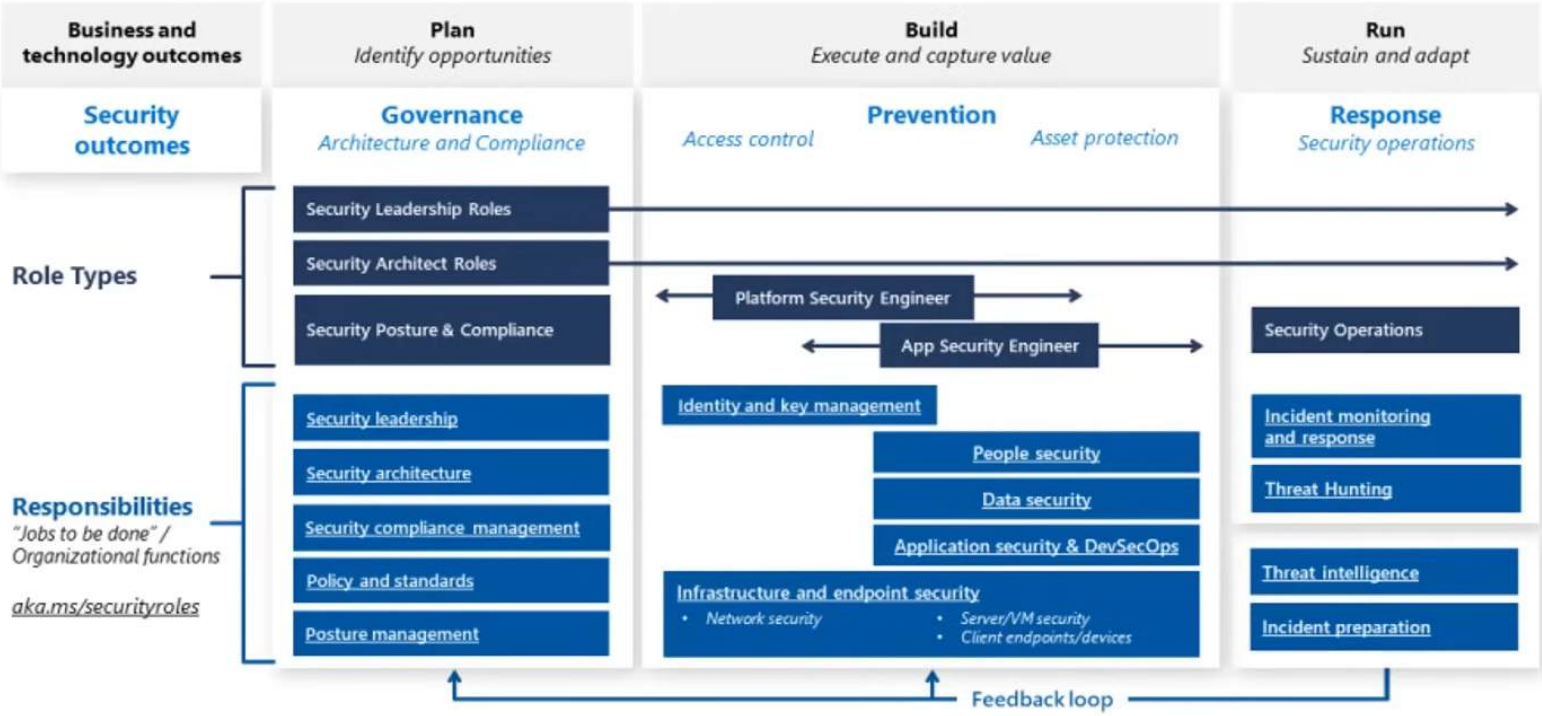
Security Roles and Responsiblities



Azure Migrate

Azure Migrate offers a streamlined service for **migration, modernization, and optimization on Azure**. It simplifies the pre-migration processes like discovering, assessing, and appropriately sizing on-premises resources for infrastructure, data, and applications.

With an extensible framework, Azure Migrate easily integrates with **third-party tools,** broadening its range of supported scenarios. Here's what it offers:

- **Unified Migration Platform**: A centralized portal to initiate, execute, and monitor your Azure migration journey.
- **Diverse Toolset**: Azure Migrate provides a suite of tools for both assessment and migration. It features tools such as **"Azure Migrate: Discovery and Assessment"** and **"Migration and Modernization."** It seamlessly integrates with other Azure services, tools, and third-party offerings from **independent software vendors (ISVs).**

Azure Migrate

Comprehensive Migration and Modernization Capabilities: In the Azure Migrate hub, you can **assess, migrate, and modernize**:

Servers, Databases, and Web Apps: Assess and migrate on-premises servers, web apps, and SQL Server instances to Azure.

- **Databases**: Analyze on-premises SQL Server instances and databases, and migrate them to **Azure SQL** on a VM, **Azure SQL Managed Instance**, or **Azure SQL Database**.
- **Web Applications**: Evaluate on-premises web applications and transition them to the Azure App Service or Azure Kubernetes Service.
- **Virtual Desktops**: Review your on-site **virtual desktop infrastructure (VDI)** and move it to Azure Virtual Desktop.
- **Data Transfer**: Efficiently and affordably transfer vast data volumes to Azure using **Azure Data Box** products.

Azure Migrate – Integrated tools

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Tool	Assess and migrate	Details
Azure Migrate: Discovery and assessment	Discover and assess servers including **SQL and web apps**	Discover and assess on-premises servers running on **VMware, Hyper-V, and physical servers** in preparation for migration to Azure.
Migration and modernization	Migrate servers	Migrate VMware VMs, Hyper-V VMs, physical servers, other virtualized servers, and public cloud VMs to Azure.
Data Migration Assistant	Assess SQL Server databases for migration to Azure SQL Database, Azure SQL Managed Instance, or Azure VMs running SQL Server.	Data Migration Assistant assesses **SQL Servers**, **identifies potential migration problems**, **unsupported features**, and suggests the best path for database migration.
Azure Database Migration Service	Migrate on-premises databases to Azure VMs running SQL Server, Azure SQL Database, or SQL Managed Instances	Azure Database Migration Service is a managed service for **seamless migrations to Azure data platforms** with minimal downtime.
Movere	Assess servers	Movere is a **SaaS platform** that enhances **business intelligence** by accurately depicting IT environments within a day.
Web app migration assistant	Assess on-premises web apps and migrate them to Azure.	Azure App Service Migration Assistant is a standalone tool to **assess on-premises websites for migration to Azure App Service**.
Azure Data Box	Migrate offline data	Use Azure Data Box products to move **large amounts of offline data to Azure**.

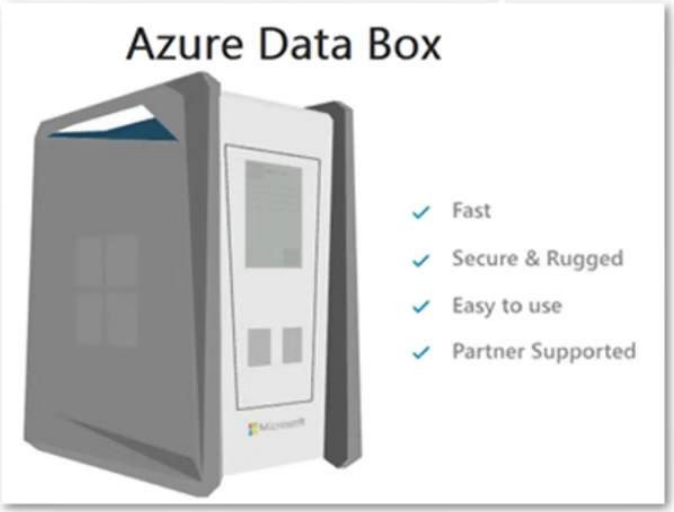
Azure Databox

Cheat sheets, Practice Exams and Flash cards 👉 www.exampro.co/az-900

The Microsoft Azure Data Box cloud solution lets you send **terabytes of data into and out of Azure** in a quick, inexpensive, and reliable way.

Each storage device has a maximum usable storage capacity of **80 TB** and is transported to your datacenter through a regional carrier.

It is designed to help customers with slow or limited internet connectivity to move large volumes of data to the cloud.



Azure Databox

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Use cases

Data Box is used to **import** data to Azure for:

- **One-time migrations**: Moving large on-premises data, transitioning offline tapes, relocating VMs, SQL servers, applications, and transferring historical data for Azure-based analysis.
- **Initial bulk transfers**: Large-scale transfers using Data Box, followed by incremental network transfers. For example, moving vast backups with partners like **Commvault**.
- **Periodic uploads**: Transferring large volumes of data generated periodically, like video content from oil rigs or windmill farms.

For **exporting** from Azure, Data Box is used for:

- **Disaster recovery**: Restoring Azure data on-premises quickly.
- **Security requirements**: Meeting mandates that require data extraction from Azure storage tiers like US Secret.

Azure Databox

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Here's how Azure Data Box works:

1. Customers order a **Data Box** from the **Azure portal**.
2. When the Data Box arrives, customers connect it to their network and configure it using the Azure portal.
3. Customers copy data to the Data Box using standard file transfer protocols, such as **SMB** or **NFS**.
4. Once the data transfer is complete, customers ship **the Data Box back to Azure**.
5. Azure copies the data from the **Data Box** to the customer's **Azure storage account**.

Introduction to Azure AD

Azure Active Directory (Azure AD) is Microsoft's cloud-based **identity and access management service**, which helps your employees sign in and access resources

External Resources

- Microsoft Office 365
- Azure Portal
- SaaS applications

Internal Resources

- Applications within your internal networking
- Access to workstations on-premise

Use Azure AD to implement **Single-Sign On (SSO)**

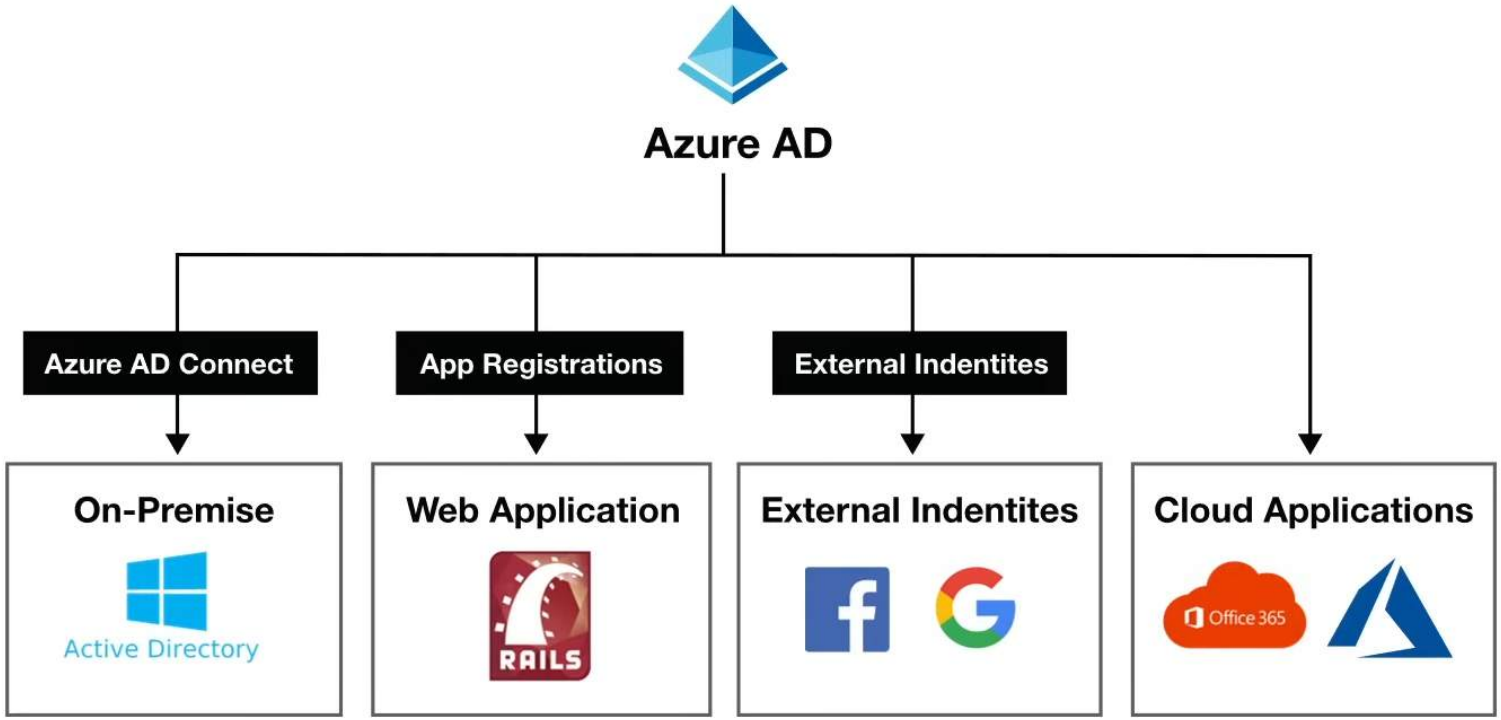
Azure Active Directory comes in four editions

1. **Free** MFA, SSO, Basic Security and Usage Reports, User Management
2. **Office 365 Apps** Company Branding, SLA, Two-Sync between On-Premise and Cloud
3. **Premium 1** Hybrid Architecture, Advanced Group Access, Conditional Access
4. **Premium 2** Identity Protection, Identity Governance

Azure AD – Use Case

Azure AD can **authorize** and **authenticate** to multiple sources.

- To your on-premise AD
- To your web-application
- Allow users to login with their IpD eg. Facebook or Google
- To Office 365 or **Azure Microsoft**



Active Directory vs Azure Active Directory

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Microsoft introduced **Active Directory** Domain Services in **Windows 2000** to give organizations the ability to manage multiple on-premises infrastructure components and systems using a single identity per user.

Azure AD takes this approach to the next level by providing organizations with an **Identity as a Service (IDaaS)** solution for all their apps **across cloud and on-premises**.

Both versions are still used today

Active Directory
The **on-premise** version

Azure AD
The **cloud** version

Active Directory Terminology

Domain
A domain is an area of a network organized by a single authentication database
An Active Directory domain is a **logical grouping** of AD objects on a network

Domain Controller (DC)
A domain controller is a server that **authenticates** user identities and **authorizes** their access to resources.

Domain Computer
A computer that is registered with a central authentication database A domain computer would be an AD Object

AD Object
An AD Object is the basic element of Active Directory such as:
Users, Groups, Printers, Computers, Shared folders

Group Policy Object (GPO)
A virtual collection of policy settings. It controls what AD Objects have access to

Organization Units (OU)
A subdivision within an Active Directory into which you can place users, groups, computers, and other organizational units

Directory Service
A directory service, such as **Active Directory Domain Services (AD DS),** provides the methods for storing directory data and making this data available to network users and administrators. A Directory service runs on a Domain Controller

Azure Active Directory Domain Services (AD DS)

In some cases you'll need to setup your own domain controller(s).

When doing a ***lift-and-shift from on-premise*** to Microsoft Azure and migrating Active Directory, Azure AD does not support some **domain services**.

Azure Active Directory Domain Services (AD DS) provides **managed domain service** such as:

- Domain joins
- Group policies
- Lightweight directory access protocol (LDAP)
- and Kerberos / NTLM authentication.

You use can these domain services without the need to:
deploy, **manage**, and **patch** **domain controllers (DCs)** in the cloud

Single Sign-On (SSO) in Entra ID

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Single Sign-On (SSO) in **Entra ID (Azure AD)** is a feature that allows users to **authenticate once** with Azure AD and then access **multiple applications and services without having to authenticate again**.

When a user signs into Entra ID with their credentials, Entra ID creates a **security token** that can be used to access other **resources** within the same organization.

- This token can be used to authenticate the user to other cloud-based or on-premises applications that have been integrated with Entra ID.

SSO supports a wide range of applications, including cloud-based applications such as **Microsoft 365, Salesforce, and Dropbox**, as well as on-premises applications such as **SharePoint** and **SAP**.

SSO can also be used with custom-built applications using industry-standard protocols such as **SAML, OpenID Connect,** and **OAuth**.

Single Sign-On (SSO) in Entra ID

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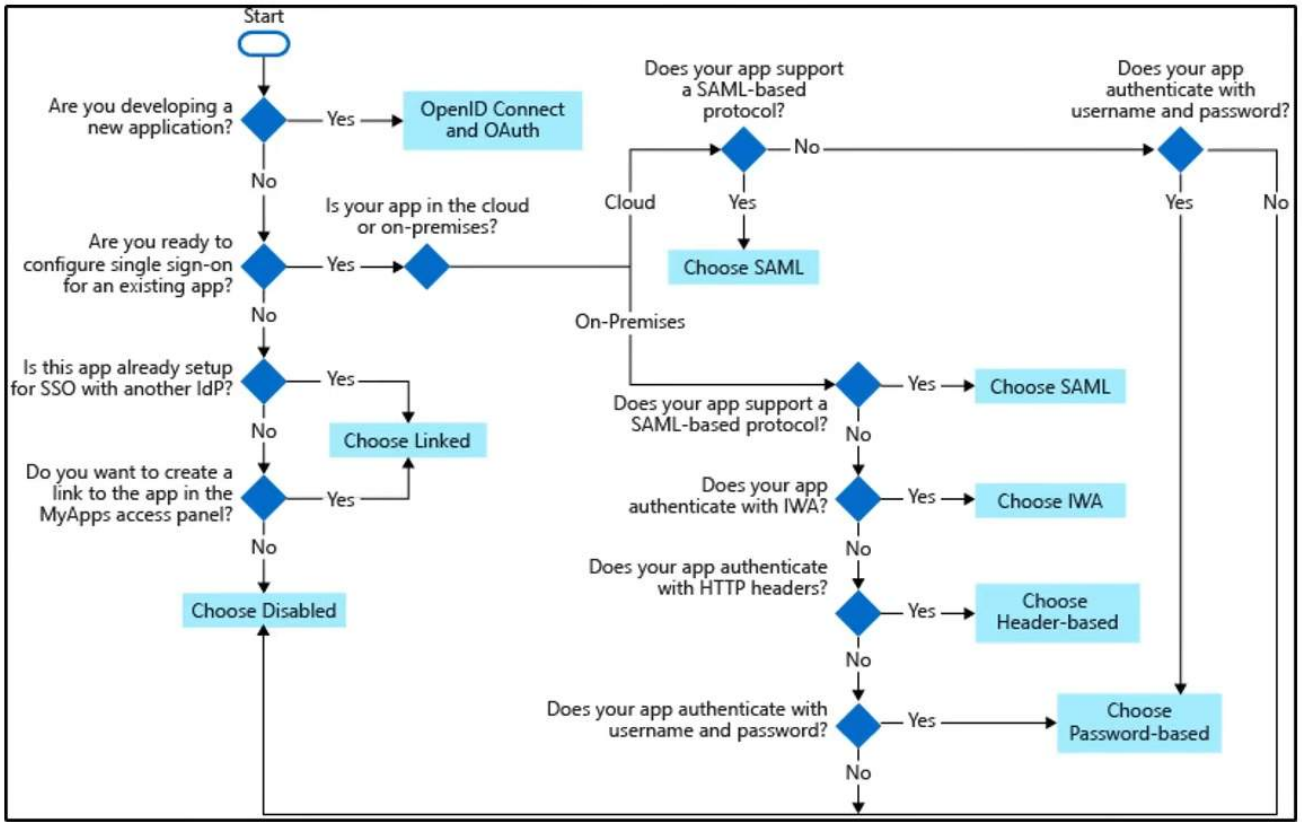
There are several ways you can configure an application for SSO.
Choosing an SSO method depends on how the application is configured for authentication.

- Cloud applications can use **OpenID Connect, OAuth, SAML, password-based**, or **linked** for SSO. Single sign-on can also be disabled.

- On-premises applications can use **password-based, Integrated Windows Authentication, header-based**, or **linked** for SSO. The on-premises choices work when applications are configured for **Application Proxy**.



Single Sign-On (SSO) protocols

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The main SSO protocols supported in Azure include:

1. **OpenID Connect and OAuth:** OpenID Connect is an identity layer built on top of OAuth 2.0. It allows for authentication and authorization of users in a secure and standardized manner. It is widely used for **web and mobile applications**.

2. **SAML (Security Assertion Markup Language):** SAML is an XML-based protocol used for exchanging authentication and authorization data between an identity provider and a service provider. It is commonly used for **federated** authentication scenarios.

3. **Password-based authentication:** This refers to the traditional username/password authentication method where users provide their credentials directly to authenticate.

4. **Linked authentication:** Azure provides the ability to link multiple accounts from different identity providers to a single user identity. This allows users to authenticate using any of their linked accounts.

5. **Integrated Windows Authentication (IWA):** IWA lets users access applications using their Windows domain credentials, utilizing their **current Windows session** for authentication.

6. **Header-based authentication:** In this method, the application accepts an authentication token in the form of a header in each request. The token is validated by the application to authenticate the user.

Azure AD – External Identities

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External Identities in Azure AD, allow people outside your organization to access your apps and resources, while letting them sign in using whatever identity they prefer.

Your partners, distributors, suppliers, vendors, and other guest users can **"bring their own identities"**.

Supports Logins from **Google** and **Facebook**

- **Share apps with external users (B2B collaboration)**.
- **Develop apps intended for other Azure AD tenants (single-tenant or multi-tenant)**
- **Develop white-labeled apps for consumers and customers (Azure AD B2C)**

Conditional Access

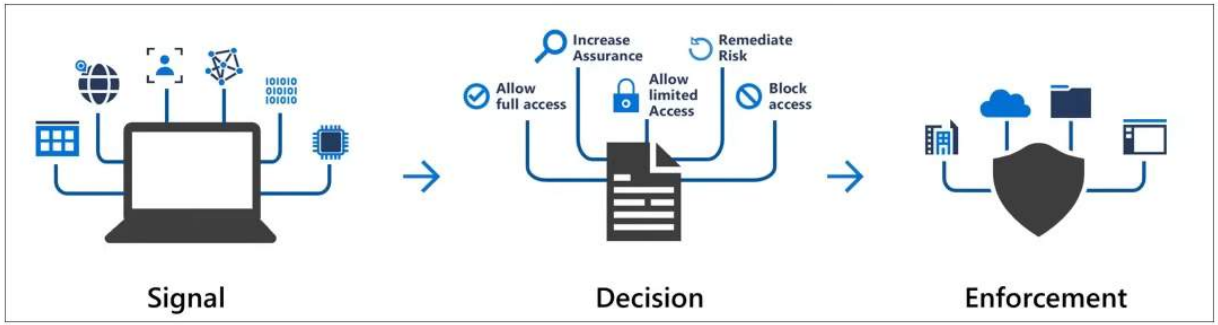
Conditional Access provides an extra layer of security before allowing authenticated users to access data or other assets.

Conditional Access is implemented via **Conditional Access policies**, which are a **set of rules** that specify the **conditions** under which sign-ins are **evaluated** and **allowed**.

For example, you can create a **Conditional Access policy** that states:

"If the user account name is a member of a group for users that are assigned the Exchange, user, password, security, SharePoint, or global administrator roles, **require MFA before allowing access.**"

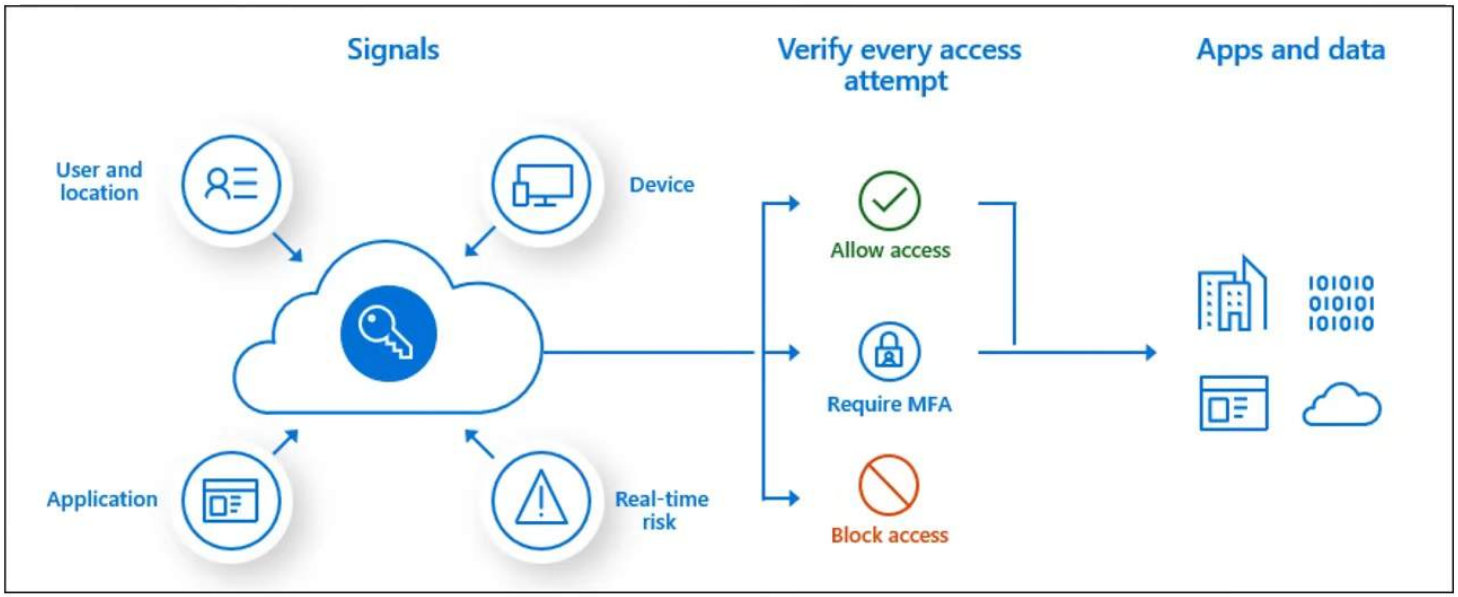
This policy enables **MFA enforcement based on group membership**, simplifying the process compared to configuring MFA for individual users when roles change.



Conditional Access

Conditional Access policy analyzes:

- **Signals**
  - User and location, Device, Application, and Real-time risk
- and **Verifies every access attempt** via **Access Controls**
  - Require MFA, Block access, and Allow access



Conditional Access – Signals

Signals are metadata associated with an identity attempting to gain access

User or group membership

- Policies target specific users and groups (including admin roles), giving admins fine-grained control over access

Named location information / IP Location Information

- IP address ranges are used to permit or deny access based on geographical locations.

Device

- Policies can be applied based on the platform or status of a user's device.

Application

- Users attempting to access specific applications can trigger different Conditional Access policies.

Real-time sign-in risk detection

- Signals in Azure AD Identity Protection detect risky sign-ins. If risks emerge, policies can prompt actions such as password resets, multi-factor authentication, or block access pending admin intervention.

Cloud apps or actions

- Cloud apps or actions can include or exclude cloud applications or user actions that will be subject to the policy.

User risk

- For customers with Identity Protection, user risk can be evaluated as part of a Conditional Access policy.
- User risk represents the probability that a given identity or account is compromised.

Conditional Access – Common Decisions

Common decisions define the access controls **that decide what level of access** based on Signal information

Block access

- Most restrictive decision

Grant access

- Least restrictive decision, still require one or more of the following options:
  - Require multi-factor authentication
  - Require device to be marked as compliant
  - Require Hybrid Azure AD joined device
  - Require approved client app
  - Require app protection policy (preview)

You can use Conditional Access policies with:

- **Microsoft 365 Business Premium**
- **Microsoft 365 E3** and **E5**
- **Azure AD Premium P1** and **Azure AD Premium P2 licenses**

Zero-Trust Methodologies

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The Zero Trust model operates on the principle of "**trust no one, verify everything.**"

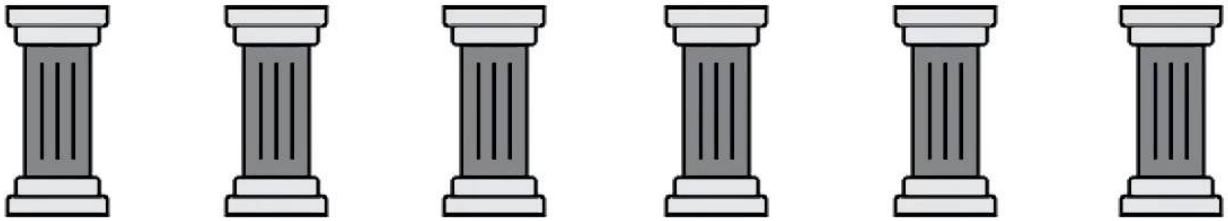
Malicious actors being able to by-pass conventional **access controls** demonstrates traditional security measures are no long sufficient

Micosoft's Zero Trust Model

3 principles

- **Verify Explicitly**
- **Least Privileged Access**
- **Assume Breach**

6 pillars



Identities | Endpoints *aka Devices* | Apps | Data | Infrastructure | Networks

Zero-Trust Methodologies – Principles

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Verify explicitly
Always authenticate and authorize based on all available data points.

Least privileged access / Principle of Least Privilege (PoLP)
Limit user access with **Just-In-Time** and **Just-Enough-Access** (JIT/JEA), risk-based adaptive policies, and data protection.

Assume breach
Minimize blast radius and segment access. Verify end-to-end encryption and use analytics to get visibility, drive threat detection, and improve defenses.

Defense in Depth

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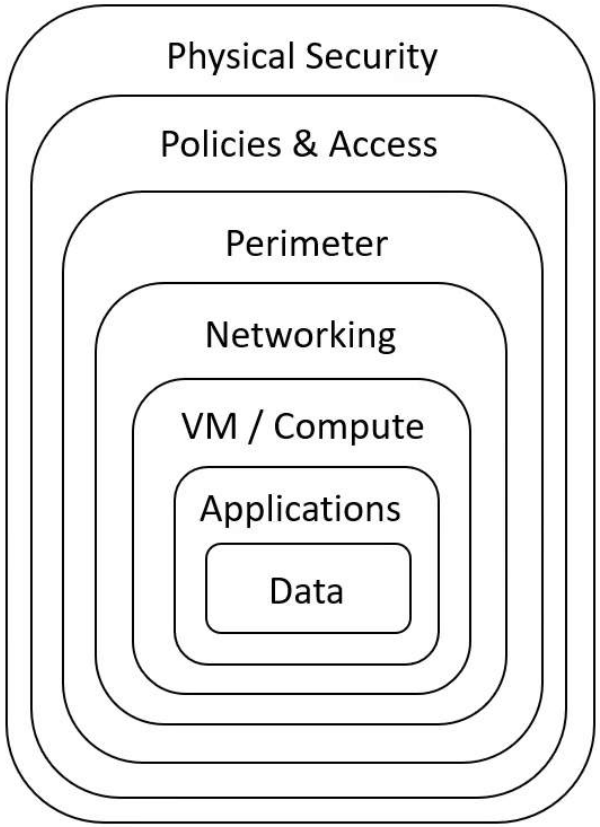

The 7 Layers of Security

1. Data
access to business and customer data, and encryption to protect data.
2. Application
applications are secure and free of security vulnerabilities.
3. Compute
Access to virtual machines (ports, on-premise, cloud)
4. Network
limit communication between resources using segmentation and access controls.
5. Perimeter
distributed denial of service (DDoS) protection to filter large-scale attacks before they can cause a denial of service for users.
6. Identity and access
controlling access to infrastructure and change control.
7. Physical
limiting access to a datacenter to only authorized personnel.

Azure Defender

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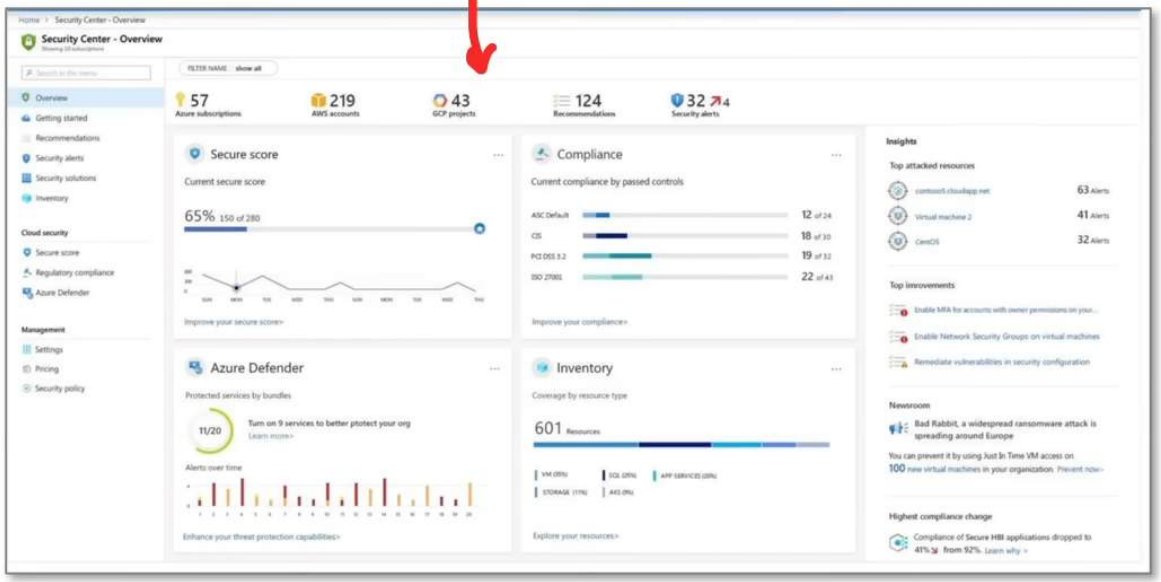
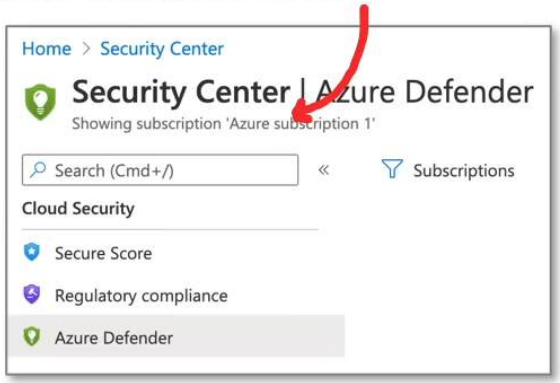
Azure Defender provides **advanced protection** for your Azure and on-premise workloads

Azure Defender can be found in the **Azure Security Center**





Azure Defender is composed of:

- Coverage
- Security Alerts
- Insights
- Advanced Protection

Azure Defender – Coverage

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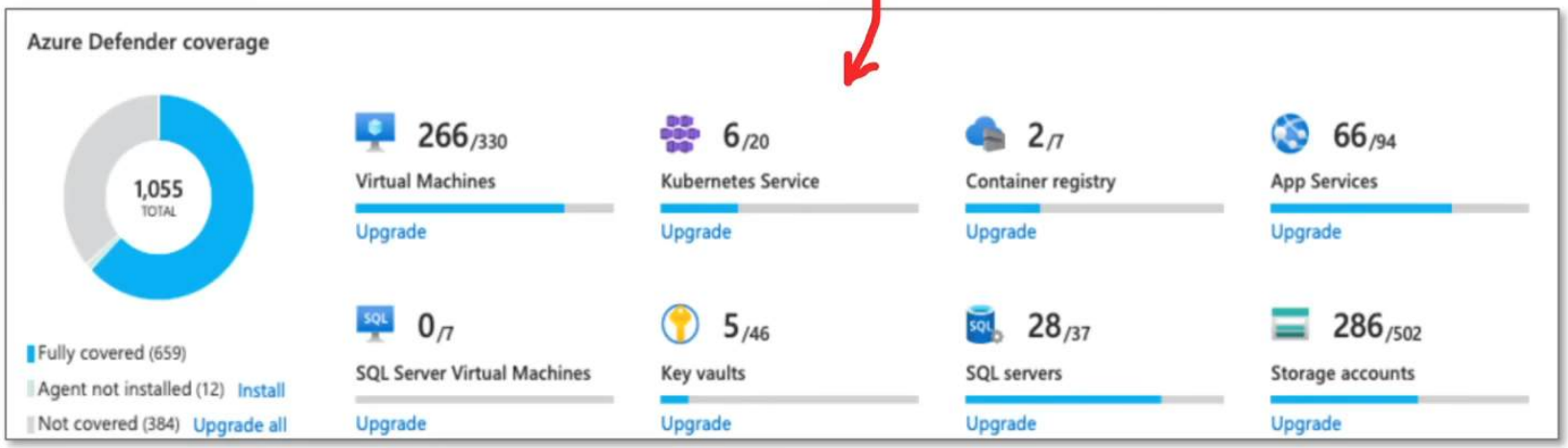
Coverage lets **see the resources types** that are in your subscription and eligible for protection by Azure Defender



Azure Defender – Security Alerts

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Security Alerts describe **details of the affected resources**, suggested **remediation** steps, and in some cases an option to trigger a logic app in response

Azure Defender – Insights

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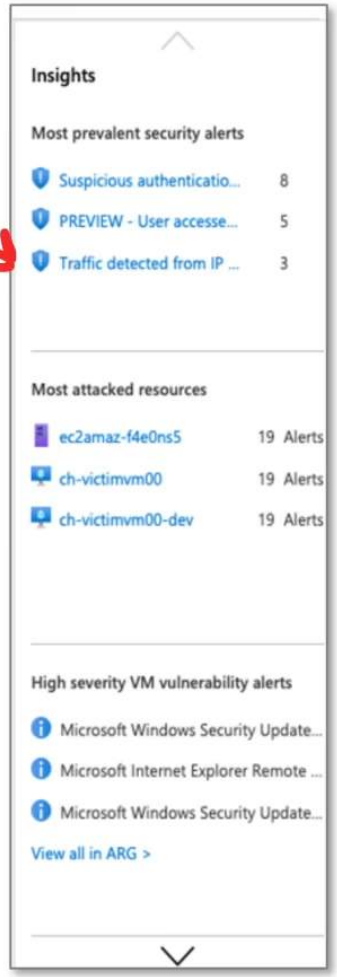
Insights is a **rolling pane of news**, suggested reading, and **high priority alerts** gives Security Center's insights into pressing security matters that are relevant to you and your subscription



Azure Defender - Advanced Protection

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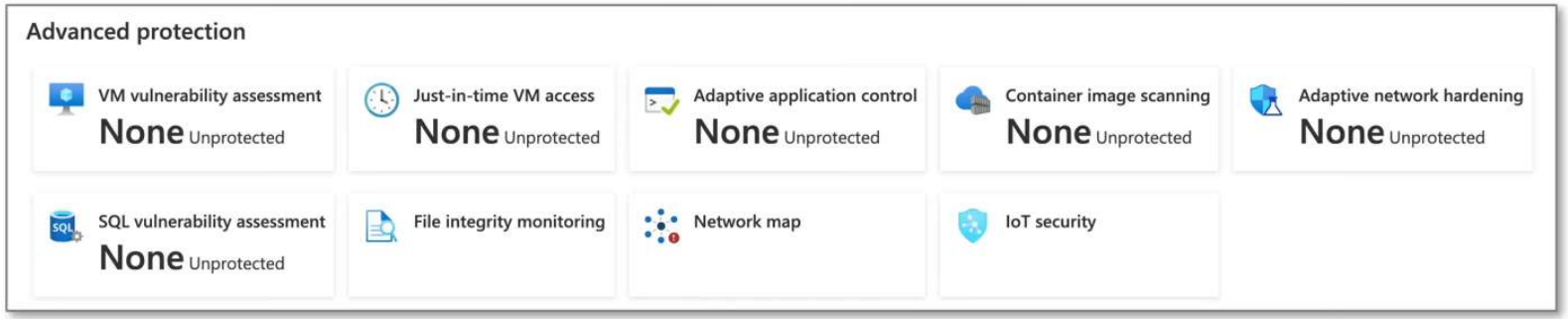
Advanced Protection within Defender are additional security features that is driven by analytics

- VM vulnerability assessment
- Just-in-time VM access
- Adaptative application control
- Container image scanning
- Adaptative network hardening
- SQL vulnerability assessment
- File integrity monitoring
- Network map
- IoT Security



Scope of Azure Defender

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Azure Defender has **many plans** for specific Azure resources:

- Azure Defender for servers
- Azure Defender for App Service
- Azure Defender for Storage
- Azure Defender for SQL
- Azure Defender for Kubernetes
- Azure Defender for container registries
- Azure Defender for Key Vault
- Azure Defender for Resource Manager
- Azure Defender for DNS
- Azure Defender for open-source relational databases

When you turn on Azure Defender **all plans are activated**

Azure Defender – Network Map

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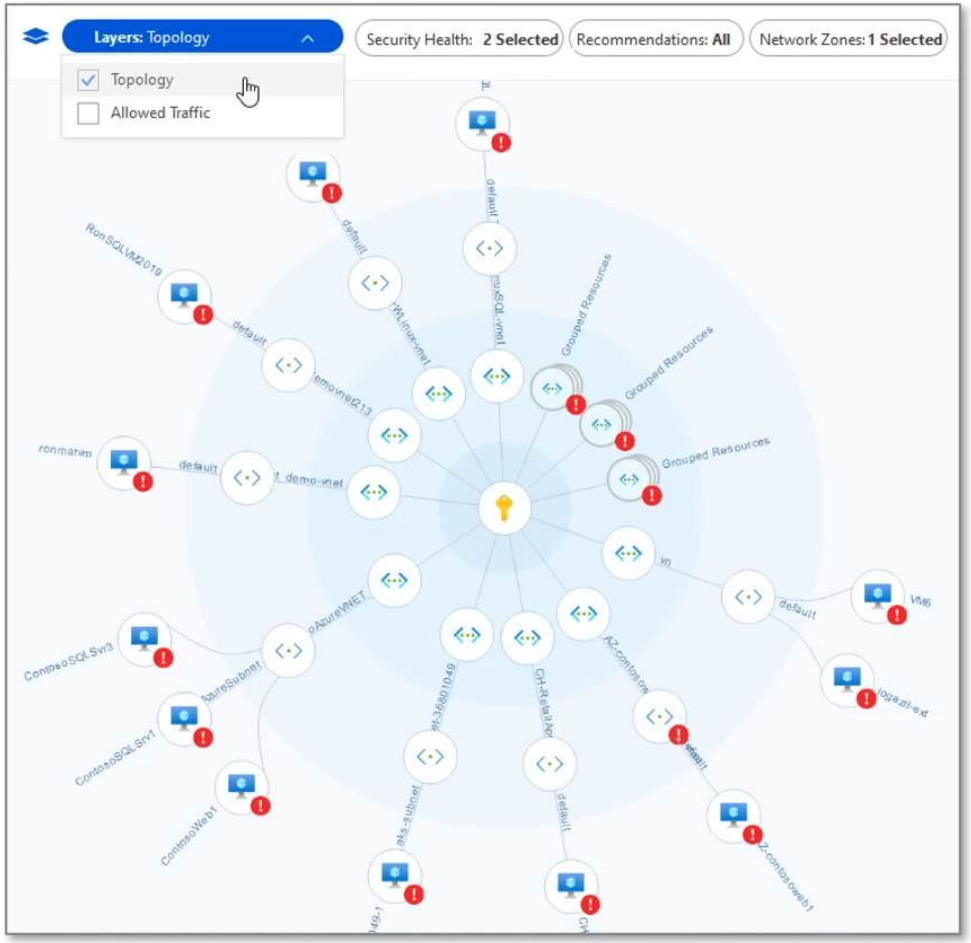
Network map provides a graphical view with security overlays giving you recommendations and insights for hardening your network resources

Using the map you can see the network topology of your Azure workloads, connections between your virtual machines and subnets, and the capability to drill down from the map into specific resources and the recommendations for those resources.



Azure Defender – Hybrid Cloud Protection

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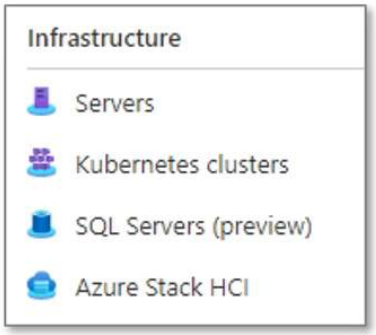
Azure Defender can protect virtual machines residing in other cloud service providers e.g. Amazon Web Services (AWS) and Google Cloud Platform (GCP) via **Azure Arc**

Azure Arc is a **control plane** that can manage **compute resources** across cloud service providers, on-premise and at the edge.



Multi-Factor Authentication

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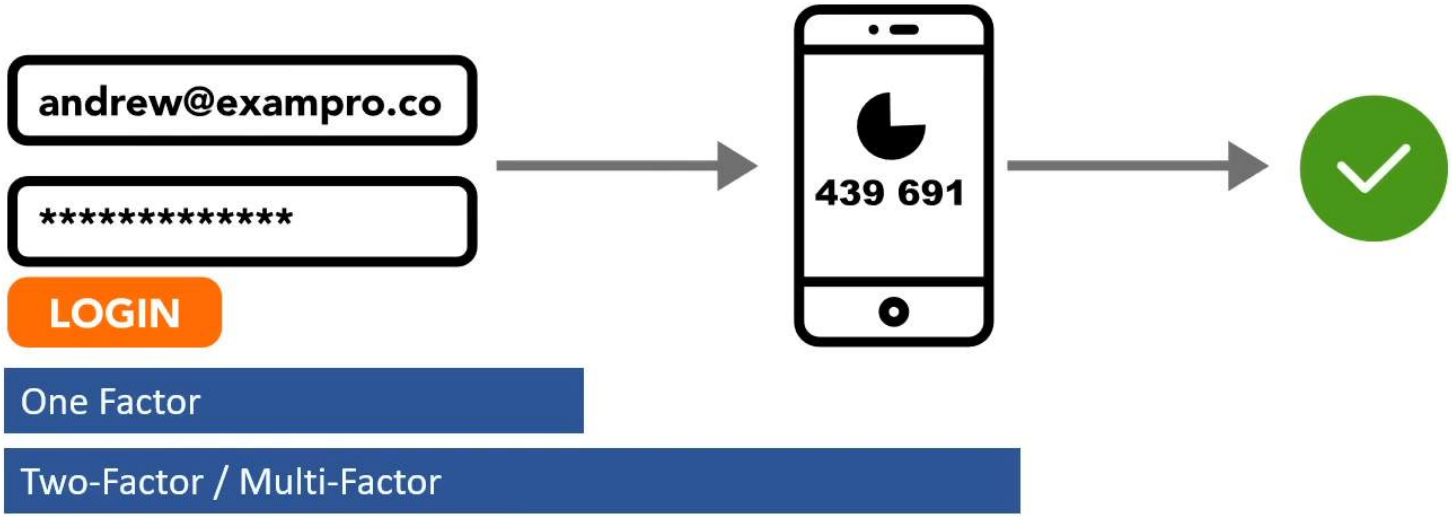
What is Multi-Factor Authentication (MFA)?

A security control where after you fill in your username/email and password **you have to use a second device** such as a phone to confirm that its you logging in.

MFA **protects** against people who have stolen your password.

MFA is an option in most cloud providers and even social media websites such as Facebook.



Azure Security Center

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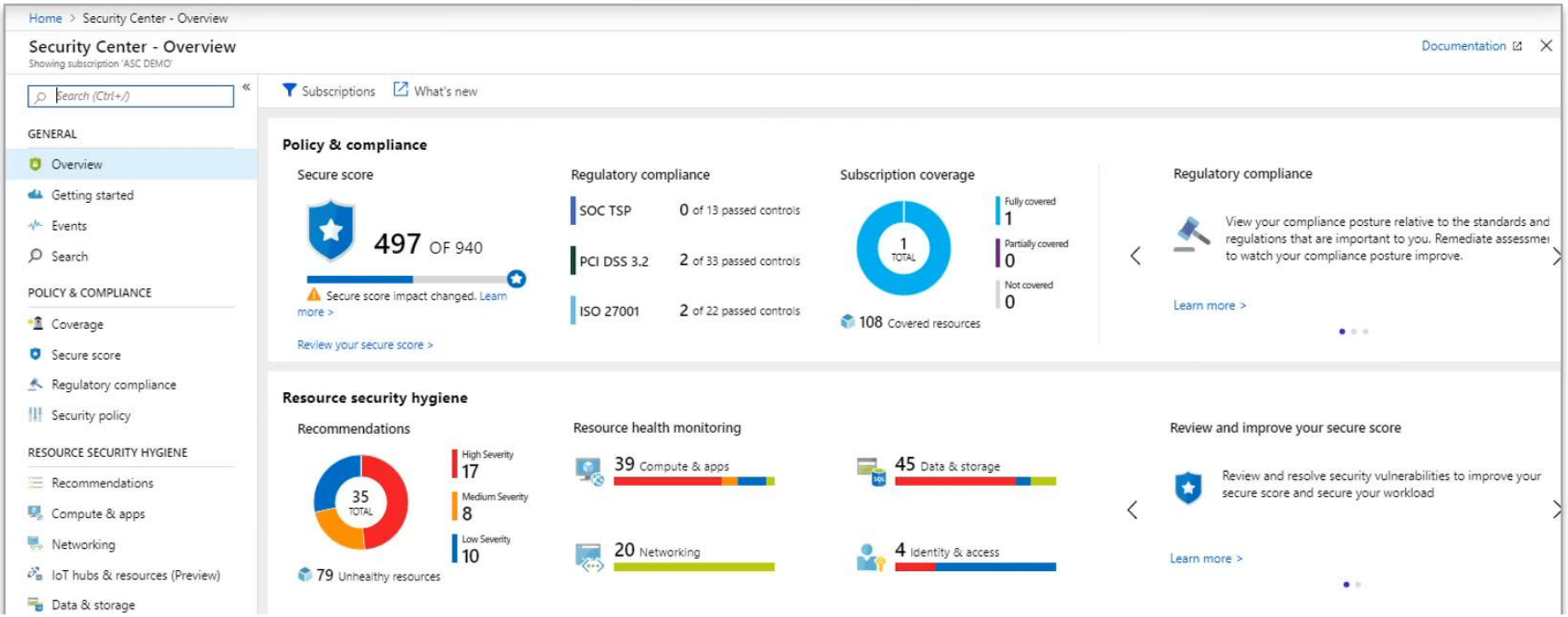
Azure Security Center is a **unified infrastructure security management system**
It strengthens the security posture of your data centers, and provides advanced threat protection across your hybrid workloads in the cloud.



Key Vault

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Azure Key Vault helps you **safeguard** **cryptographic keys and other secrets** used by cloud apps and services.

Secrets Management
store and tightly control access to **tokens, passwords, certificates, API keys, and other secrets**

Key Management
create and control the **encryption keys** used to encrypt your data

Certificate Management
easily provision, manage, and deploy public and private **SSL certificates** for use with Azure and internal connected resources.

Hardware Security Module
secrets and keys can be protected either by software or **FIPS 140-2 Level 2** validated HSMs

Key Vault

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An HSM is a **Hardware Security Module**. Its a piece of hardware designed to store encryption keys.

Federal Information Processing Standard (FIPS) 140-2
US and Canadian government standard that specifies the security requirements for cryptographic modules that protect sensitive information.

HSM's that are **multi-tenant** are **FIPS 140-2 Compliant**
(multiple customers virtually isolated on an HSM)

HSM's that are **single-tenant** are **FIPS 140-3 Compliant**
(single customer on a dedicated HSM)

Azure DDoS Protection

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Most frequent types of DDoS attack:

- **Volumetric attacks**
  - Volume-based attacks that flood the network with legitimate looking traffic
  - Exhausts available bandwidth
  - Legitimate uses cannot access website
  - Measured in Bits per second (bps)
- **Protocol attacks**
  - exhausting server resources with false protocol requests that exploit weaknesses
    - UDP and TCP flooding on Layer 3 and 4
  - Measured in packages per second (psp)
- **Application layer attacks**
  - Attacks that occurs at the application layer (Layer 7)
  - HTTP floods, SQL injections, cross-site scripting (XSS) , parameter tampering, Sowloris attacks
  - Web Application Firewalls (WAFs) are used as means of protection

Azure DDoS Protection

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Azure offers **two tiers** of DDoS Protection

DDoS Protection Basic

- Free
- Already turned on protect Azure's global network

DDoS Protection Standard

- Starting at $2,994/month
- Metrics, Alerts, Reporting
- DDoS Expert Support
- Application and Cost Protection SLAs

Azure Firewall

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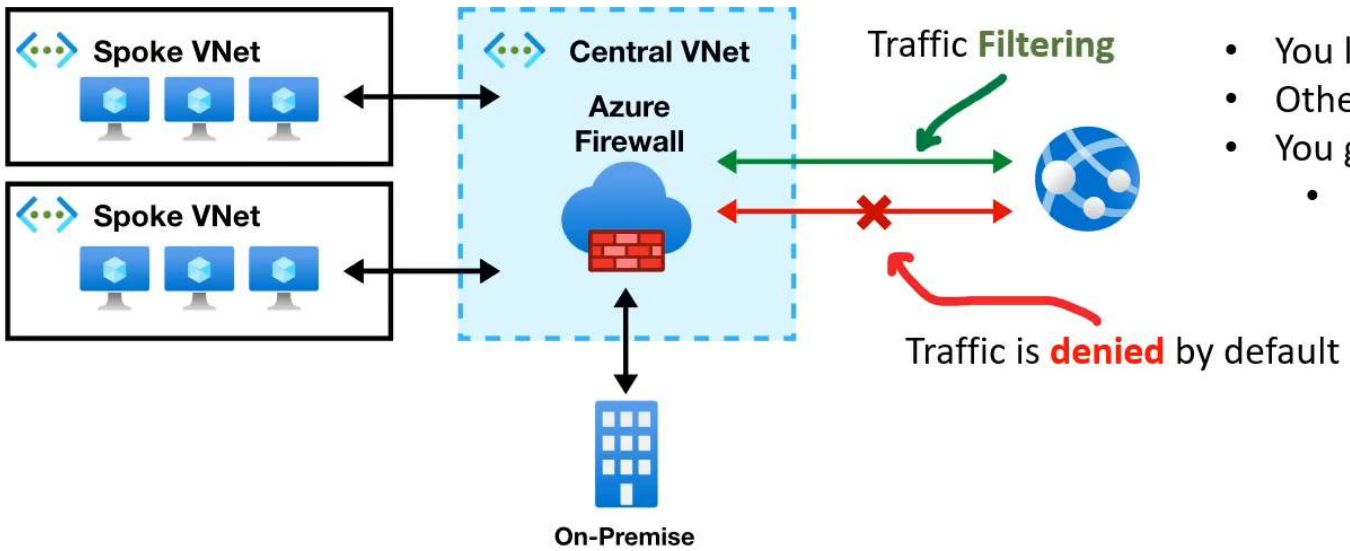
Azure Firewall is a managed, **cloud-based network security service** that protects your **Azure VNets** resources

It is a **fully stateful** Firewall as a Service (FWaaS) with:

- built-in high availability
- unrestricted cloud scalability

You can centrally **create**, **enforce**, and **log** application and network connectivity policies across subscriptions and virtual networks.

Azure Firewall uses a **static public IP address** for your VNet resources allowing outside firewalls to identify traffic originating from your virtual network. The service is fully integrated with **Azure Monitor** for logging and analytics.



- You launch an Azure Firewall in its on VNet
- Other VNets pass through this Central Vnet
- You get **Microsoft Threat Intelligence**
  - Blocks know malicious IPs and FQDNs

Introduction to Application Gateway

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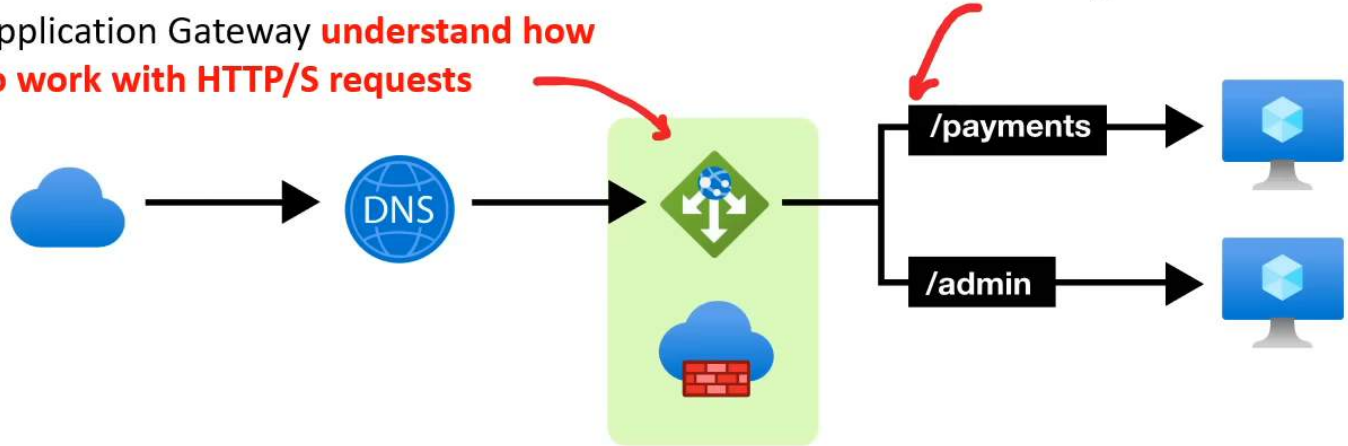
Azure Application Gateway is **application-level routing** and **load balancing** service.

Application Gateway operates on **OSI Layer 7** *also known as* the Application Layer.

advanced routing rules based on the contents of a request.

Application Gateway **understand how to work with HTTP/S requests**



Azure Web Application Firewall (WAF) polices can be attached to an Application Gateway to provide additional security

Introduction to Application Gateway

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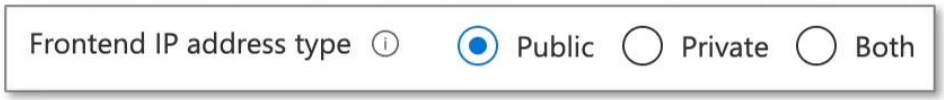
You need to configure a **Frontends**

- **Private IP** will create an Internal Load Balancer
- **Public IP** will create an Public/External Load Balancer



You need to configure a **Backends**

- You'll need to create Backend pools
  - A backend pool is a collection of resources to which your application gateway can send traffic.
  - A backend pool can contain
    - virtual machines
    - virtual machines scale sets
    - IP addresses
    - domain names
    - App Service

Introduction to Application Gateway

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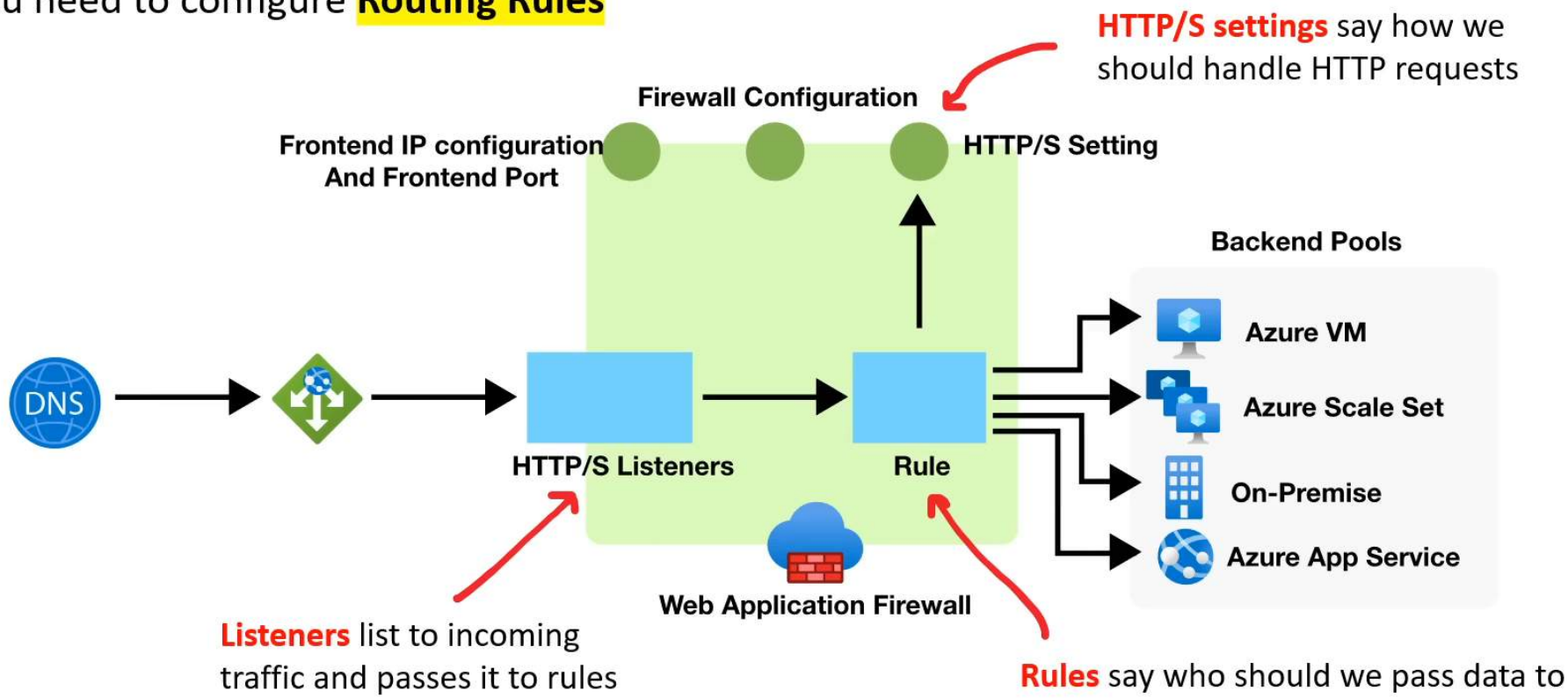
You need to configure **Routing Rules**



Application Gateway – Routing Rules

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Listeners

A listener "listens" on a specified port and IP address for traffic that uses a specified protocol.
If the listener criteria are met, the application gateway will apply this routing rule.

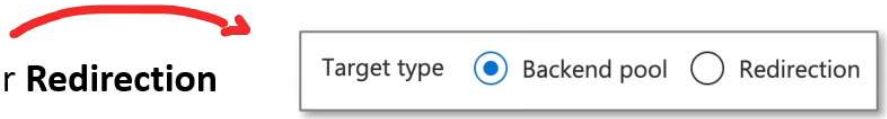
There are 2 types of listeners:

1. Basic — forward all requests for any domain to backend pools
2. Multi-site — forward requests to different backend pools based on **host header** and **host name**

- requests are matched according to the **order of the rules** and the type of listener
  - Add your basic listeners last otherwise it will capture all requests

Backend targets

Chooses where a route should go either **Backend Pool** or **Redirection**



HTTP Settings

To create a rule for Backend Pool you need to create HTTP Setting.
This allows to define how we want to handle cookies, connection draining, port request time out and more..

Application Gateway – Routing Rules

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Backend Port
the port where the back-end servers listen to incoming traffic

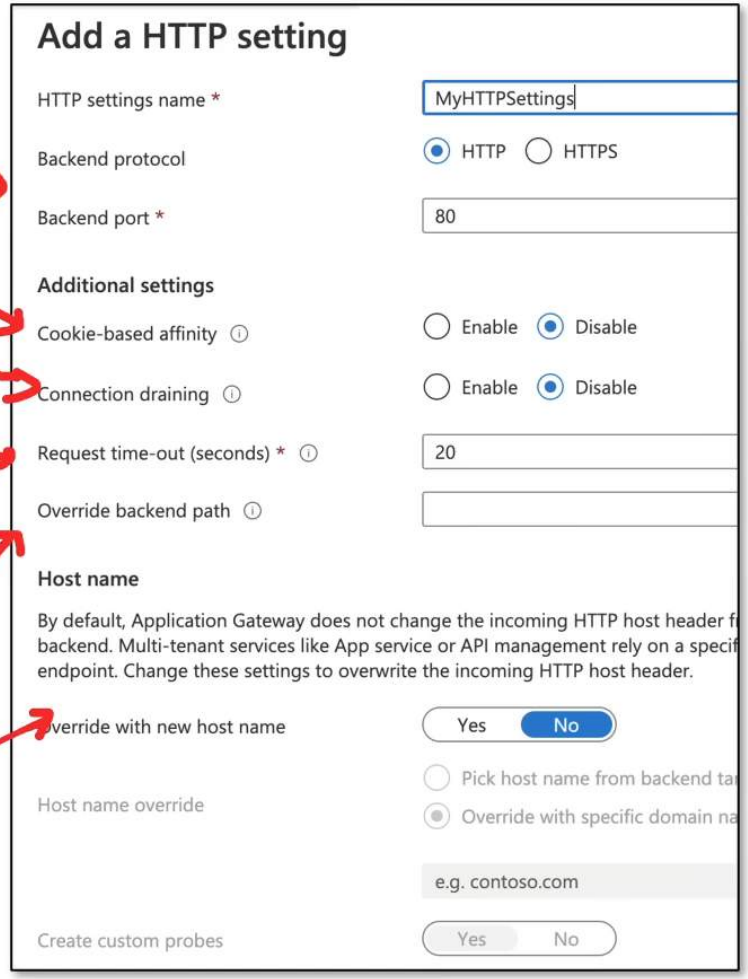
Cookie-based affinity
Use cookies to keep a user session on the same server

Connection draining
gracefully remove backend pool members during planned service updates

Request Timeouts
the number of seconds that the application gateway will wait to receive a response from the backend pool before it returns a “connection timed out” error message.

Override backend path
allows you to override the path in the URL so that the requests for a specific path can be routed to another path

Override Hostname
Multi-tenant services like App service or API management rely on a specific host header or SNI extension to resolve to the correct endpoint. Change these settings to overwrite the incoming HTTP host header



Azure Role-Based Access Control (RBAC)

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Azure role-based access control (Azure RBAC) helps you manage **who has access to Azure resources**, what they can do with those resources, and what areas they have access to.

Role Assignments the way you control access to resources

A Role Assignment is consists of these **three** elements

1. security principal
2. role definition
3. scope

There are **four fundamental** Azure roles

Azure RBAC includes over **70 built-in roles**

Azure Role-Based Access Control (RBAC)

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A Security Principal represents the identities requesting access to an Azure resource such as:

User An individual who has a profile in Azure Active Directory

Group A set of users created in Azure Active Directory.

Service Principal A security identity used by applications or services to access specific Azure resources.

Managed identity An identity in Azure Active Directory that is automatically managed by Azure.

Azure Role-Based Access Control (RBAC)

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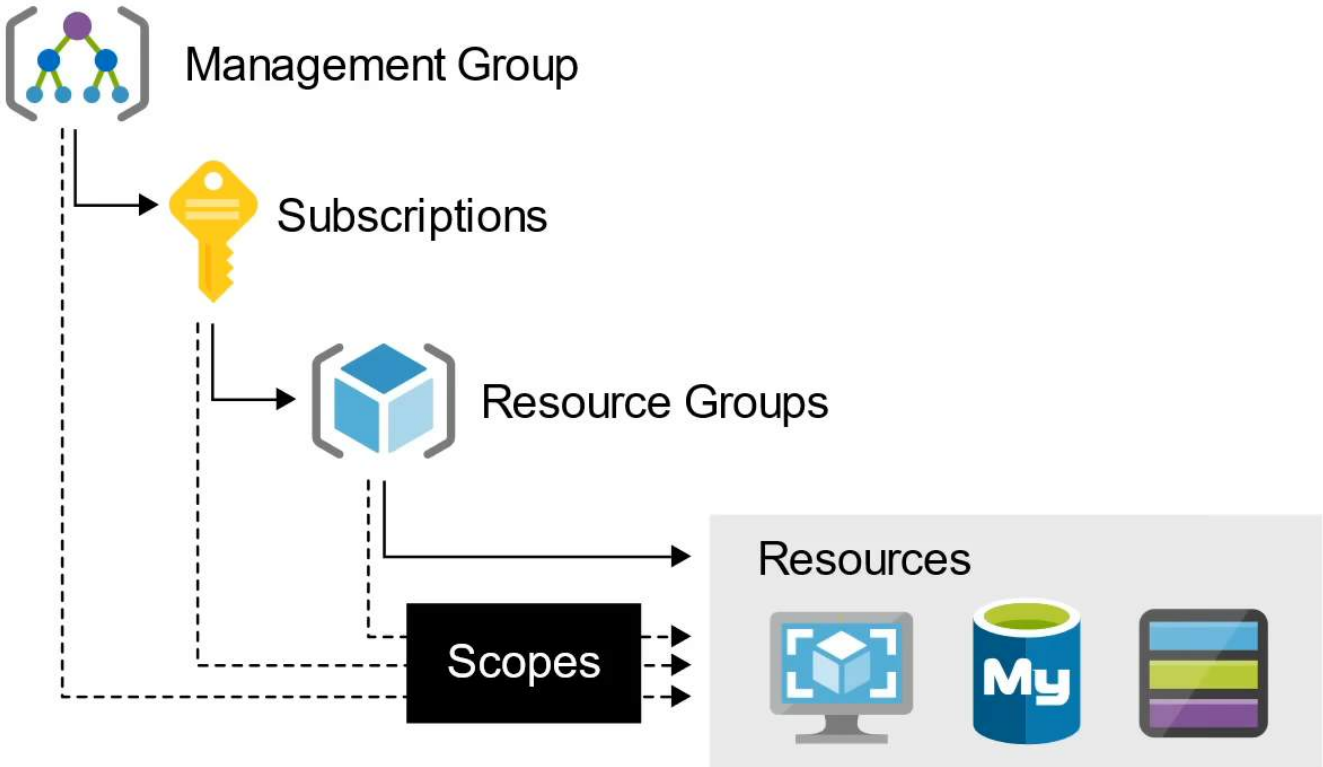
Scope is the **set of resources** that access for the Role Assignment applies to.
Scope Access Controls at the Management, Subscription or Resource Group level.



Azure Role-Based Access Control (RBAC)

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A Role Definition is a collection of permissions.
A role definition lists the operations that can be performed, such as **read, write, and delete**.
Roles can be high-level, like owner, or specific, like virtual machine reader.

Azure has **built-in roles** and you can define **custom roles**

	Read	Grant	Create, Update, Delete
Owner			
Contributor			
Reader			
User Access Administrator			

These are the four fundamental built-in role

Azure Management Groups

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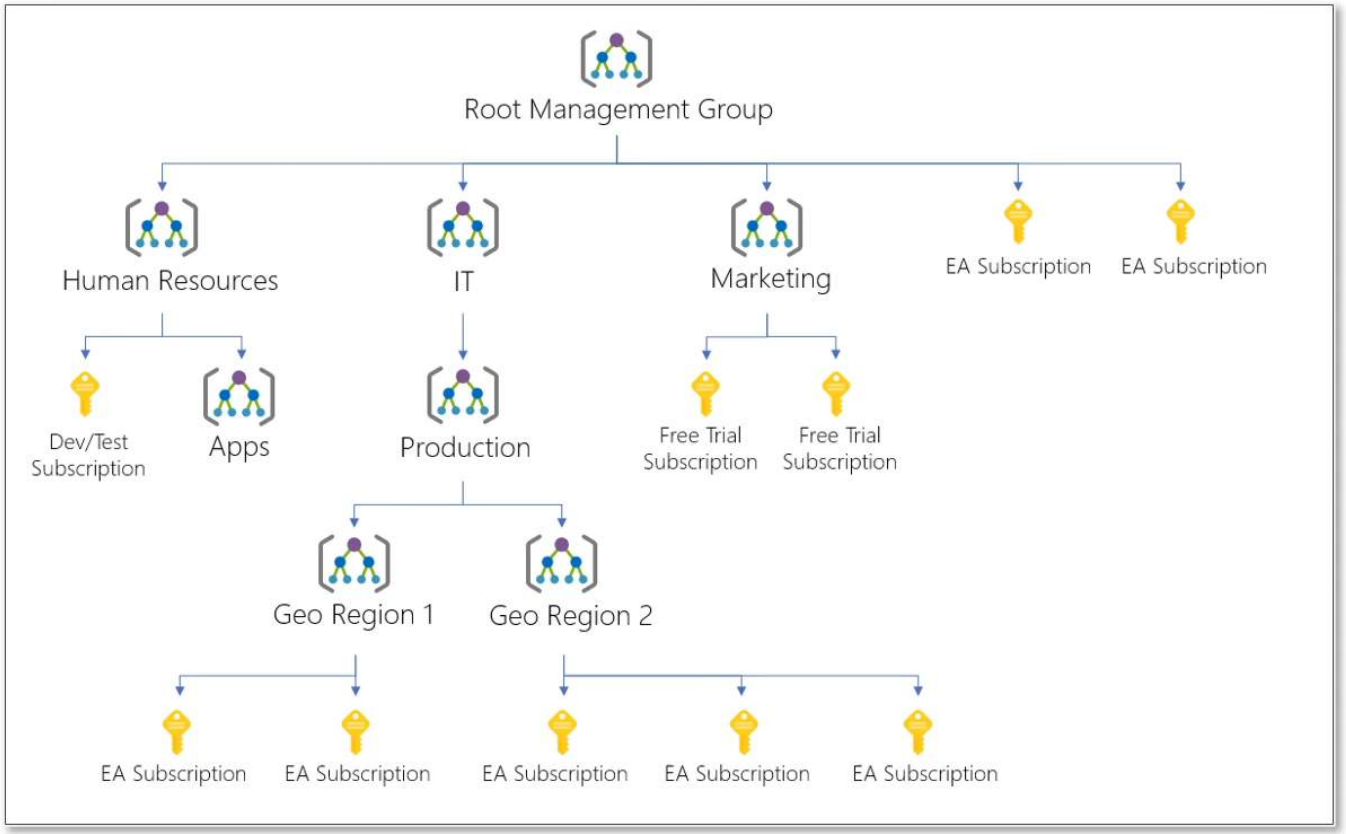
Managing multiple subscriptions (accounts) into a hierarchal structure.

Each directory is given a single top-level management group called the "Root" management group.

All subscriptions within a management group automatically inherit the conditions applied to the management group.



Azure Service Health

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Information about **current and upcoming issues** such as:

- service impacting events
- planned maintenance
- and other changes that may affect your availability.

1. **Azure Status** informs you of service outages in Azure
2. **Azure service health** a personalized view of the health of the Azure services and regions you're using.
3. **Azure resource health** information about the health of your individual cloud resources eg. VM

Azure Advisor

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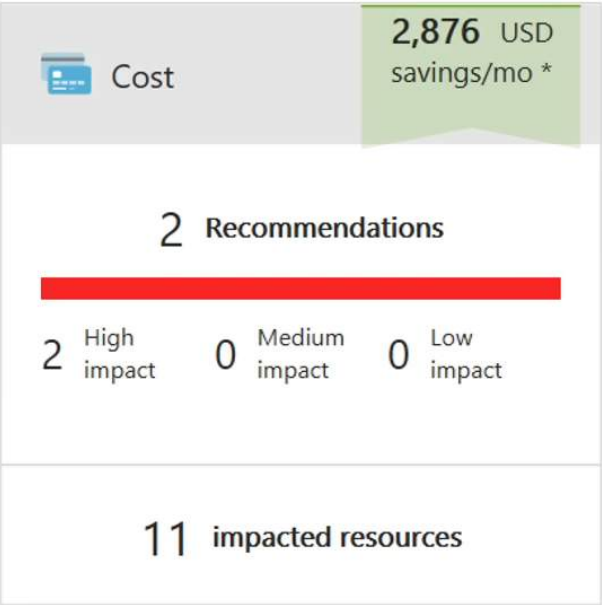
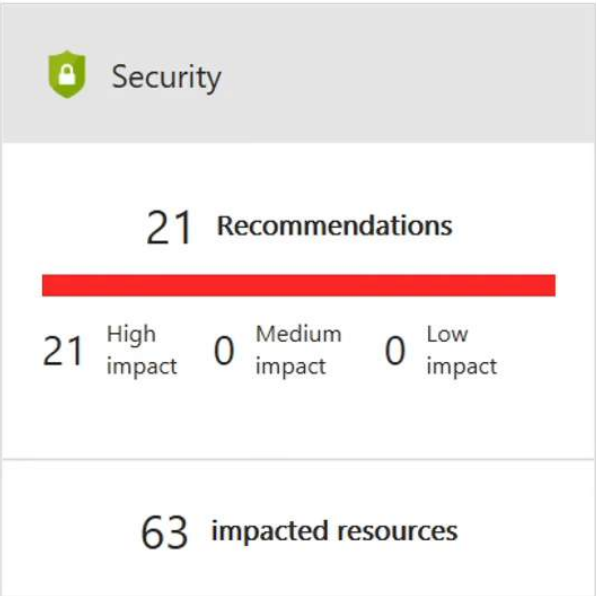
Azure Advisor is a personalized cloud consultant that helps you follow best practices to optimize your Azure deployments.

The Advisor dashboard displays personalized recommendations for all your subscriptions for the following 5 categories:

1. High Availability
2. Security
3. Performance
4. Cost
5. Operational Excellence





Database Services

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Azure Cosmos DB
A fully managed **NoSQL databases**. Designed for scale with guarantee of 99.999% availability

Azure SQL Database
Fully managed MS SQL database with auto-scale, integral intelligence, and robust security

Azure Database for MySQL / PSQL / MariaDB
Fully managed and scalable **MySQL / PostgreSQL / MariaDB database** with high availability and security

SQL Server on VMs
Host enterprise SQL Server apps in the cloud. Lift-and-shift MS SQL servers from on-premise to Azure Cloud.

Azure Synapse Analytics (Azure SQL Data Warehouse)
Fully managed **data warehouse** with integral security at every level of scale at no extra cost

Azure Database Migration Service
Migrates your databases to the cloud with no application code changes

Azure Cache for Redis
Caches frequently used and static data to reduce data and application latency

***Azure Table Storage**
Wide-Column NoSQL Database A NoSQL store that hosts unstructured data independent of any schema

Application Integration Services

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Azure Notifications Hub
Pub/Sub Send push notifications to any platform from any back end

Azure API Apps
API Gateway Quickly build and consume APIs in the cloud. Route APIs to Azure Services

Azure Service Bus
Service Bus Reliable cloud messaging as a service (MaaS) and simple hybrid integration

Azure Stream Analytics
Serverless **real-time analytics**, from the cloud to the edge

Azure Logic Apps
Schedule, automate and orchestrate tasks, businesses processes and workflows.
Integration with Enterprise SaaS and Enterprise applications.

Azure API Management
Hybrid, multi-cloud management platform for APIs across all environments.
Put in-front of existing APIs to add additional functionality.

***Azure Queue Storage**
Messaging Queue A data store for queuing and reliably delivering messages between applications

Developer and Mobile Tools

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Azure SignalR Service
Real-Time Messaging Easily add real-time web functionality to applications
Think of it like the Pusher for Azure

Azure App Service
Easy to use service for deploying and scaling web-applications with .Net, Node.js Java, Python and PHP
Developer focus on building their web-apps, and not worry about the underlying infrastructure
Think of it like Heroku for Azure

Visual Studio (Microsoft-owned)
Code Editor The integrated development environment (IDE) designed for creating powerful, scalable applications for Azure

Xamarin (Microsoft-owned)
Mobile-App Framework Create powerful and scalable native mobile apps with .NET and Azure

Azure DevOps Services

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Azure DevOps
Plan smarter, collaborate , and ship faster with a set of modern dev services.

Azure Boards
Kanban Deliver value to your users faster using proven agile tools to plan, track, and discuss work across your teams.

Azure Pipelines
Build, test, and deploy with **CI/CD** that works with any language, platform, and cloud. Connect to GitHub or any other Git provider and deploy continuously.

Azure Repos
Get unlimited, cloud-hosted private **Git repos** and collaborate to build better code with pull requests and advanced file management.

Azure Test Plans
Test and ship with confidence using **manual and exploratory testing tools**.

Azure Artifacts
Create, host, and share packages with your team, and add artifacts to CI/CD pipelines with a single click.

Azure DevTest Labs
Fast, easy, and lean dev-test environments

Cloud-Native Networking Services

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Azure DNS
Provides ultra-fast DNS responses and ultra-high domain availability

Azure Virtual Network (vNET)
A logical isolated section of the Azure network for customers to launch Azure resources within.

Azure Load Balancer
OSI Level 4 (Transport) Load Balancer

Azure Application Gateway
OSI Level 7 (HTTP) Load Balancer, can apply a Web Application Firewall

Network Security Groups
A virtual firewall at the subnet level

Enterprise/Hybrid Networking Services

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Azure Front Door
Scalable and secure entry point for fast delivery of your global applications

Azure Express Route
A connection between your on-premise to Azure cloud from 50 Mbps to 10 Gbps

Virtual WAN
a networking service that brings many networking, security, and routing functionalities together to provide a single operational interface

Azure Connection
A VPN connection securely connects two Azure local network via (IPsec).

Virtual Network Gateway
A site-to-site VPN connection between an Azure virtual network and your local network

Azure Traffic Manager

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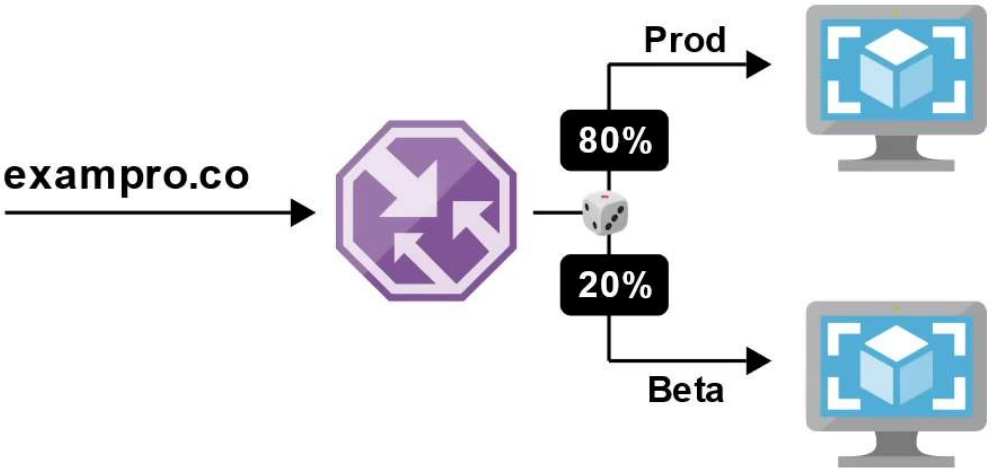
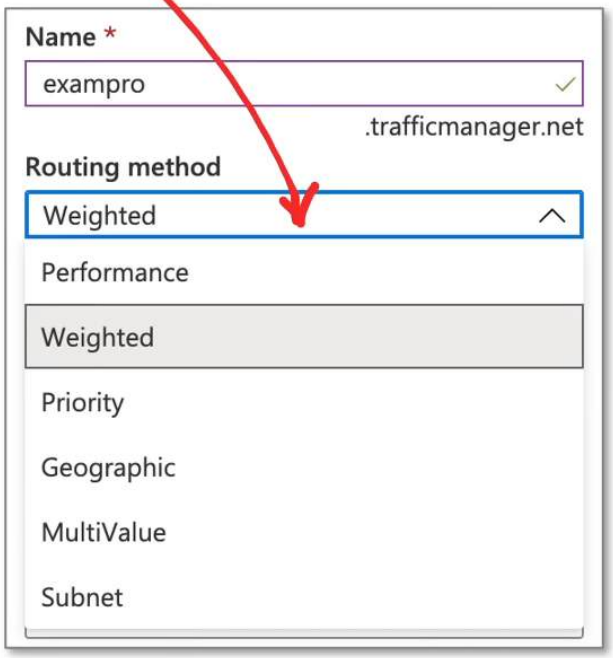
Azure Traffic Manager operates at the **DNS layer** to quickly and efficiently direct incoming DNS requests based on the **routing method of your choice**.

- Route traffic to servers the geographically near by to reduce latency
- Fail-over to redundant systems in-case primary systems become unhealthy.
- Route to random VM to simulate A/B testing





IoT Services

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What is Internet of Things (IoTs)?

A network of Internet connected objects (usually hardware) able to collect and exchange data.

- Smart Bulbs
- Smart Fridges
- Smart Light Switches
- Narrowband vs Wideband hardware
- Security Cameras
- Voice Command Speakers
- Temperature, Pressure or Humidity Sensors
- Drones
- Phones
- Buttons

IoT Services

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IoT Central

Connects your IoT devices to the cloud

IoT Hub

Enable highly secure and reliable communication between your IoT application and the devices it manage

IoT Edge

A fully managed service built on Azure IoT Hub. . It allows data processing and analysis nearest the **IoT** devices. Edge computing is when you offload compute from the cloud to local computing hardware such as IoT devices, phones or home computers

Windows 10 IOT Core Services

A cloud services subscription that provides the essential **services** needed to commercialize a device on **Windows 10 IoT Core.** Long-term OS support and services to manage device updates and assess device health

Big Data and Analytics Services

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What is BigData?

A term used to describe **massive volumes of structured/unstructured data** that is so large it is difficult to **move and process** using traditional database and software techniques..

Azure Synapse Analytics *(formally known as SQL Data Warehouse)*
Enterprise **data warehousing and Big Data analytics**.
Intended to **run SQL queries** against large databases for things such as **reporting**.

HDInsight
Run **open-source analytics software** such as Hadoop, Kafka and Spark

Azure Databricks
An Apache Spark-based analytics platform optimized for the Microsoft Azure cloud services platform.
Third-Party Databricks cloud services supported within Azure.

Data Lake Analytics
An on-demand analytics job service that simplifies big data.
A **data lake** is a storage repository that holds a vast amount of raw **data** in its native format until it is needed.

AI/ML Services

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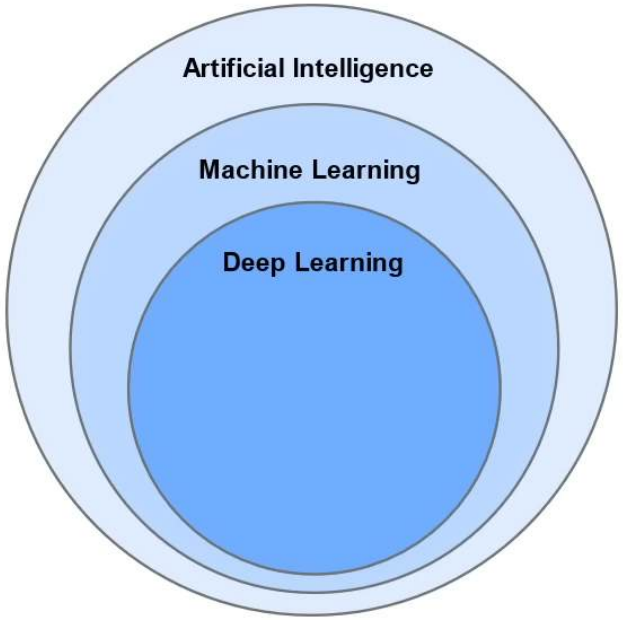
What is Artificial Intelligence (AI)?
Machines that perform jobs that mimic human behavior

What is Machine Learning (ML)?
Machines that get better at a task without explicit programming

What is Deep Learning (DL)?
Machines that have an artificial neural network inspired by the human brain to solve complex problems.



Azure Machine Learning Service

A service for that simplifies running AI/ML related workloads allowing you to build flexible Pipelines to automate workflow. Use Python an R, Run DL workloads such as Tensorflow

Azure Machine Learning Studio (classic)
An older service that manages AI/ML workloads. Does not have a pipeline and other limitations. Workloads are not easily transferable to from classic to the new service.

AI/ML Services

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Personalizer Deliver rich, personalised experiences for every user.

Translator Add real-time, multi-language text translation to your apps, website and tools.

Anomaly detector Detect anomalies in data to quickly identify and troubleshoot issues.

Azure Bot Service Intelligent, serverless bot service that scales on demand

Form Recogniser Automate the extraction of text, key/value pairs and tables from your documents.

Computer Vision Easily customise computer vision models for your unique use case.

Language Understanding Build natural language understanding into apps, bots and IoT devices.

AI/ML Services

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QnA Maker Create a conversational question-and-answer bot from your existing content.

Text Analytics Extract information such as sentiment, key phrases, named entities and language from your text.

Content moderator Moderate text and images to provide a safer, more positive user experience.

Face Detect and identify people and emotions in images.

Ink Recogniser Recognise digital ink content, such as handwriting, shapes and document layout.

Serverless Services

Cheat sheets, Practice Exams and Flash cards 👉 www.exampro.co/az-900

What is Serverless?

When the underlying servers, infrastructure and OS is taken care of by the Cloud Service Provider (CSP) It will generally be highly available, scalable and cost-effective.

Event-Driven Scale

A serverless function can be triggered or trigger other events allowing you to compose complex applications and its just scales.

Abstraction of Servers

Servers are abstracted away. Your code is described as functions. These functions can be running on different compute instances.

Micro-Billing

Serverless compute could run for a fraction of a second.
Billing into micro-seconds will save you money.

Serverless Services

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Azure Functions
Run small amounts of code known as serverless functions in your favorite language: C#, Java, JavaScript, Python and PowerShell

Blog Storage
Serverless Object Storage. Just upload files, don't think about the underlying file-systems, resizing

Logic Apps
Allows you to build serverless workflows composed of Azure Functions
Building a state machines for serverless compute.

Event Grid
Uses Pub/Sub messaging system to allow you react to events and trigger other Azure cloud services such as Azure Functions.

Pricing and Support – SLAs

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Service Level Agreement (SLA) describes Azure's commitments for **uptime** and **connectivity**

SLA's are individualized per Azure service

Uptime and connectivity is described as **Performance Targets**

A Performance Target is represented as a **percentage %**.

- 99% (two nines)
- 99.9% (three nines)
- 99.999% (five nines)
- 99.9999999% (nine nines)

Azure not does provide SLAs for Free Tier or the shared tiers.

Pricing and Support – Service Credits

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Service Credits

customers may **have a discount applied to their Azure bill**, **as compensation for an under-performing Azure product or service** based on the SLA.

Azure Virtual Machine Service Credit Calculation

Monthly Uptime %	Service Credit %
< 99.9	10
< 99	25
< 95	100

Pricing and Support – Composite SLA

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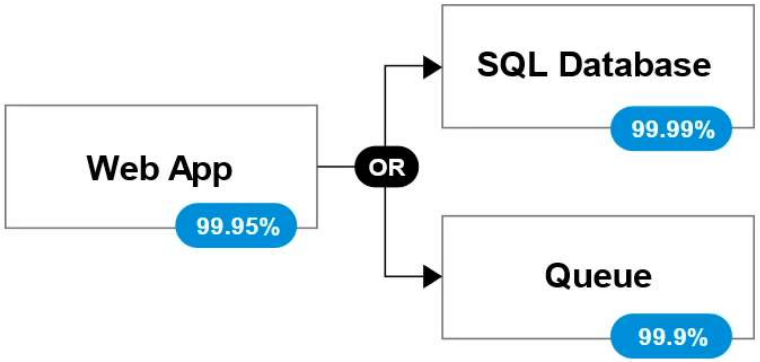
Different services have different SLAs.

A Composite SLA is when you **combine** SLAs across different service offerings.



The real SLA for a Web-App + SQL Database would be:
99.95% × 99.99% = 99.94%.

Fallback systems will improve overall SLA.
Imagine SQL Database was down but you had a queue
Saving transactions attempts from Web App to Queue to write to DB.
Web app *and* (database *or* queue) = 99.95% × 99.99999% = ~99.95%

Pricing and Support – TCO Calculator

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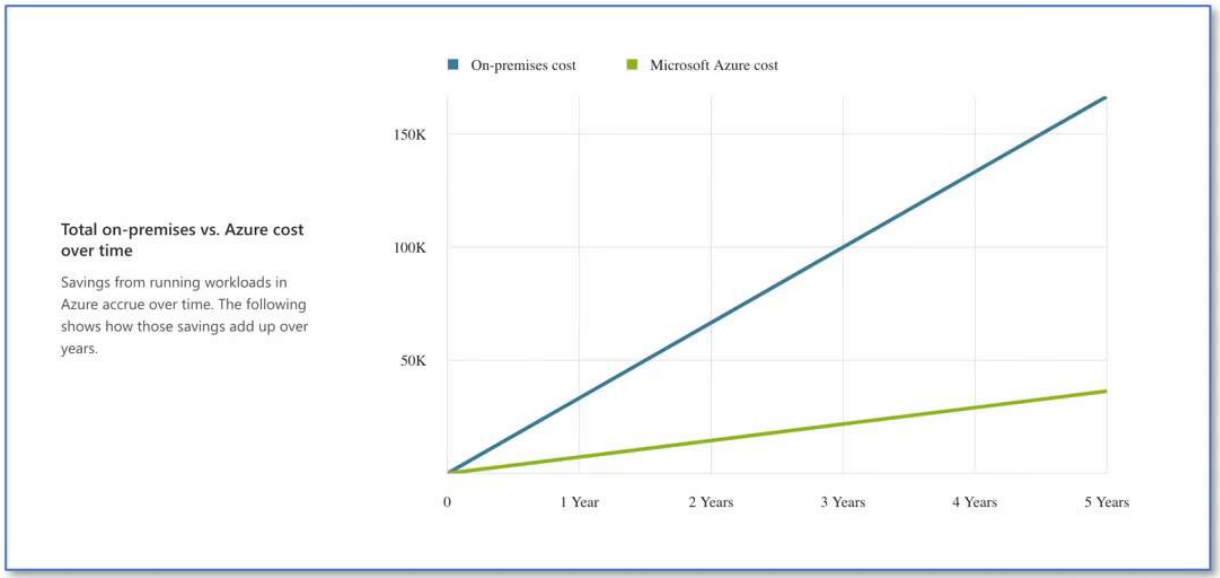
Estimate the cost savings you can realize by migrating your workloads to Azure

Generate out a detailed report and export as a PDF to send to decision makers.

azure.microsoft.com/pricing/calculator

Over 5 year(s) with Microsoft Azure, your estimated cost savings could be as much as **$130,191**



Azure Marketplace

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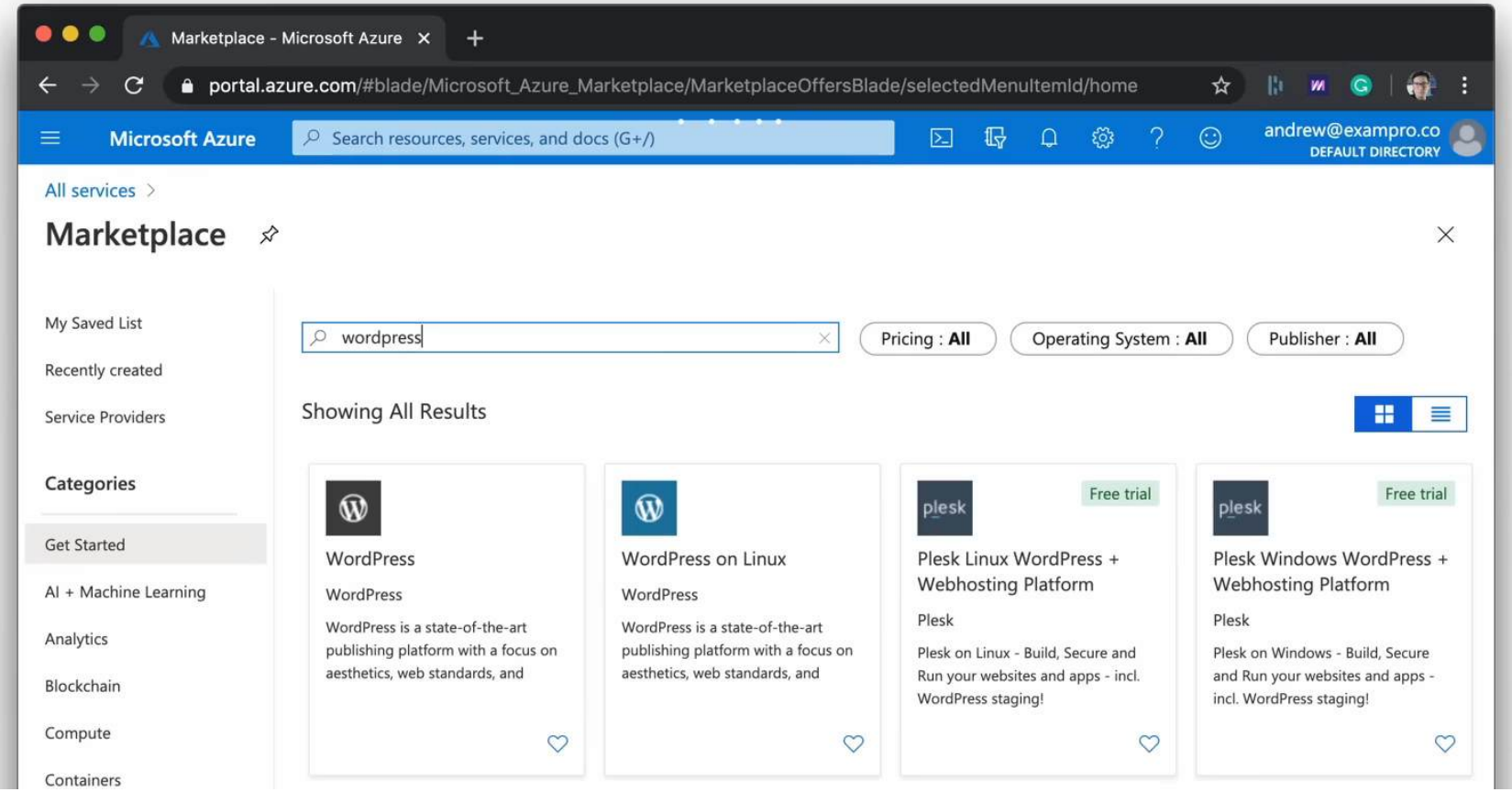
Azure Marketplace are **apps and services** made available by **third-party publishers** to quickly get started.
The available apps and services can be Free, Free-Trial, Pay-As-You-Go, Bring-Your-Own-License (BYOL)



Azure Licensing – Azure Hybrid Benefit

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Many customers have invested in **Windows Server licenses**
and would like to **repurpose this investment** on Azure.

Azure Hybrid Use Benefit (HUB)

Gives customers the right to use these licenses for virtual machines on Azure.

- Windows Servers
- SQL Servers

  - HUB can be turned on and off at anytime for existing VMs
  - HUB can be applied at deployment time for new VMs

Bring your own license (BYOL)

Azure Subscriptions

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An Azure Subscription is the same as saying our Azure Account.
There are **4 tiers** of Azure Subscriptions:

🆓 **Free Subscription**

- Credit Card Required
- $200 USD credits free for 30 days
- Certain Azure products free for 12 months

🏃‍♀️ **Pay-As-You-Go (PAYG) Subscription**

- Credit Card Required
- Charged end at the of the month based on consumed cloud resources

🏢 **Enterprise Agreement**

- An Enterprise and Azure agree on receive discounted price for licenses and cloud services

👩‍🎓 **Student Subscription**

- No Credit Card Required
- $100 USD credits for 12 months
- Requires valid student email

Azure Pricing Calculator

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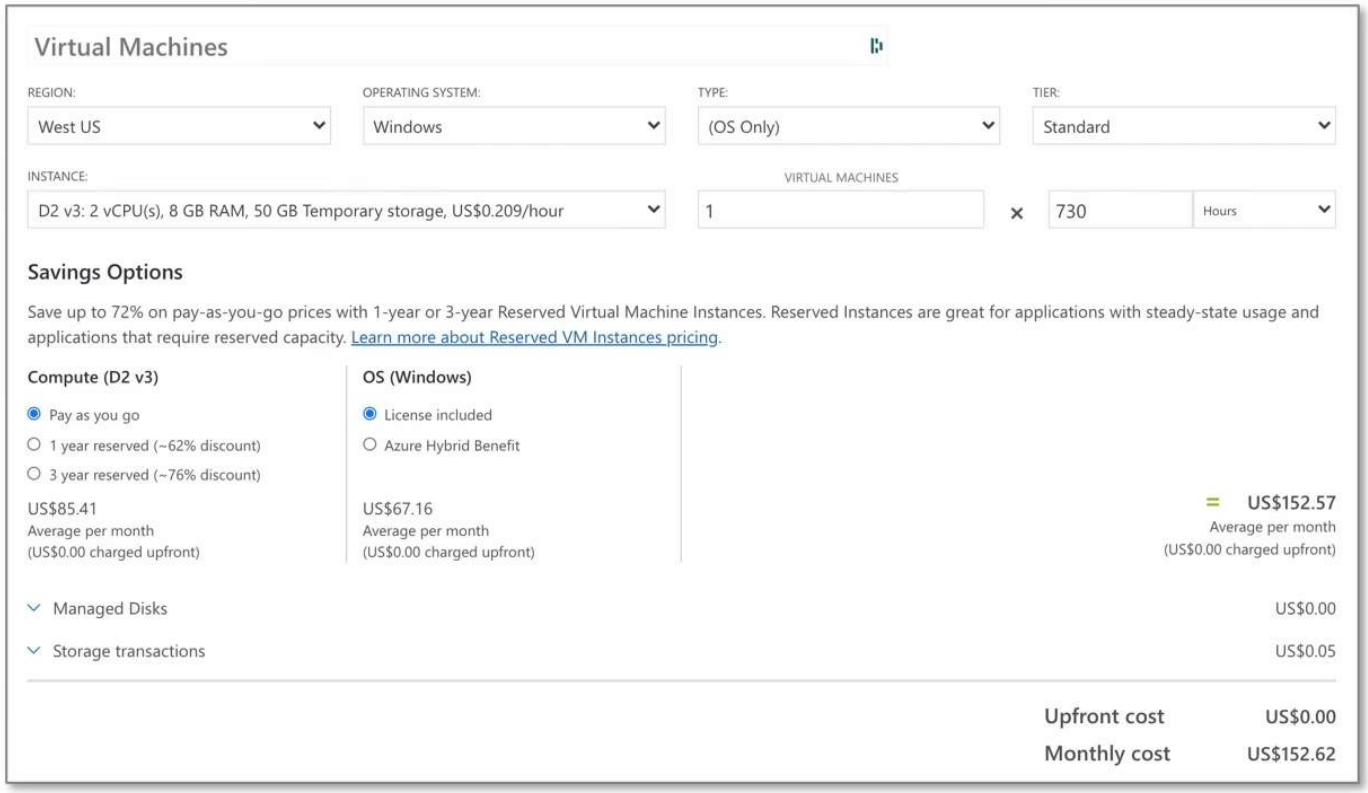
Configure and estimate the costs for Azure products. No Sign-in require.
Download an **Excel spreadsheet** and share with your boss.

azure.microsoft.com/pricing/calculator



Azure Cost Management

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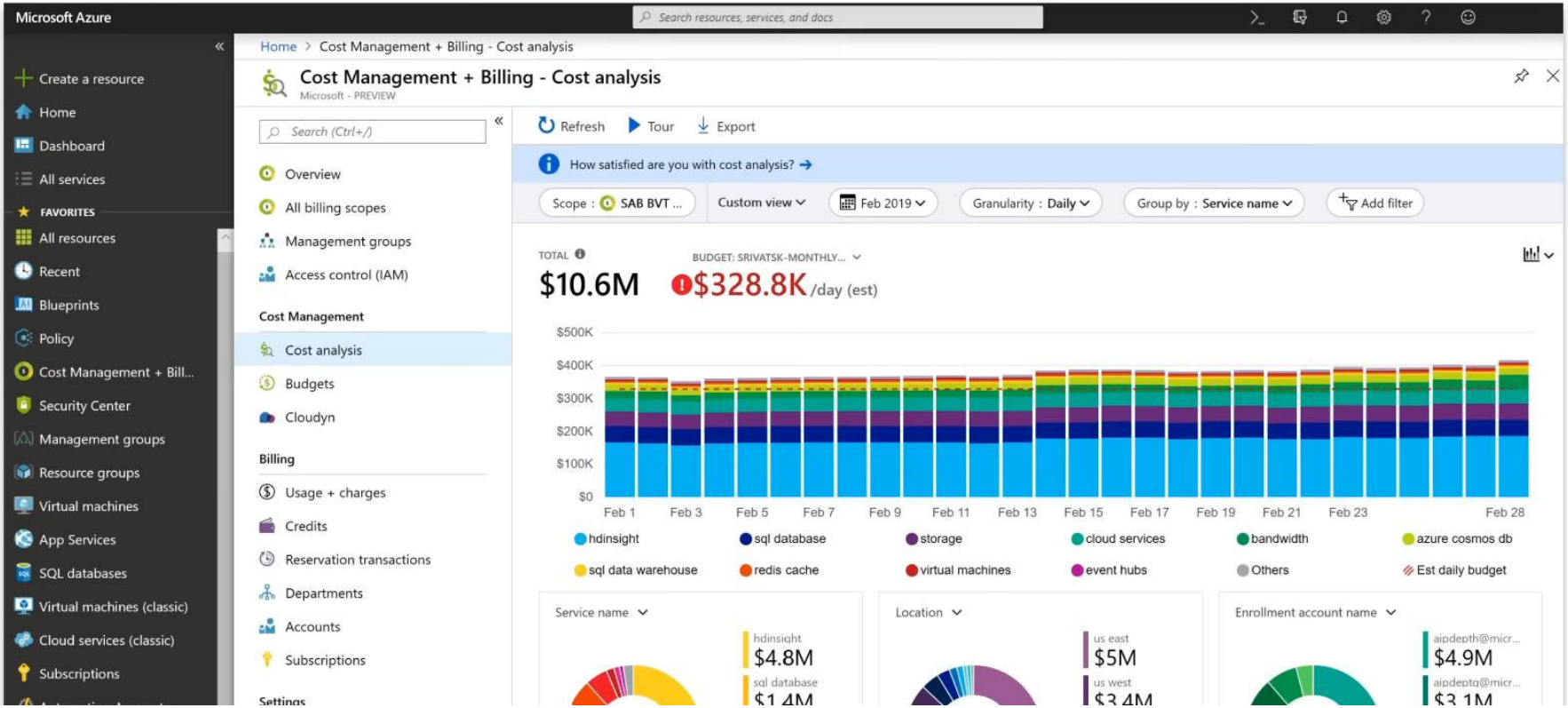
Perform **cost-analysis**, visualize the spending of your Azure cloud resources
Create **budgets**, set a budget threshold be alerted when approaching or exceeded



Resource Tags

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A tag is a **key and value pair** that you can assign to azure resources.

Name ⓘ		Value ⓘ	Resource
Env	:	Production	Storage account
Project	:	Enterprise	Storage account
	:		Storage account

Tag Examples
Dept = Finance
Status = Approved
Team = Compliance
Environment = Production
Project = Enterprise
Location = West US

Tags allow you to organize your resources in the following ways:

- **Resource management**
  - specific workloads, environments eg. Developer Environments
- **Cost management and optimization**
  - Cost tracking, Budgets, Alerts
- **Operations management**
  - Business commitments and SLA operations eg. Mission-Critical Services
- **Security**
  - Classification of data and security impact
- **Governance and regulatory compliance**
- **Automation**
- **Workload optimization**

Microsoft Purview Information Protection

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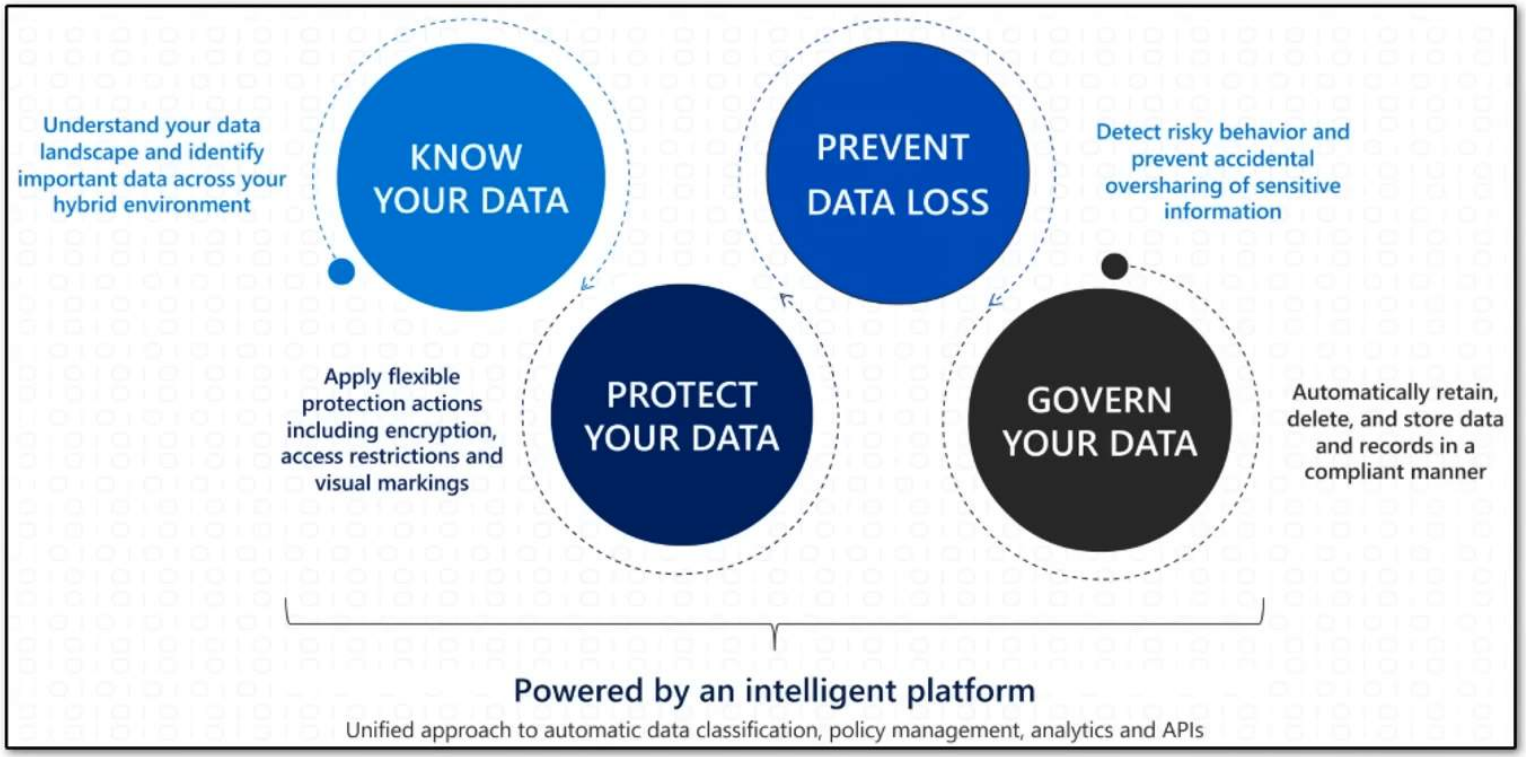
Microsoft Purview Information Protection (MPIP) is a collection of features within **Microsoft Purview** (formerly Microsoft 365 Compliance) to help **you discover, classify, and protect** sensitive information wherever it lives or travels.

MPIP capabilities:

- Know your data
- Protect your data
- Prevent Data Loss
- Govern your Data



MPIP – Know your data

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Know your data

Understand your **data landscape** and identify important data across your hybrid environment

Sensitive information types

Identifies sensitive data by using **built-in or custom regular expressions** or a function.
Corroborative evidence includes keywords, confidence levels, and proximity.

- Built-in sensitive labels

Trainable classifiers

Identifies sensitive data by using examples of the data you're interested in rather than identifying elements in the item (pattern matching). You can use built-in classifiers or train a classifier with your own content.

- Trainable classifiers

Data classification

A **graphical identification of items** in your organization that have a sensitivity label, a retention label, or have been classified.
You can also use this information to gain insights into the actions that your users are taking on these items.

MPIP – Protect your data

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Protect your data

apply **flexible protection** actions that include encryption, access restrictions, and visual markings

- Sensitivity labels
- Azure Information Protection unified labeling client
- Double Key Encryption
- Office 365 Message Encryption (OME)
- Service encryption with Customer Key
- SharePoint Information Rights Management (IRM)
- Rights Management connector
- Azure Information Protection unified labeling scanner
- Microsoft Defender for Cloud Apps
- Microsoft Information Protection SDK

MPIP – Prevent data loss

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Prevent data loss

prevent **accidental oversharing** of sensitive information

- Microsoft Purview Data loss prevention (DLP)
- Endpoint data loss prevention
- Microsoft Compliance Extension – Chrome Extension
- Microsoft Purview data loss prevention on-premises scanner
- Protect sensitive information in Microsoft Teams chat and channel messages

MPDLM – Govern Your Data

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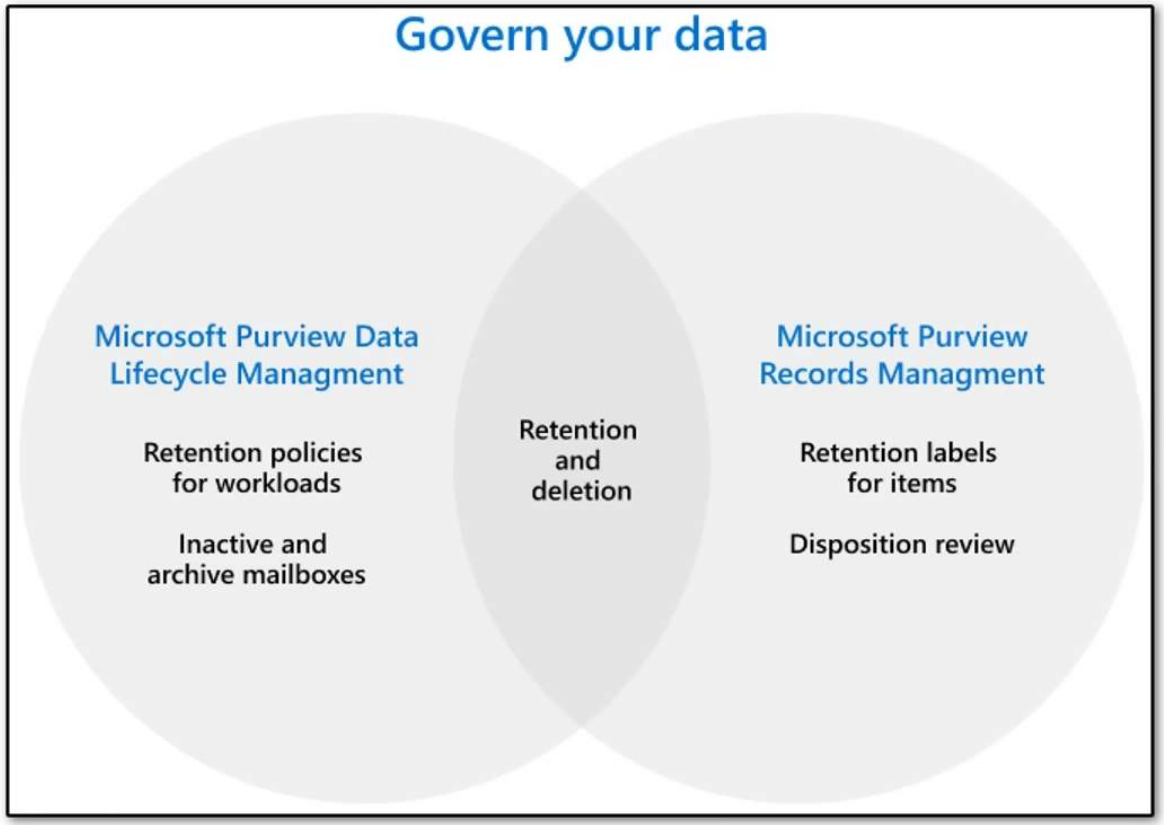
Microsoft Purview Data Lifecycle Management (formerly Microsoft Information Governance) is a collection of features to **govern your data for compliance** or regulatory

Microsoft Purview Data Lifecycle Management
To keep what you need and delete what you don't

- Retention policies and retention labels
- Inactive mailboxes
- Archive mailboxes
- Import service for PST files

Microsoft Purview Records Management
Manage high-value items for business, legal, or regulatory record-keeping requirements

- File plan
- Retention labels for individual items, retention policies if needed for baseline retention
- Disposition review and proof of disposition



Introduction to Azure Policies

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Azure Policy enforce organizational standards and to assess **compliance** at-scale

Policies do not restrict access, they only observe for compliance.

Policy Definitions

A policy definition is a **JSON** file used to describe business rules to control access to resources.

Policy Assignment

The scope of a policy can effect. Assigned to a user, a resource group or management group.

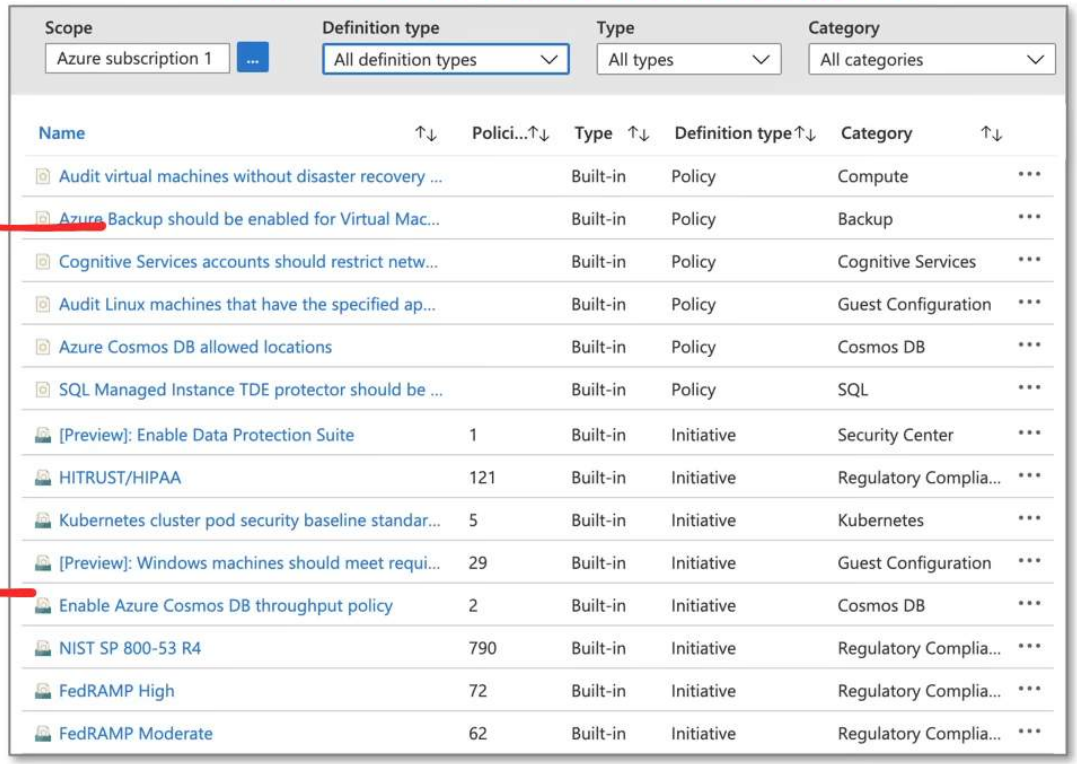
Policy Parameters

Values you can pass into your Policy definition so your Policies are more flexible for re-use.

Initiative Definitions

An initiative definition is a collection of policy definitions, that you can assign. eg. A group of policies to enforce **PCI-DSS compliance**

Azure has "built-in" policies you can used right away



Scope: Azure subscription 1 | Definition type: All definition types | Type: All types | Category: All categories

Name	Polici...	Type	Definition type	Category
Audit virtual machines without disaster recovery ...		Built-in	Policy	Compute
Azure Backup should be enabled for Virtual Mac...		Built-in	Policy	Backup
Cognitive Services accounts should restrict netw...		Built-in	Policy	Cognitive Services
Audit Linux machines that have the specified ap...		Built-in	Policy	Guest Configuration
Azure Cosmos DB allowed locations		Built-in	Policy	Cosmos DB
SQL Managed Instance TDE protector should be ...		Built-in	Policy	SQL
[Preview]: Enable Data Protection Suite	1	Built-in	Initiative	Security Center
HITRUST/HIPAA	121	Built-in	Initiative	Regulatory Complia...
Kubernetes cluster pod security baseline standar...	5	Built-in	Initiative	Kubernetes
[Preview]: Windows machines should meet requi...	29	Built-in	Initiative	Guest Configuration
Enable Azure Cosmos DB throughput policy	2	Built-in	Initiative	Cosmos DB
NIST SP 800-53 R4	790	Built-in	Initiative	Regulatory Complia...
FedRAMP High	72	Built-in	Initiative	Regulatory Complia...
FedRAMP Moderate	62	Built-in	Initiative	Regulatory Complia...

Resource Locks

As an admin, you may need to **lock a subscription, resource group, or resource** to **prevent other users from accidentally deleting or modifying critical resources.**

In the **Azure Portal** you can set the following lock levels.

CanNotDelete (Delete)
authorized users can still read and modify a resource, but they can't delete the resource.

ReadOnly (Read-only)
authorized users can read a resource, but they can't delete or update the resource

Azure Blueprints

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Azure Blueprints enable **quick creation** of **governed subscriptions**.
Compose artifacts based on common or organization-based patterns into re-usable blueprints.
The service is designed to help with *environment setup*

Blueprints are a declarative way to orchestrate the deployment of various resource templates and other artifacts such as:

- Role Assignments
- Policy Assignments
- Azure Resource Manager templates (ARM templates)
- Resource Groups

The Azure Blueprints service is backed by the globally distributed **Azure Cosmos DB**
Blueprint objects are replicated to multiple Azure regions.

ARM Templates vs Azure Blueprints

Nearly everything that you want to include for deployment in Azure Blueprints can be accomplished with an ARM template.

ARM Template

- ARM templates are stored either locally or in source control.
- There's no active connection or relationship to the ARM template

Azure Blueprints

- relationship between the blueprint definition (what *should be* deployed) and the blueprint assignment (what *was* deployed)
- can also upgrade several subscriptions at once that are governed by the same blueprint

Azure Blueprints supports **improved tracking and auditing of deployments**

Azure Portal

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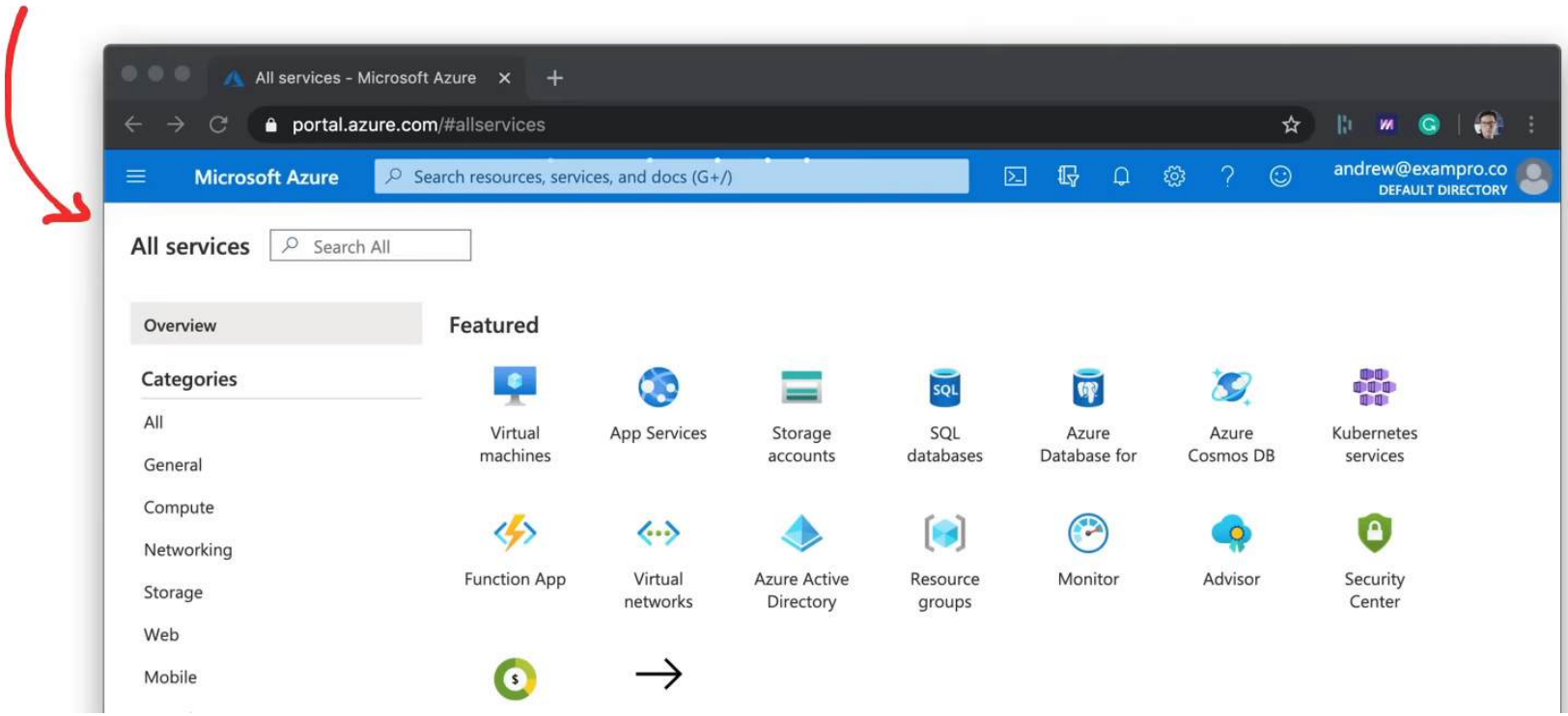
The Azure portal is **a web-based, unified console** that provides an alternative to command-line tools. You can manage your Azure subscription with the Azure portal. Build, manage, and monitor everything from simple web apps to complex cloud deployments.



Azure Preview Portal

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You can utilize new features that are in

- **Preview**
- **Beta**
- **Other pre-release**

- If you want to **test** **preview features** should use **preview.portal.azure.com**
- if you **stable-release and production-ready** features you should you use **portal.azure.com**

Azure Cloud Shell

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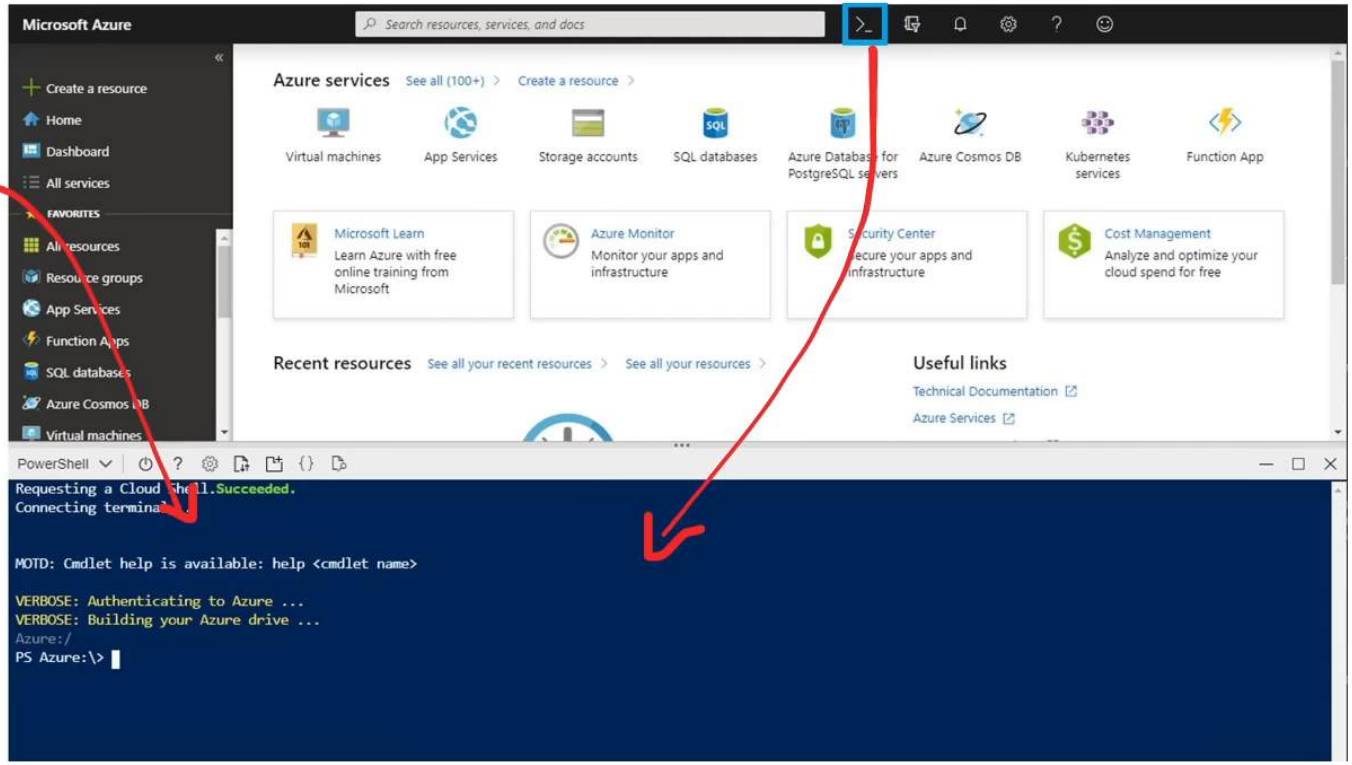
Azure Cloud Shell is an interactive, authenticated, **browser-accessible shell** for managing Azure resources.

It provides the flexibility of choosing the shell experience that best suits the way you work, either **Bash or PowerShell**.



Azure PowerShell

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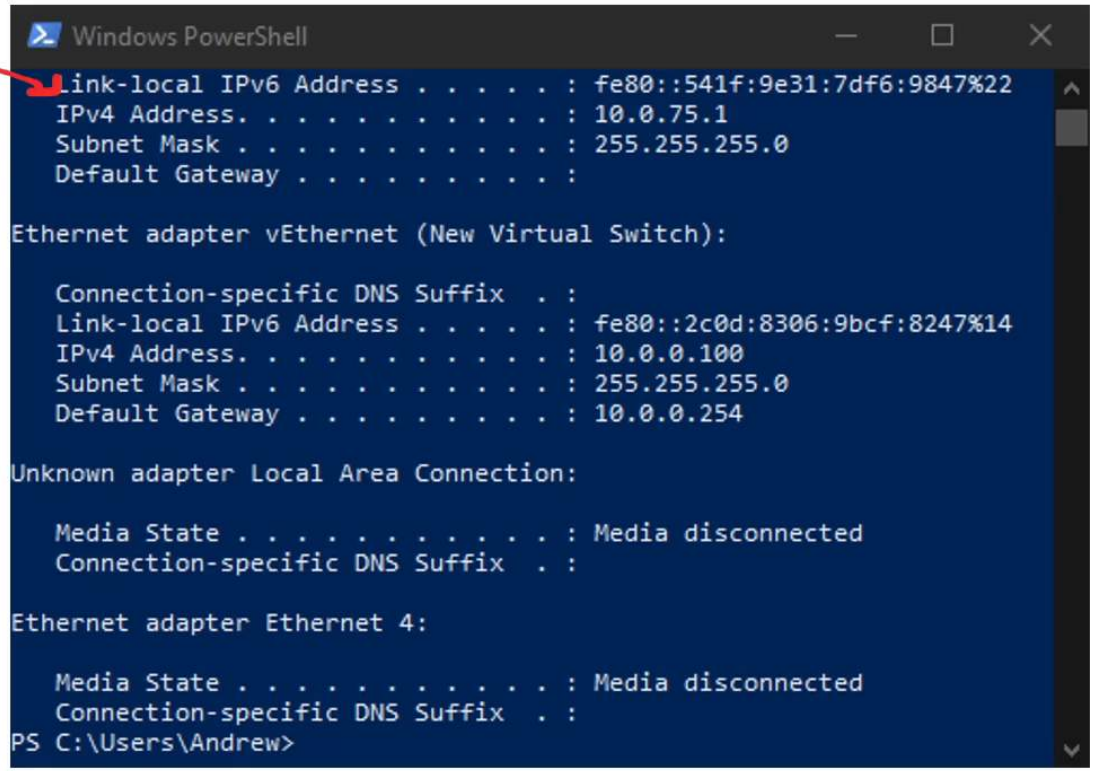
What is PowerShell?
PowerShell is a task automation and configuration management framework.
A **command-line shell** and a **scripting language**.

Unlike most shells, which accept and return text, PowerShell is built on top of the .NET Common Language Runtime (CLR), and accepts and returns .NET objects.

Azure PowerShell
A set of cmdlets for managing Azure resources directly from the PowerShell command line



Azure CLI

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What is a CLI?

A Command Line Interface (CLI) **processes commands to a computer program in the form of lines of text**. Operating systems implement a command-line interface in a shell or terminal

The Azure CLI can be installed on Windows, Mac and Linux. Once installed you can type **az** followed by other commands to create, update, delete, view and manage Azure resources.

```
#!/bin/bash

# Create a resource group.
az group create --name myResourceGroup --location westeurope

# Create a new virtual machine, this creates SSH keys if not present.
az vm create --resource-group myResourceGroup --name myVM --image UbuntuLTS --generate-ssh-keys
```

Visual Studio Code

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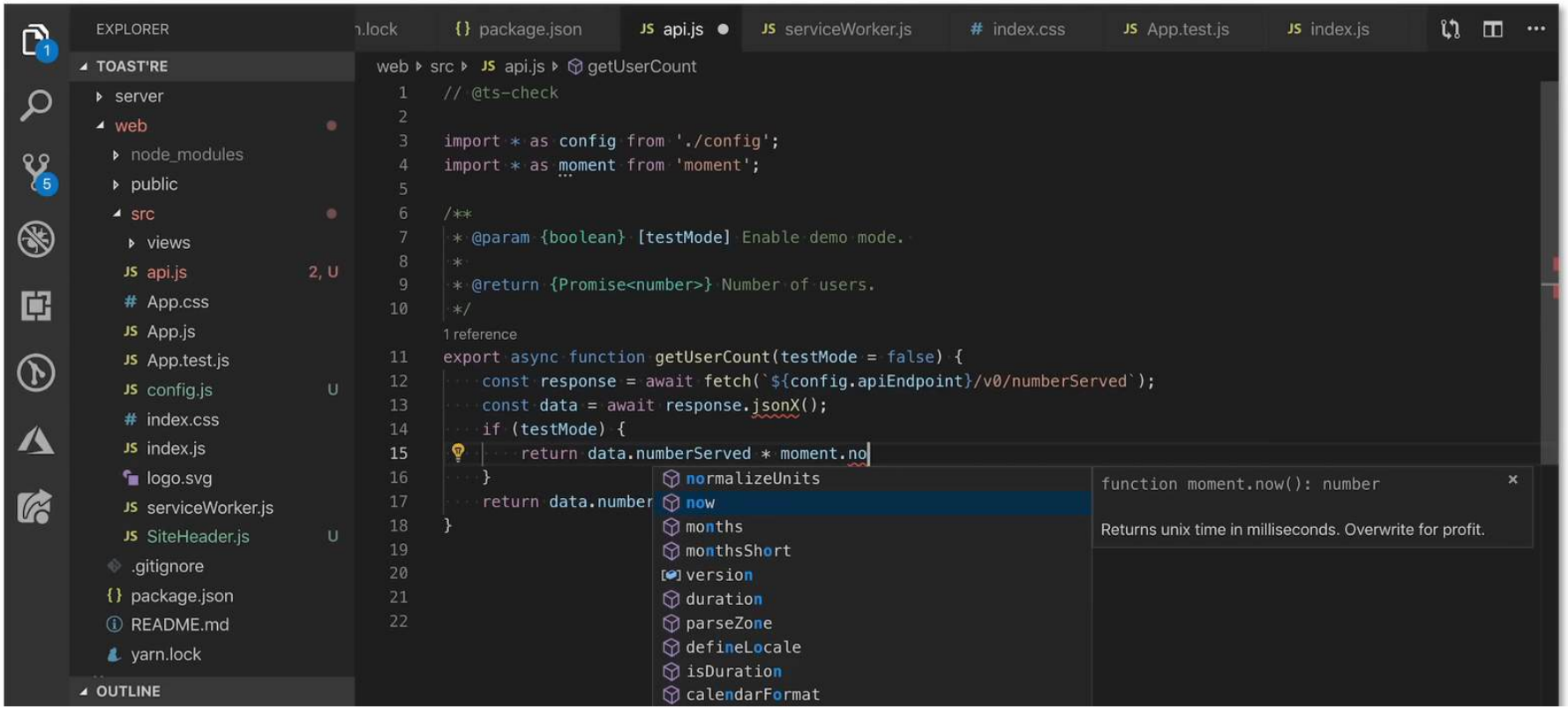
Visual Studio Code is a free source-code editor made by Microsoft for Windows, Linux and macOS.



Introduction to Azure Resource Manager

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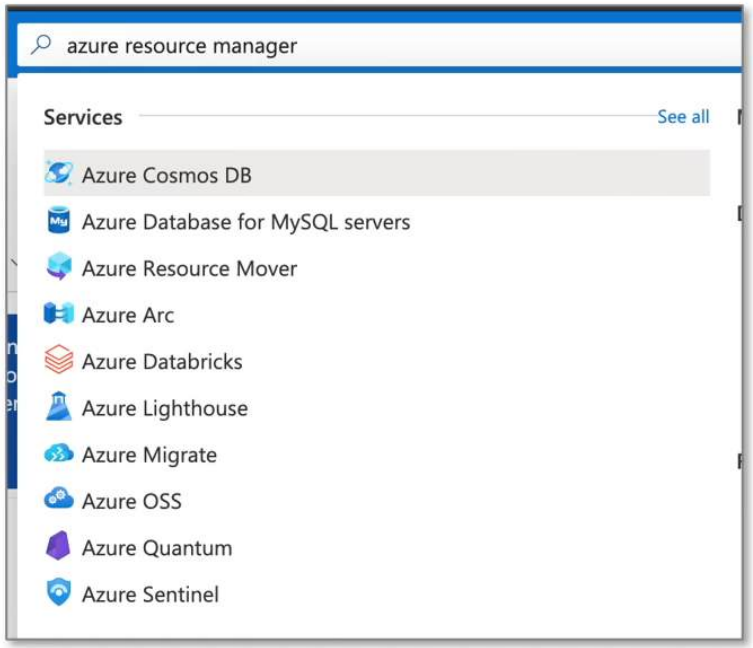
Azure Resource Manager (ARM) is a service that allows you to **manage** Azure resources.

Azure Resource Manager is a collection of services in the Azure Portal, **so you can't simply type** in "Azure Resource Manager"



It is a management layer that allows you to:

- Create, Update, Delete Resources
- Apply Management features eg. Access Controls, Locks, Tags
- Writing Infrastructure as Code (IaC) via JSON templates.

The specific features we are going to look at that make up the ARM layer are the following:

- Subscriptions
- Management Groups
- Resource Groups
- Resource Providers
- Resource Locks
- Azure Blueprints
- Resource Tags
- Access Control (IAM)
- Role-Based Access Controls (RABC)
- Azure Policies
- ARM Templates

Azure Resource Manager – Use Case

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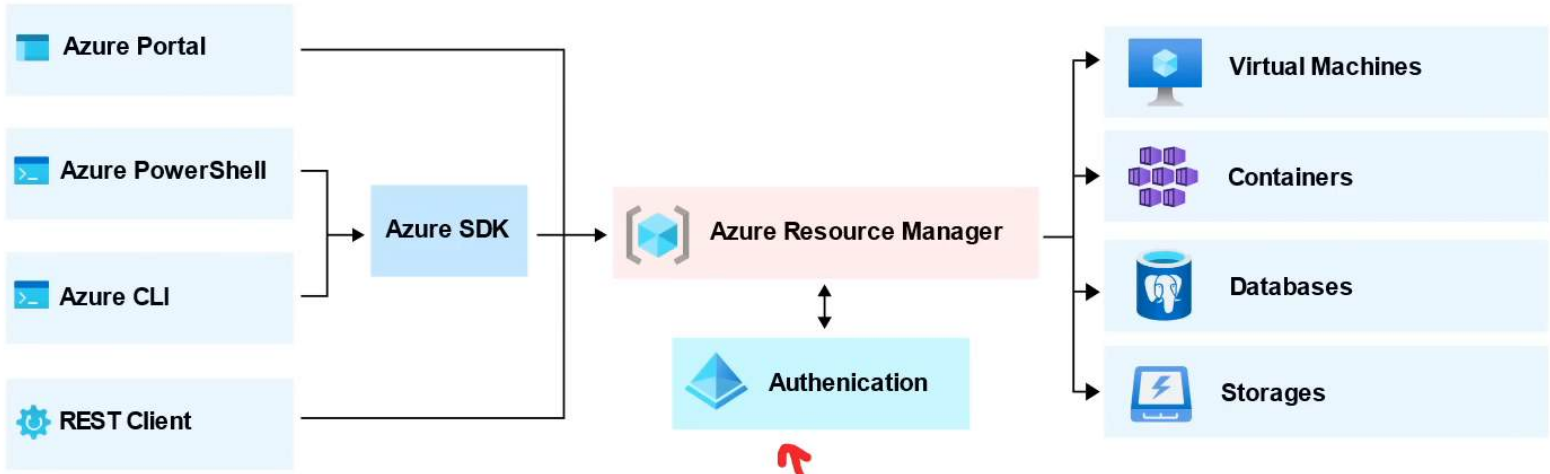

Think of Azure Resource Manager (ARM) as a **gate keeper**.

All **requests** flow through ARM and it decides whether that request can be performed on a **resource**.

Azure Resource Manager – Scoping

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What is scope?

Scope is a **boundary of control** for azure resources. It is a way to **govern** your resource by placing resources

- within a logical grouping
- and also applying logical restrictions in the form of rules.

Management Groups
A logical grouping of multiple subscriptions

Subscriptions
grants you access to Azure services based on a billing and support agreement

Resource Groups
A logical grouping of multiple resources

Resources
An azure service eg. Azure VMs

We'll revisit scope when we look at Role-Based Access Controls (RBAC)

ARM Templates

What is Infrastructure As Code? (IaC)
the process of **managing and provisioning** computer data centers (eg, Azure) through machine-readable **definition files** (eg. JSON files) rather than physical hardware configuration or interactive configuration tools.

You write a script that will setup cloud services for you.

IaCs can either be:
- **Declarative** — You defined exactly what you want, and you get exactly that
- **Imperative** — You define what you generally want, and the service will guess what you want

ARM templates are **JSON files that define azure resources** you want to provision and azure services you want to configure.

With ARM templates you can:
- **ARM templates** are declarative. (you get exactly what you define)
- stand up, tear down or share entire architectures in minutes
- Reduce configuration mistakes
- Know exactly what you have defined for a stack to establish an architecture baseline for compliance

ARM Templates

With ARM templates you can:

- **ARM templates** are declarative. (you get exactly what you define)
- stand up, tear down or share entire architectures in minutes
- Reduce configuration mistakes
- Establish an architecture baseline for compliance
- **Modularity** Break up your architecture in multiple files and reuse them
- **Extensibility** Add PowerShell and Bash scripts to your templates
- **Testing** You can use the ARM template tool kit (arm-ttk)
- **Preview Changes** Before you create infrastructure via template, see what it will create
- **Built-In Validation** Will only deploy your template if it passes
- **Tracked Deployments** Keep track of changes to architecture over time
- **Policy as Code** Apply Azure policies to ensure you remain compliant
- **Microsoft Blueprints** (establishes relationship between resource and the template)
- **CI/CD integration**
- **Exportable Code** (exporting the current state of a resource groups and resources)
- **Authoring Tools** Visual Studio Code has advanced features for authoring ARM templates

Introduction to Azure Monitor

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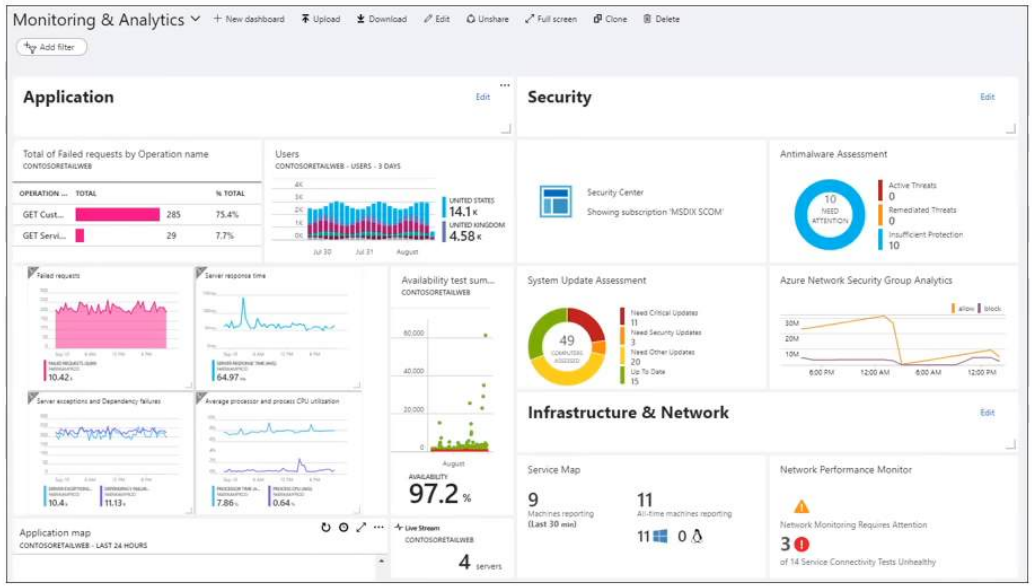
Azure Monitor comprehensive solution **for collecting, analyzing, and acting on telemetry** from your cloud and on-premises environments

- Create Visual Dashboards
- Smart Alerts
- Automated Actions
- Log Monitoring

Many Azure services by default are already sending telemetry data to Azure Monitor



The Pillars of Observability

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What is Observability?
The ability to measure and understand how internal systems work in order to to answer questions regarding performance, tolerance, security and faults with a system / application.

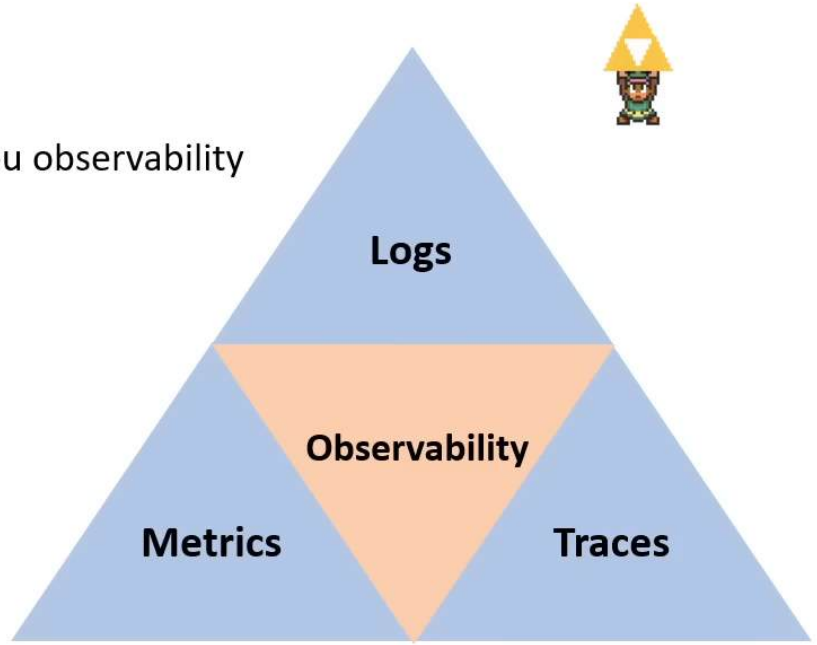
To obtain observability you need to use **Metrics**, **Logs** and **Traces**.
You have to use them together, using them in isolate does not gain you observability

Metrics
A number that is measured over period of time
eg. If we measured the CPU usage and aggerated it over an a period of time we could have an **Average CPU metric**

Logs
A text file where each line contains event data about what happened at a certain time.

Traces
A history of request that is travels through multiple Apps/services so we can pinpoint performance or failure.

Looks like they should have called it the Triforce of Observability



Anatomy of Azure Monitor

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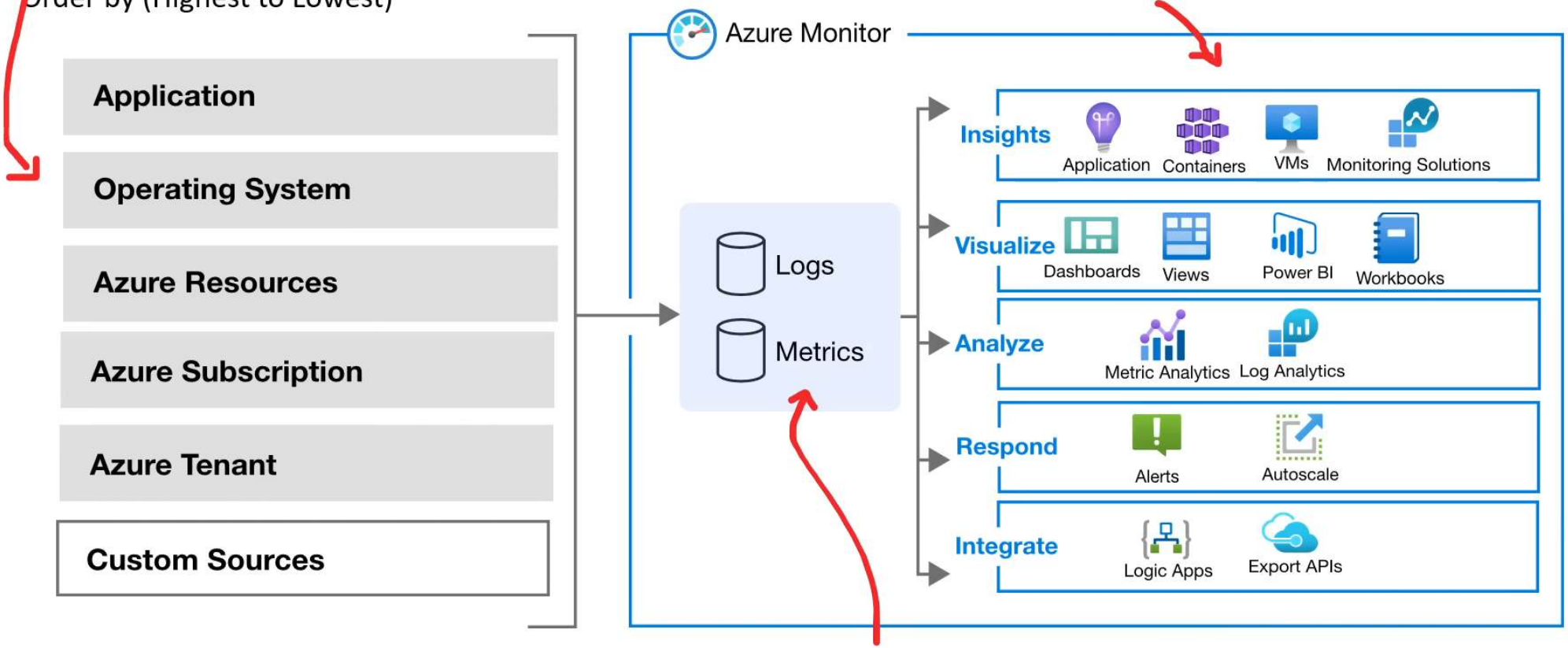
The **sources of common monitoring data** to populate datastores
Order by (Highest to Lowest)

The **functions** that Azure monitor can perform



The two fundamental data stores are **Metrics** and **Logs**

Log Analytics

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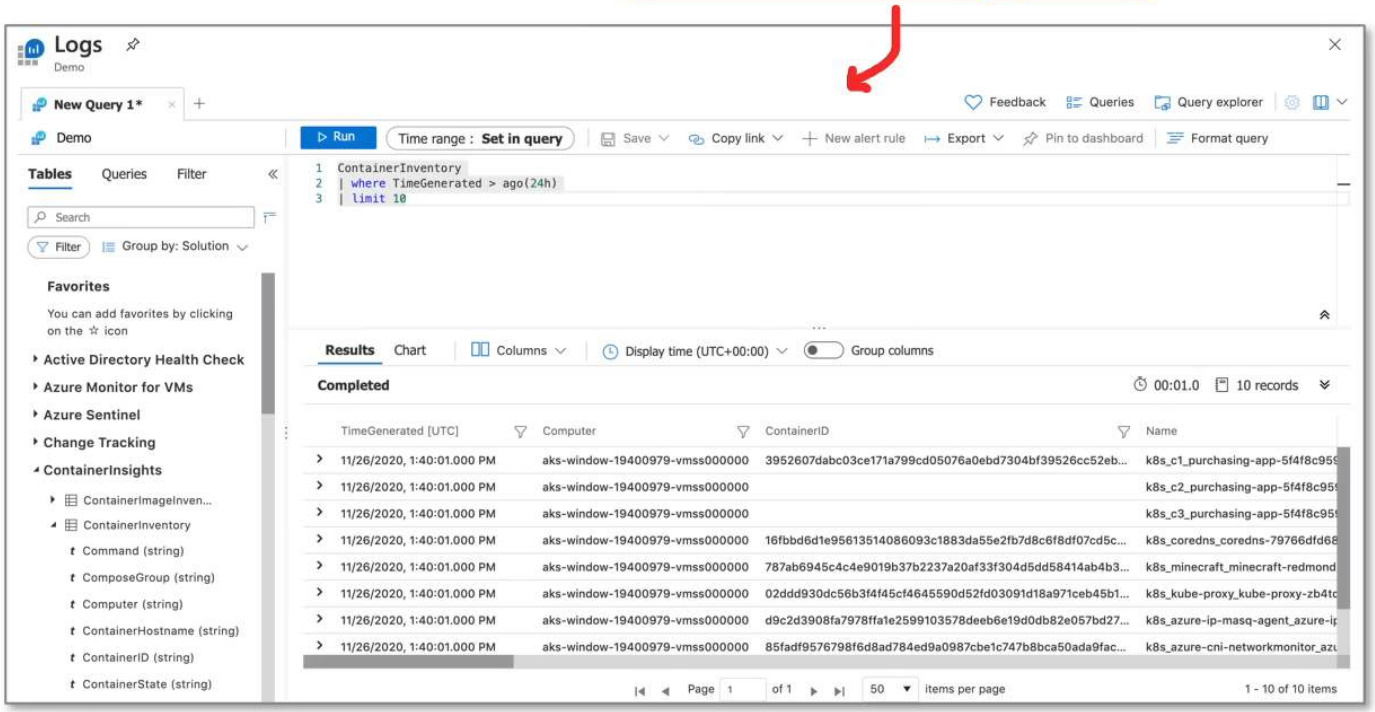
Log Analytics is a tool in the Azure portal used **to edit and run log queries** with data in **Azure Monitor Logs.**



Log Analytics uses a query language called KQL

Log Analytics Workspaces

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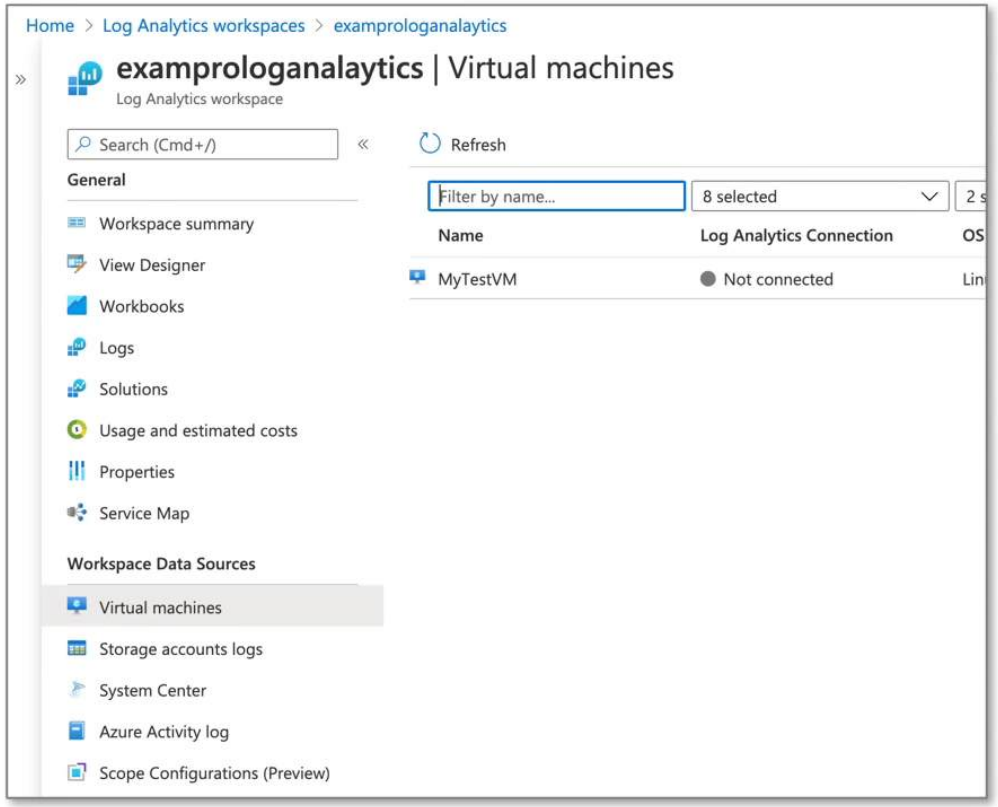
Log Analytics workspace is a unique environment for Azure Monitor log data

Each **workspace** has its own data repository and configuration, and data sources and solutions are configured to store their data in a particular **workspace**



Azure Alerts

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Alerts notify you when issues are found with your infrastructure or application
They allow you to **identify** and **address** issues before the users of your system notice them.

Azure has 3 kinds of Alerts

1. Metric Alerts
2. Log Alerts
3. Activity Log Alerts

When an alert is triggered you can be notified and have it take action

Azure Alerts

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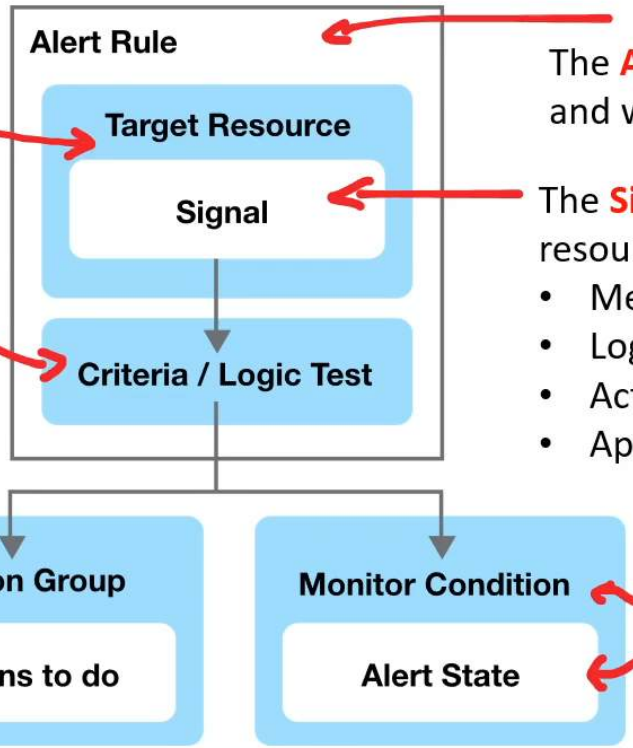
A resource such as an Azure VM is designated as the **Target Resource** and it omits a **signal**

The **Alert Rule** defines who should we monitor and when should we react



The **Signal** is a data payload emitted from the resource that could be the following types:

- Metric
- Log
- Activity log
- Application Insights

The signal is evaluated against a **criteria or logical test** to determine if the alert has been triggered
eg. Percentage CPU > 70%

An **action group** contains actions to be that will be performed when alert is triggered

The current state of your alert
Monitor Condition is set by the system
Alert state is set by the user

An **action** could be a:
Automation runbook, Azure Function, ITSM, Logic App, Webhooks or Secure Webhooks

Application Insights

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Application Insights is an **Application Performance Management (APM)** service
It is a sub-service of Azure Monitor.

What is an APM?
Monitoring and management of **performance and availability** of software apps. APM strives to detect and diagnose complex application performance problems to maintain an expected level of service.

Why use Application Insights?
- automatically detect performance anomalies
- includes powerful analytics tools to help you diagnose issues and to understand what users do with your app
- designed to help you continuously improve performance and usability
- works for apps on a for .NET, Node.js, Java, and Python hosted on-premises, hybrid, or any public cloud.
- Integrates with your DevOps process
- can monitor and analyze telemetry from mobile apps by integrating with Visual Studio App Center

Application Insights

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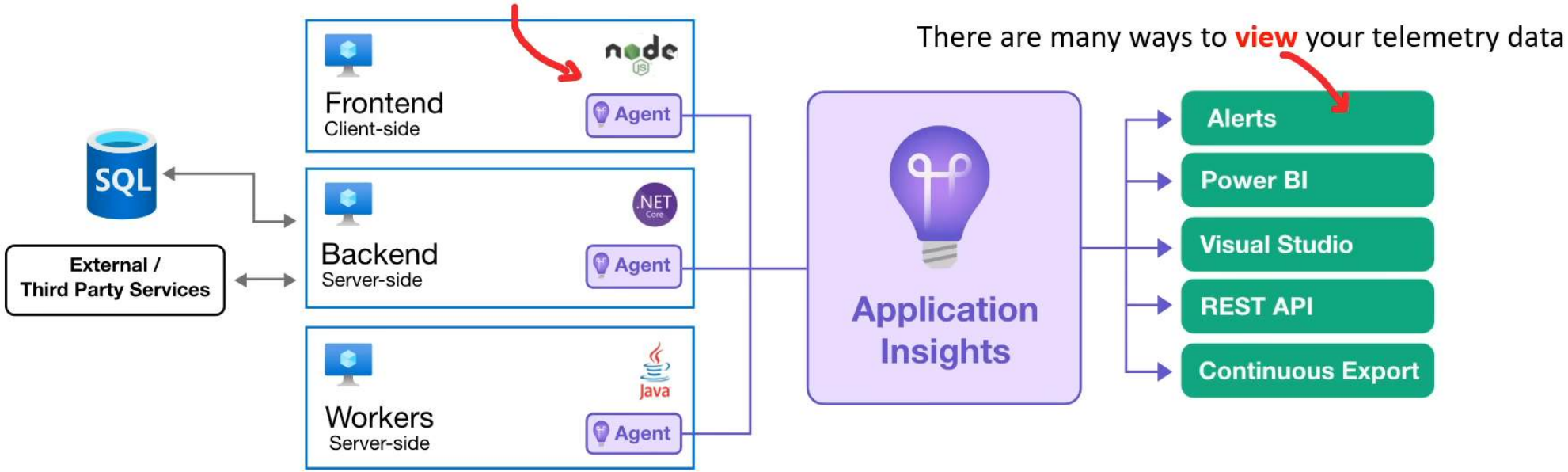
To use Application Insights **you need to instrument your application**.

- To instrument you need to install the instrument package (SDK)
- Or enable Application Insights using the Application Insights Agents when supported



- Apps can be instrumented from anywhere
- When you set up Application Insights monitoring for your web app, you create an Application Insights *resource* in Microsoft Azure.
- You open this resource in the Azure portal in order to see and analyze the telemetry collected from your app.
- The resource is identified by an instrumentation key (ikey)

Application Insights

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What does Application Insights Monitor?

- Request rates, response times, and failure rates
- Dependency rates, response times, and failure rates
- Exceptions
- Page views and load performance
- AJAX calls
- User and session counts
- Performance counters
- Host diagnostics
- Diagnostic trace logs
- Custom events and metrics

Where do I see my telemetry?

- Smart detection and manual alerts
- Application map
- Profiler
- Usage Analysis
- Diagnostic search for instance data
- Metrics Explorer for aggerated data
- Dashboards
- Live Metrics Stream
- Analytics
- Visual Studio
- Snapshot debugger
- Power BI
- REST API
- Continuous Export