



Introduction to Microsoft Azure



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A light introduction to Azure and cloud computing

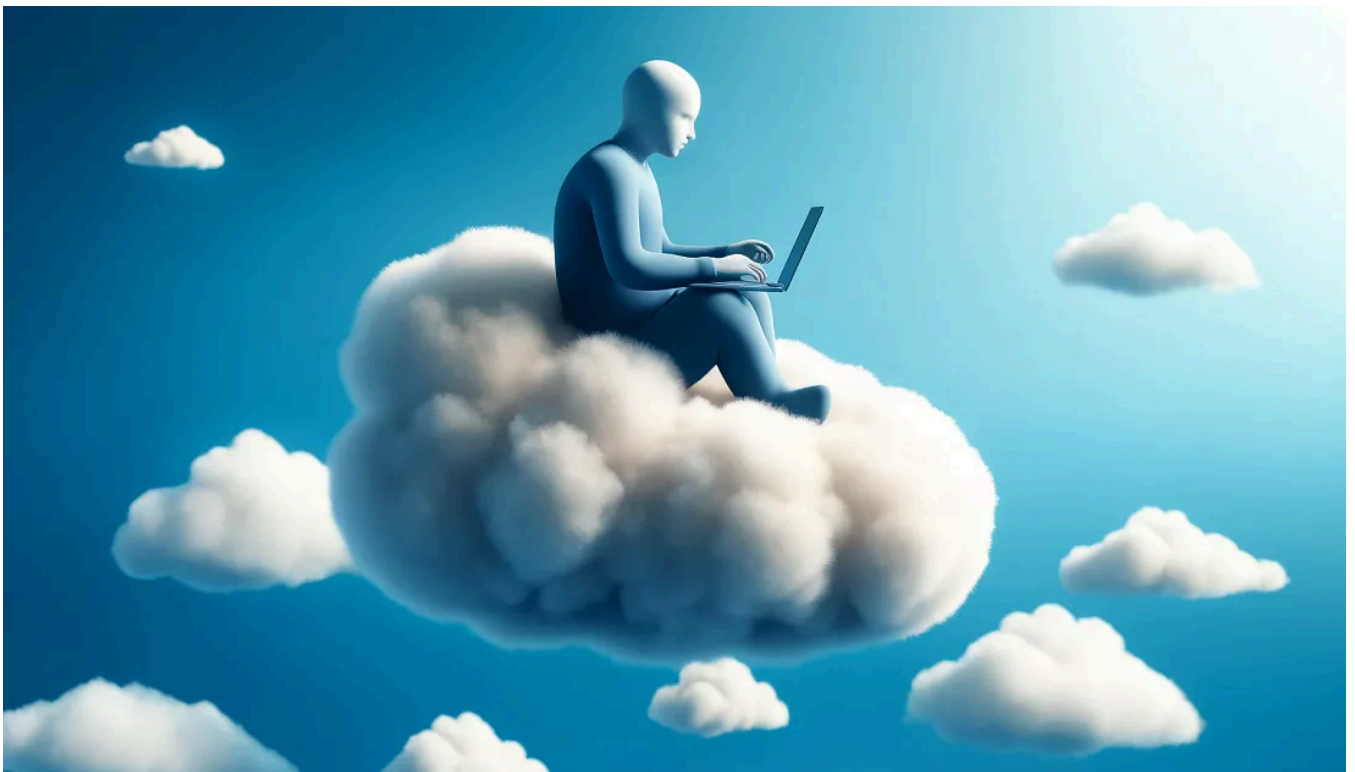


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Introduction

This article will give you a brief introduction to Azure and how it is generally used in organizations. I will sequence the topics based on the subjects covered in the AZ-900 (Azure Fundamentals) exam as it gives a basic yet comprehensive overview of Azure.

These are the topics I am going to cover.

1. Cloud concepts
2. Azure architecture
3. Azure core services
4. Data management and governance
5. Billing and pricing

I believe these 4 topics should serve as a good start to learning about Azure. I will try to illustrate concepts with visuals wherever possible so that you understand them better. Let's begin!

What is Azure?

Azure is Microsoft's cloud computing platform which provides storage, networking, computing and analytics services to its clients. Azure provides a one stop shop to its users for building and deploying applications throughout a global network of data centers.

The most important feature of Azure is the ability to scale based on computing demand. It has a Pay-As-You-Go pricing model.

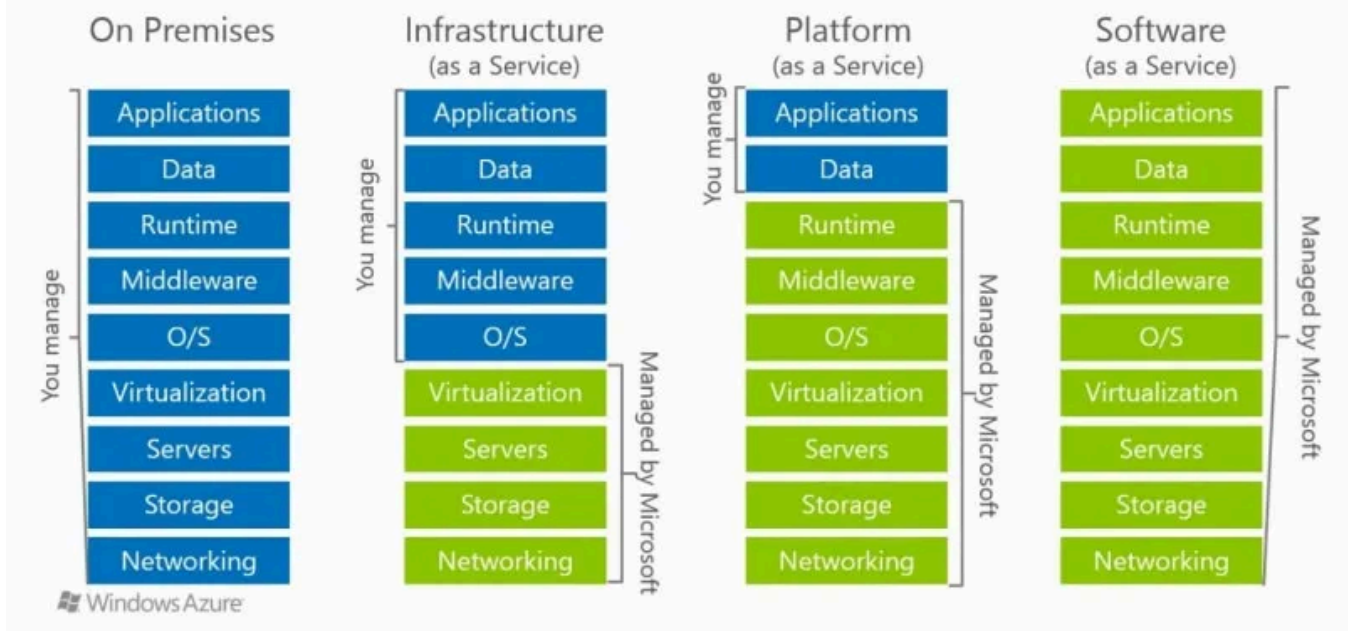
Cloud concepts

Cloud computing is the practice of using a network of remote servers hosted on the internet to manage data rather than storing it on a local server or an 'on-premise' system.

Cloud computing provides multiple benefits — the user pays only for what they consume, applications/services can be launched anywhere in the world, the cloud provider manages the physical security of the servers, resources are scalable i.e. can be increased or decreased on demand and the services are reliable i.e. user doesn't have to worry about regular backups.

There are 3 different types of cloud services other— Software as a Service (SaaS), Platform as a Service (PaaS) or Infrastructure as a Service (IaaS).

Cloud Models



Difference between Cloud Models (Image taken from Google Images)

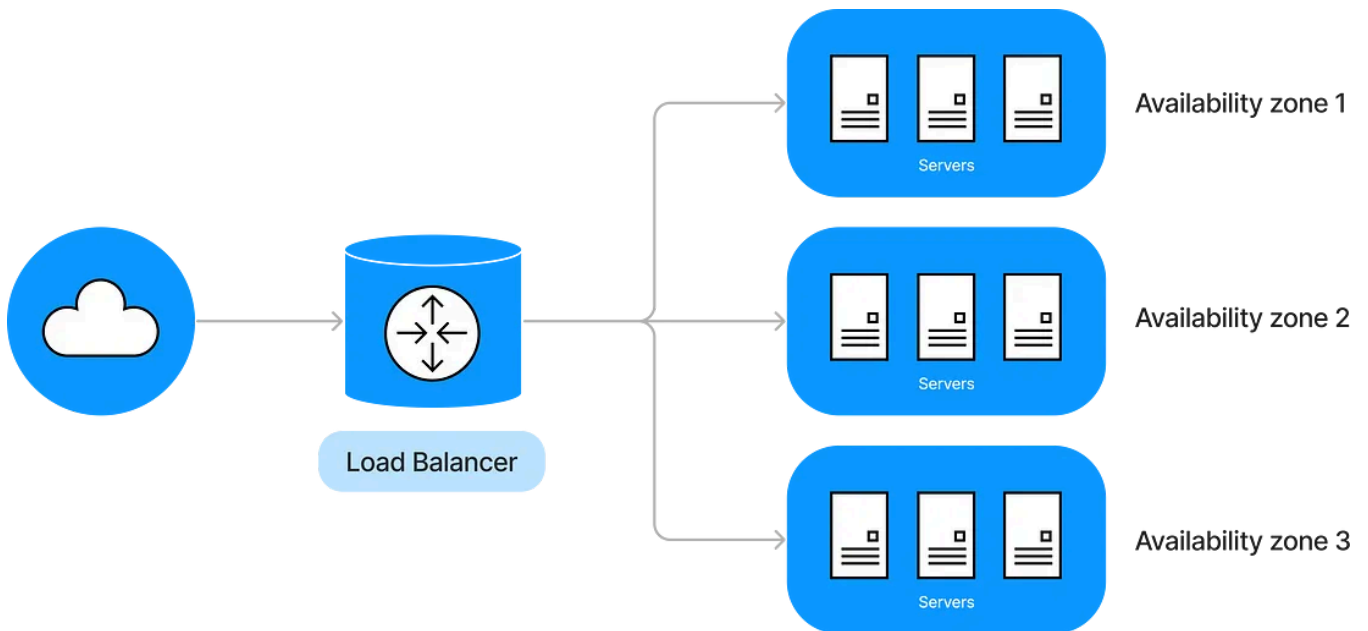
Azure has 3 deployment models — Public cloud (cloud-native), private cloud (on-premise) and hybrid cloud (using both on-premise and cloud).

Deployment Model	Cost	Security	Level of Configuration	Technical Knowledge
Public Cloud	☞ Most cost-effective	☞ Has default security controls ☞ Might not meet security requirements	☞ Limited based on what the Cloud Service Provider exposes to the user	☞ Users don't need in-depth knowledge of underlying infrastructure
Private Cloud	☞ Most expensive	☞ No guarantee of security ☞ Can meet any security compliance requirement if user does it themselves.	☞ User can configure the infrastructure however they like	☞ Users need to know in-depth how to configure all levels of your infrastructure
Hybrid Cloud	☞ ☞ Could be more cost-effective based on what is offloaded to the cloud	☞ User has to secure connection to the cloud. ☞ Can meet all security requirements	☞ ☞ Users get the best of both worlds	☞ Users need to know in-depth how to configure all levels of your infrastructure and know the CSP's services

Comparison of cloud deployment models (information taken from FreeCodeCamp)

It is important for a cloud practitioner to understand the following terminology.

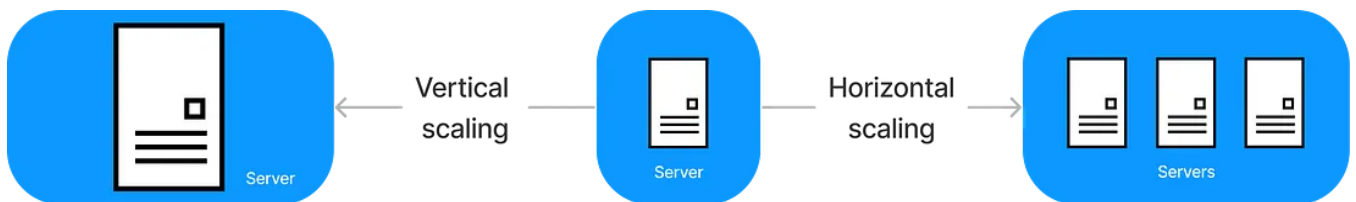
- **Availability** — this means that a service remains active without any single point of failure. This is done usually by running the workload across multiple datacenters (or Availability Zones i.e. AZs). The *load balancer* evenly distributes traffic to multiple datacenters and reroutes traffic to a backup datacenter when one datacenter goes down.



Running the workload across multiple AZs ensure the service remains available even if one server goes down (Image by author)

- **Scalability** — it is the ability to increase computing capacity based on increasing demand. There are two types of scaling — Vertical scaling (increasing the size of the server) and Horizontal scaling (adding more server of same size).

Horizontal scaling is considered to be more practical.



Scaling (image by author)

- **Elasticity** — the ability to *automatically* increase or decrease capacity based on the computing demand. This is usually done using Horizontal scaling.

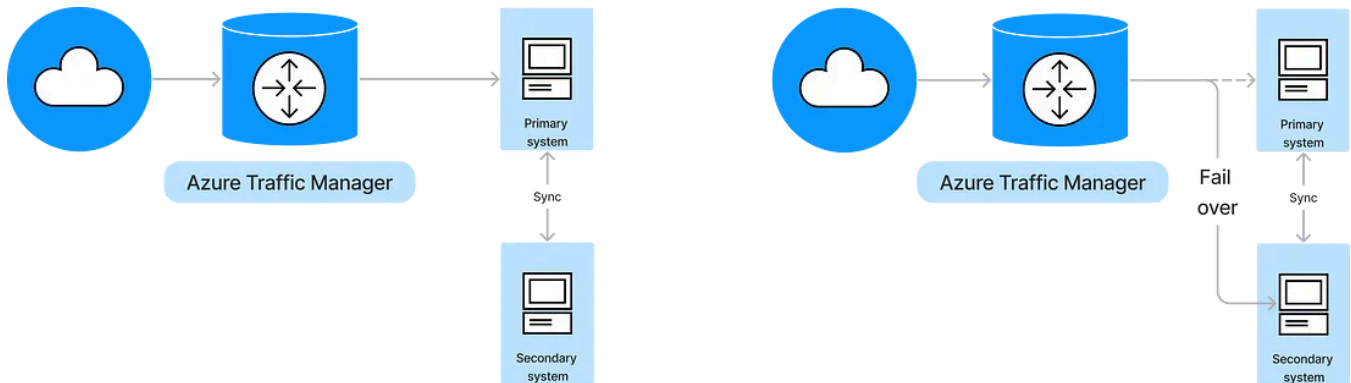
In Azure, scaling is done using VM Scale Sets. Scale sets can scale-out (increase capacity) or scale-in (decrease capacity) based on the computing demand.



Elasticity (image by author)

- **Fault tolerance** — ability for a service to ensure that there is no single point of failure. This is done by planning *fail-overs* i.e. having a redundant system so that the primary one fails, the traffic can shift to the secondary system.

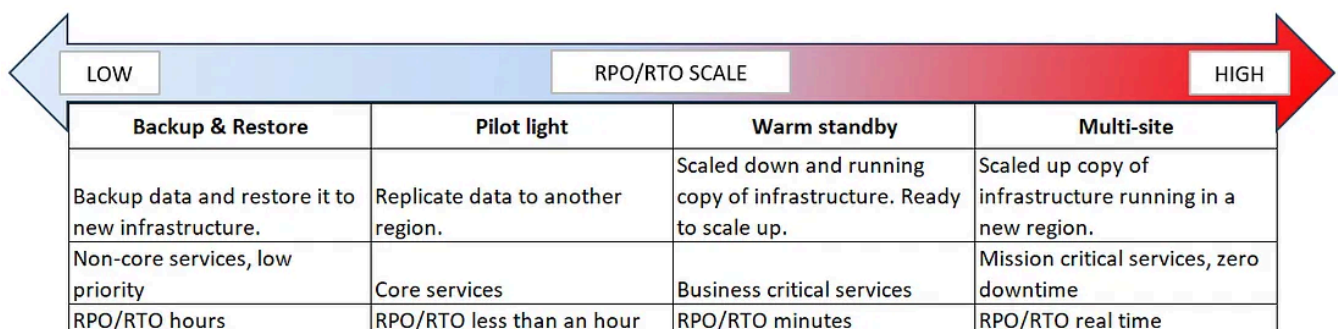
Azure Traffic Manager is a DNS-based traffic balancer which manager fail-overs.



Building a fault tolerant system (image by author)

- **High durability**— the ability to recover from a disaster and prevent loss of data. A durable system should have regular backups and the ability to restore backups fast so that work is not disrupted.

The resilience of a system must strike a balance between the Recovery Point Objective (an acceptable amount of data loss) and the Recovery Time Objective (an acceptable duration of downtime).



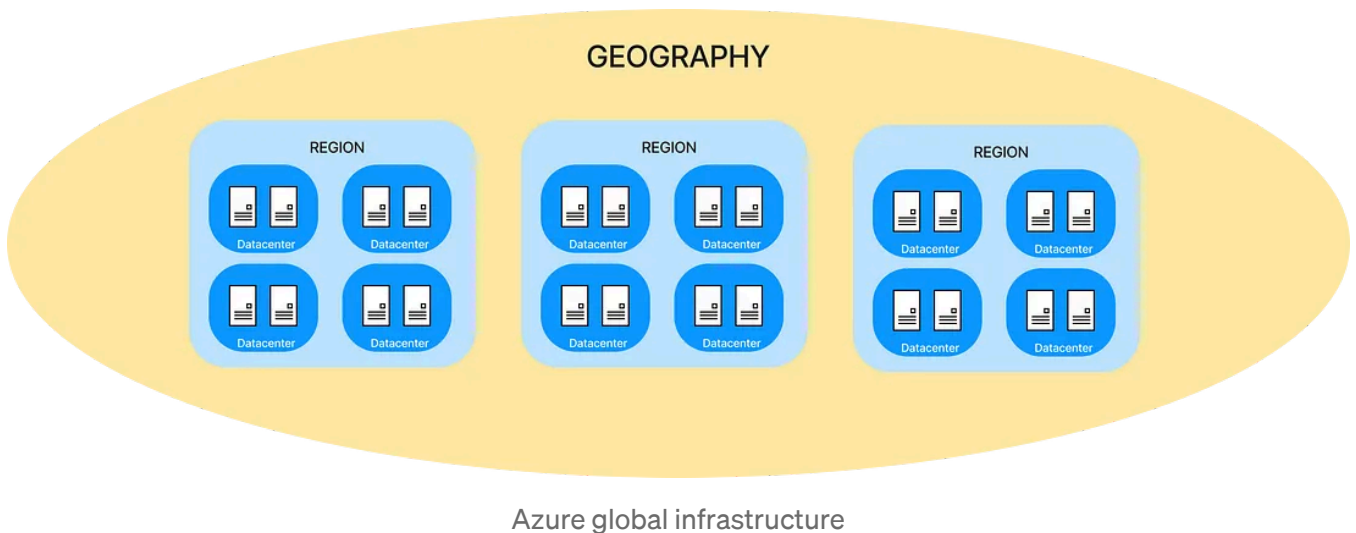
Types of systems based on their durability (information taken from FreeCodeCamp)

Azure architecture

Global infrastructure

- **Availability zone (AZ)** — it is what Azure calls its datacenters. AZs are physically separate from each other.
- **Region** — Grouping of multiple datacenters (AZs).

- Geography — Grouping of two or more regions.



Azure has a feature by which it increases its 'durability'. A region is paired with another and only one region is updated at a time to ensure 'zero outages.' This is called Geo Redundant Storage (GRS).

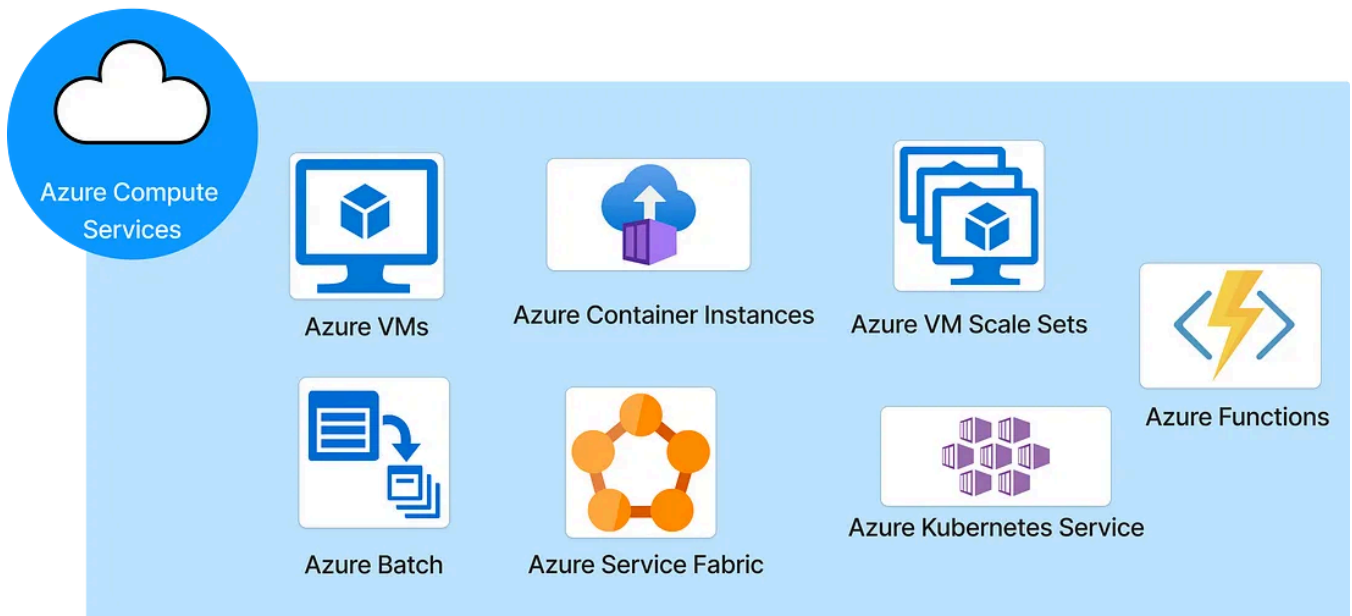
Azure core services

This is an important part of this article as it entails what services Azure provides to its users. We must first understand how Azure divides its services into different categories

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- *Compute services*
 - *App services*
 - *Network services*
 - *Storage services*
 - *Database services*
 - *Analytics and Big Data*
 - *AI and Machine Learning*
-

1. Azure Compute services

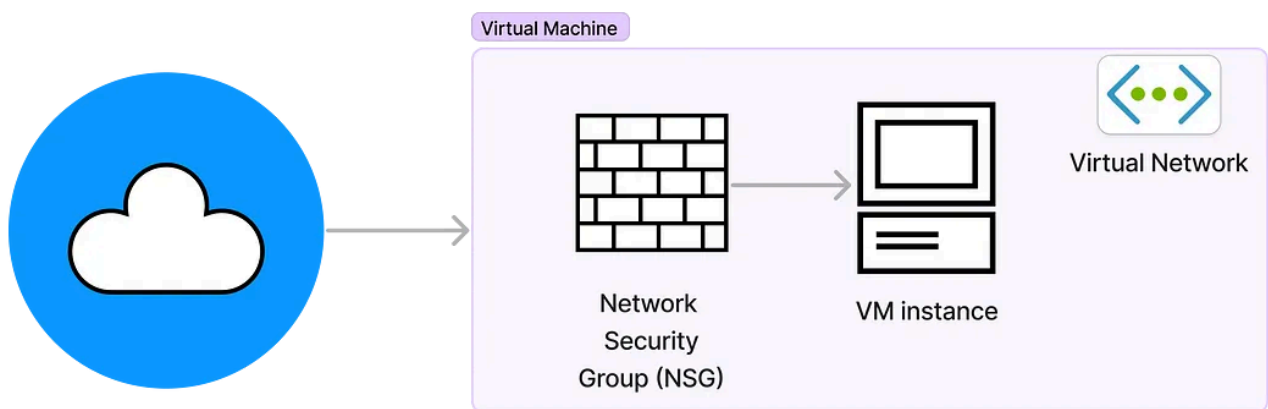
These are the core set of cloud computing services that allow you to deploy and manage workloads on Microsoft Azure. These are the building blocks of any cloud solution and of the IaaS model.



Components of Azure Compute Services (image by author)

Azure Virtual Machines (VMs)

A virtual machine is a logical computer that runs on a cloud server. Each virtual machine has its own operating system. These virtual machines are billed at an hourly rate.



Architecture of a Virtual Machine (VM)

Azure VM Scale Sets

Allows us to automatically increase or decrease our VM capacity by adding or removing an identical VM. We can add scaling policies to add or remove VMs based on some host-based metrics (like CPU usage, or by using App Insights). We can associate a load balancer to distribute newly created VMs across Availability Zones. This needs to be done to ensure high availability for the service.

2. Azure App Services

This service allows users to deploy and manage web apps on Azure. This is of the PaaS model. We can choose any runtime between — .NET, Java, Ruby, Python etc. for our containers.

One good feature of App Services is that it allows users to create *deployment slots*. These are different environments which allow users to have a testing/staging area before launching their apps.

Azure App Service also provide a dedicated environment called an App Service Environment (ASE) to run apps on high scale. This is very useful when horizontally scaling applications or deploying high bandwidth workloads.

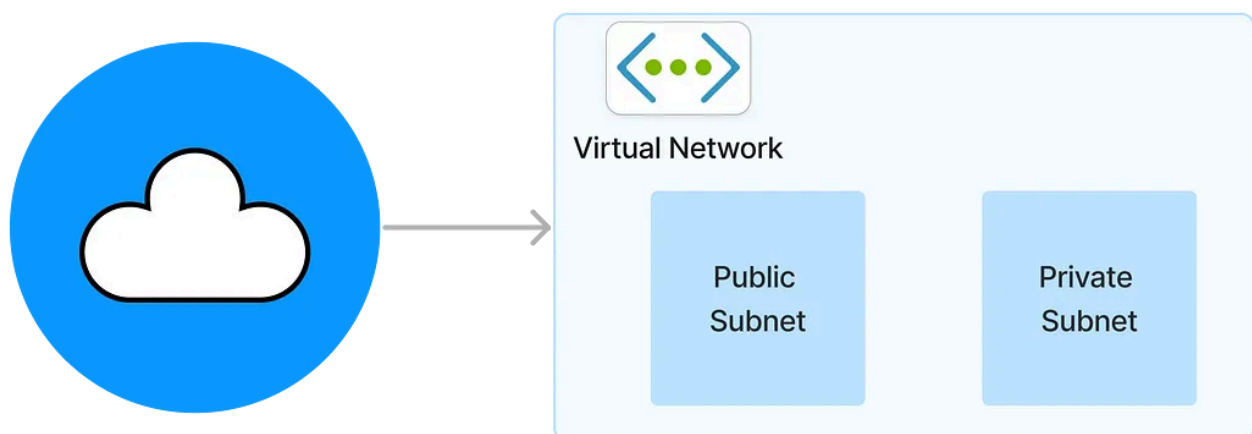
3. Azure Container Instances (ACI)

Also called Docker as a Service, ACI allows users to manage and deploy cloud applications using containers. This is of the IaaS model. Containers are billed per second. Containers can be custom sized and combined into Container Groups.

Containers have Restart Policies, which mean what they should do when their process has completed. There are 3 types of restart policies — Always (always restart), Never (one time run), On Failure (restart when there is an error).

4. Azure Virtual Networks (VNet)

A VNet is a logically isolated section of the Azure network each having its own address space, route tables, subnets and NICs. Basically, a VNet has all the component a physical network would have.



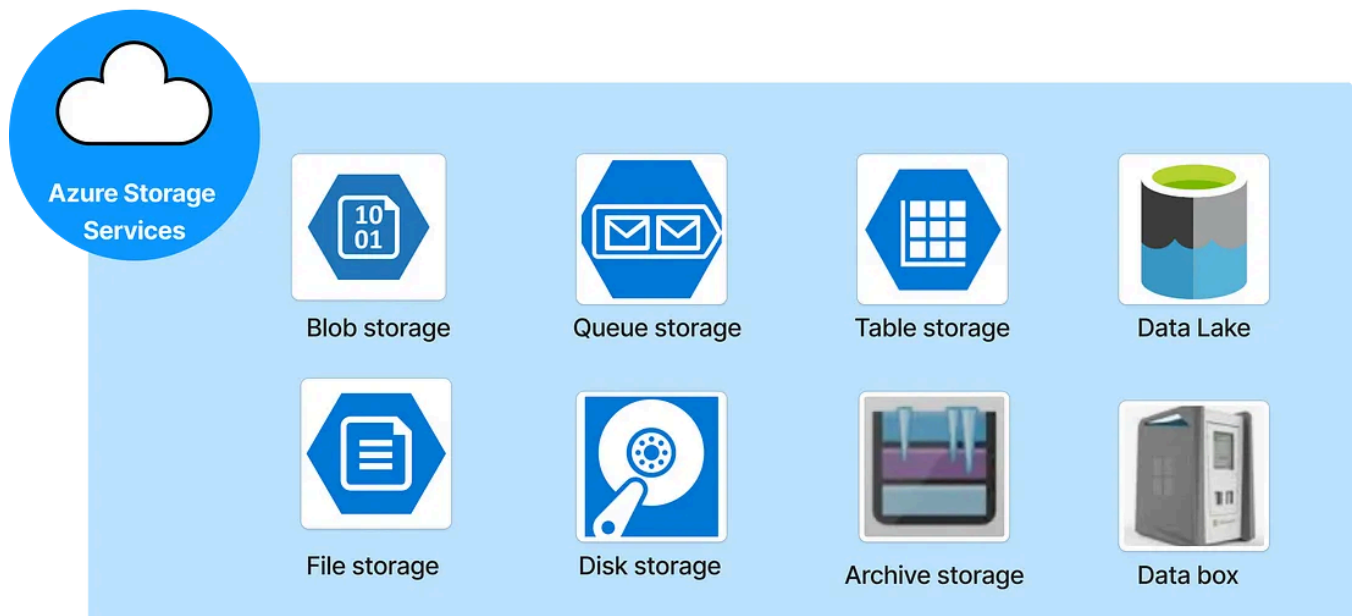
Azure Virtual Network (image by author)

Two VNets can be paired through *VNet Peering*. Users can also assign VPNs to their VNet using a *Virtual Network Gateway*.

Azure ExpressRoute is a special kind of dedicated and private connection between an organization's on-premise data center and Azure. It is a secure, high-bandwidth connection.

In case security is a concern, users can use *Azure Private Link* to connect our on-prem system or VMs to other Azure services. Using Private Link would keep all the traffic within the Azure network.

5. Azure Storage Services



Azure Storage Services (Blob, File, Queue, Disk & Table are the core storage type)

When selecting storage services, the user should keep in the mind how fast the read/write would be (fast or slow), how often would they need to access the data (hot, cool or archive), and how many redundant copies of the data should be made. Azure provided different services for all user needs and charged them based on the tier of services provided.

Storage Type	Description	Use Cases	Performance Tiers	Access Tiers	Redundancy Options
Blob Storage	Object storage for unstructured data	Storing massive amounts of unstructured data, such as text or binary data	Standard, Premium	Hot, Cool, Archive	LRS, ZRS, GRS, RA-GRS
File Storage	Fully managed file shares in the cloud or on-premise	Lift and shift applications, file shares, and distributed file systems	Standard, Premium	-	LRS, ZRS, GRS, RA-GRS
Queue Storage	Messaging store for reliable messaging between application components	Decoupling application components, building scalable and reliable messaging solutions	-	-	LRS, ZRS, GRS, RA-GRS
Table Storage	NoSQL key-value store for rapid development using massive semi-structured datasets	Storing structured, non-relational data, such as user data for web applications	-	-	LRS, ZRS, GRS, RA-GRS
Disk Storage	Persistent, durable, and high-performance disks for VMs	Virtual machine disk storage, lift and shift applications, databases, and big data	Standard HDD, Standard SSD, Premium SSD, Ultra Disk	-	LRS, ZRS

Different storage types provided by Azure Storage services

Premium	Standard
Storage in SSDs	Store on HDDs
Low latency	Varied performance based on access tier (Hot, cool, archive)
Higher throughput	Lower throughput
Use cases: Interactive workloads, AI/ML, Analytics	Use cases: Backup, disaster recovery

Azure Storage performance tiers

Hot	Cool	Archive
Frequently accessed data	Infrequently accessed data stored for at least 30 days	Rarely accessed data stored for more than 180 days
Highest storage cost and lowest access cost	Lower storage cost, higher access cost	Lowest storage cost, highest access cost

Azure access tiers

In addition to this, storage services offer *Data Redundancy*. We can choose to replicate our data to protect data loss in some unforeseen event. There are many levels of redundancy — LRS (Local), ZRS (Zonal), GRS (Geographical).

The greater the level of redundancy, the greater will be the cost.

5. Azure Database Services

Azure provides many managed database services to support different types of applications, workloads, and data models. Here are the primary Azure database services.

Service	Description
Azure SQL Database	Fully managed NoSQL database designed for scalability
Azure Cosmos DB	Fully managed relational DB based on the SQL server
Azure Database for PostgreSQL/MySQL and MariaDB	Fully managed Postgre/MySQL/MariaDB servers
Azure Synapse Analytics	Fully managed data warehouse with an analytics layer
Azure Database Migration Service	Migrates DB to the cloud without any application changes
Azure cache for Redis	Fully managed in-memory data store based on the open-source Redis project

Database service offered by Azure

6. Azure big data and analytics services

Big data is used to describe large volumes of structured/unstructured data which is difficult to move and process using traditional processes.

Azure Synapse Analytics is Azure's data warehousing and analytics service. Synapse focuses on data lake storage and on-demand querying against large databases for reporting. *Data Lake* is a highly scalable storage solution built on Azure blob storage focused towards high throughput and low latency.

Apart from these Azure offers other big data and analytics services such as Databricks (third party analytics platform based on Apache Spark), HD Insight (open source analytics software), Stream Analytics (real time stream processing), and Power BI (for visualisation).

7. AI and Machine Learning

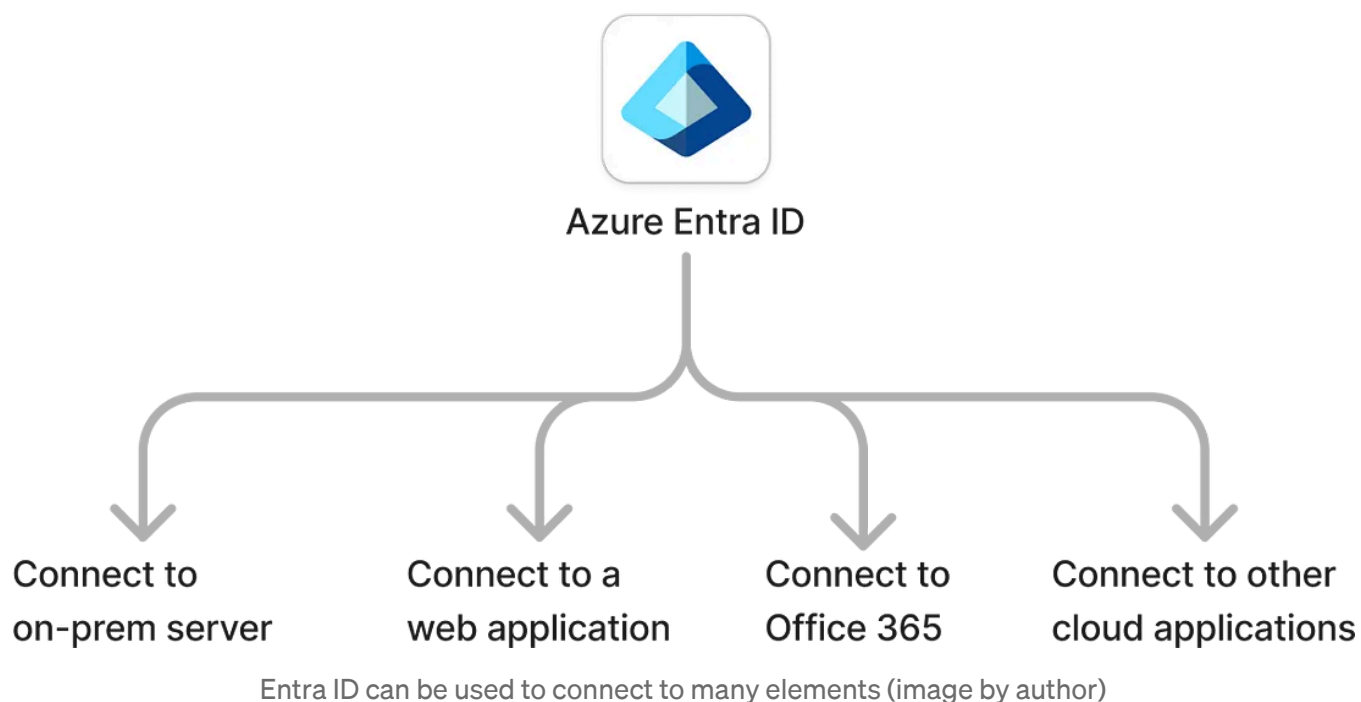
Azure also has a cloud-based service for managing machine learning models. It is used in tandem with the analytics services for model training and deployment and integration with other Azure data services. Its use cases are in areas of predictive analytics, data science, AI model development, machine learning operations (MLOps). It also allows users to create chatbots, work in computer vision, face detection, Natural Language Processing etc.

Data Management and Governance

With all these services, Microsoft has to make sure that a robust data governance system is in place.

Azure Entra ID

For that Microsoft has *Azure Entra ID*. Entra ID is an identity based access management service.



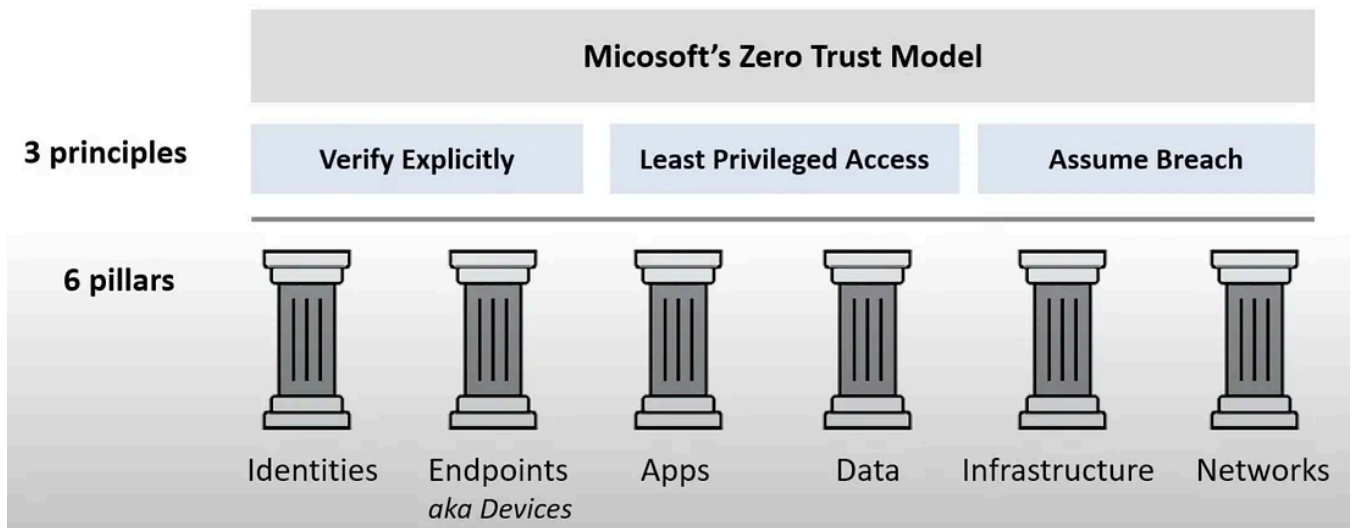
The *Single Sign On (SSO)* feature of Entra ID allows users to access multiple applications after authenticating just once. SSO supports a variety of applications from Office 365, Salesforce to ERPs like SAP.

In addition to SSO, Azure also has *Multi Factor Authentication (MFA)*. MFA is an authentication process where users need to verify their identity on a secondary device e.g. a smartphone.

If we want people outside our organisation to access our apps, then we can do that by creating *External Identities* for them. This is done whenever companies are running a B2B scenario i.e. sharing apps with external users. We can also set up *Conditional Access* policies for specific users to allow sign-ins based on some pre-defined rules and input signals (metadata associated with a user ID — location, device, application etc.).

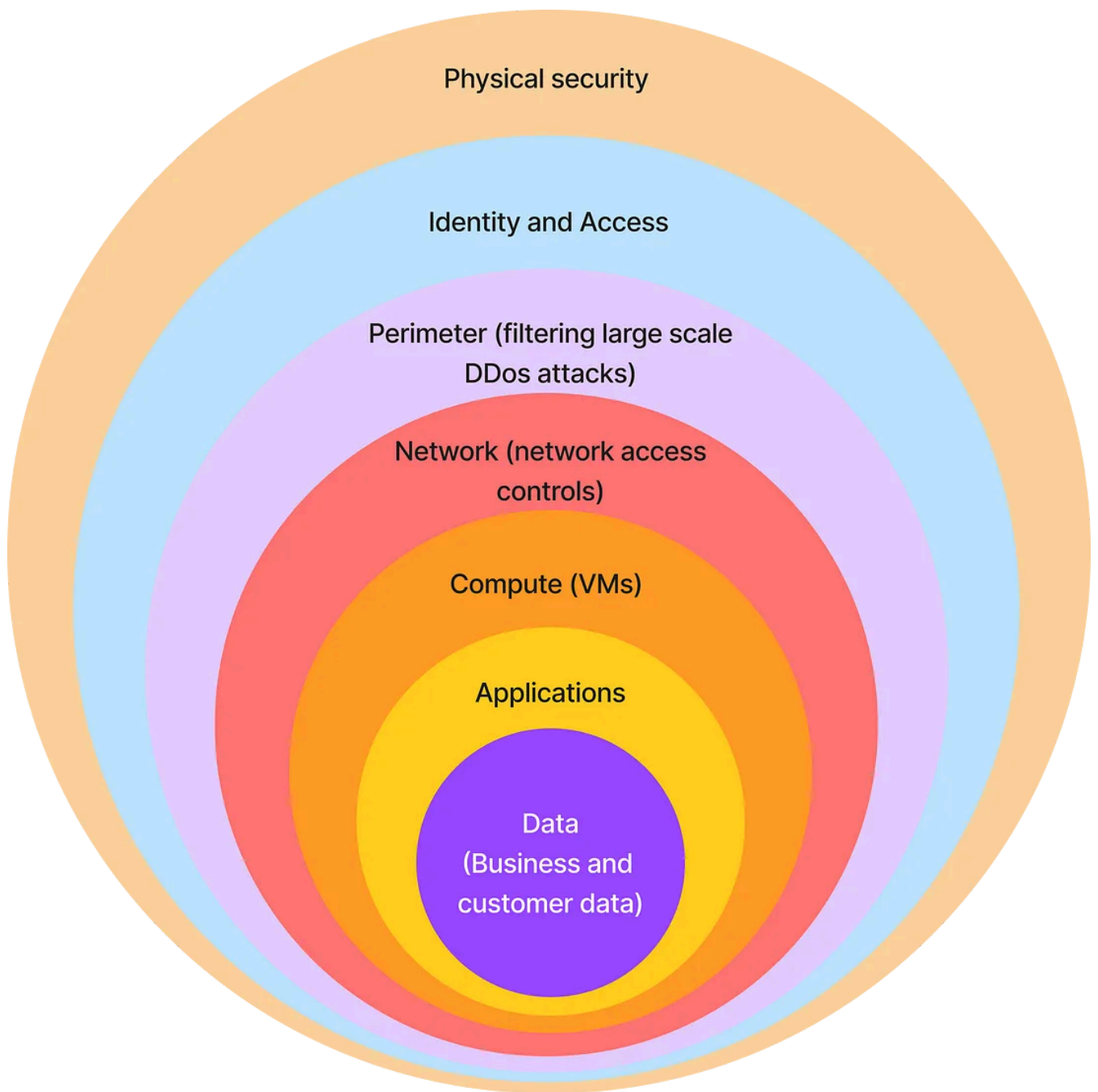
Security systems

Azure security architecture is based on a 'Zero Trust Model'. This model states — 'Trust no one, verify everything'.



Zero Trust Model principle and pillars (information from FreeCodeCamp)

Azure has a multi-layered security system. I'll try to illustrate them in the below diagram.



Defence in Depth model of Microsoft Azure (layers of security provided by Azure)

Category	Element	Description
Identity and access management	Azure Active Directory (AD)	Identity management service providing SSO, MFA and conditional access
	Azure Role Based Access Control (RBAC)	Allows assigning roles to user groups and applications based on their role
	Multi Factor Authentication (MFA)	Using a secondary device to authenticate sign-ins
Network security	Network Security Group (NSG)	Controls inbound and outbound traffic to various Azure resources
	Firewall	Protects Azure VNet resources
	DDoS protection	Protects from DDoS attacks
Data security	Key vault	Used to safeguard keys used for cloud apps and services
Threat protection	Defender	Provides advanced protection for Azure and on-prem workloads. It can be configured to show alerts and trigger responses.
	Azure Security Center	Unified security management system that provides advanced threat protection across cloud workloads. It offers continuous assessment, security recommendations, and threat detection.
Security Management	Azure Monitor	Comprehensive solution for collecting, analyzing, and acting on telemetry from cloud and on-premises environments.
	Azure Sentinel	Cloud-native Security Information and Event Management (SIEM) system that helps analyze large volumes of data for rapid threat detection and response.
Application security	Azure Application Gateway	Web application firewall (WAF) that protects web applications from common threats and vulnerabilities
Governance and Compliance	Azure Management Groups	Organize and manage access, policies, and compliance for multiple Azure subscriptions
	Azure Blueprints	Enable you to define a repeatable set of Azure resources that implement and adhere to an organization's standards, patterns, and requirements.
	Azure Policy	Service that helps you manage and enforce compliance at scale by creating, assigning, and managing policies.

Elements of Azure Security and Governance (image by author)

Billing and pricing

Azure offers several types of pricing models — free tier, pay-as-you-go, enterprise agreements, and CSP subscriptions.

Users can also buy Reserved Instances (where users commit to use a resource for a defined period) to avail a discounted price.

Pricing depends on multiple factors

- **Resource Type:** Different Azure services have different pricing structures. For example, Virtual Machines are billed based on compute, storage, and networking, while Azure Blob Storage is billed based on the amount of data stored, access frequency, and data transfer.
- **Resource Usage:** The amount of resources you consume, such as compute hours, storage space, and data transfer, directly affects your bill.
- **Region:** Prices can vary by geographic region due to differences in infrastructure costs and demand.
- **Performance Tiers:** Many services offer different performance tiers (e.g., Standard vs. Premium) with varying costs based on performance and features.
- **Service Level Agreements (SLAs):** Higher SLAs may come with increased costs due to the higher availability and reliability guarantees.

Azure offers built-in tools to track spend. *Azure Cost Management and Billing* is a suite of tools to monitor, allocate, and optimise your Azure spend. It includes features for setting budgets, viewing cost analysis, forecasting spend and setting up alerts.

It is important for an Azure admin to understand how they can minimise the operating costs. This can be done through the following ways.

1. **Right-Sizing:** Ensure that you are using appropriately sized resources for your workloads. Avoid over-provisioning.
2. **Scaling:** Use auto-scaling to dynamically adjust resources based on demand, minimising costs during low-usage periods.
3. **Reserved Instances:** Purchase reserved instances for predictable workloads to benefit from cost savings.
4. **Spot Instances:** Utilise spot instances for flexible, non-critical workloads to take advantage of reduced pricing.
5. **Resource Cleanup:** Regularly review and delete unused or underutilized resources.
6. **Azure Hybrid Benefit:** Leverage existing on-premises licenses for Windows Server and SQL Server to save on Azure costs.
7. **Tracking and monitoring:** use tags to identify which resources or resource groups are using up the most capacity.

Conclusion

Thank you for giving your time to this article. I hope it was useful to you. There is a lot more to Azure than the topics covered in this article. The AZ-900 exam is a good way to get introduced to the fundamental concepts of Azure.

I have uploaded a set of flashcards in notion to help anyone who is preparing for the AZ-900 exam. You can find it on my Gumroad page (<https://arunabhcreative.gumroad.com/1/AZ900Flashcards>).

Azure

Cloud Computing