AZ-900

Cloud Computing

Service delivery model over the internet (cloud). This includes but is not limited to

- **compute power** meaning servers such as windows, linux, hosting environments, etc.
- **storage** like files and/or databases
- **networking** in azure but also outside when connecting to your company network
- **analytics** services for visualization and telemetry data

Key concepts

- **scalability** is the ability to scale, so allocate and deallocate resources at any time
- **elasticity** is the ability to scale dynamically
- **agility** is the ability to react fast (scale quickly)
- **fault tolerance** is the ability to maintain system uptime while physical and service component failures happen Site Recovery - provides fault tolerance
- **disaster recovery** is the process and design principle which allows a system to recovers from natural or human induced disasters
- **high availability** is the agreed level of operational uptime for the system. It is a simple calculation of system uptime versus whole lifetime of the system.
- **availability** = uptime/(uptime + downtime)

Economies of Scale

The principle of economies of scale states that as the companies grow they become more effective at managing shared operations. Be that HR and hiring, taxes, accounting, internal operations, marketing, big purchases via contracts meaning better discounts, etc. etc.

Because of those, companies can save/earn more which in return allows for reduction in cost of their services to their customers. This is so called ‘price per unit’.

It’s not possible to go to 0 because in the end some underlying infrastructure needs to run to provide the services. But the larger the scale the more benefits can be passed to customers.

In fact, in the current scale, Microsoft can already offer multiple services for free due to how small a fraction of the cost it is for them

CapEx vs OpEx

> https://docs.microsoft.com/en-us/learn/modules/fundamental-azure-concepts/ Differences between Capital Expenditure and Operational Expenditure

	Capital Expenditure	Operational Expenditure
	Own infra	rent infra
	Big initial investment	No initial investment
	Low maitananes cost	cost based on usage. Minimal maitananes
	Server capaciti usage grows, wasted - loss	
	support, power and networking, Hardware	Operational teams
Up front cost	Significant	None
Ongoing cost	Low	Based on usage
Tax Deduction	Over time	Same year
Early Termination	No	Anytime
Maintenance	Significant	Low
Value over time	Lowers	No change

What is a consumption-based model?

The consumption-based model is a **pricing model** used in the cloud so that customers are only charged **based on their resource usage**.

This model is characterized by

- **No associated upfront cost**
- **No wasted resources** as such no *charges are incurred for unused resources**. Unused in this case is different per service. For instance, blob storage that stores any data is considered to be used, as it consumes the storage space. Virtual Machines that are running consume CPU, memory and other resources even if there isn't any traffic. Hence they are considered to be used and will incur charges.
- **Pay for what you need**
- **Stop paying when you don't**

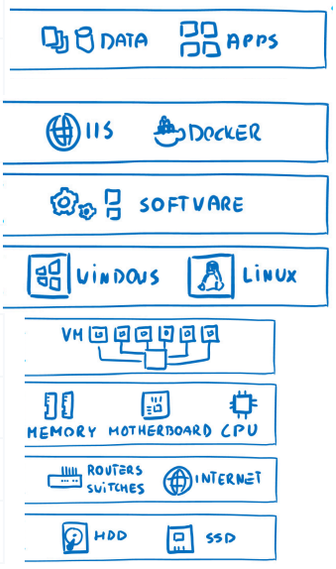
Consumption is the virtual metric used to calculate how much each resource (service) in Azure was used. Each service has many smaller metrics that track its consumption to offer best possible pricing model. Those metrics are tracked on very granular level.

Service Models responsibilities

As a service means which party will manage the particular layer and all the layers below.

- **Software layer** consists the application (application code and set) & the application data
- **Platform layer** means all the supporting software and the operating system required to host the application
- **Infrastructure layer** consists hardware the infrastructure and virtualization required to host the platform
- **On-Premis** - yoy manage all the layers

Layer	Layer
Application	Software
Data	Software
Runtime	Platform
Middleware	Platform
Operating System	Platform
Virtualization	Infrastructure
Servers	Infrastructure
Networking	Infrastructure
Storage	Infrastructure



Responsibility Matrix

As such following table represents responsibilities

Layer	On-Premises	IaaS	PaaS	SaaS
Application	You	You	You	Cloud provider
Data	You	You	You	Cloud provider
Runtime	You	You	Cloud provider	Cloud provider
Middleware	You	You	Cloud provider	Cloud provider
Operating	System	You	You	Cloud provider|Cloud provider
Virtualization	You	Cloud provider	Cloud provider	Cloud provider
Servers	You	Cloud provider	Cloud provider	Cloud provider
Networking	You	Cloud provider	Cloud provider	Cloud provider
Storage	You	Cloud provider	Cloud provider	Cloud provider

Cloud Deployment Model

Cloud Deployment Model is simple a separation which describes where are the company resources deployed. Whenever this is in public cloud provider environment or private datacenter.

Below table presents high level deployment model separation

Layer	Cloud Provider	Own Datacenter
Public	+	✖
Hybrid	+	+
Private	✖	+

Public Cloud

Cloud Provider	Own Datacenter
+	✖

Key Characteristics

- Everything runs on cloud provider hardware
- No local hardware
- Some services share hardware with other customers

Advantages

- No CapEx (No initial investment)
- High Availability
- Agility
- Pay as you Go (PAYG) pricing
- No hardware maintenance
- No deep technical skills required

Disadvantages

- Not all security and compliance policies can be met
- No ownership over the physical infrastructure
- Rare specific scenarios can't be done

Private Cloud

Cloud Provider	Own Datacenter
✖	+

Key Characteristics

- Everything runs on your own datacenter
- Self-service should be provided
- You maintain the hardware

Advantages

- Can support any scenario
- Total control over security and infrastructure
- Can meet any security and compliance policy

Disadvantages

- Initial investment is required (CapEx)
- Limited agility constrained by server capacity and team skills
- Very dependent on IT skills & expertise

Hybrid Cloud

Cloud Provider	Own Datacenter

Answer Area

An Azure web app that queries an on-premises Microsoft SQL server is an example of a [ ] cloud.

hybrid
multi-vendor
private
public

Cloud Provider	Own Datacenter
+	+

Key Characteristics

- Combines both Public & Private cloud

Advantages

- Great flexibility
- You can run any legacy apps in private cloud
- Can utilize existing infrastructure
- Meet any security& compliance requirements
- Can take advantage of all public cloud benefits

Disadvantages

- Can be more expensive
- Complicated to manage due to larger landscape
- Most dependent on IT skills & expertise from all three models

Data Center

- **Physical facility**
- **Hosting for** group of networked **servers**
- Own **power**, **cooling** & **networking** infrastructure

Region

- **Geographical area** on the planet
- **One but usually more datacenters** connected with **low-latency network** (<2 milliseconds)
- **Location** for your services
- Some services are **available only in certain regions**
- Some services are **global services**, as such are not assigned/deployed in specific region
- Globally available with **50+ regions**
- Special **government regions** (US DoD Central, US Gov Virginia, etc.)
- Special **partnered regions** (China East, China North)

Choose closes region - speed test to you current location Check products avaliable per region

Availability Zone

- **Regional feature**
- **Not all** regions are **supported**
- **Supported** region has **three or more zones**
- A **zone** is **one or more data centers**
- Grouping of **physically separate** facilities
- Designed to **protect from data center failures**
- If zone goes down **others continue working**
- Two service **categories**
    - **Zonal** services (Virtual Machines, Disks, etc.)
    - **Zone-redundant** services (SQL, Storage, etc.)

Region Pair

- **Each region** is **paired** with another region making it a region pair
- Region **pairs are static** and cannot be chosen
- Each pair resides within the **same geography***
    - Exception is Brazil South
- **Physical isolation** with at least 300 miles distance (when possible)
- Some services have **platform-provided replication**
- **Planned updates** across the pairs
- **Data residency** maintained for disaster recovery

Region Pair A	Region Pair B
East US	West US
UK West	UK South
North Europe (Ireland)	West Europe (Netherlands)

Region Pair A	Region Pair B
East Asia (Hong Kong)	Southeast Asia (Singapore)

Geographies

- **Discrete market**
- Typically contains **two or more regions**
- Ensures **data residency**, **sovereignty**, **resiliency**, and **compliance** requirements are met
- **Fault tolerant** to protect from region wide failures
- Broken up into areas
    - Americas,
    - Europe,
    - Asia Pacific,
    - Middle East and Africa
- Each **region belongs only to one Geography**

Azure Resource

- Object **used to manage services** in Azure
- Represents **service lifecycle**
- Saved as **JSON definition**

Resource Groups

- **Grouping** of resources
- Holds **logically related** resources
- Typically organizing by
    - **Type**
    - **Lifecycle** (app, environment)
    - **Department**
    - **Billing**,
    - **Location** or
    - **combination** of those

Resource Manager

- **Management Layer** for all resources and resource groups
- **Unified** language
- **Controls access** and **resources**

Additional Info

- Each **resource must** be in one, and **only one resource group**
- Resource **groups have their own location** assigned
- Resources in the resource groups **can reside in a different locations**
- Resources **can be moved** between the resource groups
- Resource **groups can't be nested**
- Organize based on your organization needs but consider
    - Billing
    - Security and access management
    - Application Lifecycle

Virtualization

- Emulation of physical machines
- Different virtual hardware configuration per machine/app
- Different operating systems per machine/app
- Total separation of environments
    - file systems,
    - services,
    - ports,
    - middleware,
    - configuration

Virtual Machines

- Infrastructure as a Service (IaaS)
- Total control over the operating system and the software
- Supports marketplace and custom images

- Best suited for
    - Custom software requiring custom system configuration
    - Lift-and-shift scenarios
- Can run any application/scenario
    - web apps & web services,
    - databases,
    - desktop applications,
    - jumpboxes,
    - gateways, etc.

Virtual Machine Scale Sets

- Infrastructure as a Service (IaaS)
- Set of identical virtual machines
- Built-in auto scaling features
- Designed for manual and auto-scaled workloads like web services,* batch processing, etc.

Containers

- Use host's operating system
- Emulate operating system (VMs emulate hardware)
- Lightweight (no O/S)
    - Development Effort
    - Maintenance
    - Compute & storage requirements
- Respond quicker to demand changes
- Designed for almost any scenario

Azure Container Instances

- Simplest and fastest way to run a container in Azure
- Platform as a Service
- Serverless Containers
- Designed for
    - Small and simple web apps/services
    - Background jobs
    - Scheduled scripts

Azure Kubernetes Service (AKS)

- Open-source container orchestration platform
- Platform as a Service
- Highly scalable and customizable
- Designed for high scale container deployments (anything really!)

App Service

- Designed as enterprise grade web application service
- Platform as a Service
- Supports multiple programming languages and containers

Azure Functions (Function Apps)

- Platform as a Service
- Serverless
- Two hosting/pricing models
- Consumption-based plan
- Dedicated plan
- Designed for micro/nano-services

PowerApps lets you quickly build business applications with little or no code. It is not used to create Azure virtual machines.
PowerApps Portals allow organizations to create websites which can be shared with users external to their organization either anonymously or through the login provider of their choice like LinkedIn, Microsoft Account, other commercial login providers.

Summary

- Virtual Machines (IaaS) - Custom software, custom requirements, very specialized, high degree of control
- VM Scale Sets (IaaS) - Auto-scaled workloads for VMs
- Container Instances (PaaS) - Simple container hosting, easy to start
- Kubernetes Service (PaaS) - Highly scalable and customizable * container hosting platform
- App Services (PaaS) - Web applications, a lot of enterprise web * hosting features, easy to start
- Functions (PaaS) (Function as a Service) (Serverless) - micro/nano-services, excellent consumption-based pricing, easy to start

Azure Networking

- Connect cloud and on-premises
- On-premise networking functionality

Azure Traffic Manager is a DNS-based load balancing solution. It is not used to ensure that a virtual machine named VM1 is accessible from the Internet over

Azure Virtual Network

- Logically isolated networking components
- Segmented into one or more subnets
- Subnets are discrete sections
- Enable communication of resources with each-other, internet and on-premises
- Scoped to a single region
- VNet peering allow cross region communication
- Isolation, Segmentation, Communication, Filtering, Routing

Azure Load Balancer

- Even traffic distribution
- Supports both inbound and outbound scenarios
- High-availability scenarios
- Both TCP (transmission control protocol) and UDP (user datagram protocol) applications
- Internal and External traffic
- Port Forwarding
- High scale with up to millions of flows

VPN Gateway

- Specific type of virtual network gateway for **on-premises to azure** traffic over the public internet

A **Local Network Gateway**

- object in Azure that represents your on-premise VPN device.
- VPN object at the Azure end of the VPN.
- typically refers to your on-premises location. You give the site a name by which Azure can refer to it, then specify the IP address of the on-premises VPN device to which you will create a connection. You also specify the IP address prefixes that will be routed through the VPN gateway to the VPN device. The address prefixes you specify are the prefixes located on your on-premises network. If your on-premises network changes or you need to change the public IP address for the VPN device, you can easily update the values later.

You need to configure a **VPN** to connect the **on-premises** network to the Azure virtual network.

The Azure VPN = Virtual Network Gateway. The virtual network gateway needs to be located in a dedicated subnet in the Azure virtual network. This dedicated subnet is known as a gateway subnet and must be named GatewaySubnet
Note: a *virtual network is also required. However, as we already have virtual machines deployed in a Azure, we can assume that the virtual network is already in place.*

Application Gateway

- Web traffic load balancer
- Web application firewall
- Redirection
- Session affinity
- URL Routing
- SSL termination

Content Delivery Network

- Define content
- Minimize latency
- POP (points of presence) with many locations

Data Types

- **Structured** - Data that can be represented using tables with very strict schema. Each row must follow defined schema. Some tables have defined relationships between them. Typically used in relational databases.
- **Semi-structured** - Data that can be represented using tables but without strict defined schema. Rows must only have unique key identifier.
- **Unstructured** - Any files in any format. Like binary files, application files, images, movies, etc.

Storage Account

- Group of services which include
  - blob storage,
  - queue storage,
  - table storage, and
  - file storage
- Used to store
  - files,
  - messages, and
  - semi-structured data
- Highly scalable (up to petabytes of data)
- Highly durable (99.999999999% - 11 nines, up to 16 nines)
- Cheapest per GB storage

Azure containers are the backbone of the virtual disks platform for Azure IaaS. Both Azure OS and data disks are implemented as virtual disks where data is durably persisted in the Azure Storage platform and then delivered to the virtual machines for maximum performance. Azure Disks are persisted in Hyper-V VHD format and stored as a page blob in Azure Storage.

Blob Storage

- BLOB – binary large object – file
- Designed for storage of files of any kind
- Three storage tiers
  - Hot – frequently accessed data
  - Cool – infrequently accessed data (lower availability, high durability)
  - Archive – rarely (if-ever) accessed data

Queue Storage

- Storage for small pieces of data (messages)

- Designed for scalable asynchronous processing

Table Storage

- Storage for semi-structured data (NoSQL)
  - No need for foreign joins, foreign keys, relationships or strict schema
  - Designed for fast access
- Many programming interfaces and SDKs

File Storage

- Storage for files accessed via shared drive protocols
- Designed to extend on-premise file shares or implement lift-and-shift scenarios

Disk Storage

- Disk emulation in the cloud
- Persistent storage for Virtual Machines
- Different
  - sizes,
  - types (SSD, HDD)
  - performance tiers
- Disk can be unmanaged or managed

All disks are encrypted by default using Microsoft-managed keys unless the customer chooses to disable that.

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Cosmos DB

- Globally distributed NoSQL (semi-structured data) Database service
- Schema-less
- Multiple APIs (SQL, MongoDB, Cassandra, Gremlin, Table Storage)
- Designed for
  - Highly responsive (real time) applications with super low latency responses <10ms
  - Multi-regional applications

SQL Database

- **Relational database** service in the cloud (PaaS) (DBaaS - Database as a Service)
- **Structured data** service defined using schema and relationships
- **Rich Query Capabilities** (SQL)
- **High-performance**, reliable, fully managed and secure database for building - applications

Azure SQL product family

- Azure **SQL Database** – Reliable relational database based on SQL Server
- Azure **Database for MySQL** – Azure SQL version for MySQL database engine
- Azure **Database for PostgreSQL** – Azure SQL version for PostgreSQL database engine
- Azure **SQL Managed Instance** – Fully fledged SQL Server managed by cloud provider
- Azure **SQL on VM** – Fully fledged SQL Server on IaaS
- Azure **SQL DW (Synapse)** – Massively Parallel Processing (MPP) version of SQL Server

Azure Marketplace

- Think of it like an “Azure Shop” where you purchase services and solutions for the Azure platform
- Each product is a template which contains one or multiple services
- Products are delivered by first and third-party vendors
- Solutions can leverage all service categories like IaaS, PaaS and SaaS

What is Internet of Things?

Internet of Things (IoT) is a network of internet connected devices (IoT Devices) embedded in everyday objects enabling sending and receiving data such as settings and telemetry.

Azure Iot Hub

- Managed service for bi-directional communication
- Platform as a Service (PaaS)
- Highly secure, scalable and reliable
- Integrates with a lot of Azure Services
- Programmable SDKs for popular languages (C, C#, Java, Python, Node.js)
- Multiple protocols (HTTPS, AMQP, MQTT)

Azure IoT Central

- IoT App Platform - Software as a Service (SaaS)
- Industry specific app templates
- No deep technical knowledge required
- Service for connecting, management and monitoring IoT devices
- Highly secure, scalable and reliable
- Built on top of the IoT Hub service and 30+ other services

Azure Sphere

- Secure end-2-end IoT Solutions
    - Azure Sphere certified chips (microcontroller units - MCUs)
    - Azure Sphere OS based on Linux
    - Azure Security Service trusted device-to-cloud communication

Azure Sphere — delivers components for building secure end-2-end IoT solutions with microcontroller standardization, secure operating system based on linux and a security secure for secure device to cloud communication and updates.

What is Big Data?

Big Data is a field of technology that helps with the **extraction**, **processing** and **analysis** of information that is **too large or complex** to be dealt with by traditional software.

The three V's rule

Big data typically has one of the following characteristics

- **Velocity** - how fast the data is coming in or how fast we are processing it
    - Batch
    - Periodic
    - Near Real Time
    - Real Time
- **Volume** - how much data we are processing
    - Megabytes
    - Gigabyte
    - Terabytes
    - Petabytes
- **Variety** - how structured/complex the data is
    - Tables
    - Databases
    - Photo, Audio
    - Video, Social Media

Azure Synapse Analytics

- Big data analytics platform (PaaS)
- Multiple components
    - Spark
    - Synapse SQL
        - SQL pools (dedicated – pay for provisioned performance)
        - SQL on-demand (ad-hoc – pay for TB processed)
    - Synapse Pipelines (Data Factory – ETL)
    - Studio (unified experience)

Azure HDInsight

- Flexible multi-purpose big data platform (PaaS)
- Multiple technologies supported (Hadoop, Spark, Kafka, HBase, Hive, Storm, Machine Learning)

Azure Databricks

- Big data collaboration platform (PaaS)
- Unified workspace for notebook, cluster, data, access management and collaboration
- Based on Apache Spark
- Integrates very well with common Azure data services

What is Artificial Intelligence?

Artificial Intelligence (AI) is the simulation of human intelligence & capabilities by computer software.

What is Machine Learning?

Azure Machine Learning is a powerful PaaS offering that allows customers to build their entire machine learning solutions in a single place.

Machine Learning is a subcategory of AI where a computer software is **"taught"** to **draw conclusions** and **make predictions** from data.

Azure Machine Learning

- Cloud-based platform for creating, managing and publishing machine learning models
- Platform as a Service (PaaS)
- Machine Learning Workspace – top level resource
- Machine Learning Studio – web portal for end-2-end development
- Features
  - Notebooks – using Python and R
  - Automated ML – run multiple algorithms/parameters combinations, choose the best model
  - Designer – graphical interface for no-code development
  - Data & Compute – management of storage and compute resources
  - Pipelines – orchestrate model training, deployment and management tasks

Machine Learning Workspace is a name for a top-level resource in Azure. It consolidates all the features of Azure Machine learning from a management perspective.

Azure Machine Learning Studio allows customers to manage a Machine Learning Workspace using a single and concise web portal interface.

Designer is a simple and powerful user interface that allows users to build their pipelines and train models with a drag-and-drop experience.

What is Serverless?

Serverless computing is cloud-hosted execution environment that allows customers to **run their applications** in the cloud while **completely abstracting underlying infrastructure**.

Azure Functions

- Serverless coding platform (Functions as a Service, FaaS)
- Designed for nano-service architectures and event-based applications
- Scales up and down very quickly
- Highly scalable
- Supports popular languages and frameworks (.NET & .NET Core, Java, Node.js, Python, PowerShell, etc.)

Azure Logic Apps

- Serverless enterprise integration service (PaaS)
- 200+ connectors for popular services
- Designed for orchestration of
  - business processes,
  - integration workflows for applications, data, systems and services
- No-code solution

logic apps:

- Process and route orders across on-premises systems and cloud services.
- Send email notifications with Office 365 when events happen in various systems, apps, and services.
- Move uploaded files from an SFTP or FTP server to Azure Storage.
- Monitor tweets for a specific subject, analyze the sentiment, and create alerts or tasks for items that need review.

Azure Event Grid

- Fully managed serverless event routing service
- Uses publish-subscribe model
- Designed for event-based and near-real time applications
- Supports dozen of built-in events from most common Azure services

What is DevOps?

DevOps is a set of practices that combine both development (Dev) and operations (Ops).

DevOps aims to **shorten the development life cycle** by providing **continuous integration** and **delivery** (CI/CD) capabilities while ensuring high quality of deliverables.

Azure DevOps

- **Collection of services** for building solutions using DevOps practices
- Services included
  - **Boards** – tracking work
  - **Pipelines** – building CI/CD workflows (build, test and deploy apps)
  - **Repos** – code collaboration and versioning with Git
  - **Test Plans** – manual and exploratory testing
  - **Artifacts** – manage project deliverables
- Extensible with **Marketplace** – over 1000 of available apps
- Evolved from **TFS** (Team Foundation Server), through **VSTS** (Visual Studio Team Services)

Azure DevTest Labs

- Service for creation of **sandbox environments** for developers/testers (PaaS)
- Quick setup of **self-managed virtual machines**
- **Preconfigured templates** for VMs
- Plenty of additional **artifacts** (tools, apps, custom actions)
- Lab **policies** (quotas, sizes, auto-shutdowns)
- **Share** and **automate** labs via custom images

- Premade plugins/API/tools for **CI/CD pipeline automation**

Azure Portal

- Public web-based interface for management of Azure platform
- Designed for self-service
- Customizable
- Simple tasks

Azure PowerShell

- PowerShell and module
- Designed for automation
- Multi-platform with PowerShell Core
- Simple to use
  - Connect-AzAccount – log into Azure
  - Get-AzResourceGroup – list resource groups
  - New-AzResourceGroup – create new resource group
  - New-AzVm – create virtual machine

A PowerShell script needs to be run in PowerShell.

Azure CLI

- Command Line Interface for Azure
- Designed for automation
- Multi-platform (Python)
- Simple to use
  - az login – log into Azure
  - az group list – list resource groups
  - az group create – create new resource group
  - az vm create – create virtual machine
- Native OS terminal scripting

Azure Cloud Shell

- Cloud-based scripting environment
- Completely free
- Supports both Azure PowerShell and Azure CLI
- Dozen of additional tools
- Multiple client interfaces
  - Azure Portal integration (portal.azure.com)
  - Shell Portal (shell.azure.com)
  - Visual Studio Code Extension
  - Windows Terminal
  - Azure Mobile App
  - Microsoft Docs integration

Azure Monitor:
Maximizes the availability and performance proactively notify you of critical condition.
Uses Target Resources

Azure Advisor

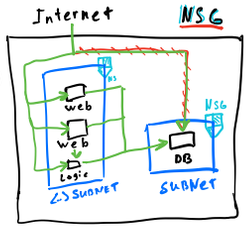
- **Personalized consultant service**
- Designed to provide **recommendations** and **best practices** for
  - **Cost** (SKU sizes, idle services, reserved instances, etc.)
  - **Security** (MFA settings, vulnerability settings, agent installations, etc.)
  - **Reliability** (redundancy settings, soft delete on blobs, etc.)
  - **Performance** (SKU sizes, SDK versions, IO throttling, etc.)
  - **Operational Excellence** (service health, subscription limits, etc.)
- **Actionable** recommendations
- **Free!**

Azure Service Health - personalized view of the azure services and regions you're using

Azure Advisor - personalized cloud consultant that helps with best practices to optimize deployment, improve performance, security, cost, operational excellence etc

Network Security Groups

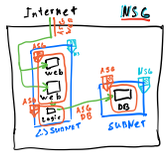
- Designed to **filter traffic** to (inbound) and from (outbound) Azure resources located in - Azure Virtual Network
- Filtering controlled by **rules**
- Ability to have **multiple** inbound and outbound **rules**
- Rules are created by specifying
  - **Source/Destination** (IP addresses, service tags, application security groups)
  - **Protocol** (TCP, UDP, any)
  - **Port** (or Port Ranges, ex. 3389 – RDP, 22 – SSH, 80 HTTP, 443 HTTPS)
  - **Direction** (inbound or outbound)
  - **Priority** (order of evaluation)



You can associate zero, or one, network security group to each virtual network subnet and network interface in a virtual machine. The same network security group can be associated to as many subnets and network interfaces as you choose.

Application Security Groups

- Feature that allows **grouping of virtual machines** located in Azure virtual network
- Designed to **reduce** the **maintenance effort** (assign ASG instead of the explicit IP address)



Routing

Process of finding/selecting a path for traffic in one or across multiple networks.

User-defined Routes

Route table

- Custom (user-defined, static) routes (UDRs)
- Designed to override Azure's default routing or add new routes
- Managed via Azure Route Table resource
- Associated with a zero or more Virtual Network subnets

Firewall

Firewall is a network security service that monitors and controls incoming and outgoing traffic.

Service firewall
You can restrict traffic to multiple virtual networks with a single Azure firewall.

Azure Firewall

By default AZ Firewall block all traffic (deny rule)

- Managed, cloud-based **firewall service** (PaaS, Firewall as a Service)
- Built-in **high availability**
- Highly **Scalable**
- **Inbound** & **outbound** traffic filtering rules
- Support for **FQDN** (Fully Qualified Domain Name), ex. microsoft.com
- Fully integrated with Azure monitor for logging and analytics

The **just-in-time (JIT) virtual machine (VM)** access feature in **Azure Security Center** allows you to **lock down inbound traffic** to your Azure Virtual Machines. This reduces exposure to attacks while providing easy access when you need to connect to a VM.

DoS - Denial of Service

Cyber-attack with intent to cause temporary or indefinite disruption of service

DDoS - Distributed Denial of Service

DoS attack that is originating from multiple servers

According to pricing page for DDoS protection service If the resource is protected with DDoS Protection Standard, any scale out costs during a DDoS attack are covered and customer will get the cost credit back for those scaled out resources

Azure DDoS Protection

- **DDoS protection service** in Azure
- Designed to
  - **Detect malicious traffic** and block it while allowing legitimate users to connect
  - **Prevent additional costs** for auto-scaling environments
- Two tiers
  - **Basic** – automatically enabled for Azure platform All Azure services are already protected by the Basic DDoS Protection
  - **Standard** – additional mitigation & monitoring capabilities for Azure Virtual Network resources
- Standard tier uses machine learning to **analyze traffic patterns** for better accuracy

Identity

- A user with a username and password.
- Also applications or other servers with secret keys or certificates.
- The fact of being something or someone. Server

Azure Advanced Threat Protection (ATP) - is a cloud-based security solution that leverages your on-premises Active Directory signals to identify, detect, and investigate advanced threats, compromised identities, and malicious insider actions directed at your organization.
Sensors are software packages you install on your servers to upload information to Azure ATP. Box 2: To enforce MFA based on a condition, you would use Azure Active Directory Identity Protection. Azure AD Identity Protection helps you manage the roll-out of Azure Multi-Factor Authentication (MFA) registration by configuring a Conditional Access policy to require MFA registration no matter what modern authentication app you are signing in to.

Authentication

The process of **verification/assertion of identity**

Authorization

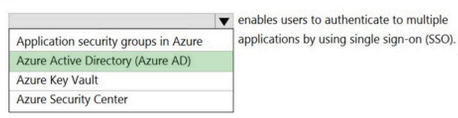
The process of **ensuring** that only **authenticated identities** get **access to the resources** for which they have been granted access.

Access Management

The process of **controlling**, **verifying**, **tracking** and **managing** access to authorized users and applications.

Azure Active Directory

Answer Area



- Identity and Access Management service in Azure
- Identities management – users, groups, applications
- Access management – subscriptions, resource groups, roles, role assignments, authentication & authorization settings, etc.

- Used by multiple Microsoft cloud platforms
  - Azure
  - Microsoft 365
  - Office 365
  - Live.com services (Skype, OneDrive, etc.)

Microsoft Sentinel is a scalable, cloud-native, security information event management (SIEM) and security orchestration automated response (SOAR) solution.
delivers intelligent security analytics and threat intelligence across the enterprise, providing a single solution for alert detection, threat visibility, proactive hunting, and threat response.

Multi-factor Authentication (MFA)

- Process of authentication using more than one factor (evidence) to prove identity
- Factor types
  - Knowledge Factor – "Something you know", ex. password, pin
  - Possession Factor – "Something you have", ex. phone, token, card, key
  - Physical Characteristic Factor – "Something you are", ex. fingerprint, voice, face, eye iris
  - Location Factor – "Somewhere you are", ex. GPS location
- Supported by Azure AD by default (simple on-off switch)

Identity

Azure AD Identity Protection includes two risk policies:
- sign-in risk policy - represents the probability that a given authentication request isn't authorized by the identity owner.
- user risk policy.

- **Centralized/unified** infrastructure and platform **security management service**
- **Natively embedded** in Azure services
- **Integrated** with **Azure Advisor** Two tiers
- **Free** (Azure Defender OFF) – included in all Azure services, provides continuous assessments, security score, and actionable security recommendations
- **Paid** (Azure Defender ON) – hybrid security, threat protection alerts, vulnerability scanning, just in time (JIT) VM access, etc.

Azure Key Vault

- **Managed service** for **securing sensitive information** (application/platform) (PaaS)
- Secure storage service for
  - **Keys**,
  - **Secrets** and
  - **Certificates**
- **Highly integrated** with other Azure services (VMs, Logic Apps, Data Factory, Web Apps, etc.)
- **Centralization**
- Access **monitoring** and **logging**

Azure Disk Encryption *requires* an **Azure Key Vault** to control and manage disk encryption keys and secrets.

What is a Role?

Role (role definition) is a **collection of actions** that the **assigned identity** will be able to perform.

Role definition is an answer to a question **"What** can be done?"

What is a Security Principal?

Security Principal is an **Azure object** (identity) that can be assigned to a role (ex. users, groups or applications).

Security Principal assignment is an answer to a question **"Who** can do it?"

What is a Scope?

Scope is **one or more Azure resources** that the access applies to.

Scope assignment is an answer to a question **"Where** can it be done?"

What is a Role Assignment?

Role assignment is a **combination** of the **role definition, security principal and scope.**

Azure Role-based Access Control (RBAC)

- Authorization system built on Azure Resource Manager (ARM)
- Designed for fine-grained access management of Azure Resources
- Role assignment is combination of
  - Role definition – list of permissions like create VM, delete SQL, assign permissions, etc.
  - Security Principal – user, group, service principal and managed identity and
  - Scope – resource, resource groups, subscription, management group
- Hierarchical
  - Management Groups > Subscriptions > Resource Groups > Resources
- Built-in and Custom roles are supported

- **Authentication** is proving your identity, proving that you are who you say you are. The most common example of this is logging in to a system by providing credentials such as a username and password.
- **Authorization** is what you're allowed to do once you've been authenticated. For example, what resources you are allowed to access and what you can do with those resources.

What is an Azure Resource Lock?

At this time locks can be only applied to:
- Azure subscriptions
- resource groups
- resources

Answer Area

Statements	Yes	No
An Azure resource can have multiple Delete locks.	○	○
An Azure resource inherits locks from its resource group.	○	○
If an Azure resource has a Read-only lock, you can add a Delete lock to the resource.	○	○

- Designed to **prevent accidental deletion** and/or **modification**
- Used in conjunction with RBAC
- Two types of locks
  - **Read-only** (ReadOnly) – only read actions are allowed
  - **Delete** (CanNotDelete) – all actions except delete are allowed
- Scopes are **hierarchical** (inherited)
  - Subscriptions > Resource Groups > Resources
- **Management Groups** can't be locked
- Only **Owner** and **User Access Administrator** roles can manage locks (**built-in** roles)

- ***CanNotDelete*** means authorized users can still read and modify a resource, but they can't delete the resource.
- ***ReadOnly*** means authorized users can read a resource, but they can't delete or update the resource. Applying this lock is similar to restricting all authorized
- users to the permissions granted by the **Reader** role.
- You can configure a lock on a resource group to prevent the accidental deletion of the resource group. The lock applies to everyone, including global administrators. *If you want to delete the resource group, the lock must be removed first.*

Azure Resource Tags

When all Azure resources are tagged, you can generate reports to list all resources based on the value of the tag. For example: All resources used by Office1.

- Tags are simple **Name** (key) - **Value** pairs
- Designed to help with **organization of Azure resources**
- Used for resource **governance, security, operations management, cost management, automation**, etc.
- Typical tagging strategies
  - **Functional** – mark by function (ex: environment = production)
  - **Classification** – mark by policies used (ex: classification = restricted)
  - **Finance/Accounting** – mark for billing purposes (ex: department = finance)
  - **Partnership** – mark by association of users/groups (ex: owner = adam)
- Applicable for **resources**, **resource groups** and **subscriptions**
- **NOT inherited** by default

Azure Policy

Az policy initiative definition collection of policy definition
Az policies provide organisations with the ability to manage the compliance of AZ resources across multiple subscriptions

- Designed to help with **resource governance**, **security**, **compliance**, **cost management**, etc.
- **Policies** focus on **resource properties** (RBAC focused on user actions)
- Policy **definition** – Defines **what** should happen
  - Define the **condition** (if/else) and the **effect** (deny, audit, append, modify, etc.)
  - Examples include allowed *resource types, allowed locations, allowed SKUs, inherit resource tags*
- **Built-in** and **custom** policies are supported
- Policy **initiative** – a **group** of policy definitions
- Policy **assignment** – assignment of a policy definition/initiative to a scope
  - Scopes can be assigned to
    - management groups,
    - subscriptions,
    - resource groups, and
    - resources
- Policies allow for **exclusions of scopes**
- Checked during **resource creation** or **updates** and **existing ones with remediation tasks**

Website Contributor role is much less privileged than an Owner as it's only targeting Azure Websites. So this role should be our priority.
The Creation of Azure AD group will reduce maintenance and role assignment effort by having to do it only once for entire group. Applying the role to a specific Azure App Service ensures that the developers have access only to the target app service. If applied on resource group level developers would have access to other app services in that group too.

Azure Blueprints

Blueprint definition describes a list of various Azure components and their configuration. Colloquially can be called a package/collection of Azure components.

- **Package** of various Azure components (**artifacts**)
  - **Resource Groups**
  - **ARM Templates**
  - **Policy Assignments**
  - **Role Assignments**
- **Centralized storage** for organizationally approved design patterns
- Blueprint **definition** – describing **what** should happen (reusable package)
- Blueprint **assignment** – describing **where** it should happen (package deployment)

Cloud adoption

Cloud adoption is a strategic move by an organization to leverage cloud in their business

Cloud Adoption Framework

Cloud Adoption Framework for Azure is a set of * **tools**, * **best practices**, * **guidelines** and * **documentation** prepared by Microsoft to help companies with their cloud adoption journey.

Strategy

1. Understand your motivation

- Answer the question **WHY MOVE**?
- Common Motivation Triggers include
  - **Migration**
    - Cost Savings on infrastructure
    - Reduction in complexity
    - Operation optimization
    - Increased business agility
  - **Innovation**
    - Reaching a global scale

        - Customer experience improvements
        - Transformation of products or services
        - Market disruption

2. Business Outcome

- Answer the question **WHAT TO MEASURE**?
- Defined, concise and observable outcome captured by a specific measure, for example
    - Increase in revenue
    - Increase in profit
    - Cost reduction
    - Global access to customers
    - Reaching new markets

3. Business Justification

- Answer the question **WHAT'S MY RETURN ON INVESTMENT**?
- Develop a business case to validate the financial model that supports your motivations and outcomes
- Tools that support this process are
    - Azure TCO (Total Cost of Ownership) calculator - estimate current on-prem costs
    - Azure Pricing Calculator - estimate future Azure costs
    - Azure Cost Management - see current Azure costs

4. First Project

- Choose first project to validate your strategy (Proof of concept - POC) based on
    - Business Criteria
        - Currently operating
        - Dedicated owner
        - Strong motivation to move
    - Technical Criteria
        - Minimum dependencies and assets

Plan

1. Digital Estate (INVENTORY OF ASSETS)
    - Review current landscape and list all projects/solutions (digital assets)
    - Choose one of the five (5) R's of rationalization
        - Rehost - move as is; typically into containers or IaaS (virtual machines)
        - Refactor - make small code changes and move to PaaS (ex. Azure SQL, Azure App Service, etc.)
        - Rearchitect - make complex code changes to introduce new features or fix incompatible apps
        - Rebuild - create a new application using cloud first design
        - Replace - review available SaaS solutions and replace legacy or unneeded applications
2. Initial Organization Alignment
    - Align people so they will support your adoption plan
    - Map people to capabilities
3. Skills Readiness Plan *Review current skills and address the gaps
4. Cloud Adoption Plan - combine everything from steps 1 to 3 into a single cloud adoption plan

Ready

1. Azure Setup Guide - Review the Azure setup guide to become familiar with the tools and approaches you need to use to create a landing zone.
2. Azure Landing Zone - Choose an appropriate Azure Subscription type that best suits your needs and establish an initial Azure environment.
3. Extend Landing Zone - Expand the initial landing zone to fit your business needs.
4. Best Practices - Review everything and ensure best practices are followed.

Adopt

Migrate

1. First Migration - migrate your first application to familiarize yourself with the cloud, guidelines and tools
2. Migration Scenarios - review and prepare migration scenarios/guidelines for your company
    - Virtual Machines - Linux, Windows, etc.
    - Apps - Java, .NET, NodeJS web apps, etc.
    - Data - SQL Server, PostreSQL, File Servers, etc.
    - Other - VMware, Azure Stack, etc.
3. Best Practices - address common migration needs through the application of consistent best practices.
4. Process Improvements - important part of this porcess heavy activity is to identify bottlenecks and improve with every migration

Innovate

1. Business Value Consensus (VALUE TO STRATEGY)
    1. Create hypothetical customer need
    2. Decide on solution that solves it
    3. Map this to your strategy
2. Innovation Guide (TOOLS) - choose available Azure tools that will help your build this application
3. Best Practices - verify that best practices are followed for all tools in the toolchain

4. Process Improvements - gather feedback from the users and the customers to improve architectural decisions and future products

Govern & Manage

1. Define governance solutions - Choose solutions to maintain compliance, security and ensure total control of the environment.
    - Those solutions should focus to
        - Address Business Needs
        - Provide Agility
        - Control Risks
2. Manage cloud environment (CLOUD OPERATIONS) - Hand over solutions and environment to cloud operations team for maintenance. Team should ensure that stability and costs are always in perfect balance to meet business commitments. Team should allow environment to grow, evolve and adapt to changing business needs.

Organize

Ensure that everyone knows what to do and when to do it for every stage in this process. One of the ways to achieve this is via RACI (Responsible, Accountable, Consulted, and Informed) matrix.

Privacy and government

The Microsoft Privacy Statement explains what personal data Microsoft processes, how Microsoft processes the data, and the purpose of processing the data

Document/Website	Info	Offers	Audience
Microsoft Privacy Statement	Collection, Purpose and Usage of Personal Data	All Microsoft offers including services, applications, websites, software, servers, devices	Everyone - end customers or companies
Online Services Terms (OST)	Licensing Terms (legal agreement) - usage rights about Azure services. What can be done and what is forbidden.	Microsoft Online Services like Azure, Microsoft 365 services, Bing Maps, etc.	Organizations - legal teams
Data Protection Addendum	Appending to OST describing obligations by both parties (Microsoft and you) with regards to the processing of customer and personal data	Microsoft Online Services like Azure, Microsoft 365 services, Bing Maps, etc.	Organizations - legal teams, security teams
Trust Center	One stop shop web portal for everything related to security, compliance, privacy, policies, best practices, etc.	Microsoft Online Services like Azure, Microsoft 365 services, Bing Maps, etc.	Organizations - legal teams, security teams, business managers, administrators
Azure Compliance Documentation	Web portal focusing on compliance offerings in Azure, simmilar to the trust center but narrowed down	Azure	Organizations - legal teams, security teams, business managers, Azure administrators

Azure Sovereign Regions

Azure Sovereign Regions provide Azure services in markets with very strict regulatory requirements

- Azure Government designed for the **US** government
    - Separate instance of Azure (lifecycle, services, portal, etc.)
    - Physically isolated from other Azure regions
    - Only autorized scanned personel can get access
- Azure **China** designed for the Chinese market
    - Separate instance of Azure (lifecycle, services, portal, etc.)
    - Physically isolated from other Azure regions
    - Operated by a Chinese telecom company called 21Vianet

Online Services Terms - (OST) is a legal agreement between your company and Microsoft. This document covers licensing terms that you agree to when you purhase any of the Mirosoft Online services, including Azure Maps. Those licensing terms cover what is included within licensed 'use rights' but also which scenarios are not allowed.

Trust centre is the best place to start because it provides compliance information for multiple Microsoft Online services information including Sharepoint and Azure.

Cost Affecting Factors

- Base Cost
    - **Resource Types** – All Azure services (resources) have resource-specific pricing models. Typically consisting of one or more metrics.
    - **Services** – Azure specific offers (Enterprise, Web Direct, CSP, etc.) have different cost and billing components like prepaids, billing cycles, - discounts, etc.
    - **Location** – running Azure services vary between Azure regions
    - **Bandwidth** – network traffic when uploading (inbound/ingress) data to Azure or downloading (outbound/egress) from Azure
- Savings
    - Reserved Instances
    - Hybrid Benefits

Azure Reservations

Answer Area

Statements	Yes	No
With a consumption-based plan, you pay a fixed rate for all data sent to or from virtual machines hosted in the cloud.	○	○
With a consumption-based plan, you reduce overall costs by paying only for extra capacity when it is required.	○	○
Serverless computing is an example of a consumption-based plan.	○	○

Purchase Azure services for 1 or 3 years in advance with a significant discounts

- **Reserved instances** – Azure Virtual Machines
- **Reserved capacity** – Azure Storage, SQL Database vCores, Databricks DBUs, Cosmos DB RUs
- **Software plans** – Red Hat, Red Hat OpenShift, SUSE Linux, etc.
- **Reservations** are made for 1 or 3 years

You need to be an administrator of the billing account that has the **subscription** to be able to transfer the subscription. This could be a Billing Administrator or
Global Administrator. A subscription owner can manage all resources and permissions within the subscription but cannot transfer ownership of the subscription.

Azure Spot VMs

Purchase unused Virtual Machine capacity for significant discount

- How it works
- **Significant dicount** for Azure VMs
- **Capacity** can be taken away at any time
- Customer can **set maximum price** after discount to keep or evict the machine
- **Best for interruptable workloads** (batch processing, dev/test environments, large compute workloads, non-critical tasks, etc.)

Hybrid use Benefit

Use existing licenses in the cloud

- Use existing licenses in the Azure
  - **Windows Server**
    - Azure VM
  - **RedHat**
    - Azure VM
  - **SUSE Linux**
    - Azure VM
  - **SQL Server**
    - Azure SQL Database
    - Azure SQL Managed Instance
    - Azure SQL Server on VM
    - Azure Data Factory SQL Server Integration Services

Azure Pricing Calculator - Use this tool to estimate your up-front cloud costs.
Azure Migrate - Assess your current datacenter workload for insights about what's needed from an Azure replacement solution.
Azure Advisor - Identify unused VMs and receive recommendations about Azure reserved instance purchases.
Azure Hybrid Benefit - Use your current on-premises Windows Server or SQL Server licenses for VMs in Azure to save.

Tools

- **Pricing calculator** – estimate the cost of Azure services
  - Select service
  - Adjust parameters (usage)
  - View the price
- **Total Cost of Ownership (TCO) calculator** – estimate and compare the cost of running workloads in datacenter versus Azure
  - Define your workloads
  - Adjust assumptions
  - View the report

Azure Pricing Calculator allows customers to estimate cost of their Azure services before making a purchase.

Azure Cost Management

Azure customers with an Azure Enterprise Agreement (EA), Microsoft Customer Agreement (MCA), or Microsoft Partner Agreement (MPA) **can use Azure Cost Management.**

- A centralized service for reporting usage and billing of Azure environment
- Self-service cost exploration capabilities
- Budgets & alerts
- Cost recommendations
- Automated exports

Cost management is the process of effectively planning and controlling costs involved in your business. Cost management tasks are normally performed by finance, management, and app teams. Azure Cost Management + Billing helps organizations plan with cost in mind. It also helps to analyze costs effectively and take action to optimize cloud spending.

Minimizing Costs in Azure

- Azure Pricing Calculator to choose the low-cost region
  - Good latency
  - All required services are available
  - Data sovereignty/compliance requirements
- Hybrid use benefit and Azure Reservations
- Azure Cost Management monitoring, budgets, alerts and recommendations
- Understand service lifecycle and automate environments
- Use autoscaling features to your advantage
- Azure Monitor to find and scale down underutilized resources
- Use tags & policies for effective governance

Data **ingress** over a VPN is data coming in to Azure over the VPN. You are **not charged** data transfer costs for data ingress.

Data **egress** over a VPN is data going out Azure over the VPN. You are **charged** for data egress.

SLA

Service Level Agreement (SLA) is a formal agreement between a service provider and a customer.

SLA is a **promise** of a service's **availability** (uptime & connectivity). **Availability** is a measure of time that a service remains operational.

- Each Service has its own SLA
- Ranges from 99% to 99.999%
- Free services typically don't have an SLA
- Broken SLA means service credit return (discount)

|SLA |Monthly Downtime| |99% |7h 18m 17s| |99.5% |3h 39m 8s| |99.9% |43m 49s| |99.95% |21m 54s| |99.99% |4m 22s| |99.999%|26s|

Monthly Uptime % = (Maximum Available Minutes-Downtime) / Maximum Available Minutes x 100.

Formulas

Logical AND - adding dependency Availability of **S1 AND S2** = Availability(S1) * Availability(S2)

Scenario - Azure website with SQL backend db

- Availability = Availability(web) app * Availability(sql)
- Availability = 99.95% * 99.95%
- Availability = 0.9995 * 0.9995
- Availability = 0.99900025
- Availability ~ 99.9%

Logical OR - adding redundancy Availability of **S1 OR S2** = 100% - (Unvailability(S1) * Unvailability(S2))

Scenario - Two redundant web apps behind a load balancer

- Availability(both-web) = 100% - (Unvailability(web1) * Unvailability(web2))
- Availability(both-web) = 100% - (0.05% * 0.05%)
- Availability(both-web) = 1 – (0.0005 * 0.0005)
- Availability(both-web) = 1 – 0.00000025
- Availability(both-web) = 0.99999975
- Availability(both-web) ~ 99.9999%

Key Items

- **Formal agreement** between **Microsoft** & the **customer**
- Calculated as a **percentage of service availability** (uptime & connetivity) (a **promise**)
- Breaking the SLA provides a discount from the final monthly bill (**Service Credit**)
- **Higher tier** services offer better SLAs
- **Free** services typically have no SLA (0% SLA)
- **Preview** services have no SLA
- **Composite SLA** is a combined SLA of all application components

Service Lifecycle

- Every service in Azure follows its own service lifecycle
- **Public preview** is a **'beta'** stage of the service available to general public use
- **Features** can also be in preview stages
- Designed for **testing**, **not production** solutions
- **General availability** is a **'production'** release of the service

Public Preview Key Info

- No SLA
- Some services have no support coverage
- Limited region availability
- Limited functionality
- Pricing changes
- Direction changes
- Azure Portal Previews (https://preview.portal.azure.com)

Most services go to private preview then public preview before being released to general availability.
The private preview is only available to certain Azure customers for evaluation purposes. The public preview is available to all Azure customers.

Links

https://marczak.io/az-900

Azure free account has a limit of 10 web, mobile or API apps

A stopped (deallocated) VM is offline and not mounted on an Azure host server. Starting a VM mounts the VM on a host server before the VM starts. As soon as the VM is mounted, it becomes chargeable. For this reason, you are unable to start a VM after a trial has expired.
Incorrect Answers:
- You are not charged for Azure Active Directory user accounts so you can continue to create accounts.
- You can access data that is already stored in Azure.
- You can access the Azure Portal. You can also reactivate and upgrade the expired subscription in the portal.