AZ-900
Azure Fundamentals

Getting Started

Advisor   Machine Learning   Cosmos DB   Azure DevOps

- Azure has *200+ services*. Exam expects you to understand *40+ services*.
- Exam *tests* your **decision making abilities**:
  - Which service do you choose in which situation?
- This course is **designed** to help you *make these choices*
- **Our Goal** : Help you get certified and start your cloud journey with Azure

How do you put your best foot forward?

- **Challenging certification** - Expects you to understand and **REMEMBER** a number of services
- As time passes, humans forget things.
- How do you improve your chances of remembering things?
  - **Active learning** - think and take notes
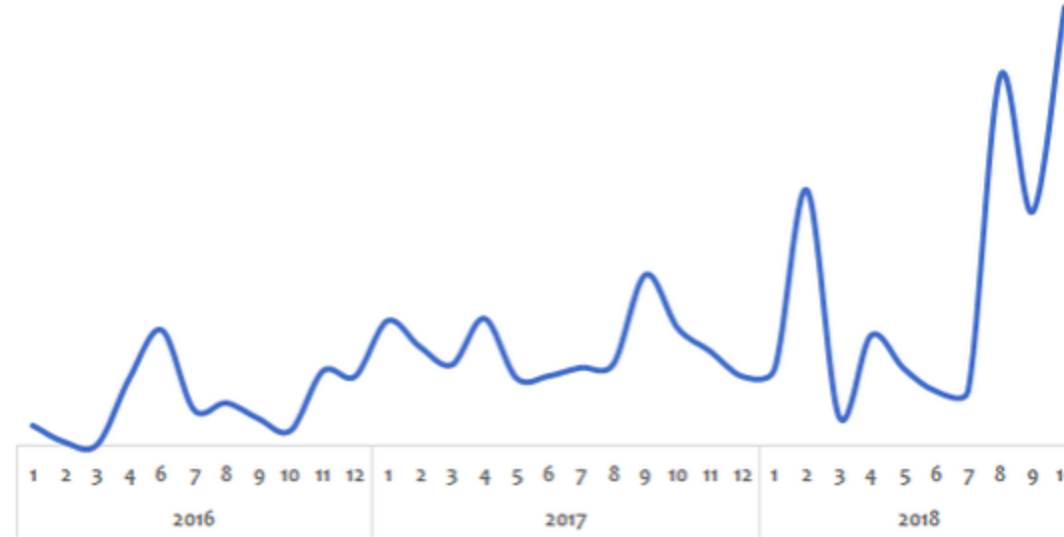 - **Review** the presentation every once in a while

100%

Elapsed Time
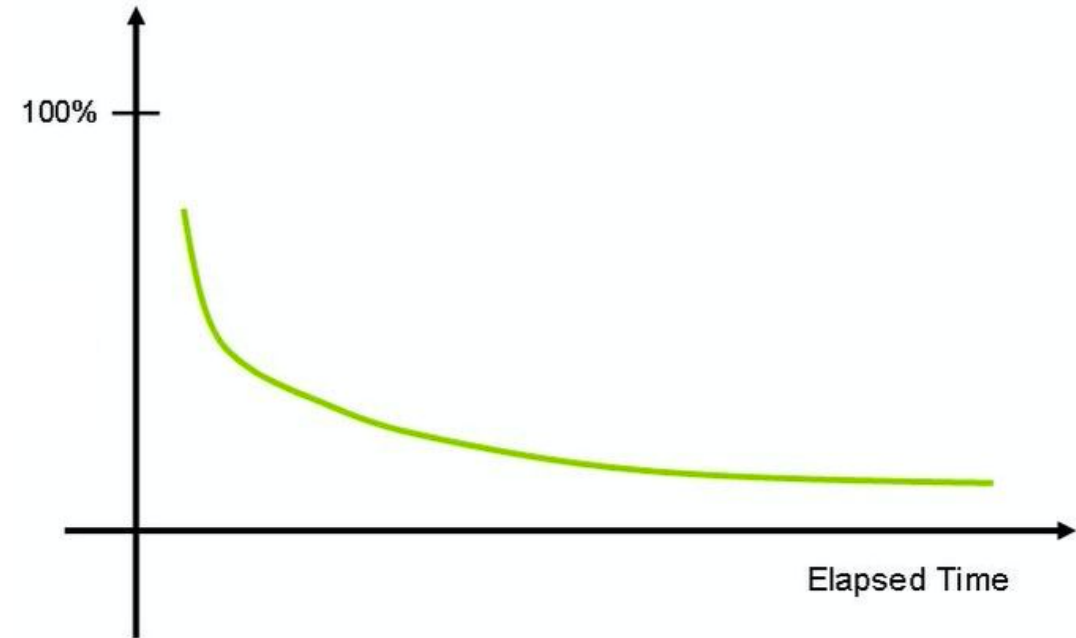
Our Approach

- Three-pronged approach to reinforce concepts:
    - Presentations (Video)
    - Demos (Video)
    - **Two kinds of quizzes**:
        - Text quizzes
        - Video quizzes

- (Recommended) Take your time. Do not hesitate to replay videos!
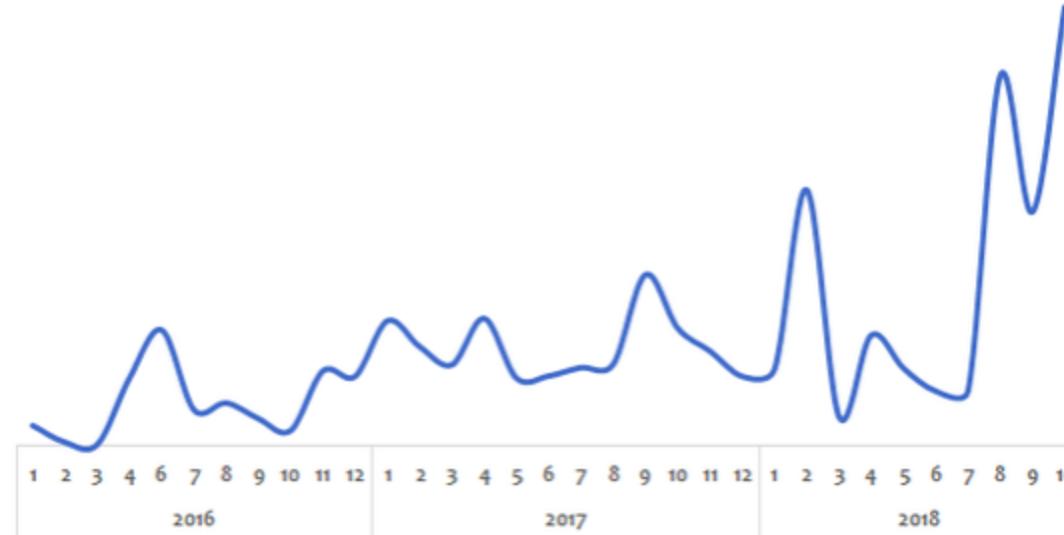- (Recommended) Have Fun!

Before the Cloud - Example 1 - Online Shopping App

- Challenge:
  - Peak usage during holidays and weekends
  - Less load during rest of the time
- Solution (before the Cloud):
  - **Procure** (Buy) infrastructure **for peak load**
    - What would the infrastructure be doing during periods of low loads?
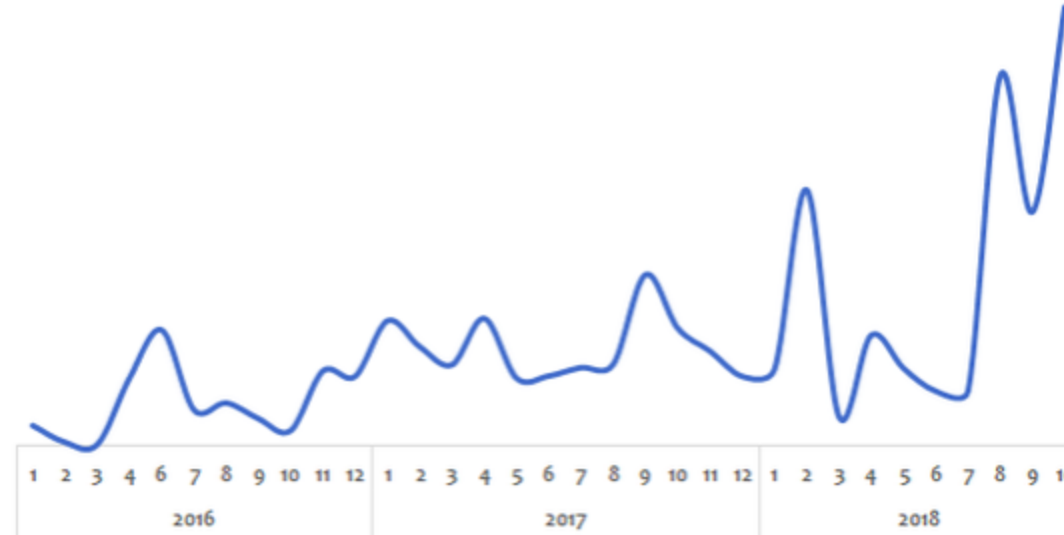
Before the Cloud - Example 2 - Startup

- Challenge:
  - It suddenly becomes popular.
  - How to handle the **sudden increase** in load?

- Solution (before the Cloud):
  - **Procure** (Buy) infrastructure assuming they would be successful
    - What if they are not successful?

7

Before the Cloud - Challenges

- High cost of procuring infrastructure
- Needs ahead of time planning (**Can you guess the future?**)
- Low infrastructure utilization (**PEAK LOAD** provisioning)
- Dedicated infrastructure maintenance team (**Can a startup afford it?**)

Silver Lining in the Cloud

- How about **provisioning (renting) resources** when you want them and releasing them back when you do not need them?
    - **On-demand resource provisioning**
    - Also called **Elasticity**

Cloud - Advantages

- Trade **"capital expense"** for **"variable expense"**
- Benefit from massive **economies of scale**
- Stop **guessing** capacity
- Stop spending money running and maintaining data centers
- **"Go global"** in minutes

Microsoft Azure

- One of the leading cloud service providers
- Provides 200+ services
- Reliable, secure and cost-effective
- The entire course is all about Azure. You will learn it as we go further.

Best path to learn Azure!

Advisor   Machine Learning   Cosmos DB   Azure DevOps

- Cloud applications make use of multiple Azure services.
- There is **no single path** to learn these services independently.
- HOWEVER, we've worked out a simple path!

Setting up Azure Account

- Create Azure Account

Regions and Zones

Regions and Zones
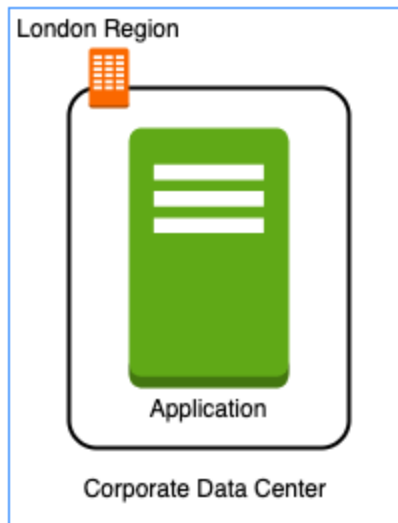
- Imagine that your application is deployed in a data center in London
- What would be the challenges?
  - Challenge 1 : Slow access for users from other parts of the world (**high latency**)
  - Challenge 2 : What if the data center crashes?
    - Your application goes down (**low availability**)

Multiple data centers
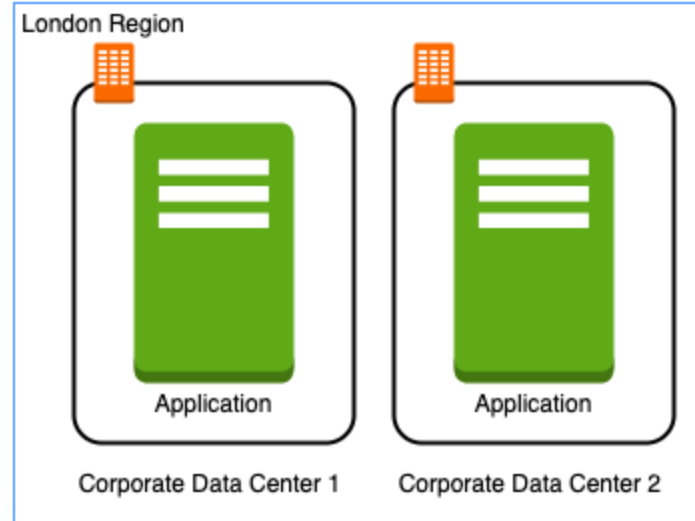
- Let's **add in one more data center** in London
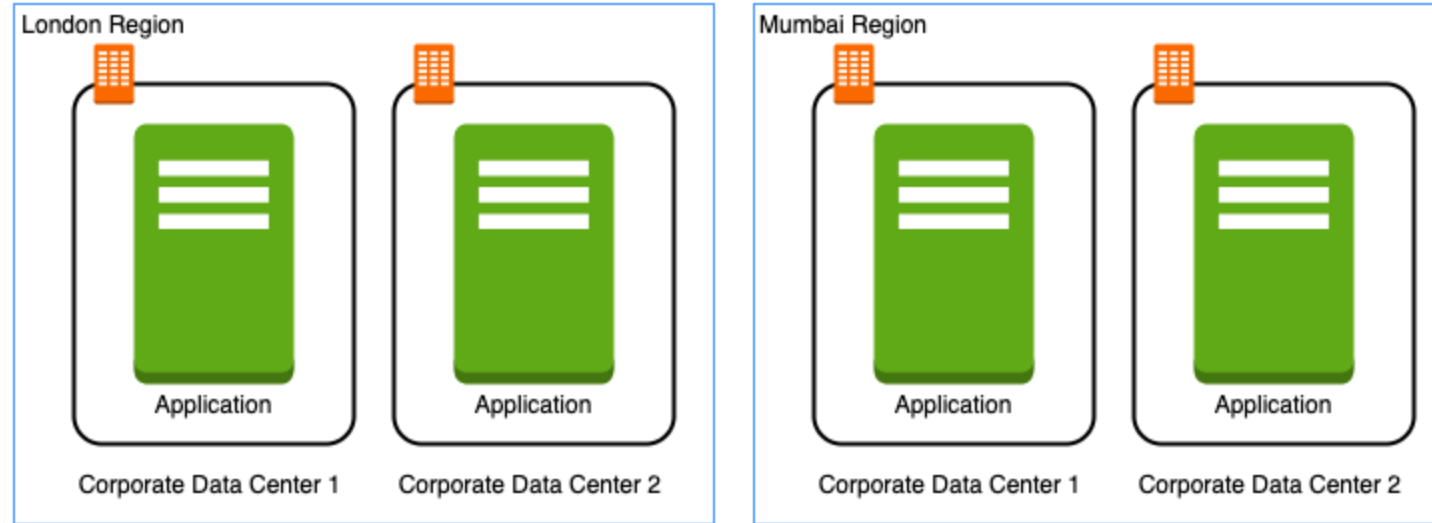- What would be the challenges?
  - Challenge 1 : Slow access for users from other parts of the world
  - Challenge 2 (**SOLVED**) : What if one data center crashes?
    - Your application is **still available** from the other data center
  - Challenge 3 : What if **entire region** of London is unavailable?
    - Your application goes down

Multiple regions

- Let's add a new region : Mumbai
- What would be the challenges?
  - Challenge 1 (**PARTLY SOLVED**) : Slow access for users from other parts of the world
    - You can solve this by adding deployments for your applications in other regions
  - Challenge 2 (SOLVED) : What if one data center crashes?
    - Your application is still live from the other data centers
  - Challenge 3 (**SOLVED**) : What if entire region of London is unavailable?
    - Your application is served from Mumbai

17

Regions

- Imagine setting up data centers in different regions around the world
  - **Would that be easy?**
- (Solution) Azure provides **60+ regions** around the world
  - Expanding every year
- **Region** : Specific geographical location to host your resources
- **Advantages**:
  - High Availability
  - Low Latency
  - Global Footprint
  - Adhere to government **regulations**

Availability Zones

- How to achieve high availability in the same region (or geographic location)?
  - Enter **Availability Zones**
    - Multiple AZs (3) in a region
    - **One or more discrete data centers**
    - Each AZ has **independent** & **redundant** power, networking & connectivity
    - AZs in a region are connected through **low-latency** links

- (Advantage) **Increased availability and fault tolerance** within same region
  - Survive the failure of a complete data center

- (Remember) NOT all Azure regions have Availability Zones

Region
Availability Zone   Availability Zone

Regions and Availability Zones examples

New Regions and AZs are constantly added

Region	Availability Zones
(US) East US	3
(Europe) West Europe	3
(Asia Pacific) Southeast Asia	3
(South America) Brazil South	3
(US) West Central US	0

Azure Virtual Machines

Azure Virtual Machines

- In corporate data centers, applications are deployed to physical servers
- Where do you deploy applications in the cloud?
    - Rent virtual servers
    - **Virtual Machines** - Virtual servers in Azure
    - **Azure Virtual Machines** - Provision & Manage Virtual Machines

VM

Azure Virtual Machines - Features

- Create and manage lifecycle of Virtual Machine (VM) instances
- **Load balancing** and **auto scaling** for multiple VM instances
- **Attach storage** to your VM instances
- Manage **network connectivity and configuration** for your VM instances
- **Our Goal**:
    - Setup VM instances as HTTP (Web) Server
    - Distribute load with Load Balancers

VM

VM Scale Set

Azure Virtual Machines Hands-on

- Let's create a few VM instances and play with them
- Let's SSH into VM instances and install web server!

VM

Azure Virtual Machines - Key Concepts

Feature	Explanation
Image	Choose Operating System and Software
VM Family	Choose the right family of hardware (General purpose or Compute/Storage/Memory optimized or GPU or HPC)
VM Size (B1s, B2s, ...)	Choose the right quantity of hardware (2 vCPUs, 4GB of memory)
Disks	Attach Virtual Disks to VMs (Block Storage)

Useful Commands

```sh
#!/bin/sh
sudo su
apt-get -y update
apt-get -y install nginx
echo "Getting started with Azure Virtual Machines" > /var/www/html/index.html
echo "Welcome to in28minutes $(whoami)" > /var/www/html/index.html
echo "Welcome to in28minutes $(hostname)" > /var/www/html/index.html
```

- Commands:
  - `sudo su` - execute commands as a root user
  - `apt-get -y update` - Update package index - pull the latest changes from the repositories
  - `apt-get -y install nginx` - Install and start nginx web server
  - `echo "Hello World" > /var/www/html/index.html` - Write to index.html
  - `$(hostname)` - Get host name
  - `$(hostname -I)` - Get host internal IP address

Availability

- Are the applications available **when the users need them**?
  - **Percentage of time** an application provides the operations expected of it
- **Example**: 99.99% availability. Also called four 9's availability

Availability Table

Availability	Downtime (in a month)	Comment
99.95%	22 minutes	
99.99% (four 9's)	4 and 1/2 minutes	Most online apps aim for 99.99% (four 9's)
99.999% (five 9's)	26 seconds	Achieving 5 9's availability is tough

Increasing Availability for Azure VMs

- Single Instance VM:
    - Premium SSD or Ultra Disk: 99.9%
    - Standard SSD Managed Disks: 99.5%
    - Standard HDD Managed Disks: 95%
- Two or more instances in same Availability Set: 99.95%
    - Availability set is a logical grouping of VMs
        - **Fault domains**: Group of VMs sharing a common power source and network switch
        - **Update domains**: Group of VMs that are rebooted (updated) at the same time
- Two or more instances in two or more Availability Zones in the same Azure region: 99.99%
- **Summary**: Create multiple instances in multiple AZs if you want high availability

VM

Virtual Machine Scale Sets

- How do you simplify creation and management of multiple VMs?
  - Enter **Virtual machine scale sets**
- Allow you to create and manage a group of Azure VMs
  - Provides high availability to your applications
- (Optional) Add a load balancer
- (Optional) Distribute VM instances across Multiple AZs (where available)
- Supports Manual Scaling and Auto Scaling
- Supports up to 1,000 VM instances
- **DEMO TIME**

VM Scale Set

Azure Virtual Machines - More Features

Feature	Explanation
Static IP Address	Assign a fixed IP address to your VM Public IP addresses are charged per IP per hour
Azure Monitoring	Monitoring for your Azure VMs
Dedicated Hosts	Physical servers dedicated to one customer
Create cheaper, temporary instances for non critical workloads	Azure Spot instances
Reserve compute instances ahead of time	Reserved VM Instances (1 or 3 years)

Designing Good Solutions with VMs

| Terminology	Description	Azure VMs
Availability	Are the applications available **when your users need them**?	Availability Sets and Scale Sets
Scalability	Can we handle a **growth in users, traffic, or data size** without any drop in performance?	VM Size, Scale Sets and Load Balancers
Resilience	Ability of system to provide acceptable behavior even when one or more parts of the system fail	Scale Sets and Load Balancers
Geo-distribution	Distribute applications across regions and zones	Scale Sets and Load Balancers
Disaster Recovery	How to keep your systems running in face of disasters?	Site Recovery
Managing Costs	You want to keep costs low	Auto Scaling (Elasticity), Reservations, Spot Instances
Security	Secure your VMs	Dedicated Hosts, (More to come...)

Vertical Scaling

- Deploying application/database to **bigger instance**:
    - A larger hard drive
    - A faster CPU
    - More RAM, CPU, I/O, or networking capabilities
- In Azure: We can increase VM size
- There are limits to vertical scaling

32

Horizontal Scaling
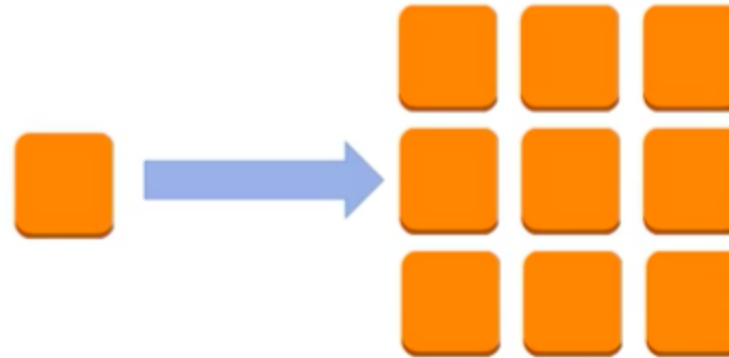
- Deploying multiple instances of application/database
- (Typically but not always) Horizontal Scaling is preferred to Vertical Scaling:
  - Vertical scaling has limits
  - Vertical scaling can be expensive
  - Horizontal scaling increases availability
- (BUT) Horizontal Scaling needs additional infrastructure:
  - Scaling Sets, Load Balancers etc.

Azure Virtual Machines - Scenarios

| Scenario	Solution
How can you automatically scale up and scale down VMs?	VM Scale Sets
How can you protect VMs from datacenter failures?	Deploy them to multiple AZs (Scale Sets)
How much availability do you get by deploying two or more VM instances in two or more AZs in same region?	99.99%
How can you perform disaster recovery for your VMs?	Site Recovery
How can you reduce costs for your VMs?	AutoScaling(Elasticity), Reserved & Spot Instances, Right Region - Cost varies from region to region
Will you be billed if you stop a VM?	Yes. For Storage.
Will two VMs of same size always cost the same?	No. Price changes with time. Price also is different in different regions.
How can you know who performed a specific action on a VM?	Activity Logs (kept for 90 days)

Managed Services

Managed Services

- Do you want to continue **running applications in the cloud**, the **same way you run them** in your **data center**?

- OR **are there OTHER approaches**?

- You should **understand some terminology** used with cloud services:
    - **IaaS** (Infrastructure as a Service)
    - **PaaS** (Platform as a Service)
    - **SaaS** (Software as a Service)
    - **Serverless**

- Let's get on a quick **journey** to understand these!

IAAS (Infrastructure as a Service)

- Use **only infrastructure** from cloud provider
- **Example**: Using VM to deploy your applications or databases
- You are responsible for:
  - Application Code and Runtime
  - Configuring load balancing
  - Auto scaling
  - OS upgrades and patches
  - Availability
  - etc.. (and a lot of things!)

Applications

Application Runtime

OS

Virtualization

Physical Hardware

Networking
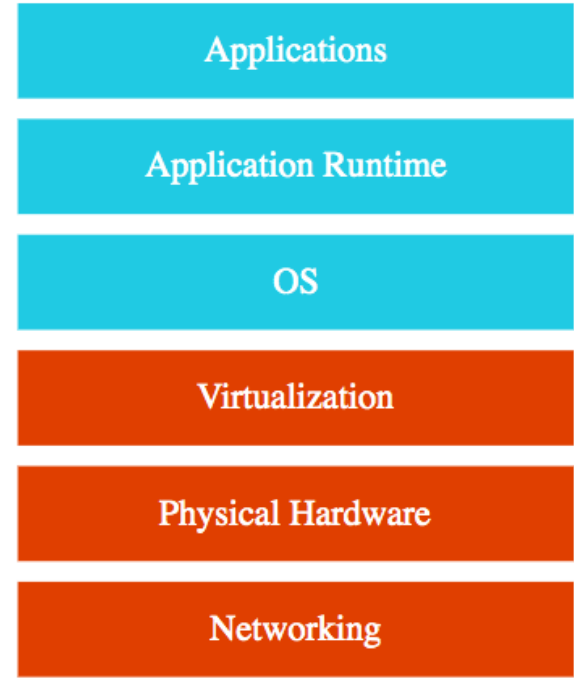
PAAS (Platform as a Service)

- Use a platform provided by cloud
- **Cloud provider** is responsible for:
  - OS (incl. upgrades and patches)
  - Application Runtime
  - Auto scaling, Availability & Load balancing etc..
- **You** are responsible for:
  - Configuration (of Application and Services)
  - Application code (if needed)
- Examples:
  - Azure App Service
  - Databases - Relational & NoSQL (Amazon RDS, Google Cloud SQL, Azure SQL Database etc)
  - Queues, AI, ML, Operations etc!

| Applications |
| Application Runtime |
| OS |
| Virtualization |
| Physical Hardware |
| Networking |
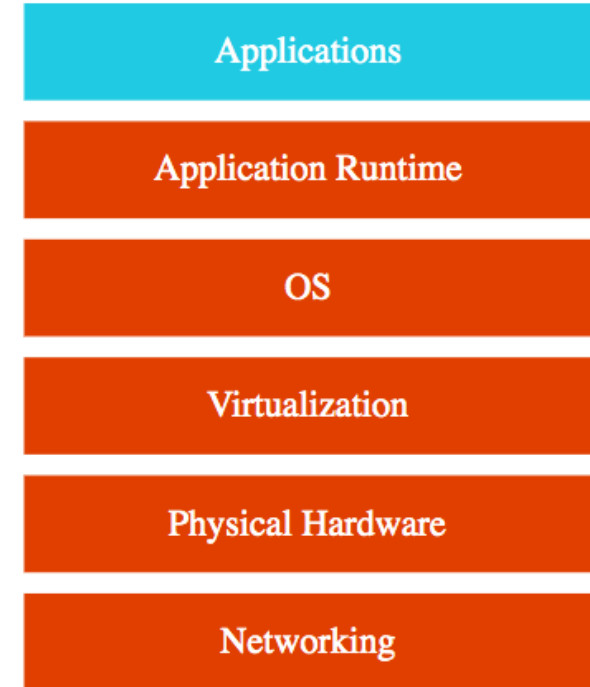
Azure App Service

- Fully managed platform for building, deploying and scaling your web apps
    - Also supports REST APIs, and mobile back ends
- Natively supports .NET, .NET Core, Node.js, Java, Python and PHP
- Choose App Service plan: defines a set of compute resources for a web app
- Features:
    - Automated Deployment and management
    - Auto Scaling
    - Built in Load Balancing

Applications
Application Runtime
OS
Virtualization
Physical Hardware
Networking
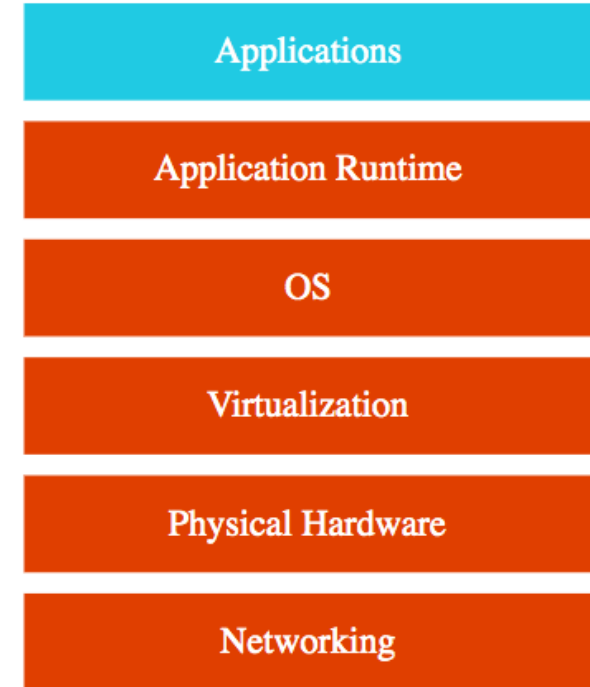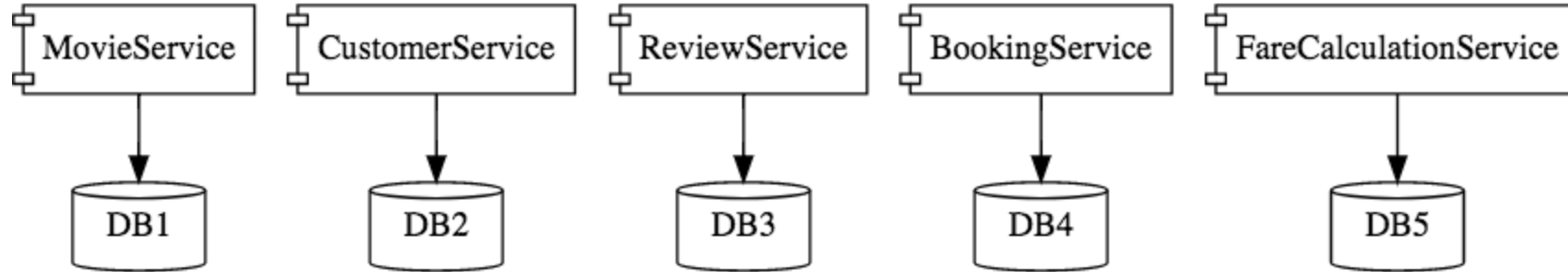
Microservices

- Enterprises are heading towards microservices architectures
  - Build small focused microservices
 - **Flexibility to innovate** and build applications in different programming languages (Go, Java, Python, JavaScript, etc)
- BUT **deployments become complex**!
- How can we have **one way of deploying** Go, Java, Python or JavaScript .. microservices?
  - Enter **containers**!

Containers - Docker

- Create **Docker images** for each microservice
- Docker image **has all needs of a microservice**:
  - Application Runtime (JDK or Python or NodeJS)
  - Application code and Dependencies
  - VMs virtualize Hardware while containers virtualize OS
  - Runs **the same way** on any infrastructure:
    - Your local machine
    - Corporate data center
    - Cloud
- Advantages
  - Docker containers are **light weight**
    - Compared to Virtual Machines as they do not have a Guest OS
  - Docker provides **isolation** for containers
  - Docker is **cloud neutral**

Container1	Container2	Container3

DockerEngine

HostOS

| CloudInfrastructure |
| --- |
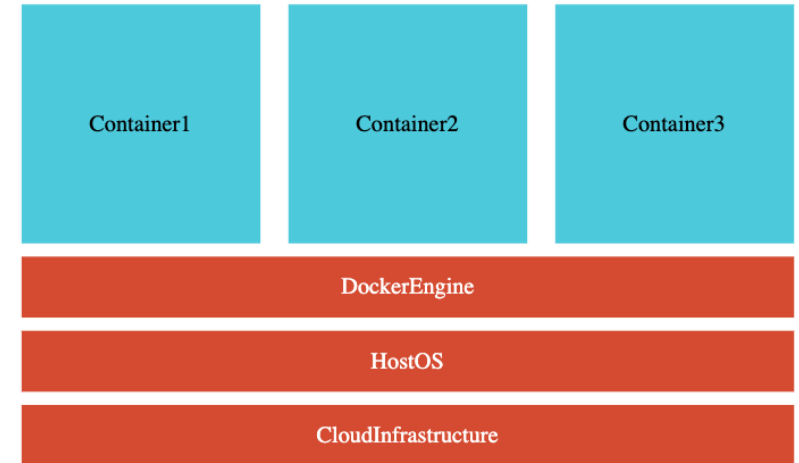
Azure Container Instances

- Manage and run simple container based applications
- **You DO NOT** need to provision and manage VMs
- Start containers in seconds
- Azure App Service also supports deploying simple containers

Container Service

Container Orchestration

- **Requirement** : I want 10 instances of Microservice A container, 15 instances of Microservice B container and ….
- Typical Features:
    - **Auto Scaling** - Scale containers based on demand
    - **Service Discovery** - Help microservices find one another
    - **Load Balancer** - Distribute load among multiple instances of a microservice
    - **Self Healing** - Do health checks and replace failing instances
    - **Zero Downtime Deployments** - Release new versions without downtime
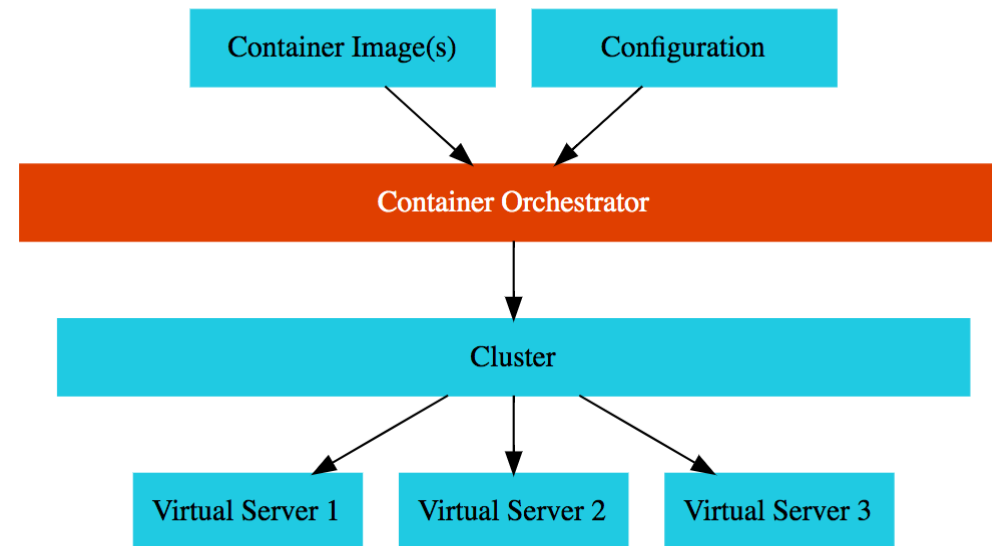
Container Orchestration - AKS and Service Fabric

- Using a Container Orchestrator:
  - 1: Create a Cluster
  - 2: Deploy & Orchestrate Microservices
- Azure Services:
  - Azure Kubernetes Service: Managed Kubernetes Service
  - Azure Service Fabric: Microsoft's container orchestrator

Serverless
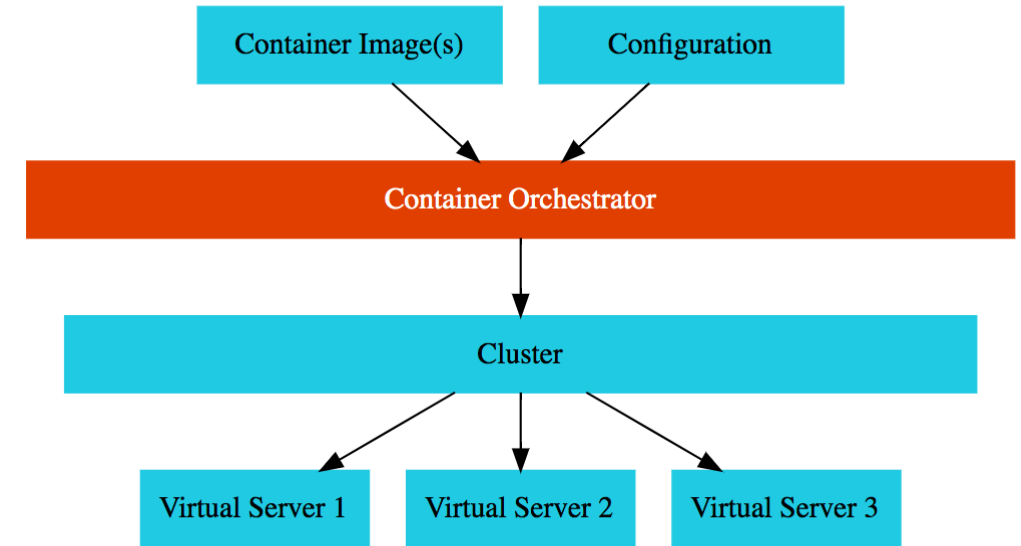
- What do we think about when we develop an application?
    - Where to deploy? What kind of server? What OS?
    - How do we take care of scaling and availability of the application?
- **What if you don't need to worry about servers and focus on your code?**
    - Enter **Serverless**
        - Remember: **Serverless does NOT mean "No Servers"**
- **Serverless for me:**
    - You **don't worry** about infrastructure (ZERO visibility into infrastructure)
        - Flexible scaling and automated high availability
    - Most Important: **Pay for use**
        - Ideally ZERO REQUESTS => ZERO COST
- **You focus on code** and the cloud managed service takes care of all that is needed to scale your code to serve millions of requests!
    - And you pay for requests and NOT servers!

Azure Functions

Functions

- You don't worry about servers or scaling or availability
- You only worry about your code
- You pay for what you use
  - Number of requests
  - Duration of requests
  - Memory consumed
- Supports C#, Python, JavaScript, Typescript and Java

Logic Apps

- **Serverless orchestration service:**
    - Recommended for orchestrating long-running processes and workflows
    - Low-code/no-code solution
        - Provides web-based designer with easy to use GUI

- **Link triggers to actions:**
    - Trigger: An event you want to react to:
        - When there are more than x number of messages in the queue OR
        - When you receive a Office 365 Outlook email OR
        - At regular intervals (schedule)
    - Action: What do you want to do?
        - Send an email OR
        - Send a message on the queue
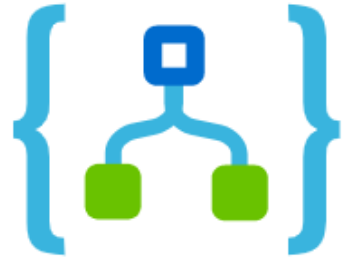
Logic Apps

SaaS (Software as a Service)

- **Centrally hosted software** (mostly on the cloud)
  - Offered on a subscription basis (pay-as-you-go)
  - Examples:
    - Email, calendaring & office tools (such as Outlook 365, Microsoft Office 365, Gmail, Google Docs)
    - Customer relationship management (CRM), enterprise resource planning (ERP) and document management tools
- **Cloud provider** is responsible for:
  - OS (incl. upgrades and patches)
  - Application Runtime
  - Auto scaling, Availability & Load balancing etc..
  - Application code and/or
  - Application Configuration (How much memory? How many instances? ..)
- **Customer** is responsible for:
  - Configuring the software!

Azure

Shared responsibility model

Responsibility	SaaS	PaaS	IaaS	On-prem	
Information and data	■	■	■	■	**RESPONSIBILITY ALWAYS RETAINED BY CUSTOMER**
Devices (Mobile and PCs)	■	■	■	■	
Accounts and identities	■	■	■	■	
Identity and directory infrastructure	◤	◤	■	■	**RESPONSIBILITY VARIES BY SERVICE TYPE**
Applications		◤	■	■	
Network controls		◤	■	■	
Operating system			■	■	
Physical hosts				■	**RESPONSIBILITY TRANSFERS TO CLOUD PROVIDER**
Physical network				■	
Physical datacenter				■	

■ Microsoft   ■ Customer

Azure Cloud Service Categories - Scenarios

Scenario	Solution
IaaS or PaaS or SaaS: Deploy Custom Application in Virtual Machines	IaaS
IaaS or PaaS or SaaS: Using Gmail	SaaS
IaaS or PaaS or SaaS: Using Azure App Service to deploy your app	PaaS
True or False: Customer is responsible for OS updates when using PaaS	False
True or False: Customer is responsible for Availability when using PaaS	False
True or False: In PaaS, customer has access to VM instances	False
True or False: In PaaS, customer can customize OS and install custom software	False
True or False: In PaaS, customer can configure auto scaling needs	True
True or False: In PaaS, customer can configure hardware needs (memory, cpu etc)	True
True or False: PaaS services only offer Compute services	False

Review - Azure Services for Compute

Azure Service Name	Description
Azure VMs	Windows or Linux VMs (IaaS) Use VMs when you need control over OS OR you want to run custom software You handle Availability, Scalability, Load Balancing, Software/OS Updates ...
Azure App Service	PaaS. Deploy web apps, mobile back ends and RESTful APIs quickly. Built-in Auto Scaling, Load Balancing
Azure Container Instances	PaaS (CaaS). Run isolated containers, without orchestration. You DO NOT need to provision and manage VMs. Start containers in seconds.
Azure Kubernetes Service	PaaS (CaaS). Managed Kubernetes Service. Provides container orchestration.
Azure Service Fabric	PaaS (CaaS). Microsoft's container orchestrator. Package, deploy, and manage scalable and reliable microservices Run anywhere - on premises and in the cloud
Azure Functions	Serverless (FaaS) compute for event-driven apps

Azure Compute Services - Scenarios

Scenario	Solution
You want to run function in response to events	Azure Functions
You want to deploy a Python application using a Managed Service	Azure App Service
You want to quickly deploy a container	Azure Container Instances
You want to setup a complex microservices architecture in Azure	AKS or Service Fabric
Your application needs customized OS and custom Software installed	Azure VMs

Storage

Storage Types - Block, File, Object, ...

File Storage   Host Computer   Block Storage
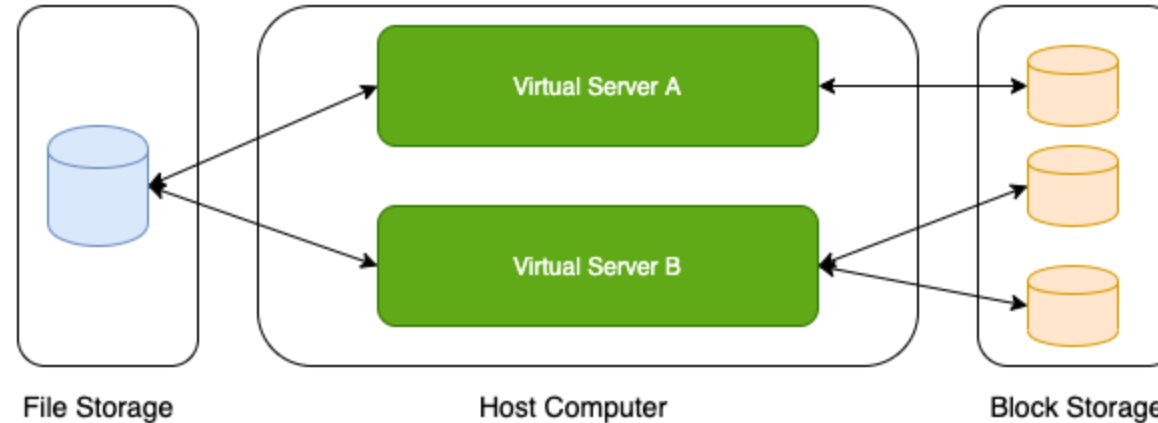
- What is the type of storage of your hard disk?
  - **Block Storage**
- You've created a file share to share a set of files with your colleagues in a enterprise. What type of storage are you using?
  - **File Storage**
- You want to be able to upload/download objects using a REST API without mounting them onto your VM. What type of storage are you using?
  - **Object Storage**

Azure Storage

- Managed Cloud Storage Solution
  - Highly available, durable and massively scalable (upto few PetaBytes)
- Core Storage Services:
  - **Azure Disks**: Block storage (hard disks) for Azure VMs
  - **Azure Files**: File shares for cloud and on-premises
  - **Azure Blobs**: Object store for text and binary data
  - **Azure Queues**: Decouple applications using messaging
  - **Azure Tables**: NoSQL store (Very Basic)
    - Prefer Azure Cosmos DB for NoSQL
- (PRE-REQUISITE) Storage Account is needed for Azure Files, Azure Blobs, Azure Queues and Azure Tables

Azure Storage

Azure Storage - Data Redundancy

Option	Redundancy	Discussion
Locally redundant storage (LRS)	Three synchronous copies in same data center	Least expensive and least availability
Zone-redundant storage (ZRS)	Three synchronous copies in three AZs in the primary region	
Geo-redundant storage (GRS)	LRS + Asynchronous copy to secondary region (three more copies using LRS)	
Geo-zone-redundant storage (GZRS)	ZRS + Asynchronous copy to secondary region (three more copies using LRS)	Most expensive and highest availability

Block Storage

- Use case: Hard-disks attached to your computers
- Typically, ONE Block Storage device can be connected to ONE virtual server
- HOWEVER, you can connect multiple different block storage devices to one virtual server

Host Computer · Block Storage
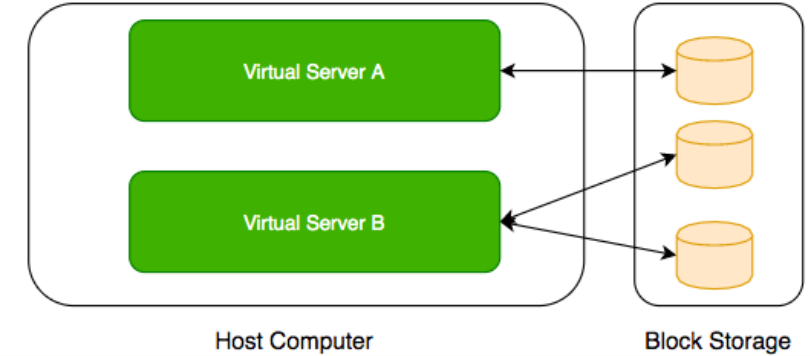
Azure Disks Storage

- **Disk storage:** Disks for Azure VMs
    - **Types:**
        - **Standard HDD**: Recommended for Backup, non-critical, infrequent access
        - **Standard SSD**: Recommended for Web servers, lightly used enterprise applications and dev/test environments
        - **Premium SSD disks**: Recommended for production and performance sensitive workloads
        - **Ultra disks (SSD)**: Recommended for IO-intensive workloads such as SAP HANA, top tier databases (for example, SQL, Oracle), and other transaction-heavy workloads
    - Premium and Ultra provide very high availability

- **Managed vs Unmanaged Disks:**
    - Managed Disks are easy to use:
        - Azure handles storage
        - High fault tolerance and availability
    - Unmanaged Disks are old and tricky (Avoid them if you can)
        - You need to manage storage and storage account
        - Disks stored in Containers (NOT Docker containers. Completely unrelated.)

Azure Storage

Azure Files

- Media workflows need huge shared storage for things like video editing
- Enterprise users need a quick way to share files in a secure & organized way
- **Azure Files**:
  - Managed File Shares
  - Connect from multiple devices concurrently:
    - From cloud or on-premises
    - From different OS: Windows, Linux, and macOS
  - Supports Server Message Block (SMB) and Network File System (NFS) protocols
  - Usecase: Shared files between multiple VMs (example: configuration files)

File Storage   Host Computer

Virtual Server A

Virtual Server B
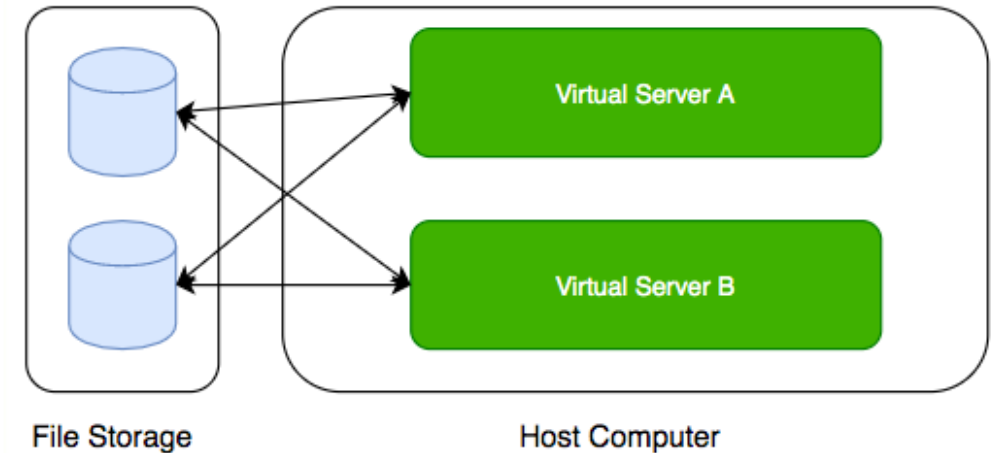
Azure Blob Storage

- **Azure Blob Storage**: Object storage in Azure
- **Structure**: Storage Account > Container(s) > Blob(s)
- Store massive volumes of unstructured data
  - **Store all file types** - text, binary, backup & archives:
    - Media files and archives, Application packages and logs
    - Backups of your databases or storage devices
- **Three Types of Blobs**
  - Block Blobs: Store text or binary files (videos, archives etc)
  - Append Blobs: Store log files (Ideal for append operations)
  - Page Blobs: Foundation for Azure IaaS Disks (512-byte pages up to 8 TB)
- **Azure Data Lake Storage Gen2**: Azure Blob Storage Enhanced
  - Designed for enterprise big data analytics (exabytes, hierarchical)
  - Low-cost, tiered storage, with high availability/disaster recovery

Azure Storage

Azure Blob Storage - Access Tiers

- **Different kinds of data** can be stored in Blob Storage
    - Media files, website static content
    - Backups of your databases or storage devices
    - Long term archives

- Huge variations in **access patterns**

- Can I pay a cheaper price for objects I access less frequently?
    - **Access tiers**
        - **Hot**: Store frequently accessed data
        - **Cool**: Infrequently accessed data stored for min. 30 days
        - **Archive**: Rarely accessed data stored for min. 180 days
            - Lowest storage cost BUT Highest access cost
            - Access latency: In hours
            - To access: **Rehydrate** (Change access tier to hot or cool) OR
                - Copy to another blob with access tier hot or cool
        - You can **change access tiers** of an object **at any point in time**

Azure Storage

Azure Queues and Tables

- **Azure Queues**: Decouple applications using messaging
- **Azure Tables**: NoSQL store (Very Basic)
    - Prefer Azure Cosmos DB for NoSQL

Database Fundamentals

Databases Primer

- Databases provide **organized** and **persistent** storage for your data
- To **choose between different database types**, we would need to understand:
  - Availability
  - Durability
  - RTO
  - RPO
  - Consistency
  - Transactions etc
- Let's get started on a **simple journey** to understand these

Database

Database - Getting Started

- Imagine a database deployed **in a data center in London**
- Let's consider some challenges:
  - **Challenge 1**: Your database will go down if the data center crashes or the server storage fails
  - **Challenge 2**: You will lose data if the database crashes

London Region

Application

Database

Corporate Data Center
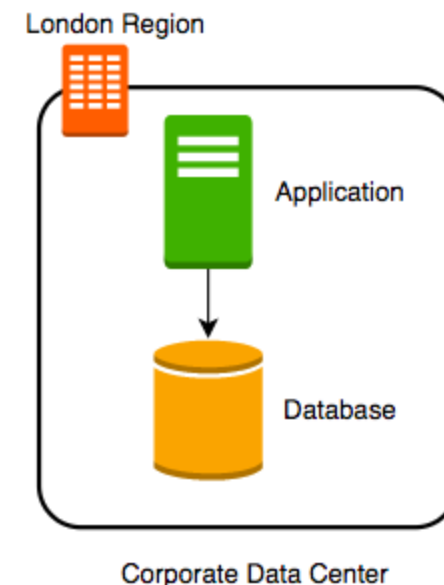
Database - Snapshots

- Let's automate taking copy of the database (**take a snapshot**) every hour to another data center in London

- Let's consider some challenges:
  - **Challenge 1**: Your database will go down if the data center crashes
  - **Challenge 2** (PARTIALLY SOLVED): You will lose data if the database crashes
    - You can setup database from latest snapshot. But depending on when failure occurs you can lose up to an hour of data
  - **Challenge 3**(NEW): Database will be slow when you take snapshots

London Region

Application

Database

Corporate Data Center-1

Database Snapshots

Corporate Data Center-2
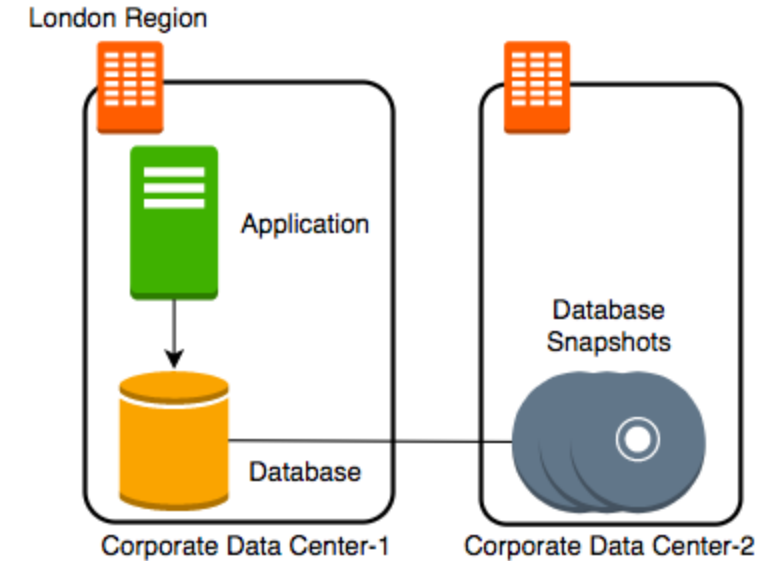
Database - Transaction Logs

- Let's add **transaction logs** to database and create a **process to copy it over** to the second data center
- Let's consider some challenges:
  - **Challenge 1**: Your database will go down if the data center crashes
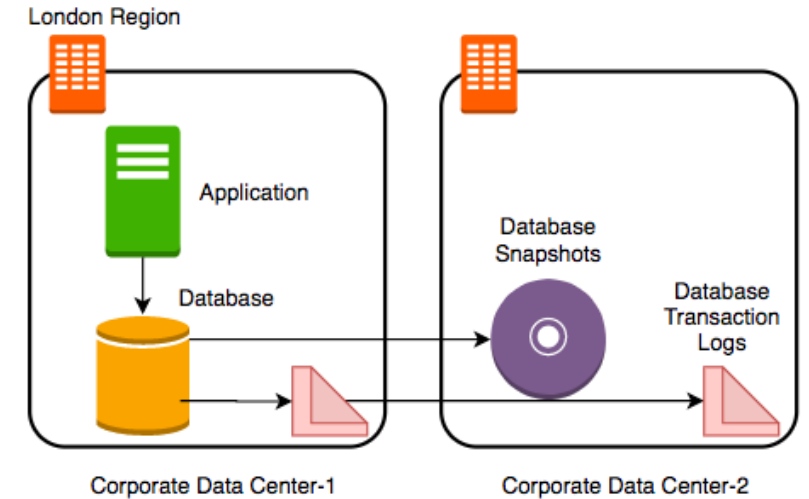 - **Challenge 2** (SOLVED): You will lose data if the database crashes
    - You can setup database from latest snapshot and apply transaction logs
  - **Challenge 3**: Database will be slow when you take snapshots

London Region

Application

Database

Corporate Data Center-1

Database Snapshots

Database Transaction Logs

Corporate Data Center-2

Database - Add a Standby

- Let's add a **standby database** in the second data center with replication
- Let's consider some challenges:
  - **Challenge 1** (SOLVED): Your database will go down if the data center crashes
    - You can switch to the standby database
  - **Challenge 2** (SOLVED): You will lose data if the database crashes
  - **Challenge 3** (SOLVED): Database will be slow when you take snapshots
    - Take snapshots from standby.
    - Applications connecting to master will get good performance always

London Region

Application

Database

Synchronous Replication

Snapshot

Standby Database

Corporate Data Center-1

Corporate Data Center-2
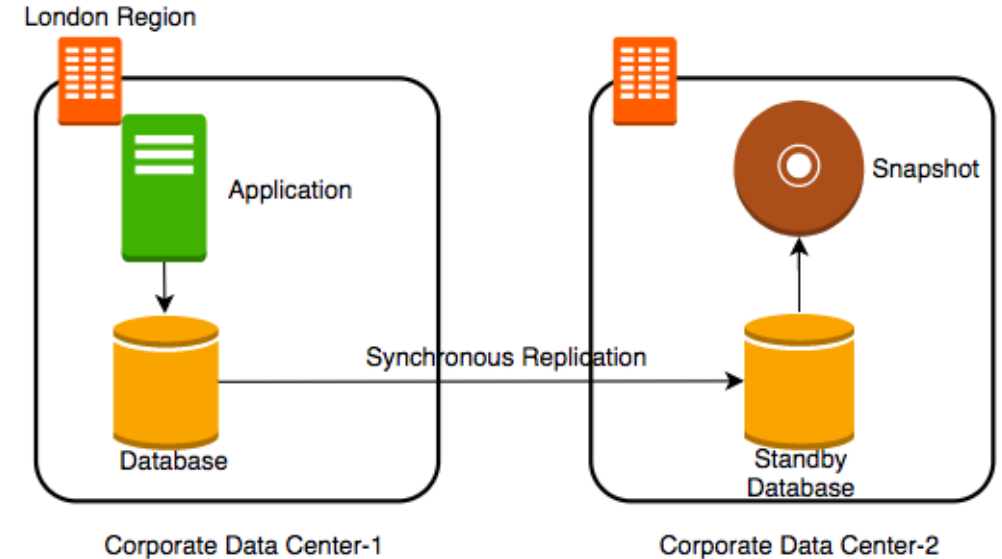
Availability and Durability

- **Availability**
  - Will I be able to access my data now and when I need it?
  - Percentage of time an application provides the operations expected of it
- **Durability**
  - Will my data be available after 10 or 100 or 1000 years?
- Examples of measuring availability and durability:
  - 4 9's - 99.99
  - 11 9's - 99.999999999
- Typically, an **availability of four 9's** is considered very good
- Typically, a **durability of eleven 9's** is considered very good

Availability

Availability	Downtime (in a month)	Comment
99.95%	22 minutes	
99.99% (4 9's)	4 and 1/2 minutes	Typically online apps aim for 99.99% (4 9's) availability
99.999% (5 9's)	26 seconds	Achieving 5 9's availability is tough

Durability

- What does a **durability of 11 9's** mean?
  - If you **store one million files for ten million years**, you would expect to **lose one file**
- Why should durability be high?
  - Because **we hate losing data**
  - Once we lose data, it is gone
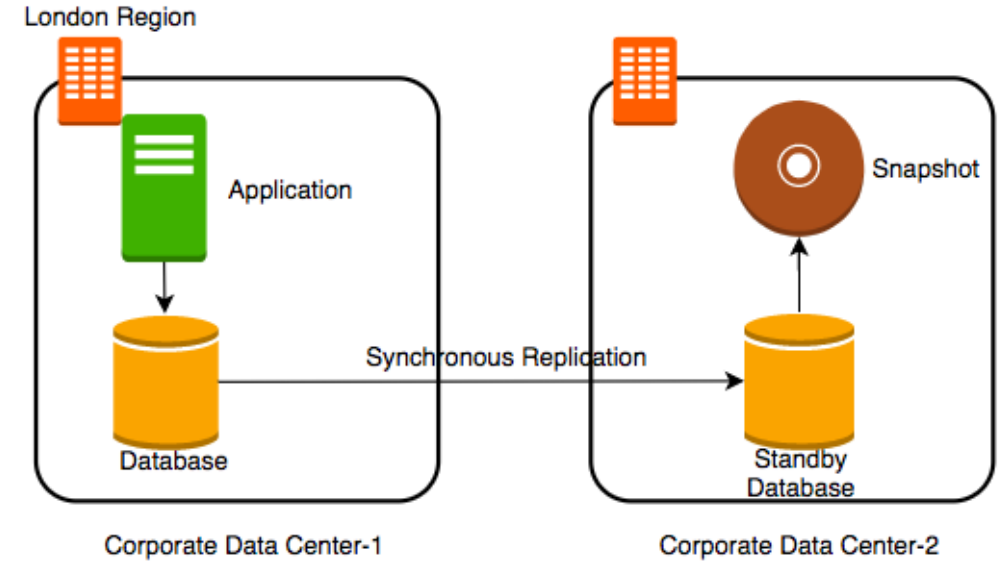
Increasing Availability and Durability of Databases

- **Increasing Availability**:
  - Have multiple standbys available OR distribute the database
    - in multiple Zones
    - in multiple Regions

- **Increasing Durability**:
  - Multiple copies of data (standbys, snapshots, transaction logs and replicas)
    - in multiple Zones
    - in multiple Regions

- **Replicating data** comes with its own challenges!
  - We will talk about them a little later
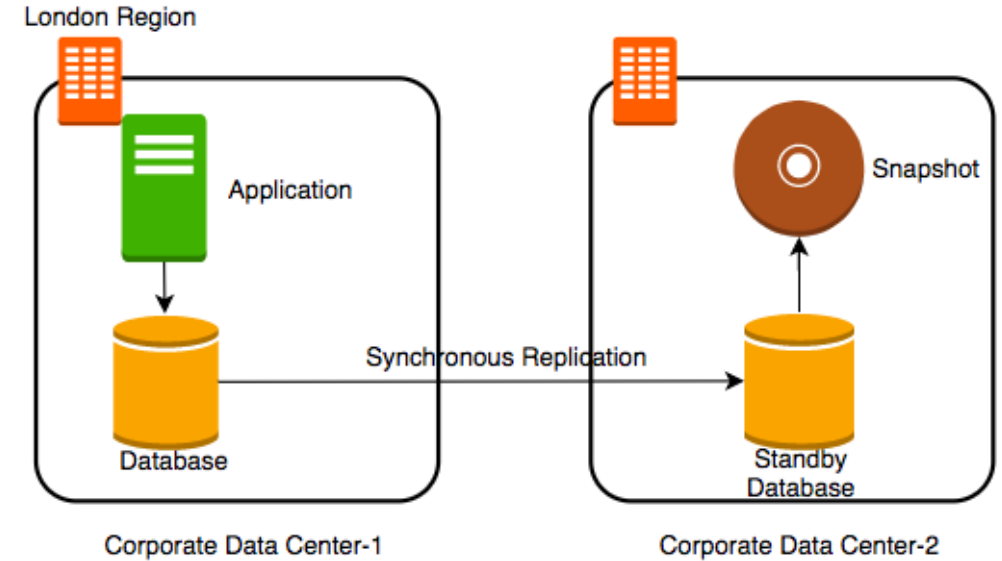
Database Terminology : RTO and RPO

- Imagine a **financial transaction being lost**
- Imagine a **trade being lost**
- Imagine a **stock exchange going down** for an hour
- **Typically** businesses are fine with some downtime but they hate losing data
- Availability and Durability are technical measures
- How do we measure **how quickly we can recover from failure**?
  - **RPO (Recovery Point Objective)**: Maximum acceptable period of data loss
  - **RTO (Recovery Time Objective)**: Maximum acceptable downtime
- Achieving **minimum RTO and RPO is expensive**
- **Trade-off** based on the criticality of the data

Database

Question - RTO and RPO

- You are running an application in VM instance storing its data on a persistent data storage. You are taking snapshots every 48 hours. If the VM instance crashes, you can manually bring it back up in 45 minutes from the snapshot. What is your RTO and RPO?
    - RTO - 45 minutes
    - RPO - 48 hours

Achieving RTO and RPO - Failover Examples

Scenario	Solution
Very small data loss (RPO - 1 minute) **Very small downtime (RTO - 5 minutes)**	**Hot standby** - Automatically synchronize data Have a standby ready to pick up load Use automatic failover from master to standby
Very small data loss (RPO - 1 minute) **BUT I can tolerate some downtimes (RTO - 15 minutes)**	**Warm standby** - Automatically synchronize data Have a standby with minimum infrastructure Scale it up when a failure happens
Data is critical (RPO - 1 minute) but I can tolerate downtime of a few hours (RTO - few hours)	Create regular data **snapshots and transaction logs** Create database from snapshots and transactions logs when a failure happens
Data can be lost without a problem (for example: cached data)	Failover to a completely new server

(New Scenario) Reporting and Analytics Applications

- New reporting and analytics applications are being launched using the same database
  - These applications will ONLY read data

- Within a few days you see that the database performance is impacted

- How can we fix the problem?
  - **Vertically scale the database** - increase CPU and memory
  - **Create a database cluster (Distribute the database)** - Typically database clusters are expensive to setup
  - **Create read replicas** - Run read only applications against read replicas

London Region

Application

Reporting Application

Database

Corporate Data Center-1
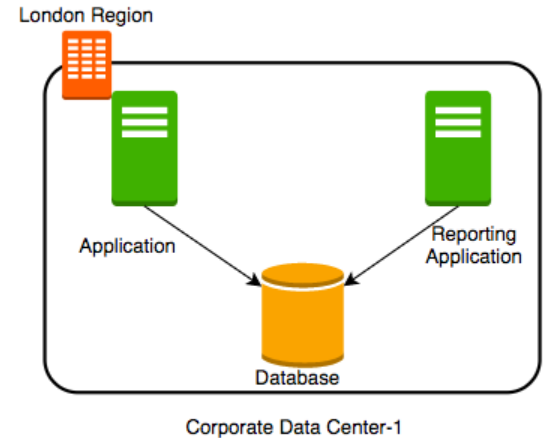
Consistency

- How do you ensure that data in multiple database instances (standbys and replicas) is updated simultaneously?
- **Strong consistency** - Synchronous replication to all replicas
  - Will be slow if you have multiple replicas or standbys
- **Eventual consistency** - Asynchronous replication. A little lag - few seconds - before the change is available in all replicas
  - In the intermediate period, different replicas might return different values
  - Used when scalability is more important than data integrity
  - Examples : Social Media Posts - Facebook status messages, Twitter tweets, Linked in posts etc
- **Read-after-Write consistency** - Inserts are immediately available
  - However, updates would have eventual consistency

London Region

Application   Reporting Application

Database   Asynchornous Replication   Read Replica

Corporate Data Center-1
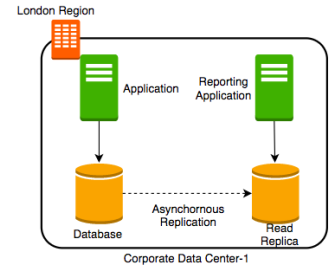
Database Categories

- There are **several categories** of databases:
    - Relational (OLTP and OLAP), Document, Key Value, Graph, In Memory among others
- **Choosing type of database** for your use case is not easy. A few factors:
    - Do you want a **fixed schema**?
        - Do you want flexibility in defining and changing your schema? (schemaless)
    - What level of **transaction properties** do you need? (atomicity and consistency)
    - What kind of **latency** do you want? (seconds, milliseconds or microseconds)
    - **How many transactions** do you expect? (hundreds or thousands or millions of transactions per second)
    - **How much data** will be stored? (MBs or GBs or TBs or PBs)
    - and a lot more...

SQL Database

Cosmos DB

Azure Database PostgreSQL

Synapse Analytics

Relational Databases

- This was the **only option** until a decade back!
- Most **popular (or unpopular)** type of databases
- **Predefined schema** with tables and relationships
- Very **strong transactional** capabilities
- Used for
  - OLTP (Online Transaction Processing) use cases and
  - OLAP (Online Analytics Processing) use cases

Instructor
ID : int
DepartmentName : varchar(255)
headedBy : varchar(255)
FirstName : varchar(255)
LastName : varchar(255)
Phone : varchar(255)

Department
Name : varchar(255)
Location : varchar(255)

Course
ID : int
DepartmentName : varchar(255)
InstructorID : int
Duration : int
Name : varchar(255)

Student
ID : int
FirstName : varchar(255)
LastName : varchar(255)
Phone : varchar(255)

Course_Student
CourseID : int
StudentID : int

Relational Database - OLTP (Online Transaction Processing)

- Applications where **large number of users make large number of small transactions**
  - small data reads, updates and deletes
- **Use cases:**Most traditional applications - ERP, CRM, e-commerce, banking
- **Popular databases:**
  - MySQL, Oracle, SQL Server etc
- **Recommended Azure Managed Services:**
  - **Azure SQL Database:** Managed Microsoft SQL Server
  - **Azure Database for MySQL:** Managed MySQL
  - **Azure Database for PostgreSQL:** Managed PostgreSQL

SQL Database

Azure Database
PostgreSQL

Azure SQL Database

- **Fully Managed Service** for Microsoft SQL Server
- 99.99% availability
- **Built-in** high availability, automatic updates and backups
- Flexible and responsive serverless compute
- Hyperscale (up to 100 TB) storage

SQL Database

Azure database for MySQL

- Fully managed, scalable **MySQL database**
- Supports 5.6, 5.7 and 8.0 community editions of MySQL
- 99.99% availability
  - Choose single zone or zone redundant high availability
- Automatic updates and backups
- Typically used as part of **LAMP (Linux, Apache, MySQL, PHP/Perl/Python)** stack

Azure Database MySQL

Azure Database for PostgreSQL

- Fully managed, intelligent and scalable **PostgreSQL**
- 99.99% availability
    - Choose single zone or zone redundant high availability
- Automatic updates and backups
- **Single Server and Hyperscale Options**
    - Hyperscale: Scale to hundreds of nodes and execute queries across multiple nodes

Azure Database
PostgreSQL

Relational Database - OLAP (Online Analytics Processing)

- Applications allowing users to **analyze petabytes of data**
  - **Examples** : Reporting applications, Data ware houses, Business intelligence applications, Analytics systems
  - **Sample application** : Decide insurance premiums analyzing data from last hundred years
  - Data is consolidated from multiple (transactional) databases
- Recommended Azure Managed Service
  - **Azure Synapse Analytics**: **Petabyte-scale** distributed data ware house
    - Provides a unified experience for developing end-to-end analytics solutions - Data integration + Enterprise data warehousing + Big data analytics
    - Enables MPP (massively parallel processing)
    - Run complex queries across petabytes of data
    - Earlier called Azure SQL Data Warehouse

Relational Databases - OLAP vs OLTP

- OLAP and OLTP use **similar data structures**
- BUT **very different approach in how data is stored**
- **OLTP databases** use row storage
  - Each table row is stored together
  - Efficient for processing small transactions
- **OLAP databases** use columnar storage
  - Each table column is stored together
  - **High compression** - store petabytes of data efficiently
  - **Distribute data** - one table in multiple cluster nodes
  - **Execute single query across multiple nodes** - Complex queries can be executed efficiently

Columnar Storage

Row Storage

Cluster   **Columnar Storage**
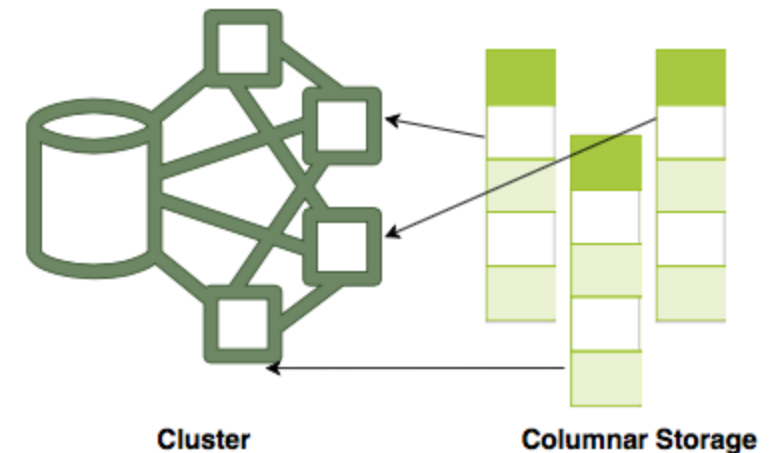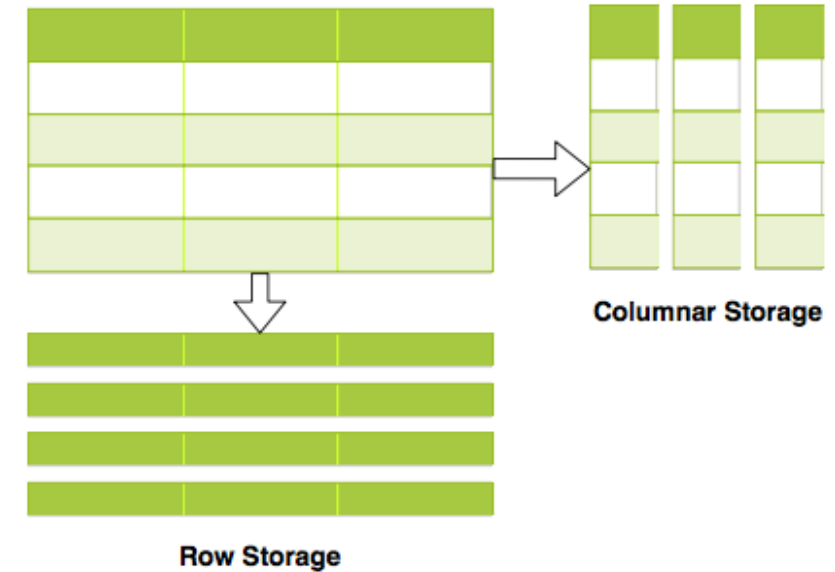
NoSQL Databases

- **New approach** (actually NOT so new!) to building your databases
  - NoSQL = not only SQL
  - Flexible schema
    - Structure data **the way your application needs it**
    - Let the schema evolve with time
  - Horizontally scale to petabytes of data with millions of TPS
- **NOT a 100% accurate generalization** but a great starting point:
  - Typical NoSQL databases trade-off "Strong consistency and SQL features" to achieve "scalability and high-performance"
- **Azure Managed Service**:
  - Azure Cosmos DB

Cosmos DB

Azure Cosmos DB

- **Fully managed NoSQL database service**
- **Global database**: Automatically replicates data across multiple Azure regions
  - Schemaless
  - Single-digit millisecond response times
  - 99.999-percent availability
  - Automatic scaling (serverless)
- Supports APIs for MongoDB (document), Cassandra (key/value) and Gremlin (graph)

In-memory Databases

- **Retrieving data from memory is much faster than retrieving data from disk**
- In-memory databases like Redis deliver microsecond latency by storing **persistent data in memory**
- Recommended Azure Managed Service
  - **Azure Cache for Redis**
- **Use cases** : Caching, session management, gaming leader boards, geospatial applications

Cache for Redis

Databases - Summary

Database Type	Azure Services	Description
Relational OLTP databases	Azure SQL Database, Azure Database for MySQL, Azure Database for PostgreSQL etc.	Transactional usecases needing **predefined schema** and very **strong transactional** capabilities (Row storage)
Relational OLAP databases	Azure Synapse Analytics	Columnar storage with predefined schema. Datawarehousing & BigData workloads
NoSQL Databases	Azure Cosmos DB	Apps needing **quickly evolving** structure (**schema-less**) MongoDB (document), Cassandra (key/value) and Gremlin (graph)
In memory databases/caches	Azure Cache for Redis	Applications needing **microsecond** responses

Databases - Scenarios

Scenario	Solution
A start up with quickly evolving schema (table structure)	Cosmos DB
Single-digit millisecond response times for global application with millions of users	Cosmos DB
Transactional local database processing thousands of transactions per second	Azure SQL Database OR Azure Database for MySQL OR Azure Database for PostgreSQL etc.
Cache data (from database) for a web application	Azure Cache for Redis
Database for analytics processing of petabytes of data	Azure Synapse Analytics

Networking

Need for Virtual Network

- In a corporate network or an on-premises data center:
    - Can anyone on the internet **see the data exchange** between the application and the database?
        - **No**
    - Can anyone from internet **directly connect to your database**?
        - Typically **NO**.
        - You need to connect to your corporate network and then access your applications or databases.

- Corporate network provides a **secure internal network** protecting your resources, data and communication from external users

- How do you do create **your own private network** in the cloud?
    - Enter **Azure Virtual Network**

London Region

Application   Database

Corporate Data Center

92
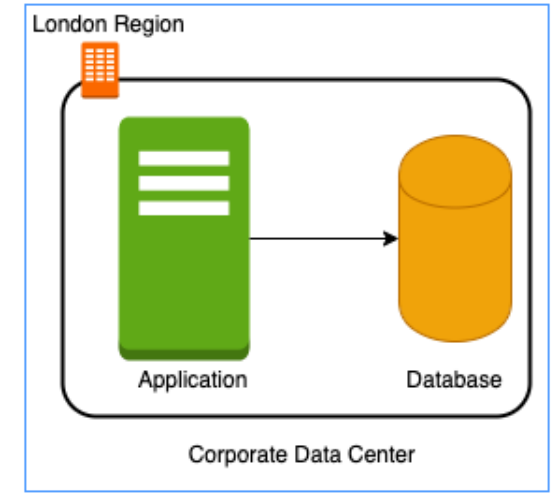
Azure Virtual Network

- Your **own isolated network** in Azure
  - Network traffic within a Virtual Network is isolated (not visible) from all other Azure Virtual Networks
  - Each Virtual Network is created in a Region
- You **control all the traffic** coming in and going outside a Virtual Network
- **(Best Practice)** Create all your Azure resources (compute, storage, databases etc) **within a Virtual Network**
  - Secure resources from unauthorized access AND
  - Enable secure communication between your cloud resources

Virtual Network

Need for Subnets

- Different resources are created on cloud
  - Databases, Compute (VMs) etc
- Each type of resource has **its own access needs**
- Load Balancers are accessible from internet (**public** resources)
- Databases or VM instances should NOT be accessible from internet
  - ONLY applications within your virtual network should be able to access them(**private** resources)
- How do you **separate public resources from private resources** inside a Virtual Network?
  - (Solution) **Create different subnets** for public and private resources
    - Resources in a public subnet **CAN** be accessed from internet
    - Resources in a private subnet **CANNOT** be accessed from internet
    - BUT resources in public subnet can talk to resources in private subnet

User

Load Balancer

Virtual Machine

Database

Things to Remember - Virtual Network

- Every VM in a VNet is **assigned a private IP address**
  - You can assign a public IP address and make it static as well!
- VMs in the same VNet **can communicate** using private IP addresses
  - Even if they are in different subnets
- **Network peering** can be use to connect resources in different Virtual Networks
  - Peered Virtual Networks can be in different regions

Virtual Network

Azure network security

Azure DDoS

- **(DDoS) attack**: Large scale attacks to bring your apps down
  - Result: App goes down or become slow. Huge bill because of unlimited auto scaling.
- **Two Azure DDoS offerings**:
  - DDoS Protection **Basic**: Protects against common network layer attacks
    - Intelligently identifies and blocks DDoS attacks
    - Enabled by default
    - No extra cost
  - DDoS Protection **Standard**:
    - Mitigates 60 different DDoS attack types
    - Provides attack analytics, metrics, alerting and reporting
    - Get quick support from DDoS Protection Rapid Response (DRR) team
    - Get a Cost guarantee (Receive service credit if DDoS attack results in scale-out)
    - Enable it on the Azure virtual network
    - DDoS Protection Standard + Web Application Firewall = Powerful combination that protects at:
      - Network layer (Layer 3 and 4, Azure DDoS Protection Standard)
      - Application layer (Layer 7, WAF)

DDoS Plans

Azure Firewall

- **Managed network security service** to control traffic in and out of a Azure Virtual Network
  - Stateful: Once traffic in is allowed, traffic out is automatically allowed
  - Centralized Configuration: With one Azure firewall, you can control traffic to multiple virtual networks (having hundreds of resources) across multiple subscriptions
    - Example : If your enterprise has 10 virtual networks (across multiple subscriptions) with 100 VMs, you can control traffic with one Azure Firewall
  - Integrates with Azure Monitor: Provides logging and analytics
- **(REMEMBER) Web application firewall (WAF)**
  - Restrict traffic into web applications
    - OWASP etc
  - Supported by Azure Application Gateway, Azure Content Delivery Network

Firewalls

Network Security Groups (NSG)

- **Azure Firewall is an external firewall** - outside your Virtual Network
  - **Network Security Group (NSG)** is like a internal firewall inside your Virtual Network right before your resources
- **Multiple inbound and outbound security rules**:
  - Allow or block traffic based on source/destination IP address, protocol and port
  - Restrict traffic between resources such as virtual machines and subnets
  - Attached with subnets and network interfaces
- **Usecases** : Allow access to web server only on port 80 and port 443 (HTTP/HTTPS)
  - Restrict database access only to web servers. Do NOT allow direct access to database from outside world/other servers.
  - Restrict outbound traffic from VMs to download software packages and system updates

Security Best Practice - Defense in depth

- "A chain is only as strong as its weakest link" - Secure at all levels:
  - Physical security: Control access to physical infrastructure (Responsibility of Microsoft)
  - **Perimeter**: Azure DDoS Protection + Azure Firewall
  - **Network**: Restrict internet access (inbound and outbound)
    - Restrict communication between resources
  - **Compute**:Secure access to virtual machines
    - Implement endpoint protection
    - Ensure that OS and software patches are applied
  - **Application**: Think of security from day one!
    - Implement security best practices depending on language and framework
    - Store secrets in Azure Key Vault
  - **Data**: Encrypt data at rest and in transit
  - **Best Practice**: Implement security at all levels!

DDoS Plans

NSG

Firewalls

Cloud Computing: Public vs Private vs Hybrid clouds

- Cloud Computing
  - Public Cloud
    - You host everything in the cloud (You DO NOT need a data center anymore)
      - No Capital Expenditure required
    - Hardware resources are owned by Azure (Microsoft)
      - Hardware failures and security of the data center are managed by Azure (Microsoft)
    - Summary: Hardware owned by Azure and shared between multiple tenants
      - Tenants: Customers who rent infrastructure (You, Me and other enterprises)
  - Private Cloud
    - You host everything in your own data center
      - Needs Capital Expenditure
      - Incur staffing and maintenance expenses for infrastructure
    - Delivers higher level of security and privacy
  - Hybrid Cloud :
    - Combination of both (Public & Private)
      - Use Public Cloud for some workloads and Private cloud for others
      - Example: Connecting an on-premise app to Azure Cosmos DB
    - Provides you with flexibility: Go on-premises or cloud based on specific requirement
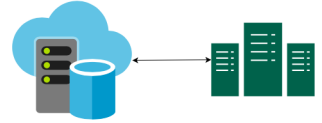
Hybrid Cloud: Connecting Azure with on-premises

- Options: VPN and Azure ExpressRoute
  - **VPN**: Encrypted connection from on-premises to Azure over internet
    - Needs VPN device or gateway on-premises
    - Need Azure VPN gateway in the Azure Virtual Network
    - Encrypted communication over Internet (public)
  - **Azure ExpressRoute**: Private connectivity to Azure Virtual Network
    - Provides very high bandwidth
    - Very high security (private connection)
    - Traffic does NOT go over internet
    - Traffic is NOT encrypted by the connection
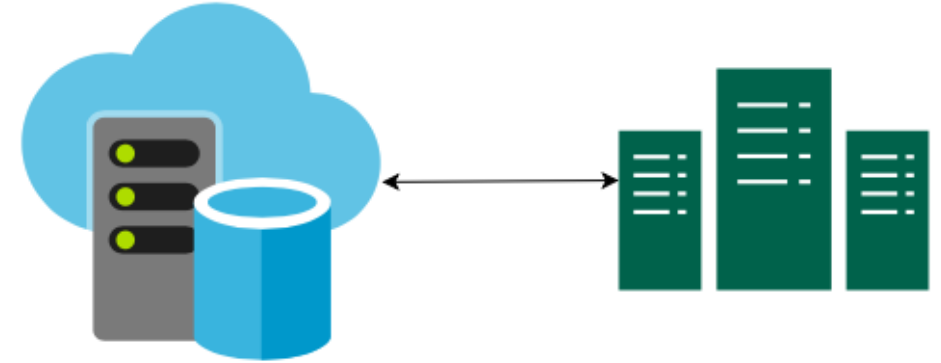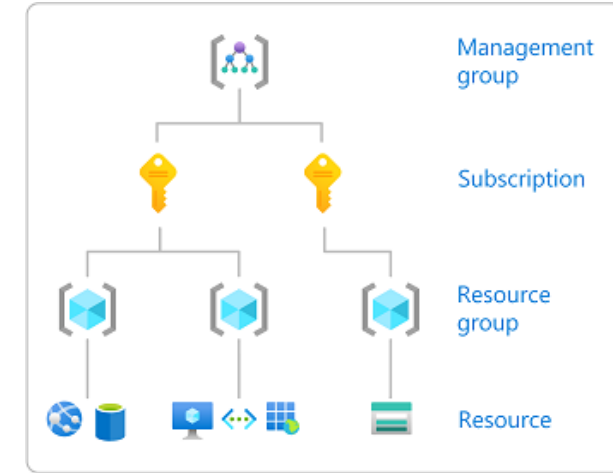
Organizing and Managing Azure Resources

Azure Resource Hierarchy

- **Hierarchy**: Management Group(s) > Subscription (s) > Resource Group (s) > Resources
  - **Resources**: VMs, Storage, Databases
  - **Resource groups**: Organize resources by grouping them into Resource groups
  - **Subscriptions**: Manage costs for resources provisioned for different teams or different projects or different business units
  - **Management groups**: Centralized management for access, policy, and compliance across multiple subscriptions
- **Remember**:
  - No hierarchy in resource groups BUT management groups can have a hierarchy

(*https://docs.microsoft.com/*)

Resource Groups

- **Resource Group**: Logical container for resources
    - Associated with a single subscription
    - Can have multiple resources
        - (REMEMBER) A resource can be associated with one and only one resource group
    - Can have resources from multiple regions
    - Deleting it deletes all resources under it
- Tags assigned to resource group are not automatically applied to resources
    - HOWEVER, Permissions/Roles assigned to user at the resource group level are inherited by all resources in the group
- Resource Groups (like Management Groups) are free
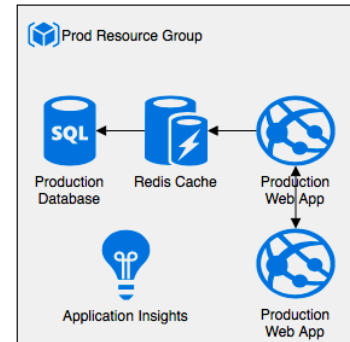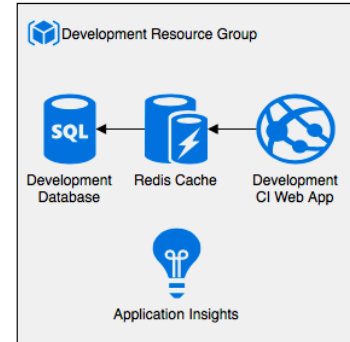
Subscriptions

- You need a Subscription to create resources in Azure
  - Subscription links Azure Account to its resources
- An Azure Account can have multiple subscriptions and multiple account administrators
- **When do you create a new subscription?**
  - I want to manage different access-management policies for different environments:
    - Create different subscriptions for different environments
    - Manage distinct Azure subscription policies for each environment
  - I want to manage costs across different departments of an organization:
    - Create different subscriptions for different departments
    - Create separate billing reports and invoices for each subscription (or department) and manage costs
  - I'm exceeding the limits available per subscription
    - Example: VMs per subscription - 25,000 per region

Subscriptions

Subscriptions - Remember

- Two Subscriptions **CANNOT be merged** into one
  - HOWEVER, you can move resources from one to another (ex: VMs)
  - You can also transfer ownership of a subscription (Needs owner role)
- If Subscription expires:
  - You will NOT be able to create new resources in the subscription
  - BUT you can continue to access the data stored
- Each subscription is associate with quotas:
  - You can raise a support request to increase some of the quotas
- You can convert a **Free Trial** to a **Pay as you go** subscription
- **Spending limit**: Prevents spending over your credit amount
  - Azure free account (spending limit: $200) or credit subscription types have default spending limits
  - You can't change spending limit BUT you can remove it

Subscriptions

Management Groups

- Allows you to manage access, policies, and compliance across multiple subscriptions
  - Group subscriptions into **Management Groups**
  - All subscriptions & resources under a Management Group inherit all constraints applied to it
- (REMEMBER) You can create a hierarchy of management groups
- (REMEMBER) All subscriptions in a management group should be associated with the same Azure AD tenant

(*https://docs.microsoft.com/*)
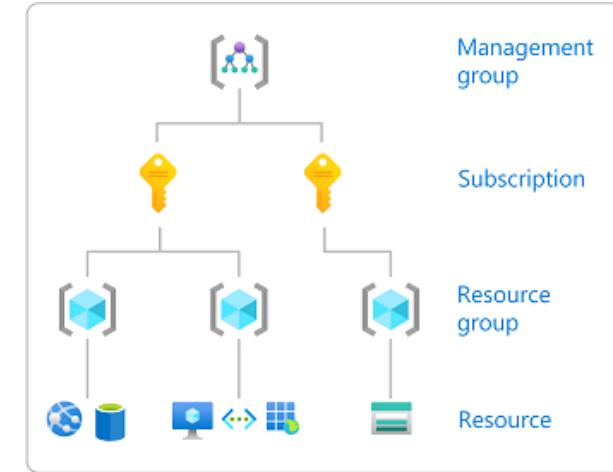
Azure Security Features

Azure Security Center

- **Security posture management & threat protection** for hybrid cloud workloads
  - Microsoft implements several types of controls to secure Azure
  - HOWEVER, You need to take additional actions to secure your workloads
  - How do you decide what actions to take?
- **Two Main Goals:**
  - To help you understand your current security situation
    - Centralized management of security policies
    - Monitor your compliance against regulatory requirements (example: Payment Card Industry's Data Security Standard (PCI DSS), ISO 27001)
      - Option to download regulatory compliance reports
    - Provides a Azure Secure Score
      - To improve secure score, adhere to more security controls
  - To help you efficiently and effectively improve your security
    - Azure Security Center provides continuous assessment and security recommendations

Azure Security Center - Continued

- **Example Rules:**
  - Encrypt data in transit
  - Enable auditing and logging
  - Azure Backup should be enabled for virtual machines
- **Basic Features** (Continuous assessment and security recommendations, Azure secure score) **are free:**
  - ($$$) Enable Azure Defender for advanced features
    - Just in time VM Access, Regulatory Compliance Dashboard, Threat protection for VMs and PaaS services
    - Provides 30-day free trial
- **Just-in-time (JIT) VM access:** Lock down inbound traffic to Azure VMs
  - Reduce exposure to attacks
  - BUT provides easy access when needed

Security Center

Azure Sentinel

- **Intelligent security analytics** for your entire enterprise
- **Security information and event management (SIEM)** solution
- **Detect threats and respond fast** using AI
  - Behaviour analytics to stay ahead of evolving threats
- Four phases:
  - Collect
  - Detect
  - Investigate
  - Respond

Azure Sentinel

Azure Key Vault

- **Securely store and access secrets**
  - Examples: API keys, passwords, certificates, or cryptographic keys
- Provides access monitoring and access control for secrets
- (Best Practice) Do NOT store secrets or passwords (example, database passwords) in your application code or configuration
  - Use Azure Key Vault

Key Vault

Core Azure identity services

Typical identity management in the cloud

Users

- You have **resources** in the cloud (examples - a virtual server, a database etc)
- You have **identities (human and non-human)** that need to access those resources and perform actions
  - For example: launch (stop, start or terminate) a virtual server
- How do you **identify users** in the cloud?
- How do you configure resources they can access?
- How can you configure what actions to allow?
- In Azure, *Azure Active Directory* provides this service

Authentication vs authorization

- **Authentication** (is it the right user?) and
- **Authorization** (do they have the right access?)
- Each app and service need to authenticate and authorize users:
    - Would it be a good solution for each app and service to store their own user details (including credentials)?
    - What if we can store the user details (including credentials) in a centralized way and use it across multiple apps and services?
    - Enter "Centralized identity provider"
    - Enter "SSO"

Active Directory

- **Active Directory**: Very popular Microsoft's proprietary directory service
- Define users, credentials and their access rights
  - Provides authentication and authorization
  - Supports groups
- **Active Directory Federation Services (AD FS)**: Single sign-on service
  - Enables you to login to multiple apps and services with the same credentials!
- Used in on-premises environments

Active Directory

Azure Active Directory

- **Azure Active Directory (Azure AD)**: Active Directory Service in Azure
    - Control enterprise users and their access to applications and Azure resources
        - Supports Azure and Microsoft 365
        - 99.9% availability SLA (Premium edition)
    - Build applications and enable them to **use SSO**
    - **Azure AD Connect**: Synchronize on-premises Active Directory with Azure AD
        - Synchronize all user details including passwords
    - **Azure AD MFA**: Authenticate users in multiple ways
        - MFA - Multi Factor Authentication
            - Use 2 of 3 authentication methods:
                - Something you know, typically a password.
                - Something you have, trusted device
                - Something you are, fingerprint or face scan
        - Recommended for Administrative accounts
        - **Needs Azure Active Directory Identity Protection**
    - **Azure AD self-service password reset**: Global Administrators can enable the feature to allow users to reset passwords by themselves

Active Directory

Conditional Access

- When a user tries to authenticate, there are **three important signals**:
    - WHO is the user? (Administrator or Super User or User)
    - WHERE is she? (Which location? Is that a normal location for that user?)
    - WHAT device is she using? (Is this the device she usually logs in from?)
- **Can we build intelligence** based on this information?
    - If the user is an administrator, mandate MFA
    - If the user is logging in from unapproved devices, deny access
    - If a user is logging in from a previously known location using a previously used device, allow access without MFA
    - If a user is logging in from an unknown or unexpected location (different country, for example), mandate MFA or even deny access
- **Conditional Access**: granular MFA experience
- Only available with Azure AD Premium P1 or P2 licenses

Conditional Access

Role-Based Access Control (RBAC)

- **Configure Authorization**: Which resources does a user have access to and what can she do with them?
- **Role assignment has 3 parts**:
  - Who? (principal)
  - What Permissions? (role)
  - What Scope? (resource OR resource group OR subscription OR management group)
- **Example**: Apply same permissions across multiple VMs
  - Create VMs in the same resource group
  - Assign role to resource group

(*https://docs.microsoft.com/*)

Azure Active Directory & Azure Subscriptions - Remember

- Subscription has a **trust relationship** with Azure Active Directory (Azure AD)
  - Trusts Azure AD to authenticate users, services, and devices
  - Multiple subscriptions can trust the same Azure AD directory
  - However, each subscription can only trust only one directory
- **You can transfer** an Azure subscription to a different Azure AD directory
- **When an Azure subscription expires**:
  - Associated Azure AD tenant is not deleted
  - You can link it with a different subscription

Azure management tools

Azure Support Plans

- **Plans**: Basic, Developer, Standard, Professional Direct (ProDirect)
  - **Earlier plans** - Premier, Professional Direct, Standard and Basic
- **Features supported for ALL plans**
  - Billing and subscription management support
  - Ability to submit as many support tickets as you need
  - Azure Advisor (Automated Azure best practices)
  - Azure health status and notifications
  - 24/7 self-help resources:
    - Documentation and community support (Forums - MSDN, StackOverflow)
- **Supported by Professional Direct ONLY**
  - Support API (Create support tickets programmatically)
  - ProDirect delivery managers: Get proactive guidance. Request for service reviews and advisory consultation.
  - Webinars led by Azure engineers

Support

Azure Support Plans - Comparison

Feature	Basic	Developer	Standard	Professional Direct
Price	FREE	$	$$	$$$$$$
Scope	All	Trial and non-production environments	Production environments	Business-critical applications
Email & Phone support	NOT APPLICABLE	During business hours by email only	24 X 7	24 X 7
Response time SLA	NOT APPLICABLE	Sev C:8 hours	Sev C:8 hours, Sev B:4 hours, Sev A: 1 hour	Sev C:8 hours, Sev B:4 hours, Sev A: 1 hour
Architecture Support	NA	General guidance	General guidance	Guidance from a pool of ProDirect delivery managers

Azure Advisor

- **Automated recommendations** to improve reliability, security & performance, achieve operational excellence & reduce costs
  - Take immediate actions or schedule or dismiss
  - Supports notifications for new recommendations
  - Filter recommendations by subscriptions, resource groups or service
  - Step-by-step guidance and quick actions for fast remediation
  - Gives you a **total score**: Score improves as you take remedial actions
  - **Example Recommendations**:
    - Reliability: Protect your VM data from accidental deletion (Identify VMs where backup isn't enabled)
    - Reliability: Create Azure Service Health alerts to be notified when Azure problems affect you
    - Cost optimization: Optimize VM spend by resizing or shutting down underutilized instances
    - Cost optimization: Optimize spend for MySQL, and PostgreSQL servers by right-sizing
    - Cost optimization: Delete unassociated public IP addresses to save money
    - Cost optimization: Use lifecycle management

Advisor

Azure Monitor

- **Gather, analyze and visualize logs and metrics:**
  - From Azure and on premise resources
  - Monitor resources across multiple subscriptions
  - Proactively identify issues and trigger alerts/automated actions
  - Things you can do with Azure Monitor:
    - **Application Insights**: Detect & diagnose application issues
    - **VM insights**: Monitor performance & health of your VMs and VM scale sets
    - **Container insights**: Monitor performance of container workloads (AKS, ACI etc)
    - **Log Analytics**: Trouble shoot issues using monitoring data extracted from logs
    - **Create smart alerts** (SMS, emails etc) and attempt to automatically take corrective action
      - Automatically send an alert if an Azure VM is stopped
      - Trigger alerts based on data in an Azure Log Analytics workspace
      - Auto scale based on thresholds
    - Create visualizations with Azure dashboards
    - Collect data from monitored resources using Azure Monitor Metrics
    - Monitor Azure Active Directory logs

Automation

Azure Service Health

- **Personalized alerts and guidance** for Azure service issues
  - Personalized based on your Azure usage - subscriptions, services and regions
  - Notifies about Azure service incidents & planned maintenance
    - Best place to know about outages, issues and planned maintenance
  - **Best Practice**: Set up Service Health alerts
    - Get notified about service issues
    - Channels: email, SMS, push notification, webhook etc

- **Hierarchy**: Azure Status > Azure Service Health > Azure Resource Health
  - Azure Status: Global view of the health of Azure services and regions
  - Azure Service Health : Personalized dashboard based on your Azure usage
  - Azure Resource Health : Provides information about the health of your individual cloud resources such as a specific virtual machine instance

- Azure service health **can only inform** (CANNOT prevent failure)

Azure Management Services - Scenarios

Scenario	Solution
Get details of upcoming planned outages for services you are making use of	Azure Service Health
Get details of services which will be decommissioned	Azure Service Health
Get alerts for new recommendations to improve reliability, security and performance, achieve operational excellence and reduce costs	Azure Advisor
Set up alerts for incidents & planned outages for services you are making use of	Azure Service Health
Set up alerts for issues specific to your resources - VM goes down or Database goes down or Autoscaling is triggered	Azure Monitor
Solve your application related issues	Azure Monitor (Application Insights)

Azure Management Services - Scenarios - 2

Scenario	Solution
Get suggestions on how to reduce costs of your Azure resources	Azure Advisor
Get suggestions on how to improve reliability of your Azure resources	Azure Advisor
Get suggestions on how to improve security of your Azure resources	Azure Advisor
You want to find out if you are adhering to recommended Azure best practices	Azure Advisor
Track performance of a specific database or a VM instance	Azure Monitor
Gather metrics that are tailored for your application	Azure Monitor

Azure SLAs and Service Lifecycles

Azure Service Level Agreement (SLA)

- **Service Level Agreements (SLA)**: "Formal agreement between service provider and the service customer (or consumer)"
    - **SLAs for individual Azure services**
        - *https://azure.microsoft.com/en-gb/support/legal/sla/*
    - (REMEMBER) Free Services do NOT have an SLA
        - ex: Azure Advisor

- **Azure Status** (*https://status.azure.com/status*): Generic health of Azure services & regions

- **Azure Service Health**: Health of Azure services and regions you're using

SLA for Azure Cosmos DB

Last updated: December 2020

Azure Cosmos DB is Microsoft's fast NoSQL database with open APIs for any scale. It offers turnkey global distribution across any number of Azure regions by transparently scaling and replicating your data wherever your users are. The service offers comprehensive 99.99% SLAs which covers the guarantees for throughput, consistency, availability and latency for the Azure Cosmos DB Database Accounts scoped to a single Azure region configured with any of the five Consistency Levels or Database Accounts spanning multiple Azure regions, configured with any of the four relaxed Consistency Levels. Azure Cosmos DB allows configuring multiple Azure regions as writable endpoints for a Database Account. In this configuration, Azure Cosmos DB offers 99.999% SLA for both read and write availability.

Introduction	∨
General Terms	∨
SLA details	∨

Azure Service Level Agreement (SLA) - Remember

- If Azure is unable to meet SLA, you can request for a "service credit"

- **Modern Lifecycle Policy** : Covers products and services that are serviced and supported continuously
  - Microsoft will provide a minimum of 12 months notification prior to ending support if no successor product or service is offered excluding free services or preview releases
  - For Security updates : 30 days notification is give if an action on customers part is required to prevent significant degradation

The following Service Levels and Service Credits are applicable to Customer's use of Virtual Machines, deployed across two or more Availability Zones in the same region:

MONTHLY UPTIME PERCENTAGE	SERVICE CREDIT
< 99.99%	10%
< 99%	25%
< 95%	100%

Identify actions that can impact an SLA

- You need to identify the right SLA for your app: **99.9% or 99.99% or ..**
  - Enterprises can use Azure SLA to calculate SLAs for their offerings:
    - If you have a database and VM with SLA's 99% each, combined SLA will be 0.99 * 0.99 = 0.9801 i.e. 98% (More services you need => Lesser SLA)

- **How can you improve the SLA of your app?**
  - Do NOT use free tier products as they do NOT offer an SLA
  - Choose the right product features:
    - 99.9% - Single Instance VM using Premium SSD or Ultra Disk
    - 95% - Single Instance VM using Standard HDD Managed Disks
    - *https://azure.microsoft.com/en-us/support/legal/sla/virtual-machines/v1_9/*
  - Deploy to **two or more Availability Zones**:
    - 99.99% - VM connectivity to at least one instance when you have two or more instances deployed across two or more Availability Zones in the same Azure region
  - **Increase Redundancy** : deploy components across multiple regions
    - Add redundancy at all layers

Service lifecycle in Azure

- New services (and features) are frequently released
- Releases follow a pre-determined **service lifecycle** :
  - **Private Preview** (OPTIONAL): Released for evaluation of a subset of customers BUT WITH NO SLAs
  - **Public Preview**: Available to all customers BUT WITH NO SLAs
    - You can experiment with the services and provide feedback to Microsoft
    - NOT recommended for business-critical workloads
      - Use the services or features in production at your own risk!
    - Azure portal preview features - *https://preview.portal.azure.com/*
    - Explore preview services - Create a resource > Search for "preview"
  - **General Availability**: Available to all customers with SLAs
    - Recommended for production use
- Stay Updated with New Features and Services - *https://azure.microsoft.com/en-us/updates/?status=inpreview*
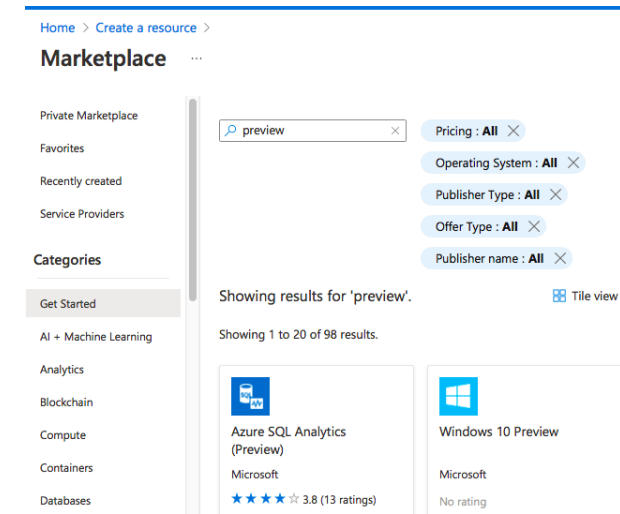
Azure governance features

Azure Policy

- **How do you ensure that resources stay compliant with your policies**?
  - Create, assign, and manage policies
    - Automatically ensure that resources stay compliant with defined standards and SLAs
  - Manage compliance of resources across multiple subscriptions
  - Assigned to a management group, a single subscription, or a resource group

- **Initiatives**: Group of policies
  - Azure provides some predefined initiatives:
    - Azure Security Benchmark, UK OFFICIAL and UK NHS, HIPAA etc
    - View them under `Policy> Authoring > Definitions`

- **Compliance dashboard**: Aggregated view of the overall compliance with options to drill down to specific resource/policy

- **Use cases**: Governance for resource consistency, regulatory compliance, security, cost, and management

Policy

Azure Policy - Examples and more..

- **Examples:**
  - Only allow creation of VMs of specific sizes
  - Only allow creation of resources in a specific region
  - Automatically tag all resources in a resource group with the same tags as that of the resource group
  - MFA should be mandatory for certain types of accounts

Policy

- Existing non-compliant resources will be marked as non-compliant
  - But they will continue to work as is
- Policy evaluation is **NOT immediate**
  - Approx: once every hour

Azure Blueprints

- **Azure Blueprint** = One or more of (Policy + Role + ARM template + Resource Group) configurations
  - Different pre-built blueprints available
    - Australian Government, UK OFFICIAL, Azure Security Benchmark, Basic Networking, Common Policies (Set of popular policies to apply to a subscription), FedRAMP, HIPAA etc
- **Your architecture team can create blueprints** adhering to your organization's standards, patterns, and requirements
  - And your teams use the blueprints to create Azure resources
    - Blueprints can be assigned to individual subscriptions
    - Blueprints can be used to set up resource groups within subscriptions
  - Helps teams to quickly set up environments adhering to organizational standards
    - You can even setup an automated CI/CD pipeline

Cloud Adoption Framework for Azure

Microsoft Cloud Adoption Framework for Azure

Define Strategy
- Understand motivations
- Business outcomes
- Business justification
- Prioritize project

Plan
- Digital estate
- Initial organization alignment
- Skills readiness plan
- Cloud adoption plan

Ready
- Azure setup guide
- First landing zone
- Expand the landing zone
- Best practices

Adopt

Migrate
- Azure migration guide
- Migration scenarios
- Best practices
- Process improvements

Innovate
- Azure innovation guide
- Innovation scenarios
- Best practices
- Process improvements

Govern
- Methodology • Benchmark
- Initial best practice •
- Governance maturity

Manage
- Business commitments
- Operations baseline •
- Operations maturity

(*https://docs.microsoft.com/*)

139

Resource Locks

- **Prevent accidental deletion/modification** of resources:
  - **Applicable at multiple levels**: subscription, resource group, or resource
    - Azure Resource inherits locks from its resource group and subscriptions
  - Two options: CanNotDelete and ReadOnly
  - Locked resource should be unlocked before it can be changed (even by owners)
- **Two Options**:
  - ReadOnlyLock : Authorized users can read BUT they can't delete or update the resource
  - CannotDelete : Authorized users can read and modify BUT they can't delete the resource
- **Example** : If a Resource Group has a Delete Lock, then administrator can first remove DELETE lock before she can delete the resources
- You can have multiple locks at different levels

Resource Groups

Subscriptions

Privacy and Compliance

Azure - Privacy & Information Protection

Service/Documentation	Description
Microsoft Privacy Statement	Explains the personal data Microsoft processes, how Microsoft processes it, and for what purposes.
Product Terms Site	Terms and conditions for software and online services products.
Data Protection Addendum	Your and Microsoft's obligations with respect to the processing and security of Customer Data and Personal Data in connection with Azure Search for DPA at *https://www.microsoftvolumelicensing.com/DocumentSearch.aspx*. Covers Data transfer, Data retention, Data deletion and Data Security
Azure Information Protection	Classify and protect your documents and emails Add labels indicating what kind of protection/encryption you want Uses Azure Rights Management (Azure RMS) - Integrates with Office 365, Azure Active Directory etc Protection stays with the documents and emails independent of the location, networks, file servers, and applications

Compliance & Azure - Compliance Hub & more...

- **What is Compliance?**
  - Depending on the domain of your enterprise, you need to adhere to several industry and security standards (in addition to corporate and regulatory policies)
- You are using services provided by Azure and storing data in Azure
- What standards & regulations does Azure services adhere to?
  - **Service Trust Portal**: *https://servicetrust.microsoft.com*
- How does Azure help you with compliance?
  - **Azure Compliance Hub**: *https://docs.microsoft.com/en-us/azure/compliance/*
    - **Azure Security and Compliance Blueprints** - Easily create environments compliant with different standards - ISO:27001, PCI DSS etc
  - **Azure Compliance Manager**: Part of Service Trust Portal
    - Automates complete compliance lifecycle: Manage Risks, Implement Controls, Check compliance against regulations and standards,Reporting to Auditors

Compliance

Compliance & Azure - Important Standards to Remember

- **90+ Azure compliance offerings can be grouped into four segments**: Global, US government, industry specific, and region/country specific
  - 50+ compliance offerings specific to global regions and countries (the US, the European Union, Germany, etc.)
  - 35+ compliance offerings specific to the needs of key industries (health, government, finance etc)
  - Important Standards to Remember:
    - International Organization for Standardization (ISO): ISO:27001 (Security controls), ISO:27017(Security controls for use of cloud services), ISO:27701 (privacy standard), ISO:27018 (privacy on cloud)
    - Service Organization Compliance (SOC): SOC-1 (Auditing standard), SOC-2 (Assessment of service provider controls)
    - General Data Protection Regulation (GDPR): Strengthens personal data protection in Europe
    - Health Insurance Portability & Accountability Act (HIPAA): Data privacy & security requirements for organizations handling PHI
    - Payment Card Industry - Data Security Standards (PCI-DSS)

Compliance

Azure & Compliance - A Quick Summary

Service	Description
Service Trust Portal	Independent audit reports for Microsoft's Cloud services ***https://servicetrust.microsoft.com***
Azure Compliance Hub	Compliance offerings in Azure ***https://docs.microsoft.com/en-us/azure/compliance/*** Offers blueprints to simplify your compliance implementations
Azure Compliance Manager	Manage your organization's compliance requirements Part of Service Trust Portal

Azure Sovereign Regions

Service	Detail
Azure global	What we are using until now!
Azure Government	Cloud environment specifically built to meet compliance and security requirements for US government Examples: FedRAMP (Federal Risk and Authorization Management Program), NIST (National Institute of Standards and Technology), ITAR (International Traffic in Arms Regulations), IRS 1075 (Internal Revenue Service), DoD (U.S. Department of Defense) L4, and CJIS (Criminal Justice Information Services) Uses physically isolated data centers and networks located in US Only US government entities and contractors are eligible to use Azure Government services
Azure China	Physically separated instance of cloud services located in China Operated by **21Vianet** (Azure China) Complies with regulation in China (China Telecommunication Regulation)
Azure Germany	Physically isolated instance of Microsoft Azure in Germany. No longer accepting customers!

Azure cost management - planning and managing costs

Consumption-based vs Fixed-price Pricing Models

- **Consumption-based** – You are billed for only what you use
  - Example: Azure Functions - You pay for no of invocations!
- **Fixed-price** - You are billed for instances irrespective of whether they are used or not
  - Example: You provision a VM instance
    - You pay for its lifetime irrespective of whether you use it or NOT
  - Example: App Service - You choose App Service plan (Basic, Standard or Premium plans)
    - You are billed irrespective of whether you use it or not

Expenditure Models: CapEx vs OpEx

- **Capital Expenditure (CapEx):** Money spent to buy infrastructure
  - Additional cost to maintain infrastructure with time
  - You might need a team to manage the infrastructure
  - Example: Deploying your own data center with physical servers
  - Example: Purchasing Azure Reserved VM Instances
  - Example: Leasing Software

- **Operational Expenditure (OpEx):** Money spent to use a service or a product
  - Zero upfront costs
  - You Pay for services as you use them (Pay-as-you-go model)
  - Example: Provisioning VMs as you need them
  - Example: Using Azure Functions and paying for invocations

Total Cost of Ownership (TCO) calculator

1 Define your workloads — 2 Adjust assumptions — 3 View report

- **Estimate the cost savings** you get by migrating your workloads to Azure
- **1: Define your workloads**: Enter the details of your on-premises workloads
  - Servers, Databases, Storage, Networking details
- **2:Adjust assumptions**: Customize Electricity costs, Storage costs, IT labour costs, Hardware costs, Software costs etc
- **3:View report**: Side-by-side comparison of the cost breakdown

Pricing calculator

- **Estimate the costs for Azure services**
- Example Services that you can estimate costs for:
  - Virtual Machines
  - Storage Accounts
  - Azure SQL Database
  - App Service
  - Azure Cosmos DB
  - Azure Kubernetes Service (AKS)
  - Azure Functions
- Ideal place to explore and learn important factors about different Azure services

How is cost decided?

Factor	Details
Resource type and configuration	How much memory? How much CPU? Which access tier?
Usage meters	How long was your VM running for? How much ingress and How much egress? How many invocations of an Azure function?
Azure subscription type	Free trial vs Pay as you go vs Enterprise Agreement
Azure Marketplace	Vendors decide pricing on Azure Marketplace
Which Region?	Price varies from Region to Region
Data transfer	Ingress and Egress Inbound data from on-premises to Azure is free Outbound data from Azure to On-Premises is NOT free Data traffic between Azure Services in the same region/AZ is free
Reserved or Not	Some services offer reservations ahead of time

Azure Cost Management

- **Setup and manage your account**
  - Configure subscriptions, manage invoices and payment methods
- **Analyze and optimize cloud costs**
  - Break down and analyze costs to get a deeper understanding of cost and usage patterns
- **Control and optimize costs**
  - Setup Budget and Cost Alerts

Cost Management

Managing Costs - Best Practices

- Estimate costs before you deploy (Pricing Calculator)
  - Calculate TCO
- Group resources based on cost ownership
  - Subscriptions, Resource Groups, Tags
- Use Cost Management features
  - Cost analysis
  - Budgets and Cost alerts
  - Advisor recommendations
- Stop Resources when you don't need them
  - (Remember) You pay for active resources
    - Even if you stop a VM, hard disks and data are still stored. You need to pay for storage.
- Use Managed Services (PaaS >>> IaaS)
- Reserve VMs for 1 or 3 years (Azure Reservations)

Cost Management

More Azure

Tags

- **Identify applications, environments or business units** that a specific resource is associated with
  - **Report and track costs** for a group of resources by assigning them with the same tag
  - **Group resources** based on their SLA, security or compliance requirements
- **Best Practice**: Identify mandatory tags that all resources should have and enforce it using Azure Policy
  - Example: Environment, BusinessUnit, Priority
- **Tags for Resources** are not inherited by default from their Resource Group

Tags

Windows Virtual Desktop

- Your enterprise has remote developers. **How do you provide Desktops to them?**
    - One option to consider is "Windows Virtual Desktop"
- Connect with any device (Windows, Mac, iOS, Android, and Linux) over the internet
- Centralized security with Azure Active Directory (Azure AD)
- Option to **Bring your own licenses (BYOL)**
    - Bring in an eligible Microsoft 365 license

Azure

Azure Marketplace

- Discover, try, and deploy the cloud software you want
  - *https://azuremarketplace.microsoft.com*
- **Customized and certified solutions** optimized for Azure, provided by Microsoft partners and other software vendors
- Provision **end-to-end solutions** (applications and services)
- Solutions under a variety of categories
  - Compute, Containers, Databases, Developer Tools, DevOps etc
- Run Wordpress, RabbitMQ, CouchDB etc
- Flexible **Hourly Billing**

Core Azure Solutions

Getting started with Internet of Things (IoT)

- **IoT devices**: hardware with sensors to
  - Capture temperature and humidity levels
  - Detect smoke, gas etc
  - Capture Geo-location and proximity
  - Capture Device metrics
  - etc ...
- **IoT devices are all around us**:
  - Smart Watches, Fitness Trackers, and other Wearables
  - Health Monitoring
  - Smart Homes (lighting, coffee maker, security devices)
  - Autonomous and Connected Vehicles
- **IoT devices** generate huge volumes of time-series data

IoT Hub

IoT Central

Azure Sphere

Managing IoT Devices and Communication

- **Typical IoT use cases:**
  - Authenticate an IoT device
  - Receive telemetry (data) from an IoT device
  - Manage an IoT device from the cloud
- How do you manage and communicate with millions of IOT devices?
  - Use Cloud IoT services
- **IoT in the Cloud - Typical Steps**
  - 0: Authenticate and Register IoT Device
  - 1: Capture Data
  - 2: Relay Data
    - Cloud IoT services can relay data from sensors to your service end points in the cloud
  - 3: Analyze and get intelligence
    - Using Cloud AI services, you can
      - Predict if a machine needs maintenance
      - Predict equipment failure ahead of time (and replace) and .....

IoT Hub

IoT Central

Azure Sphere

Internet of Things (IoT) in Azure - 3 Important Services

- **Azure IoT Hub**: Managed message hub for IoT devices
    - Programmatic reporting and IoT device management

- **Azure IoT Central**: IoT Hub + Dashboard
    - Reporting and management with a simple user interface
    - Recommended to manage an IoT device with a simple user interface OR
        - When you need to be able to generate and access reports from the Azure portal

- **Azure Sphere**: End-to-end IoT solution with device tampering detection
    - Hardware (Micro-controller unit) + Software + Communication + End-to-end Security
    - Recommended for high security usecases: ATMs, Point of Sale devices

IoT Hub

IoT Central

Azure Sphere

Internet of Things (IoT) in Azure - Azure IoT Hub

- **Managed message hub for IoT devices**
  - Enables bi-directional communication between IoT devices and IoT cloud services
- **Things you can do**:
  - Send regular telemetry from IoT device to cloud
  - Upload files from IoT devices to cloud (For example - Azure Blob Storage and Azure Data Lake Storage Gen 2)
  - Manage your IoT device by sending messages (command and control)

Internet of Things (IoT) in Azure - Azure IoT Central

- IoT Hub + Dashboard (reporting and management)
- Connect, monitor, and manage your IoT devices using a simple user interface
  - Perform maintenance (Push a software/firmware update) for your IoT devices
  - Adjust IoT device properties
- Provides starter templates for various IoT usecases
- **IoT Hub**: Control Device and Generate Reports via REST API
- **IoT Central**: Starter templates + Visual Dashboards (reporting, management of IoT devices)

Internet of Things (IoT) in Azure - Azure Sphere

In28Minutes

- **End-to-end IoT solution**
  - IoT Device
    - Hardware: Micro-controller unit
    - Linux operating system
  - Security
    - Azure Sphere Security Service - AS3
    - Ensure that the device is not tampered
    - Handles authentication
  - Communication (with IoT Hub)
    - Telemetry & Errors

- **Highly secure IOT devices**
  - For use in ATMs, Point of sale devices etc

Modern Architectures in Azure

Azure Big Data - Synapse Analytics, HDInsight & Databricks

Service	Description
Azure Synapse Analytics	Provides a unified experience for developing end-to-end analytics solutions Data integration + Enterprise data warehousing + Big data analytics Enables MPP (massively parallel processing) Run complex queries across petabytes of data Earlier called Azure SQL Data Warehouse
Azure HDInsight	Managed open-source analytics service based on Hadoop Run open-source frameworks like Apache Hadoop, Spark, Hive, Kafka Used for complex processing like ETL, data warehousing, machine learning
Azure Databricks	Managed Apache Spark-based analytics service Launch Apache Spark environment in minutes Build artificial intelligence (AI) solutions using Python, Scala, R, Java and SQL Supports popular data science frameworks and libraries including TensorFlow, PyTorch and scikit-learn

Machine Learning in Azure

Service	Discussion
Azure Cognitive Services	Pre-built machine learning models Language Services: Process written text Speech Services: Translation. Text to speech and vice-versa. Vision Services: Intelligence around pictures and videos Decision Services: Automatically moderate content. Identify anomalies.
Azure Bot Service	Talk with humans like a human Virtual agents (intelligent, enterprise-grade bots) that enhance customer experience Provides natural language understanding and automatic translation features Use cases: Handling reservations
Azure Machine learning	Quickly build and deploy models programmatically & visually (End-to-end machine learning life cycle) Supports popular ML languages and frameworks - MLflow, Kubeflow, ONNX, PyTorch, TensorFlow, Python, R and Jupyter notebooks Features: Drag-and-drop machine learning & Automated machine learning

Machine Learning Scenarios

| Scenario	Solution
Virtual agent that talks with humans like a human	Azure Bot Service
Identify objects in a video	Azure Cognitive Services (Vision Services)
Automate creation of custom ML models	Azure Machine learning
Help Data scientists and AI engineers create complex ML models	Azure Machine learning

DevOps

DevOps

Business Development Operations

- Getting Better at **"Three Elements of Great Software Teams"**
  - Communication - Get teams together
  - Feedback - Earlier you find a problem, easier it is to fix
  - Automation - Automate testing, infrastructure provisioning, deployment, and monitoring

171

DevOps - CI, CD

- **Continuous Integration**
  - Continuously run your tests and packaging
- **Continuous Deployment**
  - Continuously deploy to test environments
- **Continuous Delivery**
  - Continuously deploy to production
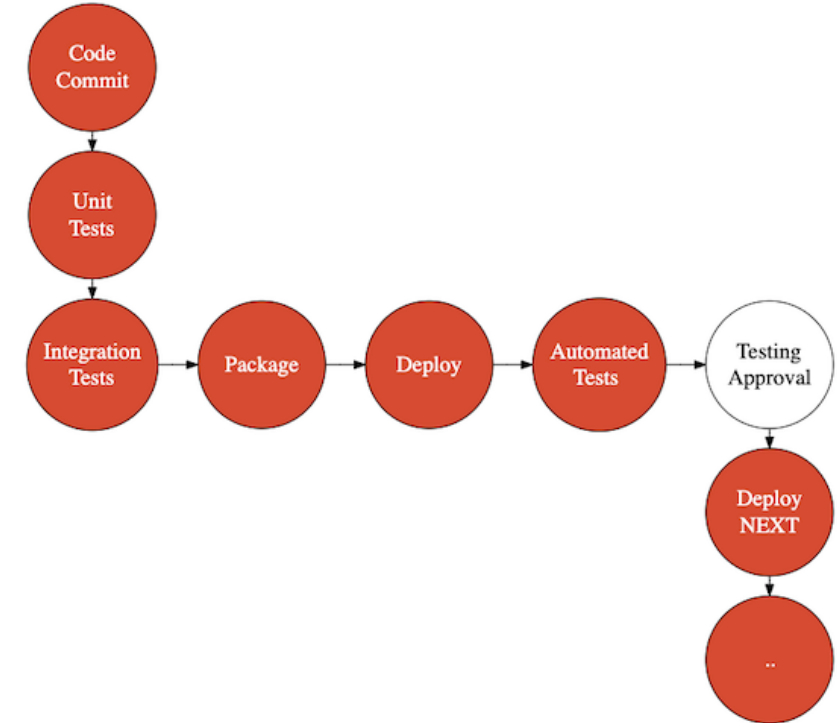
Azure DevOps - CI, CD Tools

- **Azure Repos** - Private source control (Git)
  - Alternative: GitHub - Public and Private Source Control
- **Azure Pipelines** - Orchestrate CI/CD pipelines
  - Alternative: GitHub Actions
- **Azure Boards** - Scrum, Agile and Kanban boards
- **Azure Artifacts** - Artifact repository to store artifacts
- **Azure Test Plans** - Automation Test tool to check software quality
  - Integrate it into your CI/CD pipelines

Azure DevOps

DevOps - IAAC

- **Treat infrastructure the same way as application code**
    - Track your infrastructure changes over time (version control)
    - Bring repeatability into your infrastructure
    - **1: Infrastructure Provisioning**
        - Provisioning compute, database, storage and networking
        - Open source cloud neutral - Terraform
        - Azure Service - Azure Resource Manager Templates (can also use Powershell or Azure CLI automation)
    - **2: Configuration Management**
        - Install right software and tools on the provisioned resources
        - Open Source Tools - Chef, Puppet, Ansible

Azure Resource Manager (ARM) templates - Introduction

- **Lets consider an example**:
    - I would want to create a new VNet with two subnets
    - I want to provision a Load Balancer, Scale Set with 5 VM instances and an Azure Cosmos DB database in the subnet
    - I would want to setup the right network security groups
- AND I would want to create 4 environments
    - Dev, QA, Stage and Production!
- **Azure Resource Manager (ARM) templates** can help you do all these with a simple (actually NOT so simple) script!

Azure Resource Manager (ARM) templates - Advantages

- Define resources in a JSON file - **ARM template**
- **Advantages:**
  - Avoid configuration drift
  - Avoid mistakes with manual configuration
  - Think of it as version control for your environments
- **Declarative approach** to Infrastructure as Code:
  - Understands dependencies and creates them in the right order
  - Parallelizes creation of resources when possible
  - Automatically rollback in case of failures
  - PowerShell and Bash scripts can also be used for IaaC
    - But they need step by step instructions
      - 1: Do this
      - 2: Do that..
    - And they don't handle failures very well

Azure Resource Manager

(*https://docs.microsoft.com/*)
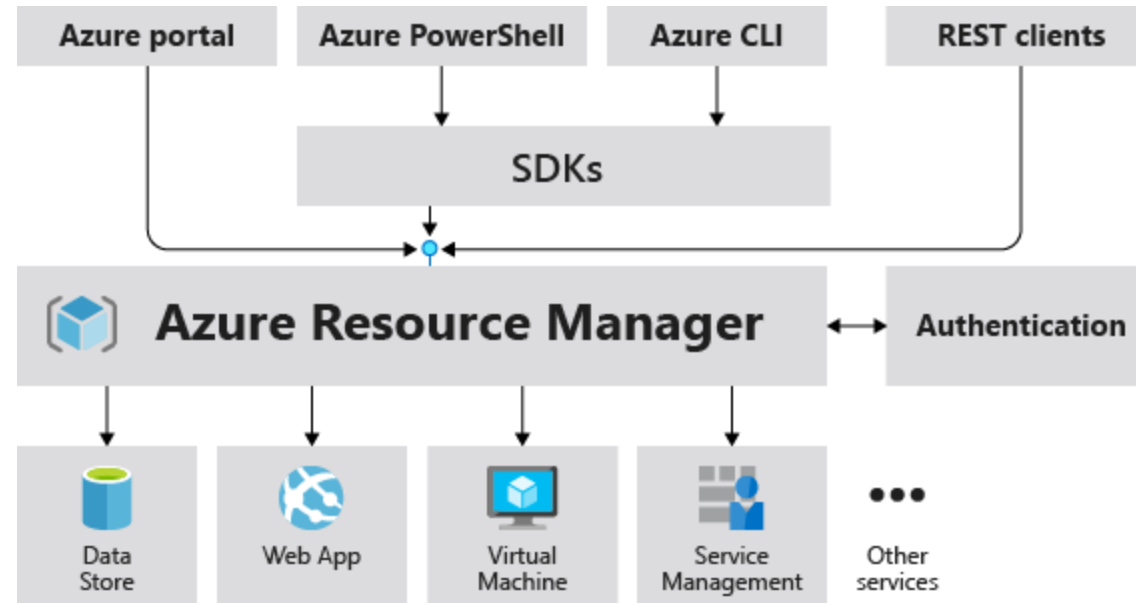
- Deployment and management service for Azure
- All actions to any resource in Azure **go through ARM**
    - Irrespective of where you are performing it from
        - Azure portal OR Powershell OR CLI or ARM template or ...

Azure Portal, PowerShell, CLI, Cloud Shell, & Mobile App

Tool	Details
Azure Portal	Web-based user interface. Great to get started BUT NO automation possible. Runs in all modern desktop and tablet browsers
Azure Mobile App	iOS and Android Apps (subset of features). Convenience of managing from anywhere.
Azure PowerShell	Execute cmdlets (sequence of commands) and create scripts (PowerShell script) Recommended for teams familiar with Windows administration Cross-platform (Windows, Linux, and macOS)
Azure CLI	Similar to Azure PowerShell BUT uses a different syntax (Bash Scripts) Recommended for teams familiar with Linux administration (and Bash Scripts) Cross-platform (Windows, Linux, and macOS)
Azure Cloud Shell	Free Browser based interactive shell (Access from Azure Portal) Common Azure tools pre-installed and configured to use with your account Supports both PowerShell and CLI (bash) Runs in all modern desktop and tablet browsers

Scenarios - Azure Portal, PowerShell, CLI ....

Scenario	Solution
Can you run PowerShell scripts using Azure CLI?	No. You can use either Azure Shell or Azure PowerShell.
Which OS can Azure CLI, PowerShell, Cloud Shell and portal run on?	Windows, Linux and Mac
Where can Azure Cloud shell be accessed from?	Browser-based shell - Access from desktops (Windows, Mac, ChromeOS, Linux), mobile, tablet.
Tool to analyze costs and run reports during a cost review meeting	Azure portal or Azure mobile app
Tool for one time testing, management, and administrative actions (Ex: create a VM or create a group of resources)	Azure PowerShell, Azure CLI, Azure portal or Azure mobile app
Repeatedly set up resources across multiple environments	ARM templates

DevTest Labs

- **Quickly provision development and test environments**
  - Build Windows and Linux environments
  - Uses ARM templates: can be used to deploy anything in Azure
    - Compute - VMs etc
    - Storage
    - Databases ...

DevTest Labs

- Can be **integrated into your CI/CD pipelines**
  - Set automated shutdowns to minimise costs
- **Usecases:**
  - Quickly test your application with an old version of software or OS
  - Setup a quick load test environment for your app
  - Quickly provision 100 VMs for testing a specific scenario
  - Quickly provision environments for training and demos

Quick Review

Compute

Azure Service Name	Description
Azure VMs	Windows or Linux VMs (IaaS) Use VMs when you need control over OS OR you want to run custom software
Azure VM Scale Sets	Scaling for Azure VMs
Azure Load Balancer	Balance load to multiple instances of an application or a service. Typically listed in Networking category.
Azure App Service	PaaS. Deploy web apps, mobile back ends and RESTful APIs quickly.
Azure Container Instances	Run isolated containers, without orchestration. You DO NOT need to provision and manage VMs. Start containers in seconds.
Azure Kubernetes Service	Managed Kubernetes Service. Provides container orchestration.
Azure Service Fabric	Microsoft's container orchestrator for cloud and on-premises. Package, deploy, and manage scalable and reliable microservices
Azure Functions	Serverless compute for event-driven apps

Networking

Azure Service Name	Description
Azure Virtual Network	Create your own private network in the cloud
Azure Firewall	Stateful firewall to protect resources in your Azure Virtual Network
Azure DDoS Protection	Protects Azure-hosted applications from DDOS attacks
Azure ExpressRoute	Dedicated private connection from Azure to on-premises
Azure VPN Gateway	Encrypt traffic between virtual network & on-premises Traffic goes over Internet (public).
Azure DNS	Manage your DNS records Map Domain Name to IP Address
Azure Content Delivery Network	Cache content on edge servers (POPs) located around the world Minimize latency to global users

Storage

Service	Description
Azure Disk storage	Store disks attached to VMs.
Azure Blob storage	Store unstructured data - video files, database archives etc.
Azure File storage	Create file shares or file servers in the cloud
Azure Queue storage	Decouple applications using a queue (asynchronous communication)
Azure Table storage	Store structure data using NoSQL approach (NON-relational). Schemaless. Key/attribute store.

Databases

Service	Description
Azure Cosmos DB	NoSQL database. Globally distributed.
Azure SQL Database	Relational database
Azure Database for MySQL	Fully managed MySQL database
Azure Database for PostgreSQL	Fully managed PostgreSQL database
Azure Database Migration Service	Migrate databases to the cloud
Azure Cache for Redis	Managed service for Redis

Get Ready

Certification Exam

- Certification Home Page
  - *https://docs.microsoft.com/en-gb/learn/certifications/exams/az-900*
- Different Types of Multiple Choice Questions
  - Type 1 : Single Answer - 2/3/4 options and 1 right answer
  - Type 2 : Multiple Answer - 5 (or more) options and 2 (or more) right answers
- No penalty for wrong answers
  - Feel free to guess if you do not know the answer
- 40-60 questions and 80 minutes
- Result immediately shown after exam completion
- Email with detailed scores (a couple of days later)

Certification Exam - My Recommendations

- Read the entire question
  - Identify the key parts of the question
- Read all answers at least once
- If you do NOT know the answer, eliminate wrong answers first
- Mark questions for future consideration and review them before final submission

You are all set!

Let's clap for you!

- You have a lot of patience! Congratulations
- You have put your best foot forward to get Microsoft Certified - Azure Fundamental
- Make sure you prepare well and
- Good Luck!

Do Not Forget!

- Recommend the course to your friends!
  - Do not forget to review!
- Your Success = My Success
  - Share your success story with me on LinkedIn (Ranga Karanam)
  - Share your success story and lessons learnt in Q&A with other learners!

What next?

https://github.com/in28minutes/learn

- Learn Other Cloud Platforms:
    - Gartner predicts a multi cloud world soon
    - Get certified on AWS, Azure and Google Cloud
- Learn DevOps (Containers and Container Orchestration)
- Learn Full Stack Development