Azure Handbook

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Overview of Cloud Computing

Cloud computing offers a modern alternative to traditional on-premises data centers, shifting hardware and maintenance responsibilities to public cloud providers. These providers offer various platform services on a pay-as-you-go basis, converting capital expenses into operational costs. This model grants access to advanced hardware and software without requiring large upfront investments, with charges applied only for actual usage.

Cloud platforms feature online portals for seamless resource management, such as Azure, where users can configure and deploy virtual machines (VMs) within minutes—significantly reducing deployment time compared to physical hardware procurement.

Cloud environments come in three main types:

- **Public Cloud**: Fully managed by vendors like Microsoft Azure, offering scalable and on-demand resources.
- **Private Cloud**: Hosted within an organization's data center, providing cloud-like self-service while requiring internal maintenance.
- **Hybrid Cloud**: Integrates public and private clouds, allowing organizations to strategically distribute workloads. For example, a public cloud can host a high-traffic website, while a secure database remains in a private cloud.

Microsoft supports all three models. Azure serves as its public cloud solution, while Azure Stack extends core Azure services to private data centers, enabling hybrid cloud deployment via a virtual private network (VPN).

Cloud Offerings

Cloud computing is generally classified into three main categories: **SaaS, PaaS, and IaaS**. However, as cloud technology evolves, these distinctions are becoming less rigid.

- **SaaS (Software as a Service)**: Centrally hosted and managed applications provided on a subscription basis. Examples include Microsoft Office 365, Dropbox, and WordPress. SaaS eliminates the need for installation, maintenance, and updates, making it cost-effective and hassle-free.
- **PaaS (Platform as a Service)**: A managed environment for application deployment, allowing developers to focus on coding without managing infrastructure. Azure PaaS offerings include Azure App Service and Azure Cloud Services, enabling quick deployment without handling VMs manually.
- **IaaS (Infrastructure as a Service)**: Provides virtualized computing resources such as VMs, storage, and networking. Users have full control over the OS and applications but not the underlying hardware. Azure Virtual Machines support "lift and shift" migrations, while Azure VM Scale Sets (VMSS) offer autoscaling for high-demand workloads.

Introduction to Azure

What is Azure?

Microsoft Azure is a cloud computing platform that provides a wide range of services, including computing, storage, networking, databases, artificial intelligence, and analytics. It enables businesses to build, manage, and deploy applications on a global scale using Microsoft-managed data centers. Azure supports multiple programming languages, frameworks, and tools, making it a versatile choice for various industries.

Azure Services

Azure includes many services in its cloud computing platform.

1. **Compute services**

   This includes the Azure Virtual Machines—both Linux and Windows, Cloud Services, App Services (Web Apps, Mobile Apps, Logic Apps, API Apps, and Function Apps), Batch (for large-scale parallel and batch compute jobs), RemoteApp, Service Fabric, and the Azure Container Service.

2. **Data services**

   This includes Microsoft Azure Storage (comprised of the Blob, Queue, Table, and Azure Files services), Azure SQL Database, DocumentDB, StorSimple, and the Redis Cache.

3. **Application services**

   This includes services that you can use to help build and operate your applications, such as Azure Active Directory (Azure AD), Service Bus for connecting distributed systems, HDInsight for processing big data, Azure Scheduler, and Azure Media Services.

4. **Network services**

   This includes Azure features such as Virtual Networks, ExpressRoute, Azure DNS, Azure Traffic Manager, and the Azure Content Delivery Network.

Azure Virtual Machines

Azure Virtual Machines (VMs) is a core Infrastructure as a Service (IaaS) offering that allows users to deploy and manage Windows or Linux virtual machines in Microsoft Azure data centers. Unlike Platform as a Service (PaaS) solutions, where Azure manages the infrastructure, Azure VMs give users complete control over configuration, software installation, and maintenance. This flexibility makes them ideal for a wide range of workloads that require a high level of customization.

Azure VMs utilize persistent storage, meaning they rely on OS disks (mandatory) and data disks (optional), both backed by Azure Storage. This ensures data durability even if the VM is stopped or deallocated. Because of this, Azure VMs are suitable for hosting database servers such as SQL Server, Oracle, and MongoDB, as well as enterprise applications like Active Directory and SharePoint. Additionally, they support lift-and-shift migrations, allowing organizations to move on-premises workloads to Azure without major modifications.

Billing for Azure Virtual Machines is based on a pay-as-you-go model, where users are charged per minute of usage. The cost includes the base VM charge, and for Windows VMs, the OS licensing fee is included. Linux-based VMs tend to be more affordable due to the absence of OS licensing costs. If users install additional software, such as SQL Server, extra licensing fees may apply.

The billing structure is also influenced by the VM's status. When a VM is running, it incurs compute charges. If it is stopped but still allocated to a physical host, billing continues. However, when a VM is stopped (deallocated)—meaning it is no longer using compute resources—it is not billed for compute usage, though storage charges still apply. By default, stopping a VM through the Azure portal deallocates it, but users can keep it allocated using PowerShell or the Azure CLI.

Azure offers two primary deployment models for Virtual Machines:

1. Azure Resource Manager (ARM) Model – This is the modern and recommended deployment model. It provides template-based deployment, improved management capabilities, and role-based access control (RBAC). With ARM, resources such as VMs, storage, and networking are grouped into resource groups, making it easier to manage and automate deployments using ARM templates.
2. Classic/Azure Service Management (ASM) Model – This is the older model, now largely deprecated. In this model, VMs and resources were managed individually, with limited automation and access controls. It lacked resource grouping and RBAC, making large-scale management more complex.

Azure Virtual Machines consist of key components:

1. Virtual Machine (VM) – A Windows or Linux-based cloud instance with full configuration control.
2. Disks – OS Disk (mandatory), Data Disks (optional), and Temporary Disk
3. Virtual Network (VNet) – Enables secure communication between VMs and other resources.
4. Availability Set – Distributes VMs across fault and update domains to ensure high availability.

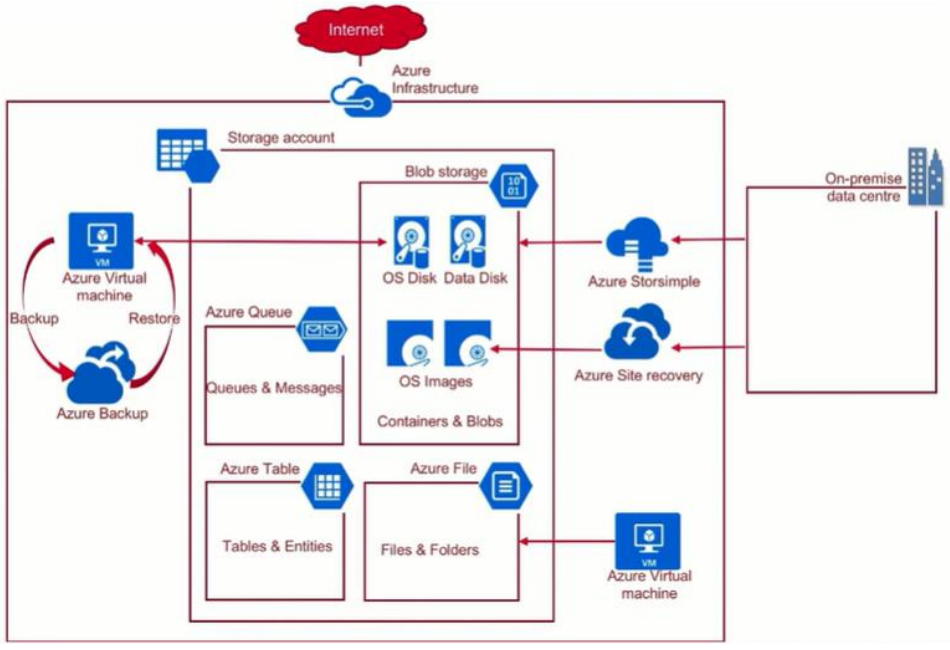
Azure Storage

Microsoft Azure Storage is a cloud-based, fully managed storage service that offers durability, scalability, and redundancy. Microsoft handles maintenance and critical issues, ensuring reliable data storage. Each Azure subscription can support up to 100 storage accounts, with a capacity of 500 TB per account. For higher storage needs, businesses can request an increase to 250 storage accounts per subscription.

Azure Storage includes four main data services:

1. Blob Storage – Used for storing large amounts of unstructured data, including images, videos, and backups. It supports both standard and premium storage, with the latter using SSDs for high-speed performance.
    - Block blobs: Best for large data, up to 195 GB.
    - Page blobs: For random access to files, mainly for virtual hard disks (VHDs) up to 1 TB.
    - Append blobs: Used for data that needs to be appended, such as log files.
2. File Storage – Provides fully managed file shares accessible through the SMB protocol. It allows multiple virtual machines (VMs) to access and work on shared files, like traditional network file systems.
3. Table Storage – A NoSQL store for storing large amounts of structured data. Data is organized into entities with partition keys and row keys, making it easy to scale and query.
4. Queue Storage – A message queueing service used for asynchronous task processing. It's ideal for decoupling components of an application and handling background jobs.

These storage options are secured through Azure Storage accounts, which are accessed using keys, connection strings, or shared access signatures (SAS) for more granular access control.



Azure SQL Database

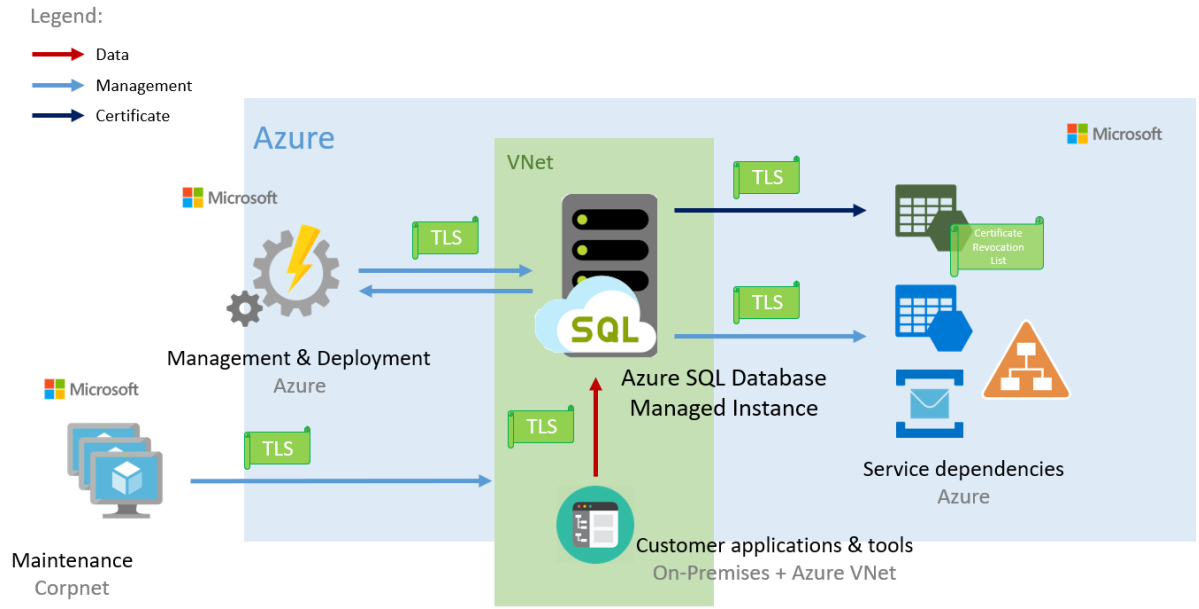
Azure SQL Database is a cloud-based relational database service designed for online transaction processing (OLTP) workloads. As a Platform-as-a-Service (PaaS) offering, it removes the need for managing physical servers while still allowing you to handle most of the logical management tasks. It offers features like elastic scaling, predictable performance, business continuity, and minimal maintenance, while using familiar development tools and languages.

SQL Database comes in two models:

1. Elastic Database Pools: This model allows you to manage multiple databases in a pool, with shared performance resources that can scale up or down based on demand, while staying within a predictable budget.
2. Single Database Model: Best suited for smaller setups with a few databases, offering dedicated resources and predictable performance.

Both models are available in three service tiers: Basic, Standard, and Premium. Performance is measured in Database Throughput Units (DTUs), which are used to compare the relative performance across tiers. Performance levels (S0, S1, S2, S3) within the Standard tier adjust the number of DTUs. Database sizes range from 2 GB to 1 TB, depending on the tier.

With Azure SQL Database, the physical infrastructure is abstracted, meaning you don't control the underlying hardware, but you still have significant control over the database's configuration and performance.



Azure App Service

Azure App Service is a fully managed platform for building, deploying, and scaling web apps and APIs. It supports multiple programming languages, including .NET, Node.js, Java, Python, and PHP, and allows developers to deploy applications through GitHub, Azure Repos, Bitbucket, or FTP.

Key technical features of Azure App Service include:

1. **Automatic Scaling and Load Balancing**: Azure App Service supports automatic scaling based on demand, automatically adjusting the number of instances running your app to ensure optimal performance. This scaling is done without downtime and is highly customizable, including scaling by instance count, CPU usage, or other metrics.
2. **Integrated Developer Tools**: It integrates with popular IDEs such as VS and GitHub for Continuous Integration (CI) and Continuous Deployment (CD).
3. **Custom Domains and SSL Support**: Azure App Service enables custom domain mapping for your web applications. You can also configure SSL certificates for secure communication. It offers built-in support for free SSL certificates as well as the option to upload your own certificates for higher security levels.
4. **High Availability and Fault Tolerance**: With built-in load balancing, Azure App Service ensures that your applications are always available. It can distribute traffic across multiple instances.
5. **Managed Environment**: As a Platform-as-a-Service (PaaS), Azure App Service abstracts away the need for managing infrastructure. It handles updates, security patches, and the underlying infrastructure, allowing developers to focus purely on code and application logic.
6. **Integrated Monitoring and Diagnostics**: Azure App Service provides robust monitoring capabilities through Azure Monitor, Application Insights, and Log Analytics. Developers can track performance metrics, detect anomalies, and troubleshoot issues using logs and diagnostics tools.
7. **Security**: It offers a secure environment with built-in features like authentication via Azure Active Directory (AAD), integration with third-party identity providers, and automatic security patches. Additionally, Azure App Service can work with Virtual Networks (VNets) for network isolation and communication with on-premises resources securely.
8. **App Service Environments (ASE)**: For higher isolation, Azure App Service offers App Service Environments, which provide network isolation by running apps in a customer's virtual network. ASE ensures that your apps are isolated from the public internet, providing a higher level of security and compliance.
9. **Container Support**: Azure App Service supports Docker containers, enabling the deployment of containerized applications. This allows for greater flexibility, especially when running microservices-based architectures or porting applications that run in containers.

Azure AI & Machine Learning

Azure AI & Machine Learning provides a comprehensive set of tools and services designed to help organizations build, deploy, and manage artificial intelligence (AI) and machine learning (ML) models. It supports a wide range of use cases, from pre-built AI solutions to custom machine learning workflows. Below are the key components:

1. **Azure Machine Learning (Azure ML)**: A robust platform that facilitates the entire machine learning lifecycle. Azure ML allows data scientists to prepare data, train models, and deploy them at scale. Key features include Automated Machine Learning (AutoML) for automated model selection and tuning, Azure ML Studio for drag-and-drop model design, and model management tools for tracking experiments and managing model versions. Azure ML also integrates with popular frameworks like TensorFlow, PyTorch, and Scikit-learn, providing flexibility for developers and data scientists.

2. **Azure Cognitive Services**: A suite of pre-built AI models that can be easily integrated into applications without requiring deep machine learning expertise. These services provide ready-to-use APIs for tasks such as computer vision (e.g., image classification, facial recognition), speech recognition and synthesis (e.g., transcription, translation), natural language processing (e.g., sentiment analysis, text translation), and decision-making (e.g., anomaly detection). Cognitive Services help add advanced AI capabilities to applications quickly.

3. **Azure Bot Services**: This service simplifies the creation and deployment of intelligent bots that use natural language processing (NLP) and machine learning to engage with users. It integrates seamlessly with Azure Cognitive Services for voice and text-based interactions. Developers can build, test, and deploy bots across multiple platforms, including websites, mobile apps, and messaging services.

4. **Azure Databricks**: A collaborative Apache Spark-based platform designed for big data analytics and machine learning. It provides an interactive workspace for data engineers, data scientists, and analysts to collaborate on data processing and model development. Azure Databricks integrates with Azure ML and supports scalable model training, making it an ideal solution for handling large datasets and complex ML workflows.

5. **Azure Synapse Analytics**: A unified analytics platform that brings together big data and data warehousing capabilities. It integrates with Azure ML and allows users to perform advanced analytics and ML tasks on large datasets, making it easier to prepare data for model training and to generate insights at scale.

6. **Azure AI for Edge**: Azure AI enables developers to deploy AI models on edge devices such as IoT devices, cameras, and mobile devices. This reduces latency and bandwidth usage by performing real-time inference on the devices themselves, allowing for faster decision-making and minimizing the need for constant cloud connectivity.

7. **Azure ML SDK**: A Python-based software development kit that provides a set of tools for automating the machine learning lifecycle. It supports tasks such as model training, deployment, and experiment tracking. The SDK is ideal for developers who prefer to work in a coding environment and require custom workflows.

Examples and Usage

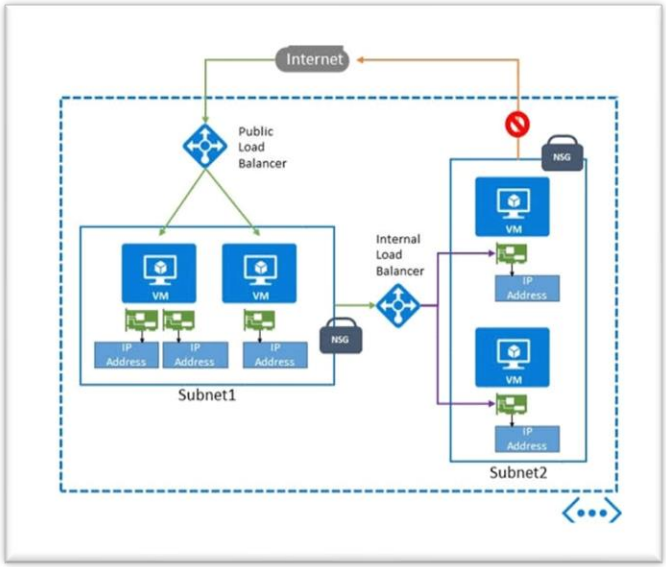
1. Azure Virtual Machines (VMs)

Example:

A financial services company migrates its on-premises applications to Azure VMs to reduce hardware costs and improve scalability. This allows them to adjust resources dynamically based on trading volume.

Usage:

- **Development and Testing** – Quickly set up development and test environments.
- **Disaster Recovery** – Use VMs for backup and failover strategies.
- **Scalability** – Handle increased workloads without investing in physical hardware.



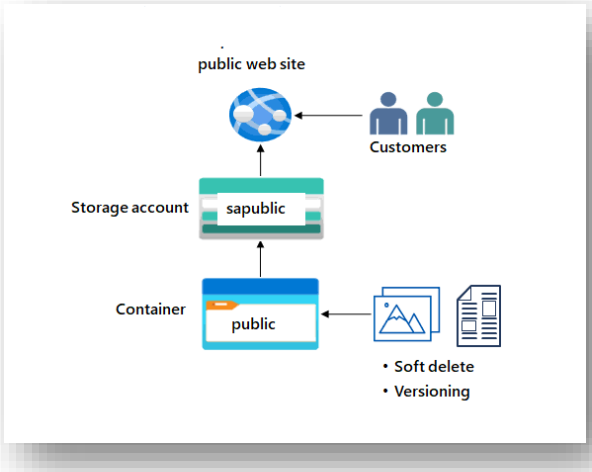
2. Azure Blob Storage

Example:

A media streaming company stores large volumes of high-resolution video content on Azure Blob Storage. This enables efficient content delivery to users worldwide through a Content Delivery Network (CDN).

Usage:

- **Backup and Archive** – Securely store backups of business-critical data.
- **Streaming Content** – Store and deliver media files for apps like YouTube or Netflix.
- **Big Data Analytics** – Store massive datasets for AI and machine learning applications.



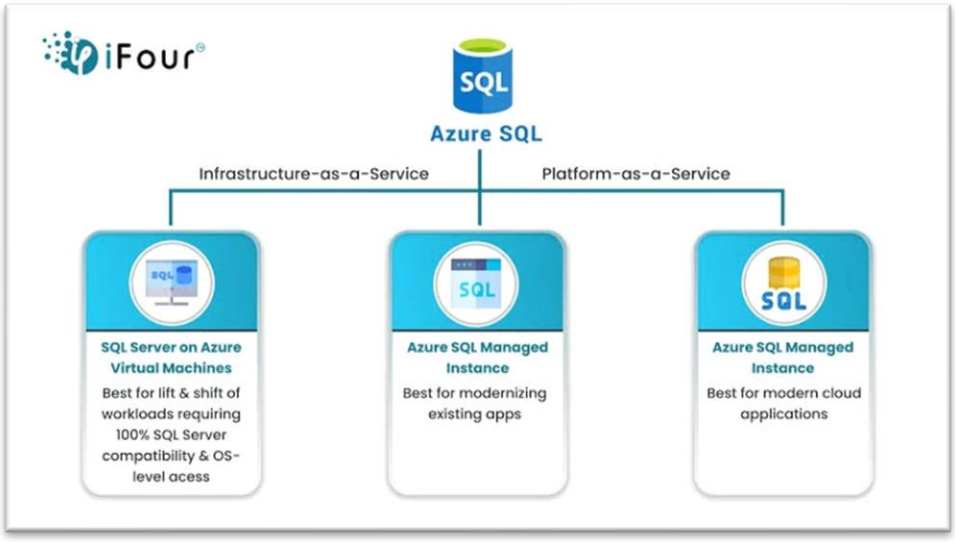
3. Azure SQL Database

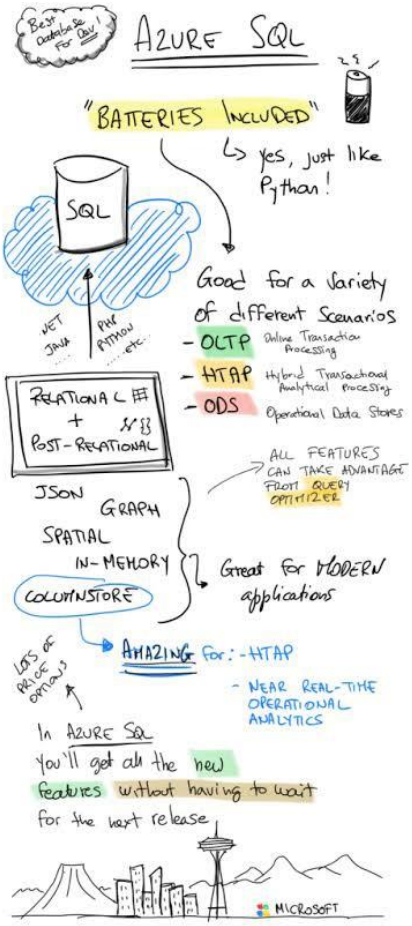
Example:

An e-commerce website relies on Azure SQL Database to store and manage customer orders, transaction details, and inventory data while ensuring high availability and security.

Usage:

- **Business Applications** – Host relational databases for enterprise solutions.
- **Web and Mobile Apps** – Manage user data for dynamic web and mobile applications.
- **Real-Time Analytics** – Perform high-speed queries for reporting and decision-making.





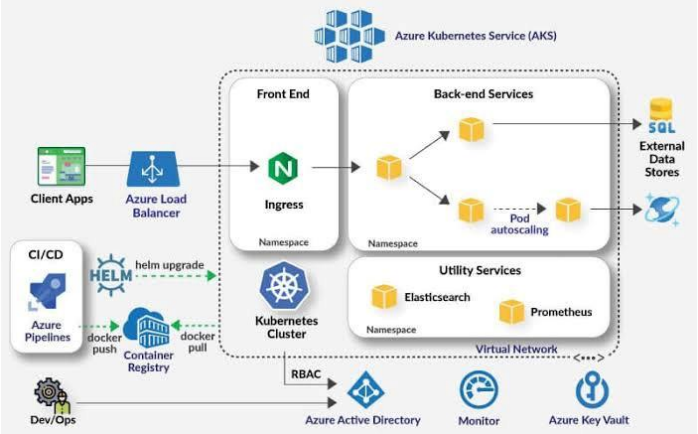
4. Azure Kubernetes Service (AKS)

Example:

A fintech company deploys its banking application on AKS to manage microservices efficiently, enabling seamless updates and high availability.

Usage:

- **Microservices Architecture** – Deploy and manage containerized applications at scale.
- **CI/CD Pipelines** – Automate the deployment and scaling of applications.
- **Hybrid Cloud Solutions** – Run workloads consistently across cloud and on-premises environments.



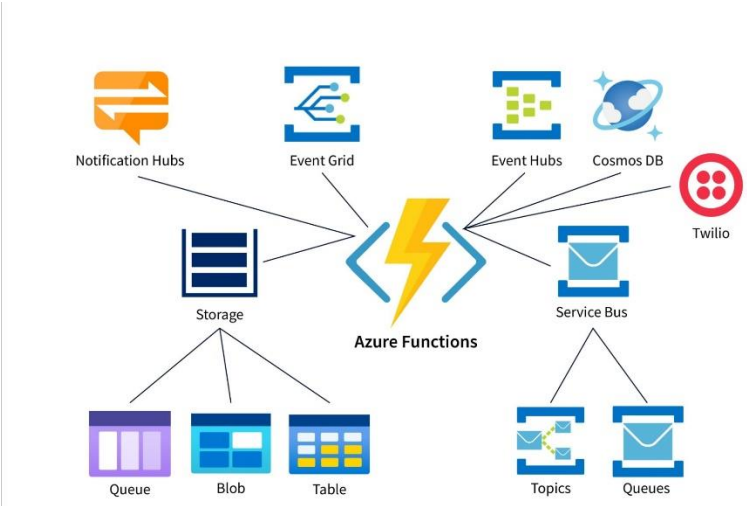
5. Azure Functions

Example:

A logistics company uses Azure Functions to process GPS data from delivery trucks in real time. The function triggers alerts if a truck deviates from its planned route.

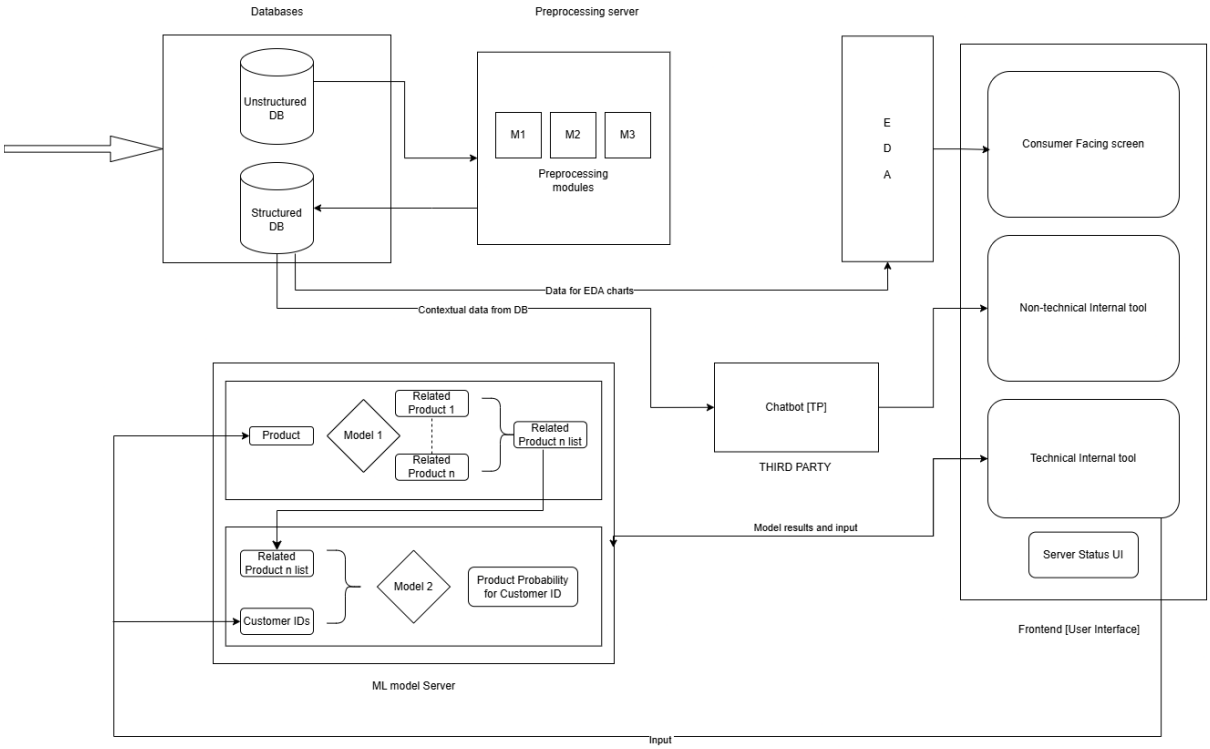
Usage:

- **Event-Driven Processing** – Execute code in response to events like database updates or IoT signals.
- **Automation** – Automate background tasks such as sending notifications or data cleanup.
- **Real-Time Data Handling** – Process data streams from devices, social media, or user interactions.



Commercial Usage :

System designed for our hackathon project .
This system was designed with the cloud architechture in mind .



1. Databases

- **Azure Cosmos DB / Azure SQL Database**: To store structured and unstructured data.
- **Azure Data Lake Storage**: For scalable and cost-effective storage of large datasets.

2. Preprocessing Server

- **Azure Machine Learning**: For managing and training models (M1, M2, M3) efficiently.
- **Azure Data Factory**: To automate data ingestion and preprocessing.
- **Azure Synapse Analytics**: For performing advanced analytics and data exploration (EDA).

3. ML Model Server

- **Azure Kubernetes Service (AKS)**: To deploy and scale machine learning models.
- **Azure Machine Learning Managed Endpoints**: For deploying and serving models securely.

4. Chatbot (Third Party)

- **Azure Bot Services**: To integrate chatbot functionalities using AI and NLP.

- **Azure Cognitive Services**: To enhance chatbot capabilities with speech and text analysis.

5. Frontend (User Interface)

- **Azure App Service**: To host consumer-facing, technical, and non-technical UI tools.
- **Azure API Management**: To manage APIs securely for UI and chatbot interactions.

6. Monitoring and Status

- **Azure Monitor & Application Insights**: To track server health and performance.
- **Azure Log Analytics**: To log and analyze system errors.

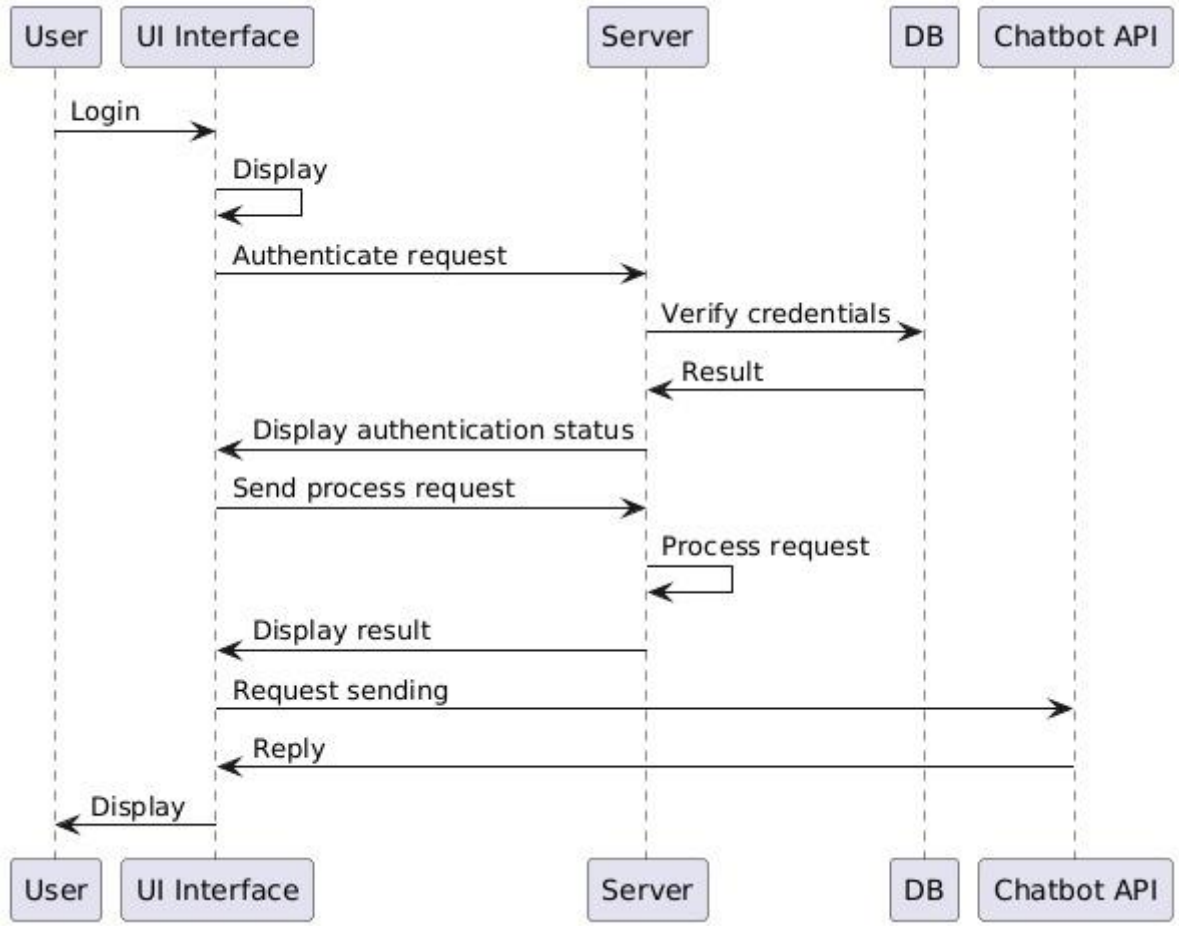


Diagram for the api calls and stuff relating to the system diagram .

Yes, I would be highly interested in working on cloud frameworks, particularly Azure, during my corporate career. Azure provides a robust set of tools and services that cater to various aspects of cloud computing, including infrastructure, machine learning, data processing, security, and automation. Given my background in AI, data engineering, and system development, Azure's offerings align well with my career goals. Here's a detailed breakdown of how working with Azure would be beneficial for me:

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1. AI & Machine Learning (ML) on Azure

Why It Interests Me?

I have a strong inclination towards AI and ML, and Azure provides powerful solutions for deploying, training, and managing ML models at scale.

Relevant Azure Services:

- **Azure Machine Learning (AML)**: A fully managed ML service that allows model training, deployment, and monitoring.
- **Azure Databricks**: Optimized Apache Spark-based analytics for large-scale ML training.
- **Azure Cognitive Services**: Ready-made AI services for vision, speech, text, and language processing.
- **Azure Synapse Analytics**: Big data analytics service for handling structured and unstructured data.

How It Aligns with My Interests?

- I would love to deploy ML models using **AML Managed Endpoints** and use **Azure Functions** to trigger AI workloads dynamically.
- Using **Databricks and Synapse Analytics**, I can scale ML workloads while integrating with big data pipelines.
- **Cognitive Services** would allow me to integrate NLP and vision-based AI into applications without extensive model training.

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2. Cloud DevOps & Automation

Why It Interests Me?

I enjoy building efficient, automated workflows, and Azure's DevOps and automation tools allow seamless CI/CD (Continuous Integration/Deployment).

Relevant Azure Services:

- **Azure DevOps**: Complete CI/CD pipelines for software development.
- **Azure Kubernetes Service (AKS)**: Container orchestration for scalable applications.
- **Azure Functions**: Serverless computing to trigger workflows dynamically.
- **Azure Logic Apps**: Automating cloud processes with minimal coding.

How It Aligns with My Interests?

- I can automate deployment pipelines using **Azure DevOps & GitHub Actions**.
- Using **AKS**, I can containerize ML models and applications for scalable deployments.
- **Azure Functions** can help trigger AI predictions or event-based workflows dynamically.

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3. Data Engineering & Big Data Processing

Why It Interests Me?

Handling massive amounts of structured/unstructured data and optimizing its flow is an area I find fascinating.

Relevant Azure Services:

- **Azure Data Factory**: ETL (Extract, Transform, Load) pipelines for data ingestion.
- **Azure Event Hubs / Kafka on Azure**: Real-time data streaming for big data applications.
- **Azure Synapse Analytics**: Combining SQL & Spark for large-scale analytics.
- **Azure Cosmos DB / Azure SQL Database**: Scalable database solutions for handling structured and unstructured data.

How It Aligns with My Interests?

- **Data Factory** can automate ETL pipelines for ML models and analytics.
- **Event Hubs & Kafka** allow me to work with real-time streaming applications.
- **Synapse Analytics** provides a complete platform for big data processing.

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4. Security & Compliance in Cloud Applications

Why It Interests Me?

Ensuring security in cloud-based applications is crucial, and Azure provides enterprise-level security tools.

Relevant Azure Services:

- **Azure Active Directory (AAD)**: Identity management and authentication.
- **Azure Security Center**: Monitoring and securing cloud resources.
- **Azure Sentinel**: AI-driven threat detection and response.
- **Azure Key Vault**: Securely storing credentials, API keys, and certificates.

How It Aligns with My Interests?

- Using **AAD**, I can implement authentication and access control in cloud applications.
- **Azure Security Center** helps in securing ML models and backend applications.

- **Key Vault** ensures secure credential management.

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5. Cloud-Based Application Development

Why It Interests Me?

Building scalable, cloud-native applications interests me, and Azure provides the necessary infrastructure.

Relevant Azure Services:

- **Azure App Service**: Hosting web applications without managing infrastructure.
- **Azure API Management**: Securely managing and exposing APIs.
- **Azure Service Bus**: Enabling microservices communication.
- **Azure Blob Storage**: Scalable storage for files and application assets.

How It Aligns with My Interests?

- **App Service** allows me to deploy full-stack applications without worrying about servers.
- **API Management** helps expose ML models and backend services securely.
- **Service Bus** can help me manage event-driven applications.

Conclusion: Why I Want to Work on Azure?

Working on Azure would allow me to leverage its diverse set of services in the following ways:

- **Developing & Deploying AI/ML models at scale**
- **Automating workflows & CI/CD pipelines with Azure DevOps**
- **Handling big data & real-time analytics with Azure Data Services**
- **Securing cloud applications with enterprise-grade security features**
- **Building cloud-native applications that are scalable and cost-effective**

Azure is a rapidly growing cloud platform, and its integration with **AI, DevOps, Big Data, and Security** aligns well with my career aspirations. Whether it's deploying an ML model, automating cloud workflows, or securing cloud-based systems, Azure provides a comprehensive ecosystem to explore and innovate.