IntelliPaat

Designing and Implementing an Azure Data Solution

DP 200 and DP 201

IntelliPaat

Relational Data Stores

Agenda

01 Introduction to Relational Data Stores

02 Azure SQL Database

03 Azure SQL Security Capabilities

04 High Availability and Azure SQL Database

05 Azure Database for MySQL

06 Azure Database for MariaDB

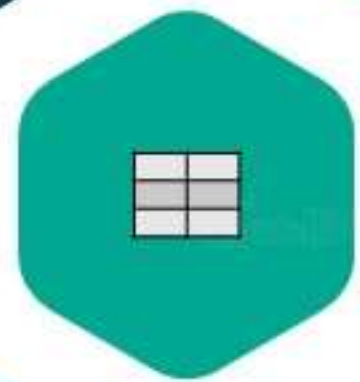
07 What is PolyBase?

08 What is Azure Synapse Analytics ?

Introduction to Relational Data Stores

Relational Data Stores

A relational database is a type of database that stores and provides access to data points that are related to one another



Each table has its own columns, and every row in a table has the same set of columns

A relational database organizes data as a series of two-dimensional tables with rows and columns

Relational Data Store

These are the four crucial properties that define relational database transactions:

Relational Data Store

Atomicity — Defines all the elements that make up a complete database transaction

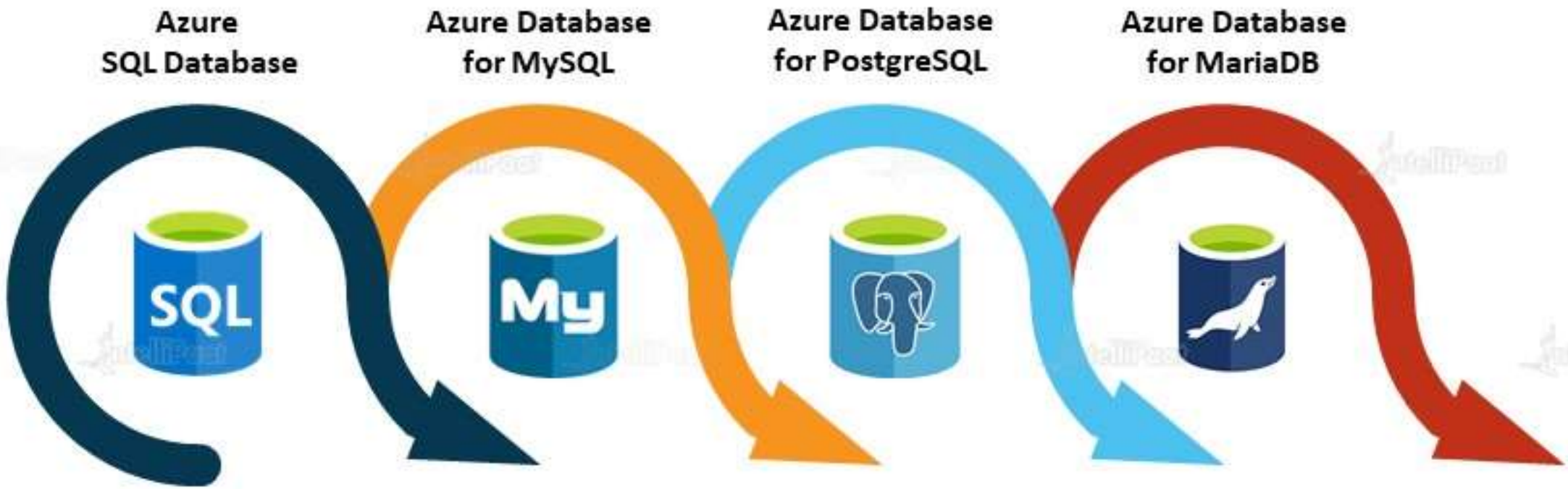
Consistency — Defines the rules for maintaining data points in a correct state after a transaction

Isolation — Keeps the effect of a transaction invisible to others until it is committed to avoid confusion

Durability — Ensures that data changes become permanent once a transaction is committed

Relational Data Store

Relevant Azure Services



Azure SQL Database

Azure SQL Database

Azure SQL Database is a general-purpose relational database, provided as a managed service

With it, we can create a high-available and high-performance data storage layer for the applications and solutions in Azure

It is the right choice for a variety of modern cloud applications as it enables us to process both relational data and non-relational structures

Azure SQL Database

We can use advanced query processing features, such as **high-performance in-memory technologies** and **intelligent query processing**

It is based on the latest stable version of the **Microsoft SQL Server database engine**

In fact, the newest capabilities of SQL Server are released first to the SQL Database and then to SQL Server

Azure SQL Database

01

SQL Database enables us to easily define and scale performance within two different purchasing models: a **vCore-based purchasing model** and a **DTU-based purchasing model**

SQL Database is a fully managed service that has built-in high availability, backups, and other common maintenance operations

02

Deployment Models

Azure SQL Database provides the following deployment options

Deployment Models

Single database represents a fully managed, isolated database

A single database is similar to a contained database in Microsoft SQL Server Database Engine

We use this if we have modern cloud applications and microservices that need a single reliable data source

Deployment Models

Managed instance is a fully managed instance of the Microsoft SQL Server Database Engine

We use this option for easy migration of on-premises SQL Server databases to the Azure cloud

It contains a set of databases that can be used together

Deployment Models

Elastic pool is a collection of single databases with a shared set of resources, such as CPU or memory

Single databases can be moved into and out of an elastic pool

Azure SQL Database

1

It delivers predictable performance with multiple resource types, service tiers, and compute sizes

2

It provides dynamic scalability with no downtime, built-in intelligent optimization, global scalability & availability, and advanced security options

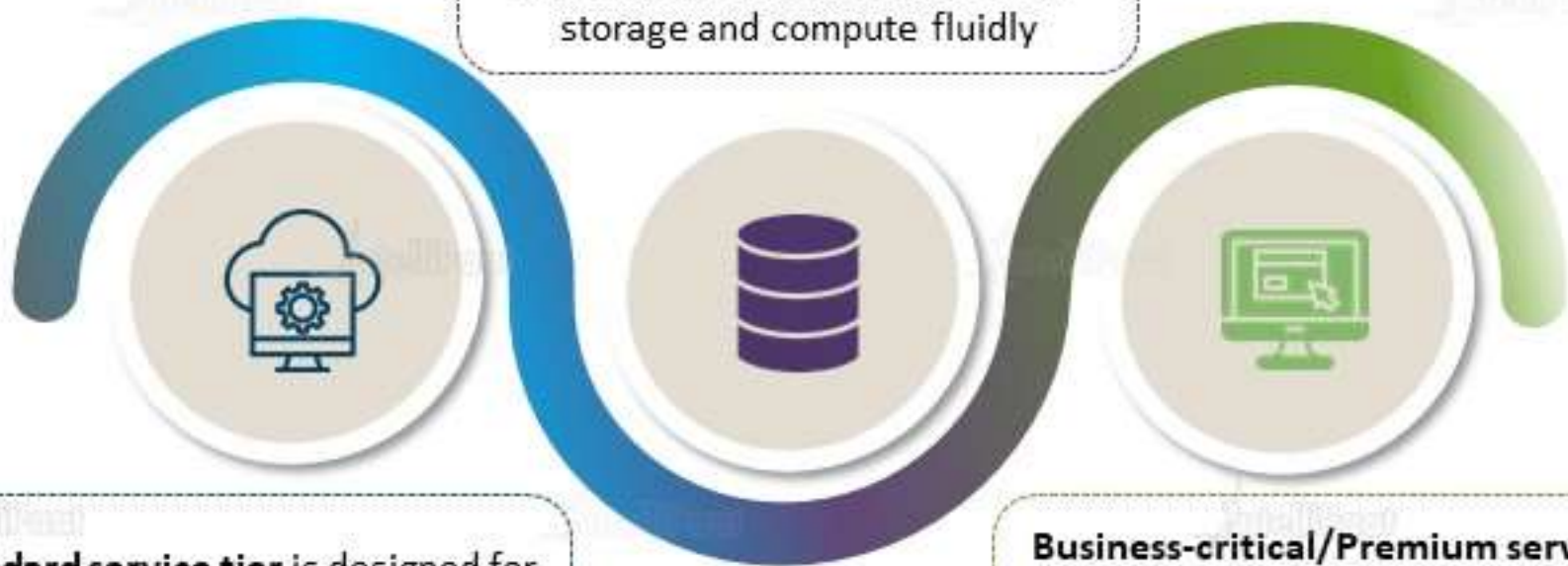
3

The SQL Database service is currently in 38 data centers around the world

Service Tiers

Azure SQL Database offers three service tiers designed for different types of applications:

Hyperscale service tier designed for very large OLTP databases to leverage the ability to auto-scale storage and compute fluidly



General-purpose/Standard service tier is designed for common workloads. It offers budget-oriented balanced compute and storage options

Business-critical/Premium service tier is designed for OLTP applications with a high transaction rate and the lowest latency I/O. It offers the highest resilience to failures by using several isolated replicas

Hands-on: Creating a Single Database Using Azure Portal

Hands-on: Creating a Managed Instance

Hands-on: Creating an Elastic Pool

Why SQL Database Elastic Pool?

Why SQL Database Elastic Pool?

Pools are well suited for a large number of databases with specific utilization patterns

For a given database, this pattern is characterized by a low average utilization with relatively infrequent utilization spikes

The more databases we add to a pool the greater our savings become

Hands-on: Creating a SQL Virtual Machine

Hands-on: Configuring Active Geo-replication for Azure SQL Database in Azure Portal & Initiating a Failover

Why Azure SQL?

Why Azure SQL?

Frictionless Migration

- Accelerates the on-premises SQL Server migrations without changing the application code with the Managed Instance
- Always has the latest SQL Server capabilities in the cloud with an evergreen SQL Database that requires no patching or upgrading from our end

Why Azure SQL?

Built-in Machine Learning

- Gets peak database performance and durability with safe, reliable, and proven AI technology
- Maximizes the performance of our application with customized auto-tuning recommendations
- Uses Intelligent Insights to monitor and detect disruptive events that can cause poor performance

Why Azure SQL?

Unmatched Scaling and High Availability

- Scales our application on demand with up to 99.995 percent availability
- Scales compute and storage resources independently for maximum flexibility and lowers the costs with discounted readable replicas
- Its built-in high availability guarantees that the database will never be a single point of failure in our software architecture

Why Azure SQL?

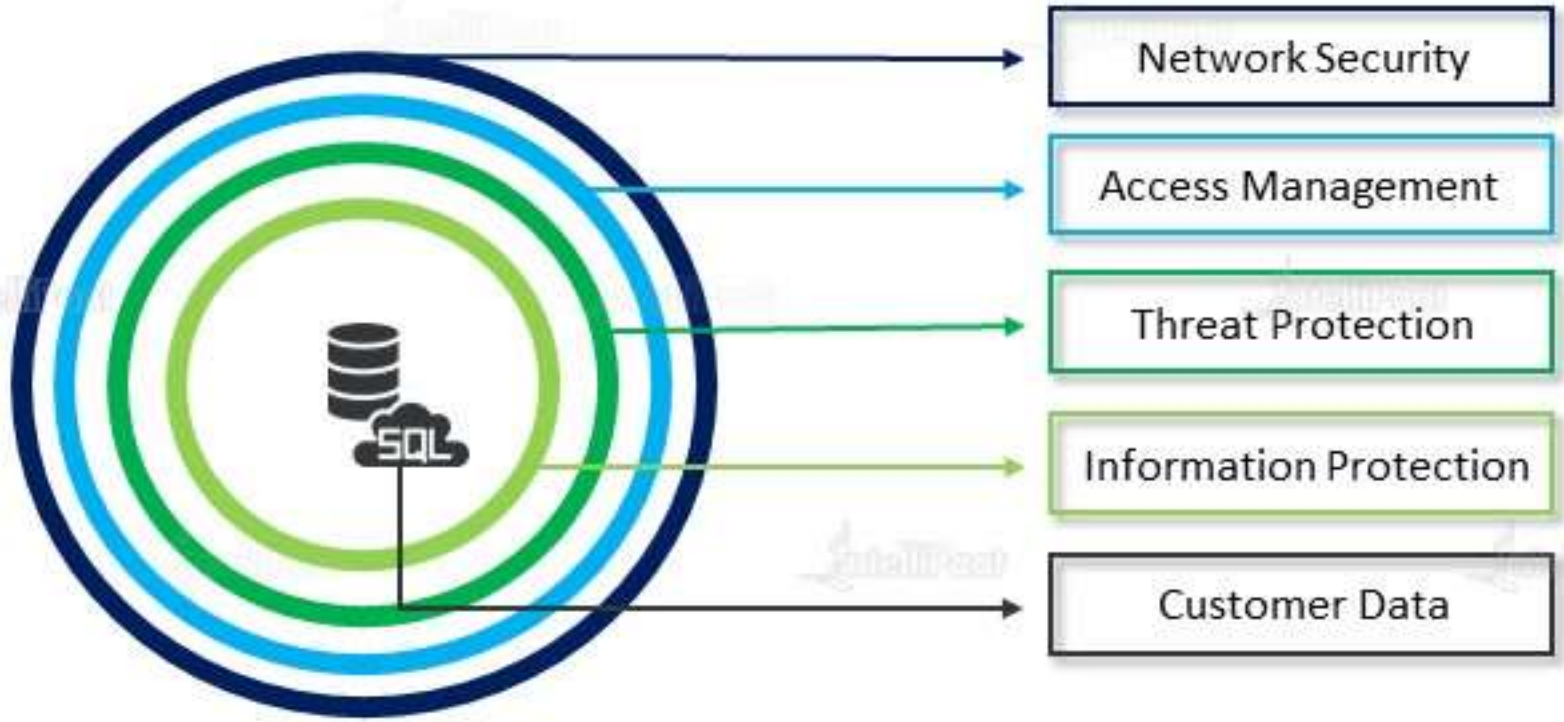
Advanced Data Security

- Protects our databases from malicious acts with fine-grained access controls, Always Encrypted technology, and advanced threat protection capabilities
- Discovers, tracks, and remediates potential vulnerabilities from a single screen
- Meets the most stringent compliance standards with built-in auditing and information protection technologies

Azure SQL Security Capabilities

Azure SQL Security Capabilities

The security strategy follows a layered defense-in-depth (DiD) approach that moves outside in, as shown in the picture below:



Azure SQL Security Capabilities

- Network Security
- Access Management
- Threat Protection
- Information Protection

Microsoft Azure SQL Database provides a relational database service for cloud and enterprise applications

To help protect customer data, firewalls prevent network access to the database server until the access is explicitly granted based on the IP address or Azure VNet traffic origin

Azure SQL Security Capabilities

- Network Security
- Access Management
- Threat Protection
- Information Protection

IP firewall rules grant access to databases based on the originating IP address of each request

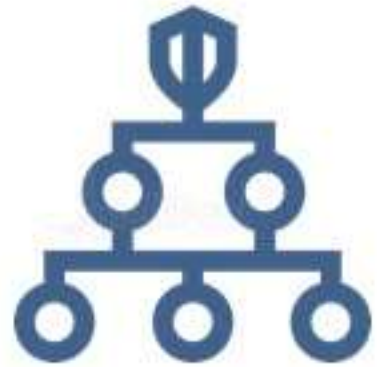
Virtual network service endpoints extend our VNet connectivity over the Azure backbone

Virtual network service endpoints enable Azure SQL Database to identify the virtual network subnet that the traffic originates from

Azure SQL Security Capabilities

- Network Security
- Access Management
- Threat Protection
- Information Protection

To allow traffic to reach Azure SQL Database, we use the SQL service tags that allow the outbound traffic through Network Security Groups

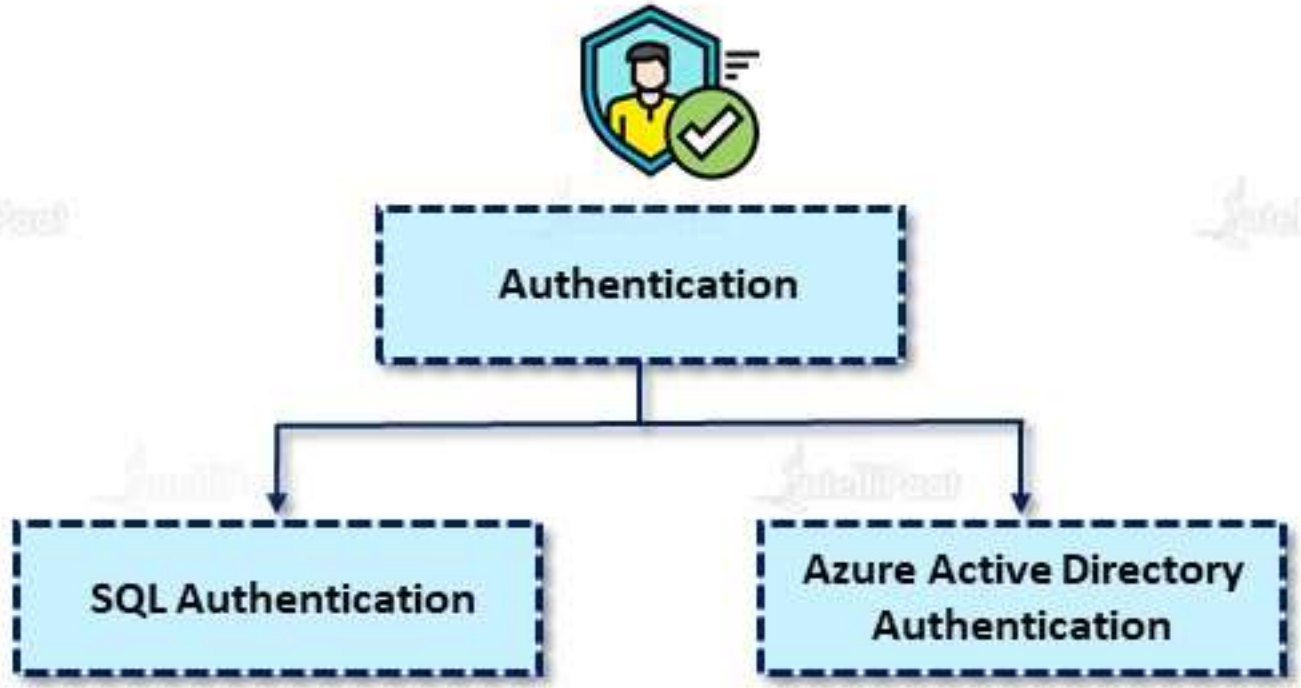


Virtual network rules enable Azure SQL Database to accept communications that are sent only from select subnets inside a virtual network

Azure SQL Security Capabilities

- Network Security
- Access Management
- Threat Protection
- Information Protection

- Managing databases and database servers within Azure is controlled by the portal's role assignments of user accounts
- **Authentication** is the process of proving that a user is who he/she claims to be



Azure SQL Security Capabilities

- Network Security
- Access Management
- Threat Protection
- Information Protection

SQL Authentication

SQL database authentication refers to the authentication of a user when connecting to Azure SQL Database using username and password

Azure SQL Security Capabilities

- Network Security
- Access Management
- Threat Protection
- Information Protection

Azure Active Directory Authentication

- Azure Active Directory authentication is a mechanism of connecting to Azure SQL Database and SQL Data Warehouse by using the identities in Azure Active Directory
- A Server Admin called the **Active Directory Administrator** must be created to use Azure AD authentication with SQL Database

Azure SQL Security Capabilities

- Network Security
- Access Management
- Threat Protection
- Information Protection

- **Authorization** refers to the permissions assigned to a user within Azure SQL Database, and it determines what the user is allowed to do
- Permissions are controlled by adding user accounts to database roles and assigning database-level permissions to those roles or by granting a user certain object-level permissions

Azure SQL Security Capabilities

- Network Security
- Access Management
- Threat Protection
- Information Protection

Row-level Security

Row-level security enables customers to control access to rows in a database table based on the characteristics of the user executing a query

Example: Group membership or execution context

Azure SQL Security Capabilities

- Network Security
- Access Management
- **Threat Protection**
- Information Protection

- SQL Database secures customer data by providing auditing and threat detection capabilities

SQL Auditing in Azure Monitor Logs and Event Hubs

SQL Database auditing tracks database activities and helps maintain compliance with security standards by recording database events to an audit log in a customer-owned Azure storage account

Azure SQL Security Capabilities

- Network Security
- Access Management
- Threat Protection
- Information Protection

Advanced Threat Protection

Advanced Threat Protection is analyzing our SQL Server logs to detect unusual behavior and potentially harmful attempts to access or exploit databases

Azure SQL Security Capabilities

- Network Security
- Access Management
- Threat Protection
- Information Protection

Transport Layer Security (Encryption-in-transit)

- SQL Database secures customer data by encrypting it in motion with **Transport Layer Security (TLS)**
- SQL Server enforces encryption (SSL/TLS) at all times for all connections
- This ensures that all data is encrypted 'in transit' between the client and the server, irrespective of the setting of Encrypt or TrustServerCertificate in the connection string

Azure SQL Security Capabilities

- Network Security
- Access Management
- Threat Protection
- Information Protection

Transport Layer Security (Encryption-in-transit)

For example: When using the ADO.NET driver, this is accomplished via **Encrypt=True** and **TrustServerCertificate=False**. If have we obtained our connection string from Azure Portal, it will have the correct settings

Azure SQL Security Capabilities

- Network Security
- Access Management
- Threat Protection
- Information Protection

Transparent Data Encryption (Encryption-at-rest)

- Transparent Data Encryption (TDE) for Azure SQL Database adds a layer of security to help protect data at rest (the raw files or backup) from unauthorized or offline access
- In Azure, all newly created SQL databases are encrypted by default, and the database encryption key is protected by a built-in server certificate

Azure SQL Security Capabilities

Key Management with Azure Key Vault

- **Bring Your Own Key (BYOK)** support for **Transparent Data Encryption (TDE)** allows customers to take ownership of key management and rotation using Azure Key Vault, Azure's cloud-based external key management system
- Azure Key Vault provides a central key management platform, leverages tightly monitored hardware security modules (HSMs), and enables the separation of duties between management of keys and data to help meet security compliance requirements

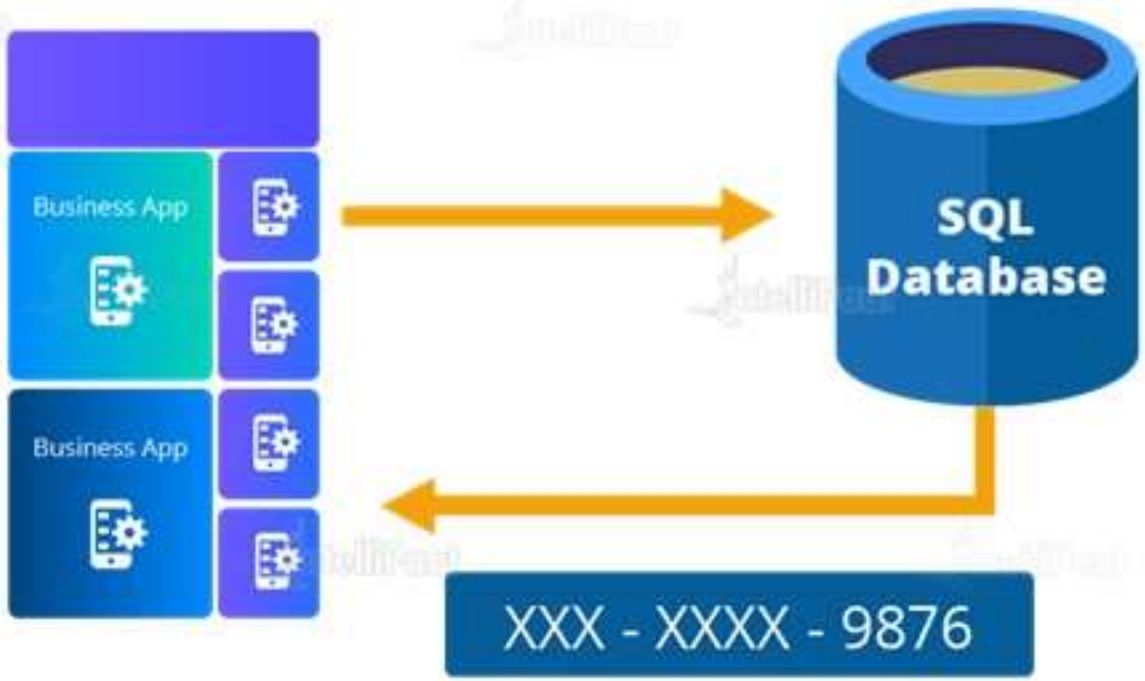
Azure SQL Security Capabilities

Always Encrypted (Encryption-in-use)

- Always Encrypted is a feature designed to protect sensitive data stored in specific database columns from access
- **Example**: credit card numbers, national identification numbers, etc.

Azure SQL Security Capabilities

Dynamic Data Masking



- SQL Database dynamic data masking limits sensitive data exposure by masking it from non-privileged users
- Dynamic data masking automatically discovers potentially sensitive data in Azure SQL Database and provides actionable recommendations to mask these fields, with minimal impact on the application layer

High Availability and Azure SQL Database

High Availability and Azure SQL Database

- The goal of the High Availability architecture in Azure SQL Database is to guarantee that our database is up and running 99.99 percent of time, without worrying about the impact of maintenance operations and outages
- The high-availability solution is designed to ensure that the committed data is never lost due to failures, that maintenance operations do not affect our workload, and that the database will not be a single point of failure in our software architecture

High Availability and Azure SQL Database

There are two high-availability architectural models that are used in Azure SQL Database:

- **Standard Availability Model**
- **Premium Availability Model**

High Availability and Azure SQL Database

Standard Availability Model

Premium Availability Model

Standard Availability Model

- This model is based on a separation of compute and storage
- It relies on high availability and reliability of the remote storage tier
- This architecture targets budget-oriented business applications that can tolerate some performance degradation during maintenance activities

High Availability and Azure SQL Database

- Standard Availability Model
- Premium Availability Model

Standard Availability Model

The standard availability model includes two layers:

- **Stateless Compute Layer**
- **Stateful Data Layer**

High Availability and Azure SQL Database

Standard Availability Model

Premium Availability Model

Stateless Compute Layer

- Stateless compute layer runs the **sqlservr.exe** process and contains only transient and cached data, such as TempDB, model databases on the attached SSD, and plan cache, buffer pool, and columnstore pool in memory
- This stateless node is operated by Azure Service Fabric that initializes **sqlservr.exe**, controls the health of the node, and performs a failover to another node if necessary

High Availability and Azure SQL Database

Standard Availability Model

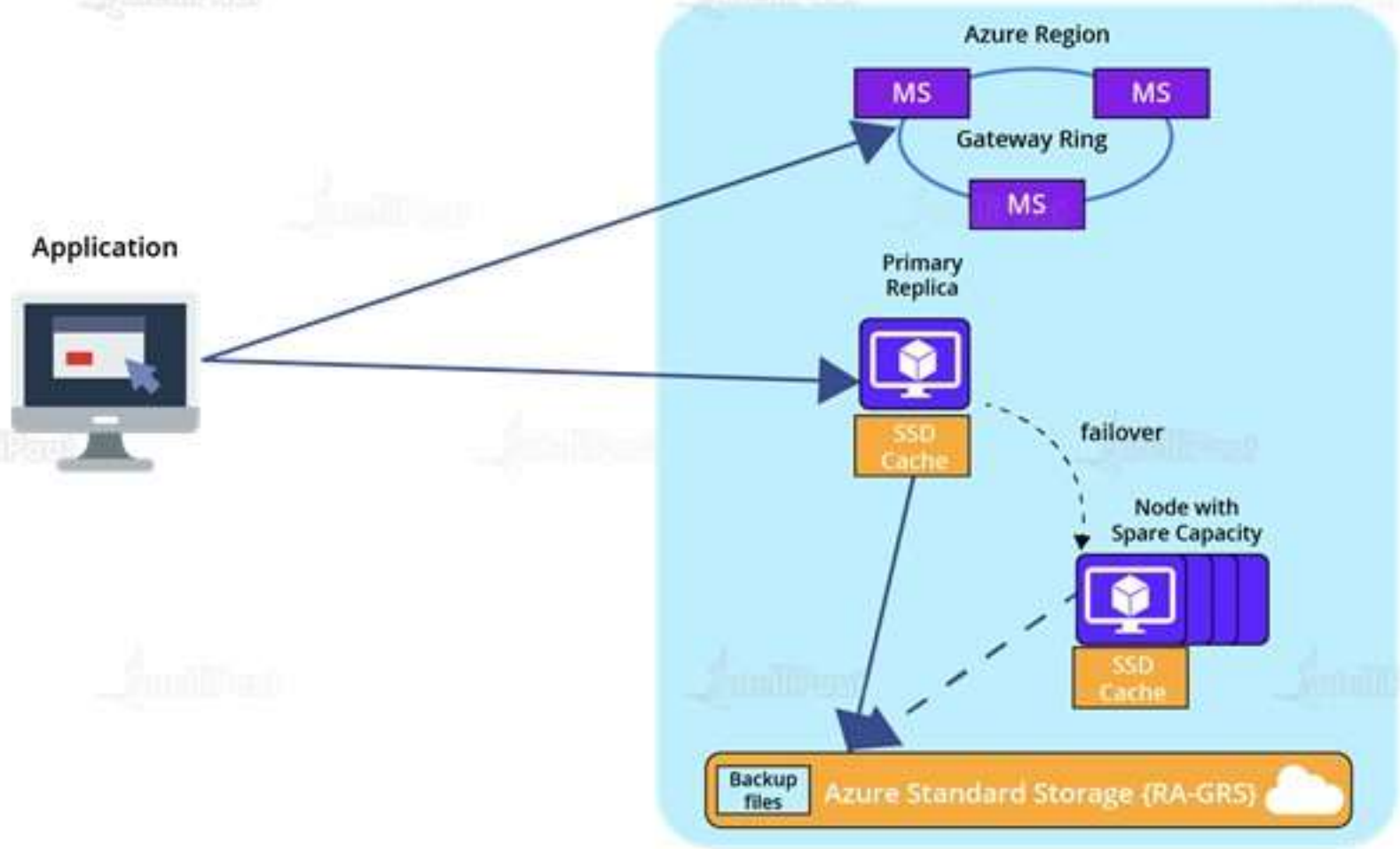
Premium Availability Model

Stateful Data Layer

- A stateful data layer, along with the database files (.mdf/.ldf), is stored in Azure Blob Storage
- Azure Blob Storage has built-in data availability and redundancy features
- It guarantees that every record in a log file or page in a data file will be preserved even if the SQL Server process crashes

High Availability and Azure SQL Database

- Standard Availability Model
- Premium Availability Model



High Availability and Azure SQL Database

Standard Availability Model

Premium Availability Model

Premium Availability Model

- This model is based on a cluster of database engine processes
- It relies on the fact that there is always a quorum of available database engine nodes
- This architecture targets mission-critical applications with high I/O performance and a high transaction rate and guarantees minimal performance impact to our workload during maintenance activities

High Availability and Azure SQL Database

Standard Availability Model

Premium Availability Model

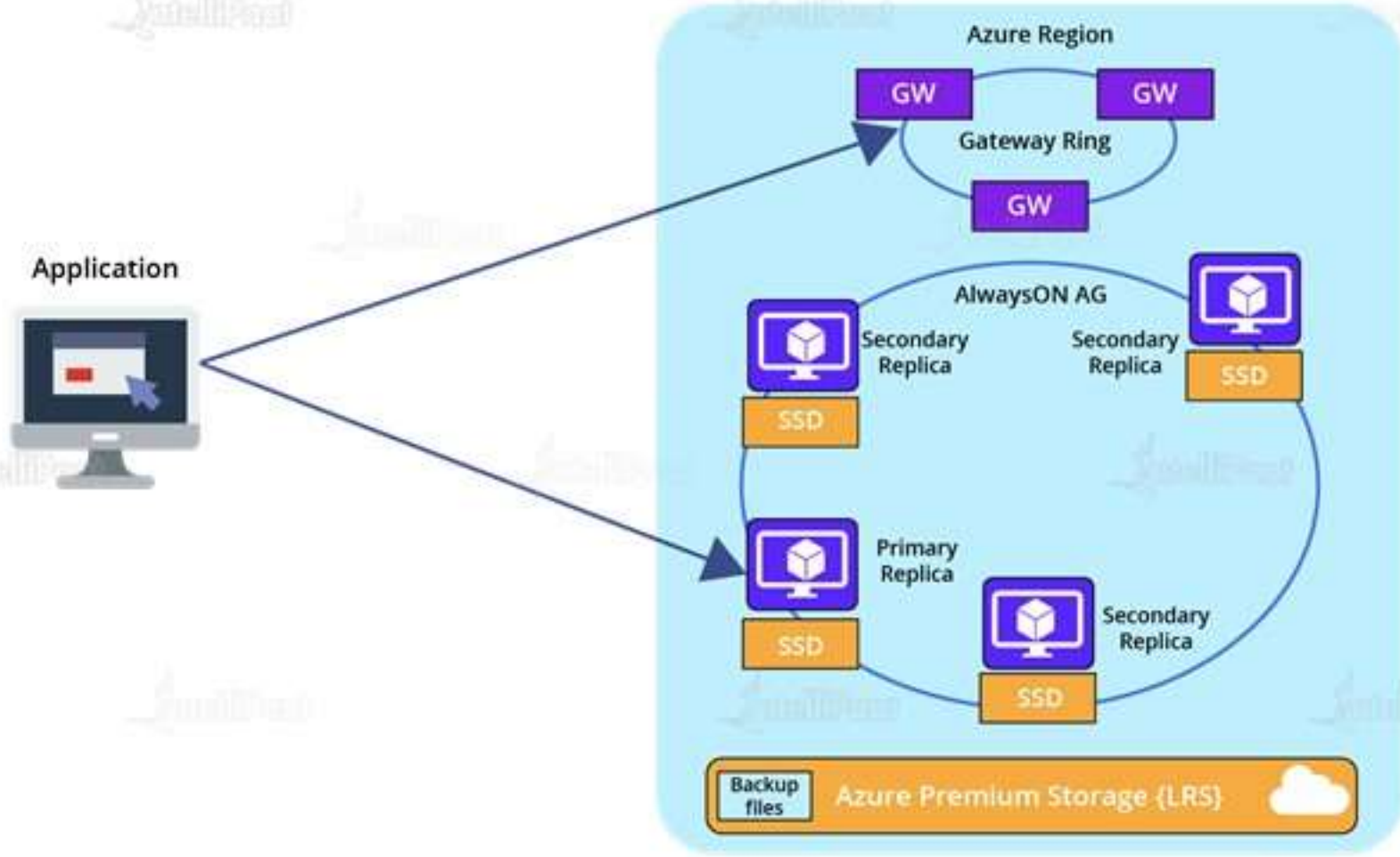
Premium Availability Model

- Premium/Business-critical service tiers leverage the premium availability model, which integrates compute resources (the SQL Server Database Engine process) and storage (locally attached SSD) on a single node
- High availability is achieved by replicating both compute and storage to additional nodes creating a 3-to-4-node cluster
- The underlying database files (.mdf/.ldf) are placed on the attached SSD storage to provide very low latency I/O to our workload

High Availability and Azure SQL Database

Standard Availability Model

Premium Availability Model



Azure Database for MySQL

Azure Database for MySQL

Azure Database for MySQL is a relational database service powered by the MySQL community edition

It is a fully managed Database-as-a-Service offering that can handle mission-critical workloads with predictable performance and dynamic scalability

Azure Database for MySQL upholds, with features that limit access, protect data at rest and in motion and help us monitor the activities

Azure Database for MySQL

Azure Database for MySQL delivers:

- Enterprise-grade security and compliance
- Automatic backups and point-in-time restore for up to 35 days
- Secured protection of sensitive data at rest and in motion

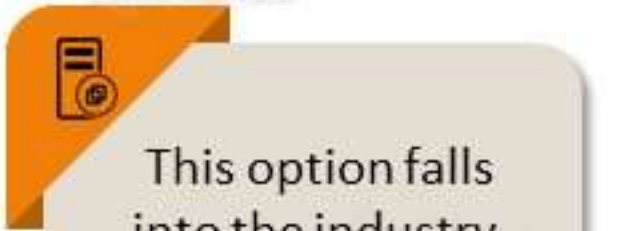
- Built-in high availability with no additional cost
- Predictable performance, using the inclusive pay-as-you-go pricing
- Scaling as needed within seconds

Which MySQL option to choose?

With Azure, our MySQL server workloads can run in a hosted virtual machine infrastructure as a service (IaaS) or as a hosted platform as a service (PaaS)

When we choose between IaaS and PaaS, we must decide if our aim is to manage our database, apply patches, and make backups

MySQL on Azure VMs



This option falls into the industry category of IaaS. With this service, we can run MySQL Server inside a fully managed virtual machine on the Azure cloud platform

01

All recent versions and editions of MySQL can be installed on an IaaS virtual machine

02

The most significant difference from Azure Database for MySQL is that MySQL on Azure VMs offers control over the database engine

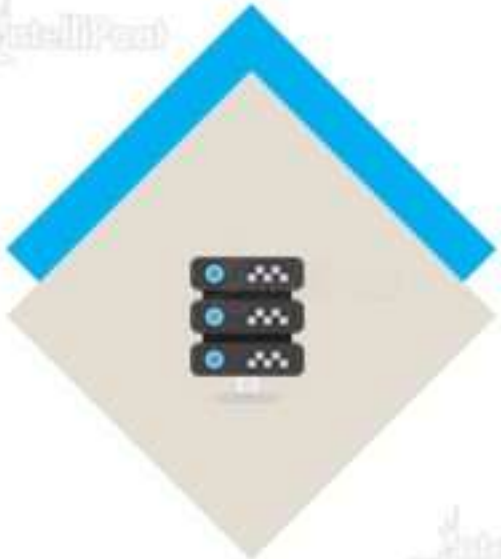
03

Hands-on: Designing an Azure Database for MySQL Using Azure Portal

Hands-on: Connecting Using MySQL Workbench

Azure Database for PostgreSQL

Azure Database for PostgreSQL



Azure Database for PostgreSQL is a relational database service in the Microsoft cloud built for developers

It is based on the community version of open-source PostgreSQL database engine

It is available in two deployment options: **Single Server** and **Hyperscale (Citus)**

Single Server

The Single Server deployment option delivers:

Monitoring and alerting to assess our server

Automatic backups and point-in-time-restore for up to 35 days

Secured to protect sensitive data at-rest and in-motion

Built-in high availability with no additional cost (99.99% SLA)

Predictable performance, using inclusive pay-as-you-go pricing

Vertical scale as needed within seconds

Hyperscale (Citus)

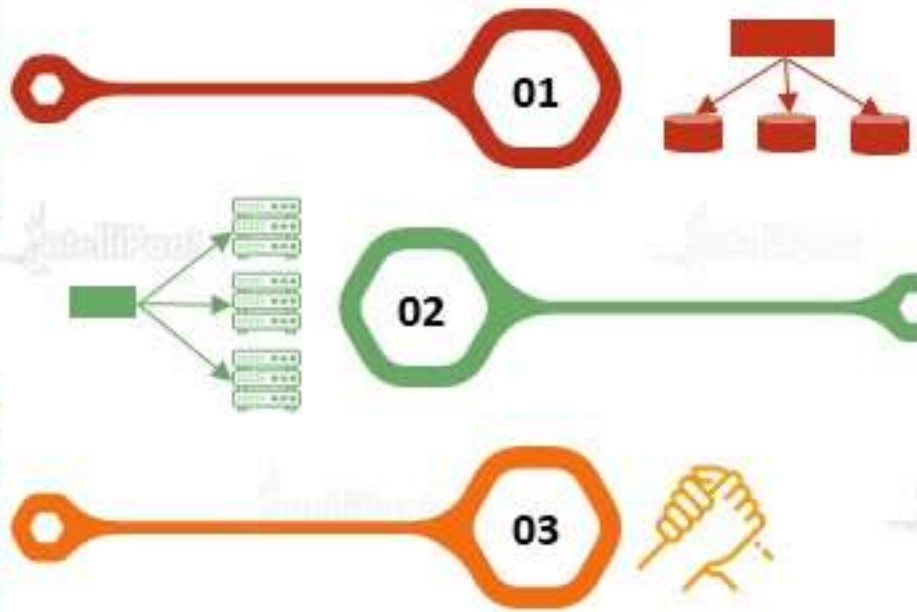
The **Hyperscale (Citus)** option horizontally scales queries across multiple machines using sharding

Its query engine parallelizes the incoming SQL queries across these servers for faster responses on large datasets

Hyperscale (Citus)

The Hyperscale deployment option delivers:

Horizontal scaling across multiple machines using sharding



Query parallelization across multiple servers for faster responses on large datasets

Excellent support for multi-tenant applications, real-time operational analytics, and high-throughput transactional workloads

Hands-on: Designing an Azure Database for PostgreSQL - Single Server

Azure Database for MariaDB

Azure Database for MariaDB

Azure Database for MariaDB is a relational database service in the Microsoft cloud

It is based on the MariaDB community edition database engine, version 10.2 and 10.3

Azure Database for MariaDB

Azure Database for MariaDB delivers:

- Enterprise-grade security and compliance
- Automatic backups and point-in-time restore for up to 35 days
- Secured protection of sensitive data at rest and in motion

- Built-in high availability with no additional cost
- Predictable performance, using the inclusive pay-as-you-go pricing
- Scaling as needed within seconds

Azure Database for MariaDB

Azure Database for MariaDB can help us rapidly develop our app and accelerate our Time to Market

We can also continue to develop our application by using the open-source tools and a platform of our choice

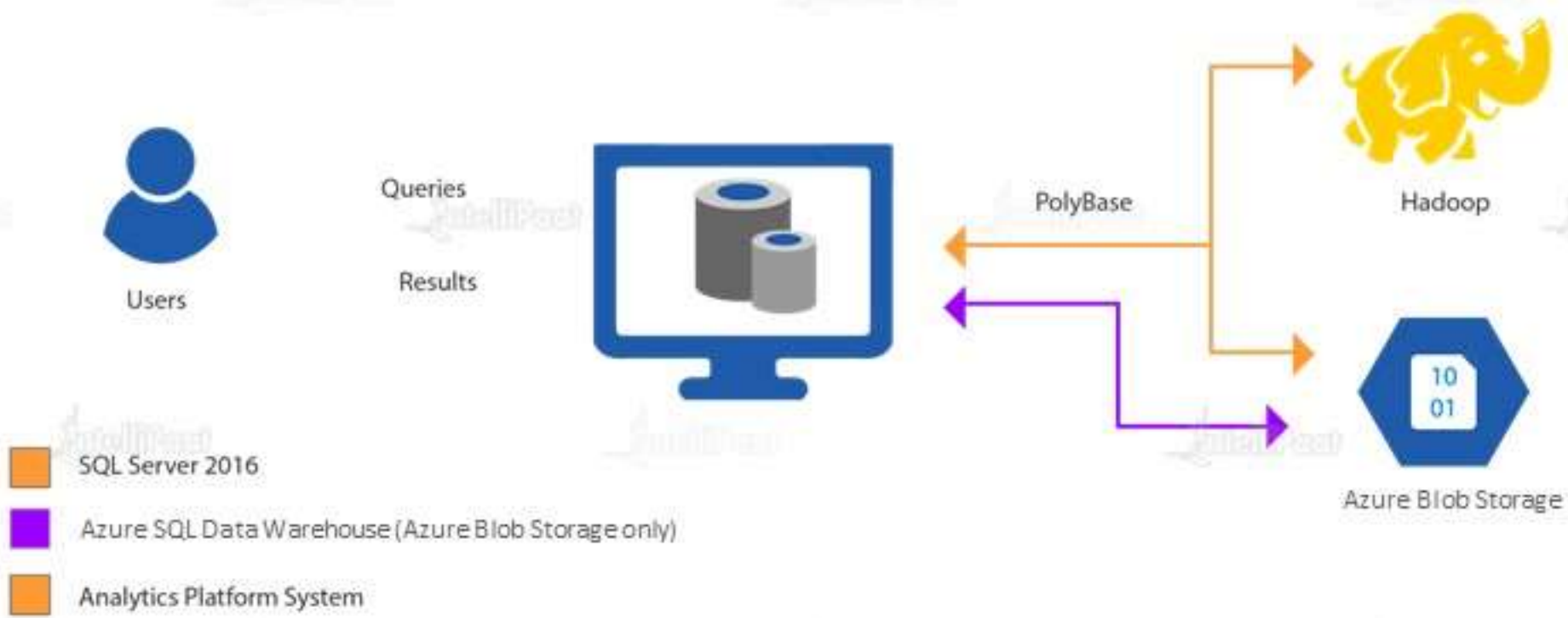
Azure Database for MariaDB delivers speed and efficiency for our business demands, all without learning new skills

Hands-on: Creating an Azure Database for MariaDB Server by Using Azure Portal

What is PolyBase?

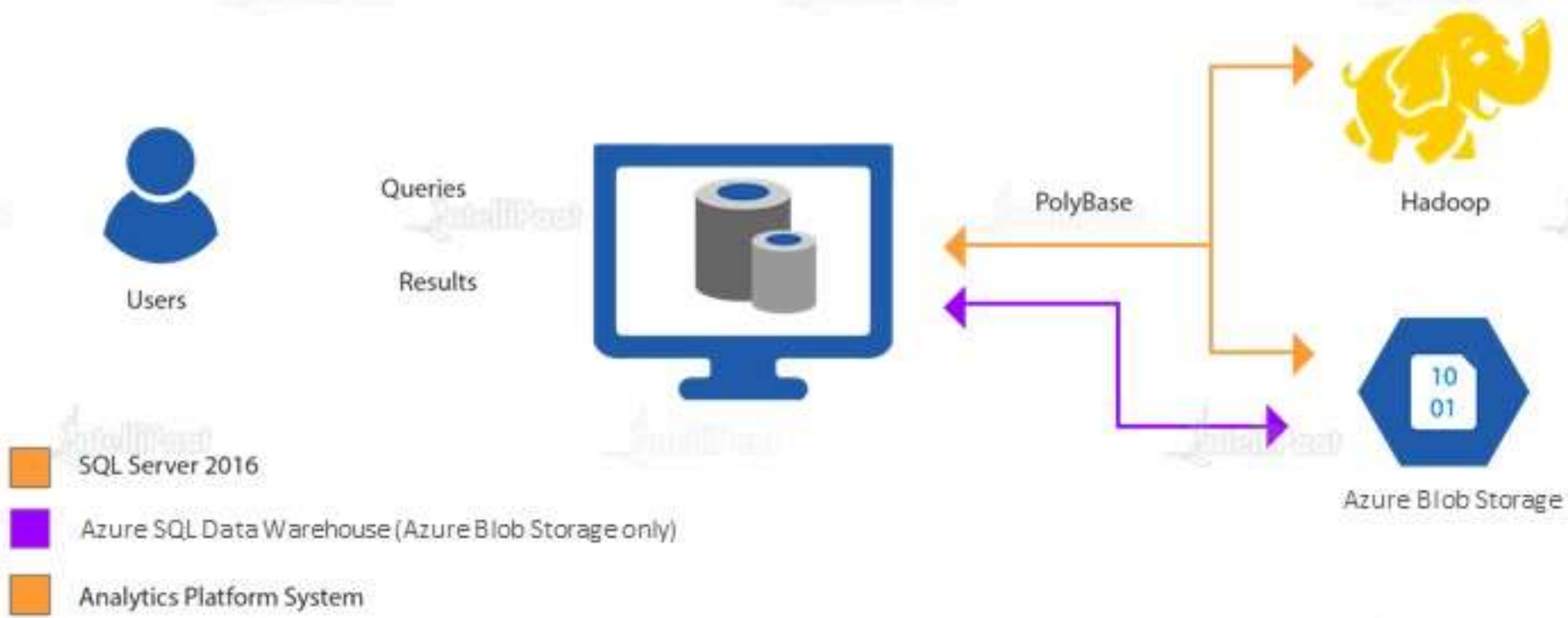
PolyBase

- PolyBase enables our SQL Server 2016 instance to process Transact-SQL queries that read data from Hadoop
- The same query can also access the relational tables in our SQL Server



PolyBase

- In SQL Server, an **external table** or an **external data source** provides the connection to Hadoop
- PolyBase pushes some computations to the Hadoop node to optimize the overall query



Azure Integration

01

With the underlying help of PolyBase, T-SQL queries can also import and export data from Azure Blob Storage

02

PolyBase enables Azure SQL Data Warehouse to import and export data from Azure Data Lake Store and from Azure Blob Storage

Why PolyBase?

In the past, it was more difficult to join our SQL Server data with the external data. Then, we had only the following two unpleasant options:

- Transfer half of our data so that all our data s in one format or the other
- Query both sources of the data and then write custom query logic to join and integrate the data at the client level

PolyBase avoids these unpleasant options by using T-SQL to join the data

Why PolyBase?

PolyBase enables the following scenarios in SQL Server:

1. Querying the data stored in Hadoop from SQL Server or PDW
2. Querying the data stored in Azure Blob Storage
3. Importing data from Hadoop, Azure Blob Storage, or Azure Data Lake Store
4. Exporting data to Hadoop, Azure Blob Storage, or Azure Data Lake Store
5. Integrating with BI tools

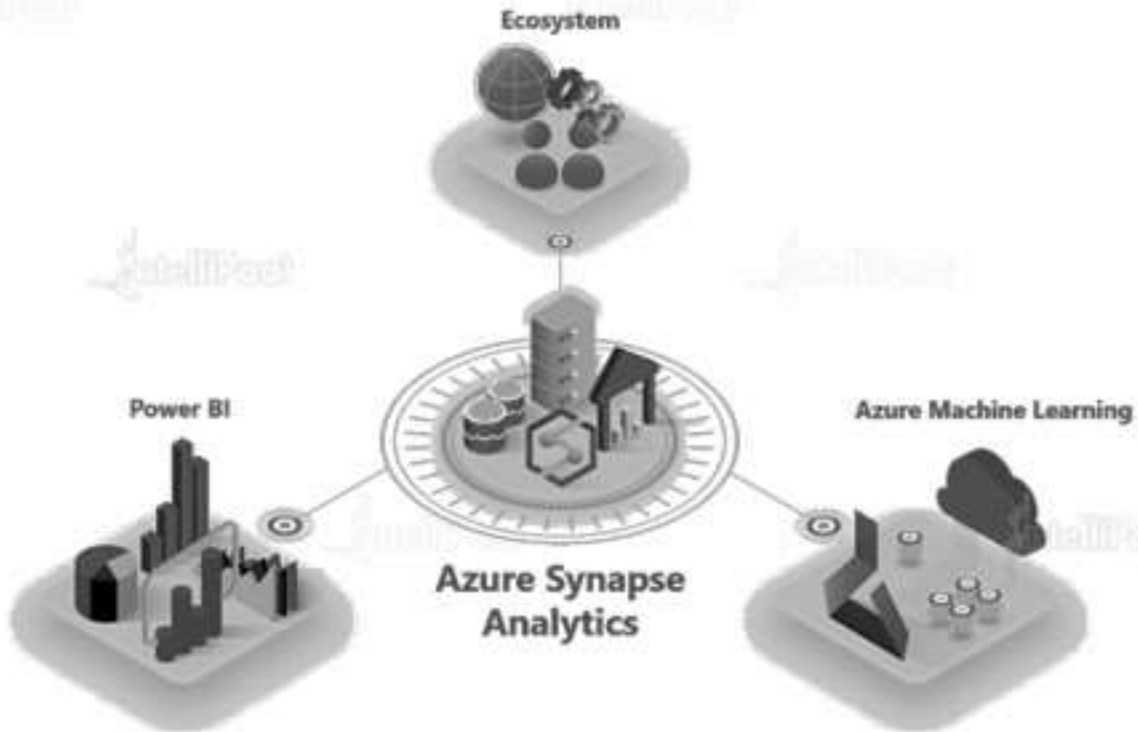
What is Azure Synapse Analytics (Formerly, SQL DW)?

Azure Synapse Analytics

01

Azure Synapse is a limitless analytics service that brings together enterprise data warehousing and Big Data Analytics

Azure Synapse brings these two worlds together with a unified experience to ingest, prepare, manage, and serve data for immediate **BI** and **Machine Learning** needs



02

It gives us the freedom to query data on our terms, using either serverless on-demand or provisioned resources at scale

Azure Synapse Analytics

Azure Synapse has four components:

Complete T-SQL-based analytics

- SQL pool
- SQL on-demand

SQL Analytics

Spark

Deeply integrated Apache Spark

Hybrid data integration

Data Integration

Studio

Unified user experience

SQL Analytics & SQL Pool in Azure Synapse

01

SQL Analytics refers to the enterprise data warehousing features that are generally available in Azure Synapse

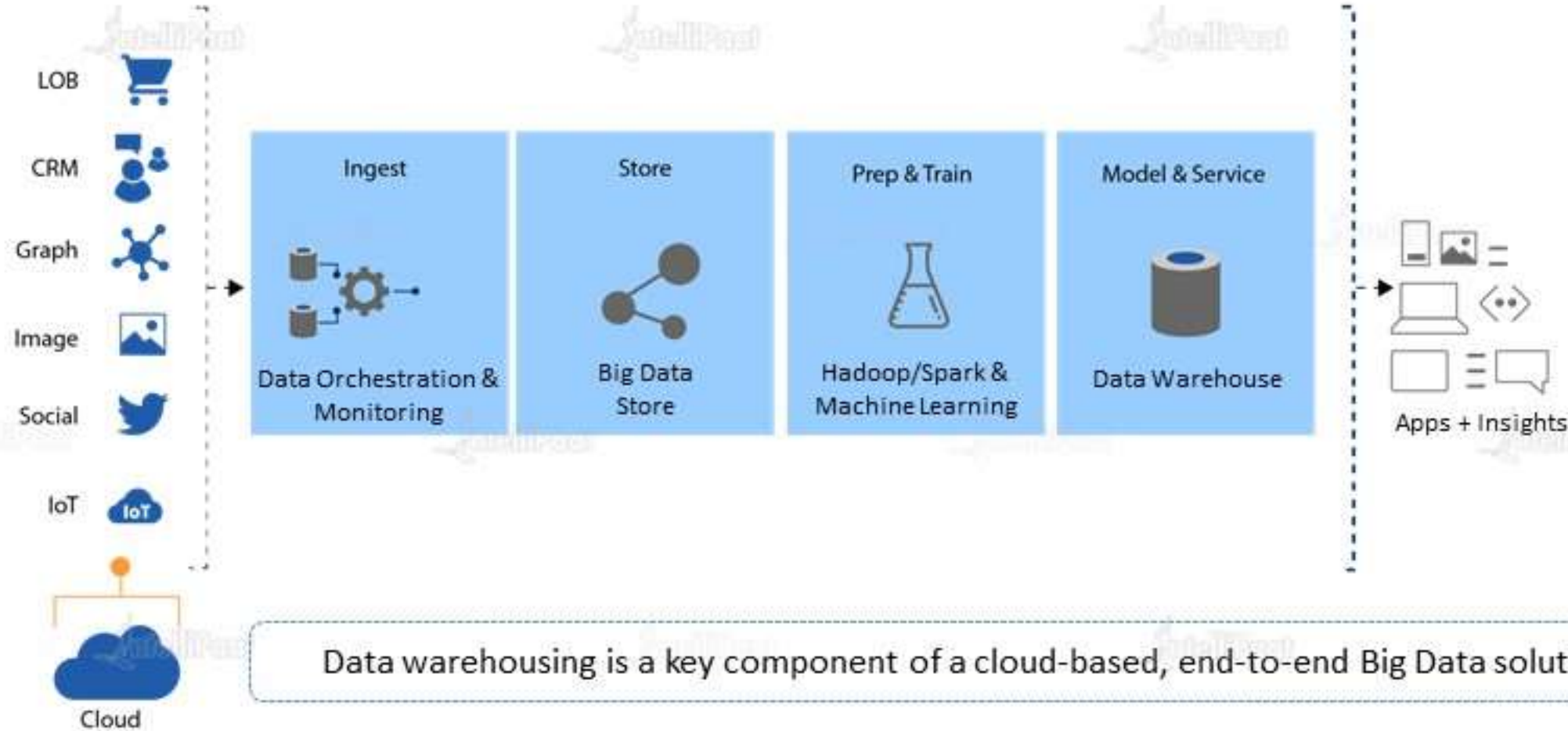
02

SQL pool represents a collection of analytic resources that are being provisioned when using SQL Analytics. The size of the SQL pool is determined by Data Warehousing Units (DWU)

03

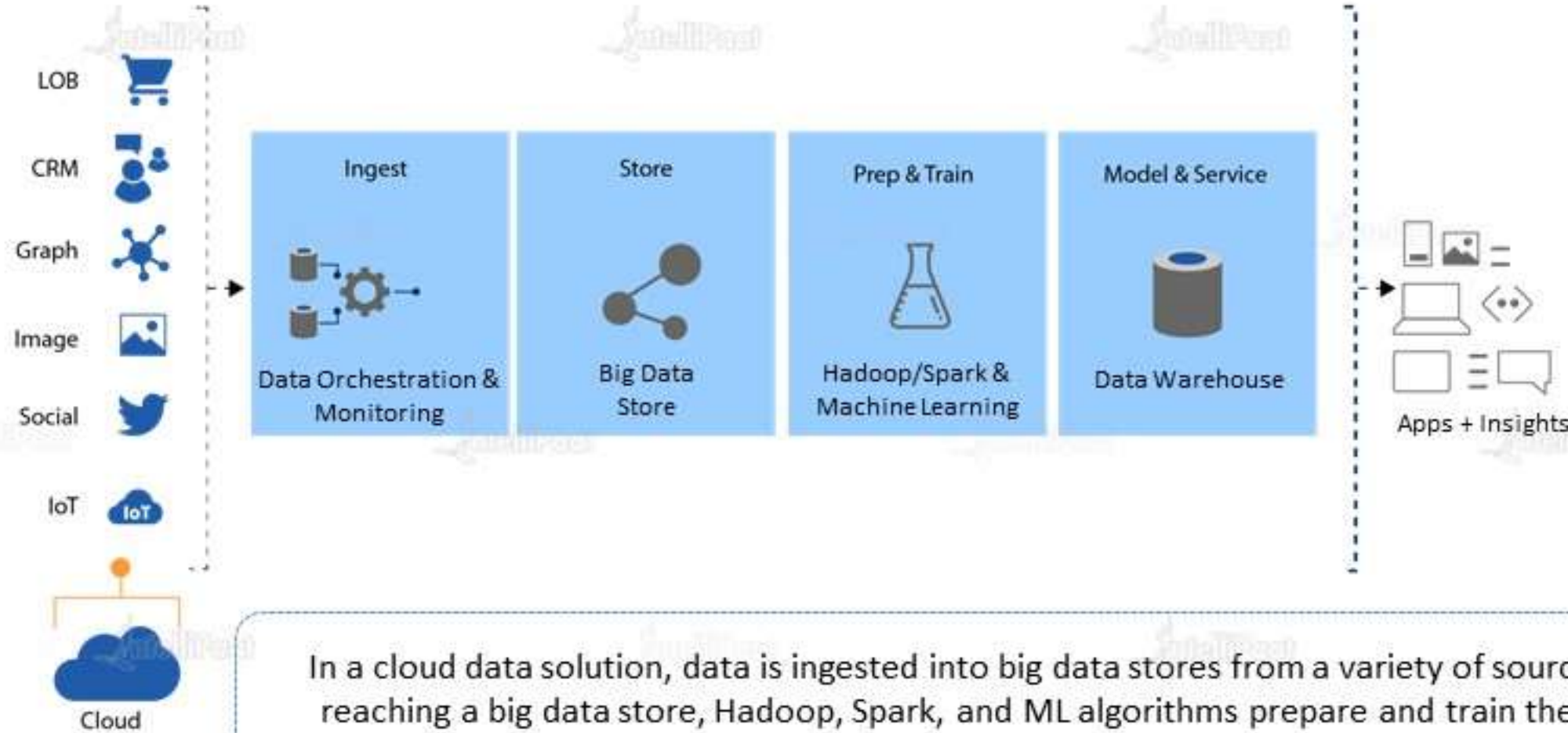
We can import big data with simple PolyBase T-SQL queries and then use the power of Massive Parallel Processing (MPP) to run high-performance analytics

Key Components of a Big Data Solution



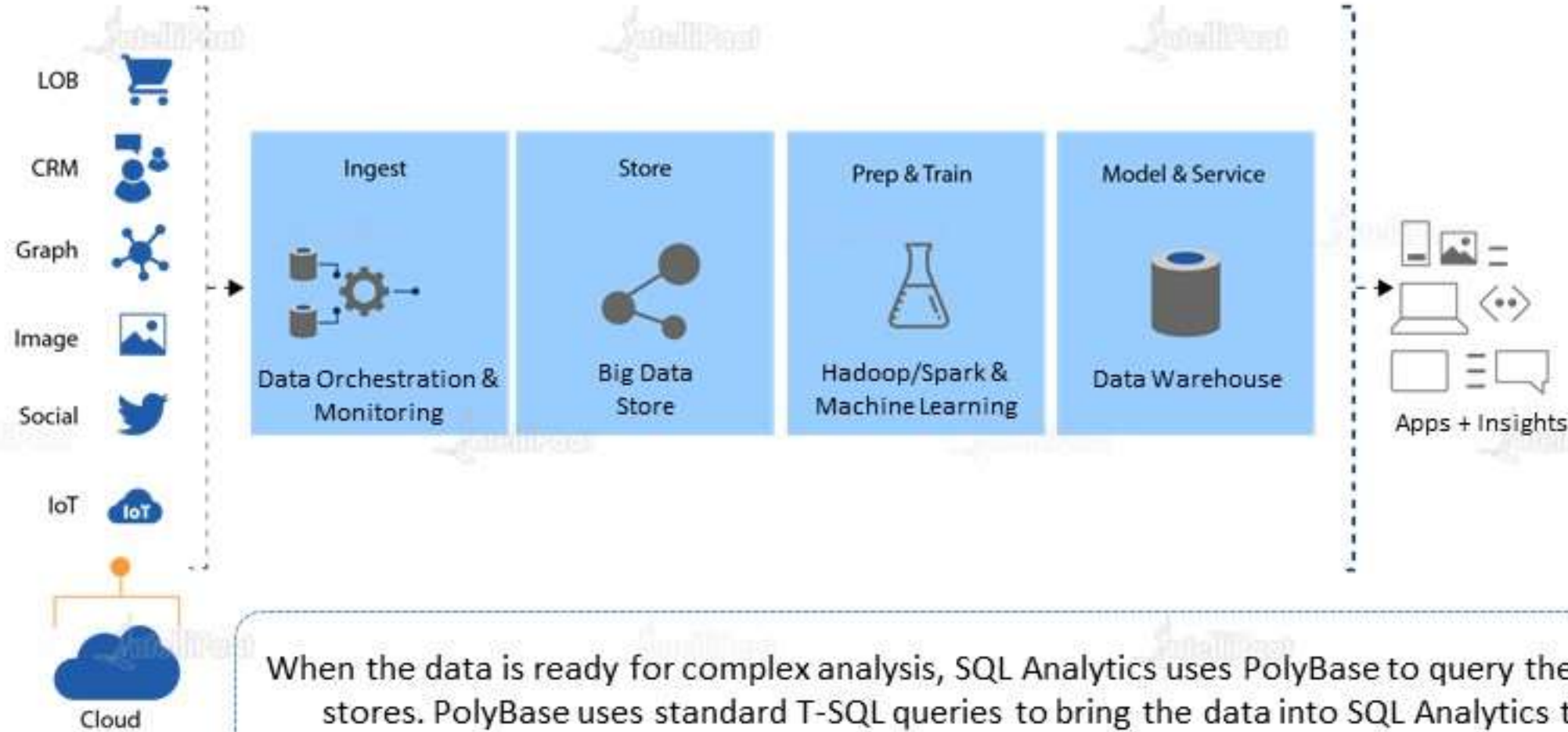
Data warehousing is a key component of a cloud-based, end-to-end Big Data solution

Key Components of a Big Data Solution



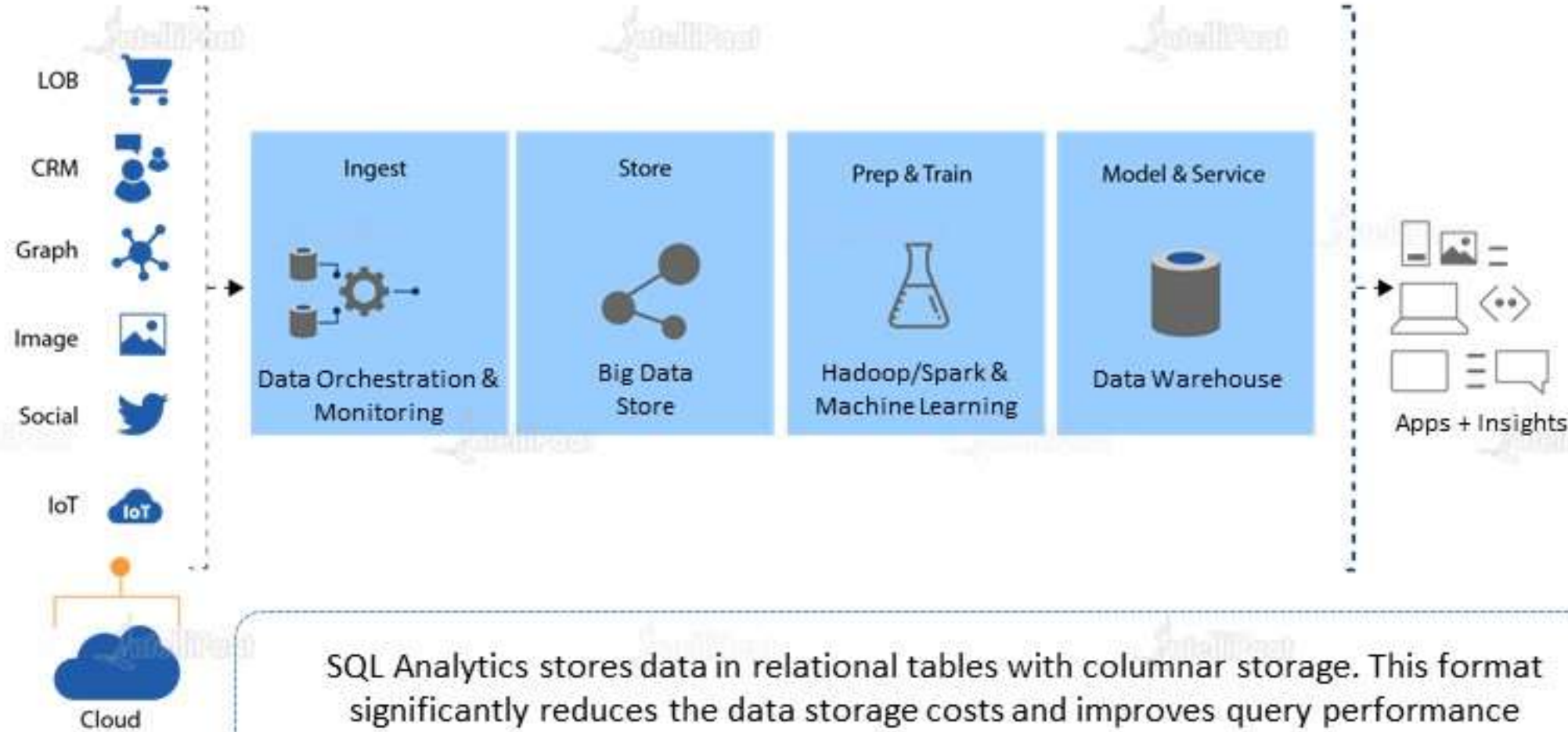
In a cloud data solution, data is ingested into big data stores from a variety of sources. On reaching a big data store, Hadoop, Spark, and ML algorithms prepare and train the data

Key Components of a Big Data Solution



When the data is ready for complex analysis, SQL Analytics uses PolyBase to query the big data stores. PolyBase uses standard T-SQL queries to bring the data into SQL Analytics tables

Key Components of a Big Data Solution



SQL Analytics stores data in relational tables with columnar storage. This format significantly reduces the data storage costs and improves query performance

Key Components of a Big Data Solution

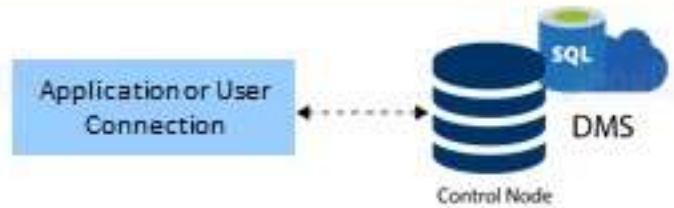
Once the data is stored, we can run analytics at a massive scale. Compared to traditional database systems, these queries finish in seconds instead of minutes or hours instead of days

Key Components of a Big Data Solution

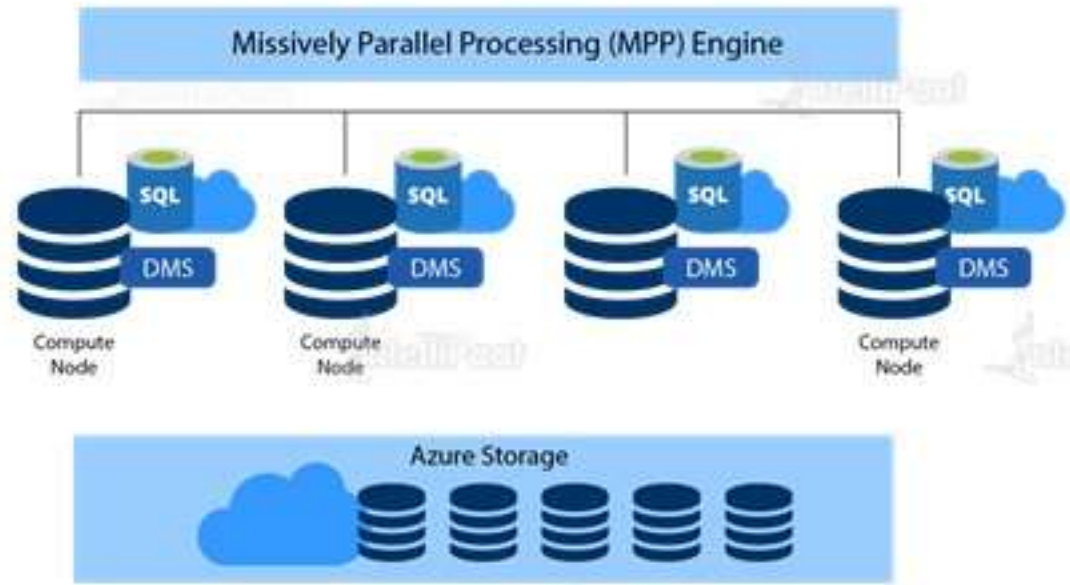
The analysis results can go to worldwide reporting databases or applications. Business Analysts can then gain insights into making well-informed business decisions

SQL Analytics MPP Architecture Components

- SQL Analytics leverages a scale-out architecture to distribute computational processing of data across multiple nodes
- The unit of scale is an abstraction of compute power that is known as a data warehouse unit

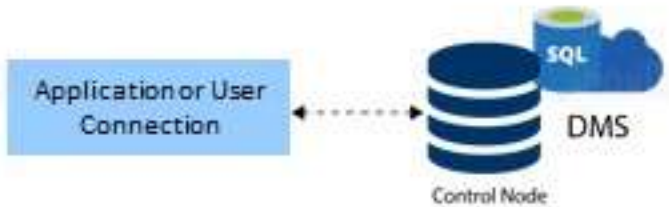


Compute is separate from storage, which enables us to scale compute independently of the data in our system

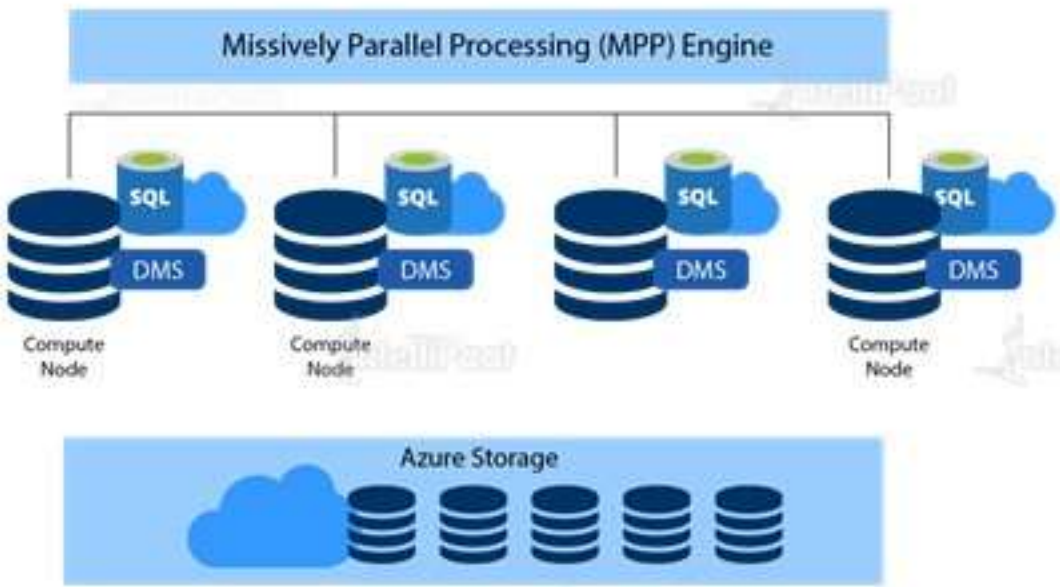


SQL Analytics MPP Architecture Components

- SQL Analytics uses a node-based architecture
- Applications connect and issue T-SQL commands to a Control node, which is the single point of entry for SQL Analytics

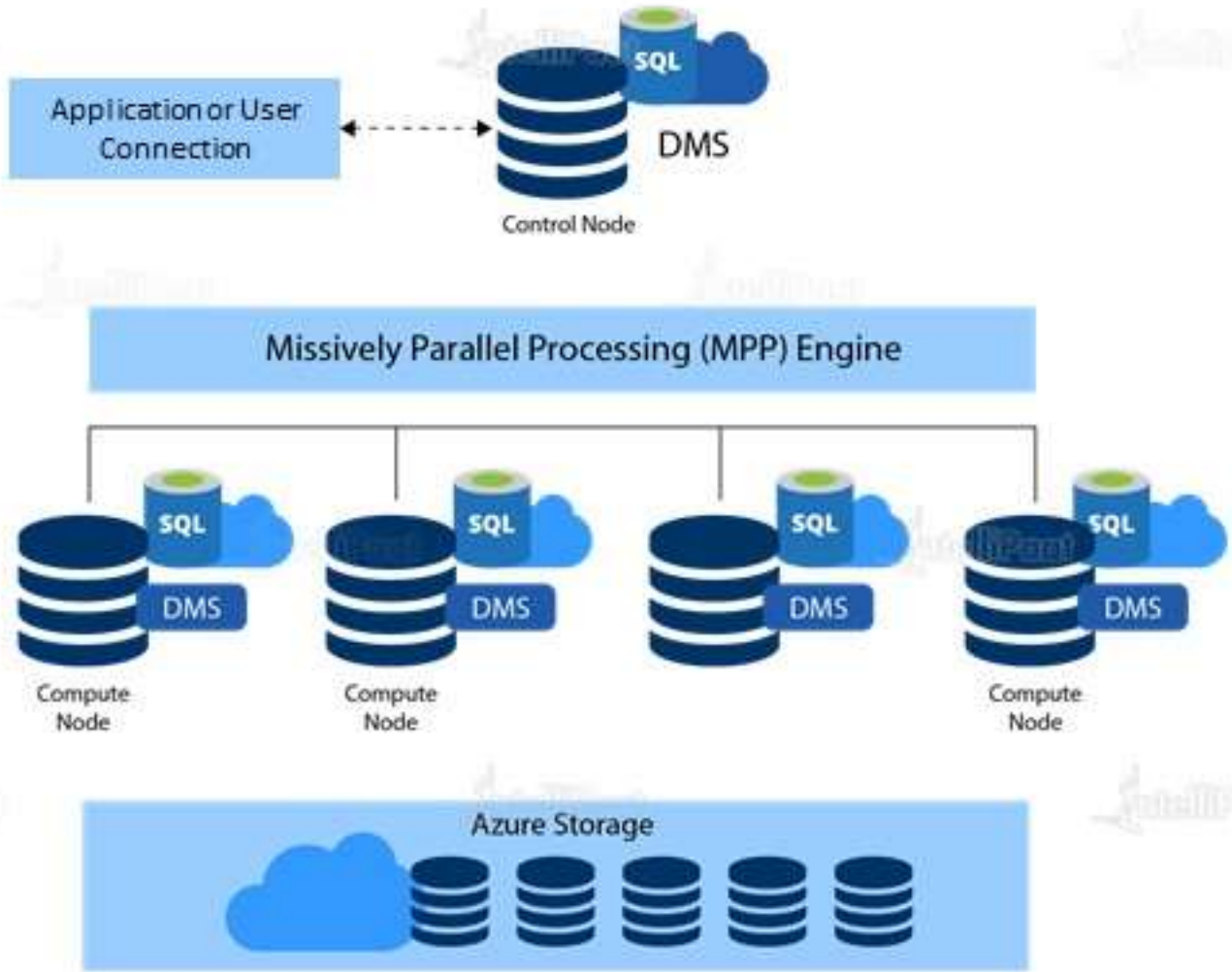


The Control node runs the MPP engine, which optimizes queries for parallel processing, and then passes operations to the Compute nodes to do the work in parallel



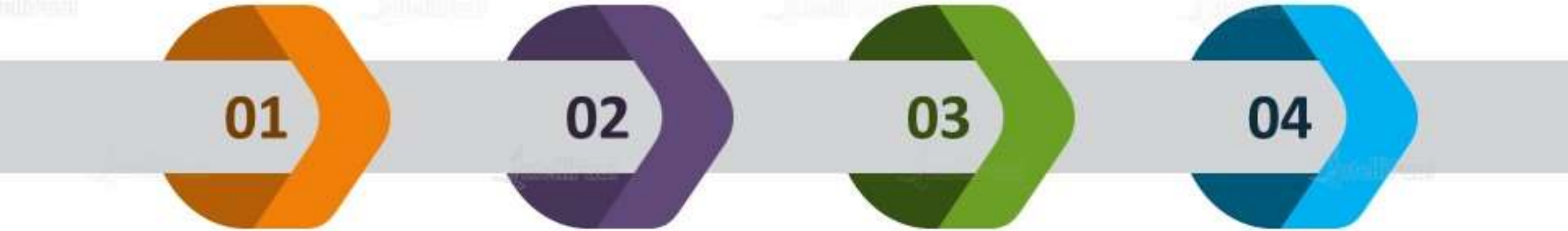
SQL Analytics MPP Architecture Components

- The Compute nodes store all user data in Azure Storage and run the parallel queries
- The Data Movement Service (DMS) is a system-level internal service that moves data across the nodes as necessary to run queries in parallel and return accurate results



SQL Analytics MPP Architecture Components

With decoupled storage and compute, when using SQL Analytics, we can



- Independently size the compute power irrespective of our storage needs
- Grow or shrink the compute power, within a SQL pool (data warehouse), without moving data
- Pause compute capacity while leaving the data intact so that we only pay for storage
- Resume compute capacity during operational hours

Hands-on: Importing Data from Blob Storage to Azure Synapse Analytics Using PolyBase

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