



Introduction to Azure SQL

Module 1



Learning Units covered in this Module

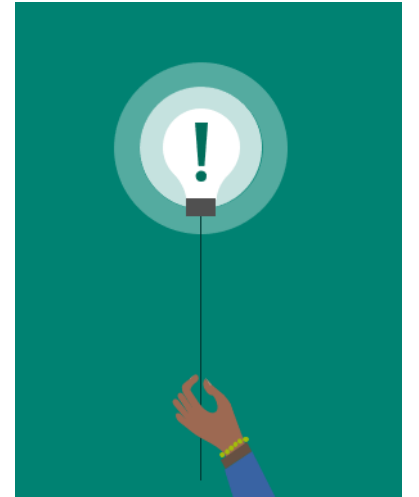
- Lesson 1: Basic concepts of Azure SQL
- Lesson 2: Managing Azure SQL Databases
- Lesson 3: Working with Managed Instances

Lesson 1: Basic concepts of Azure SQL

Objectives

After completing this learning, you will be able to:

- Describe the basic concept and architecture
- Describe the difference between the purchase models.
- Describe the service tiers compute and hardware generation of the Azure SQL Database.



What is Microsoft Azure?

Microsoft Azure is Microsoft's public cloud computing platform

Over 140 countries across 60 regions worldwide

Windows and Linux

Scale globally

- Reach more locations, faster, with the performance and reliability of a vast global infrastructure.

Safeguard data

- Rely on industry-leading data security in the region and across our network.

Promote sustainability

- Help build a clean-energy future and accelerate progress toward your sustainability goals.

What is Microsoft Azure?

<https://azure.microsoft.com/en-us/global-infrastructure/regions/>



Hosting Models

Managed by customer

Managed by Microsoft

On-premises costs tend to be driven by hardware and data center management costs

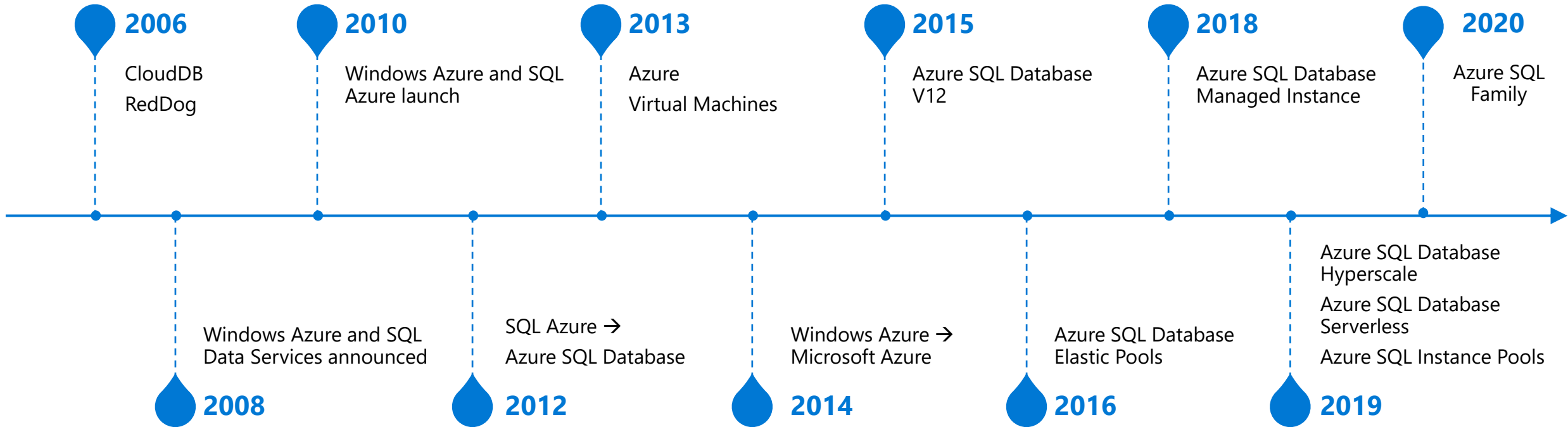
Infrastructure-as-a-Service reduces cost categories related to data center and compute

Platform-as-a-Service off-loads customers' most administrative tasks to Azure, further improving efficiency with machine-learning capabilities for performance and security

- **Managed Instance:** instance-level deployment for lift-shift existing apps to Azure, fully backward compatible
- **Single database:** database-level deployment for new apps

On-premises	Infrastructure (as a Service)	Platform (as a Service)
Applications	Applications	Applications
Data	Data	Data
High availability /DR/Backups	High availability /DR/Backups	High Availability/ DR/Backups
Database Provision/ Patch/Scaling	Database Provision/ Patch/Scaling	Database Provision/ Patch/Scaling
O/S provision /patching	O/S	O/S
Virtualization	Virtualization	Virtualization
Hardware	Hardware	Hardware
Datacenter Management	Datacenter Management	Datacenter Management
SQL Server 2017/2019	Azure SQL VMs	Azure SQL Database SQL Managed Instance

Azure SQL has come a long way



Azure SQL Family

Explore Azure SQL database services



SQL Server on Azure Virtual Machines

Migrate your SQL workloads to Azure with ease while maintaining complete SQL Server compatibility and operating system-level access

[Learn more >](#)



Azure SQL Managed Instance

Modernize your existing SQL Server applications at scale with an intelligent, fully managed service

[Learn more >](#)



Azure SQL Database

Support modern cloud applications on an intelligent, fully managed service that includes serverless compute

[Learn more >](#)

What are my options?



I want a Virtual Machine

Azure manages the hardware

You own the OS and SQL Server

You own monitoring and HADR



SQL Server in
Azure Virtual Machine



I want a SQL Server

Azure manages the hardware and OS

You get a SQL Server, but we help
you manage it

You need SQL Server feature
compatibility and low friction move



Managed Instance
Single Instance Pool



Azure SQL Database
Single Elastic Pool

I want a database

Azure manages the hardware, OS,
and SQL Server

Azure gives you predictable
performance

Azure provides HADR, monitoring,
and intelligence

Azure SQL PaaS deployment options



Azure SQL Database

Managed instances

Best for most lift-and-shift migrations to the cloud



Single instance

- SQL Server surface area (vast majority).
- Native virtual network support.
- Fully managed service.

Instance pool*

- Resource sharing between multiple instances to price optimize.
- Simplified performance management for multiple databases.
- Fully managed service.

*Instance pool is currently in public preview, more details [here](#)

Databases

Best for modern cloud applications. Hyperscale and serverless options are available



Single database

- Hyperscale storage (up to 100TB).
- Serverless compute.
- Fully managed service.

Elastic pool

- Resource sharing between multiple databases to price optimize.
- Simplified performance management for multiple databases.
- Fully managed service.

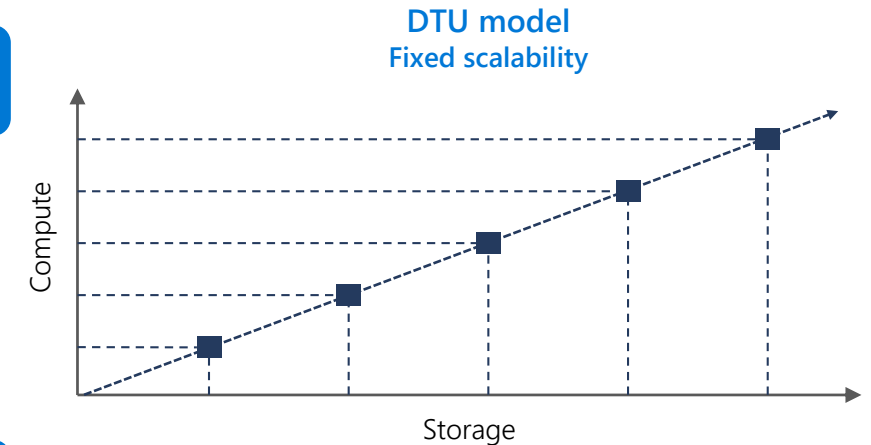
Questions?



Azure SQL Database Purchasing models and resources

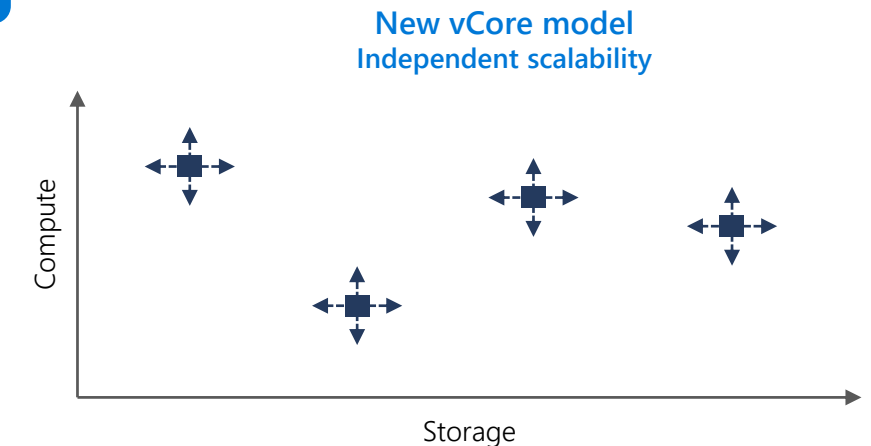
Database Transaction Unit (DTU) model

- Pre-packaged, bundled unit that represents the database power.
- Designed for **predictable performance**, but somewhat inflexible and limited in options.
- DTU sizing offers simplicity of choice.
- Blended measure of CPU, memory, and read-write rates.



vCore model

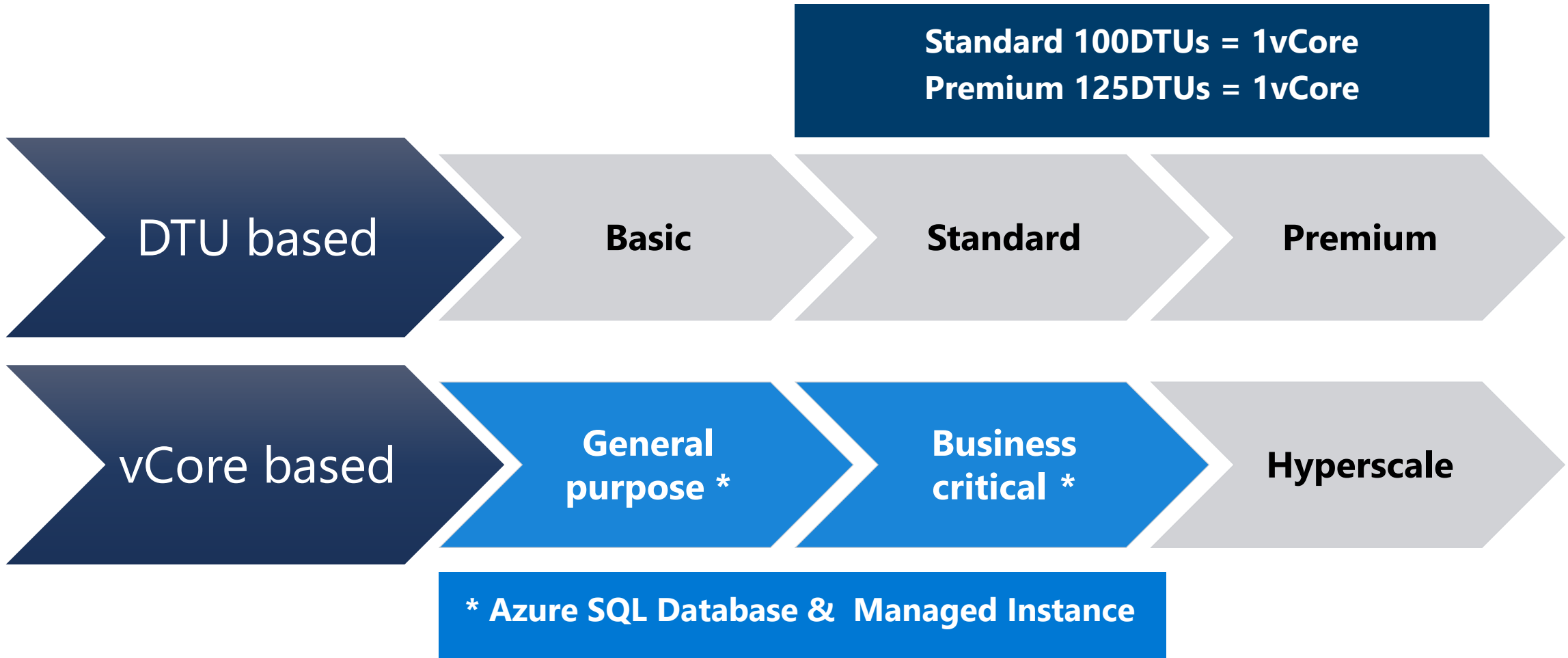
- À La carte approach deconstructs the DTU model into separate parts.
- Customers can select compute and storage independently.
- Allows customers to right-size their compute requirements in the cloud.
- vCore sizing offers flexibility of choice.
- Provides a choice between a **provisioned compute tier** and a **serverless compute tier**.



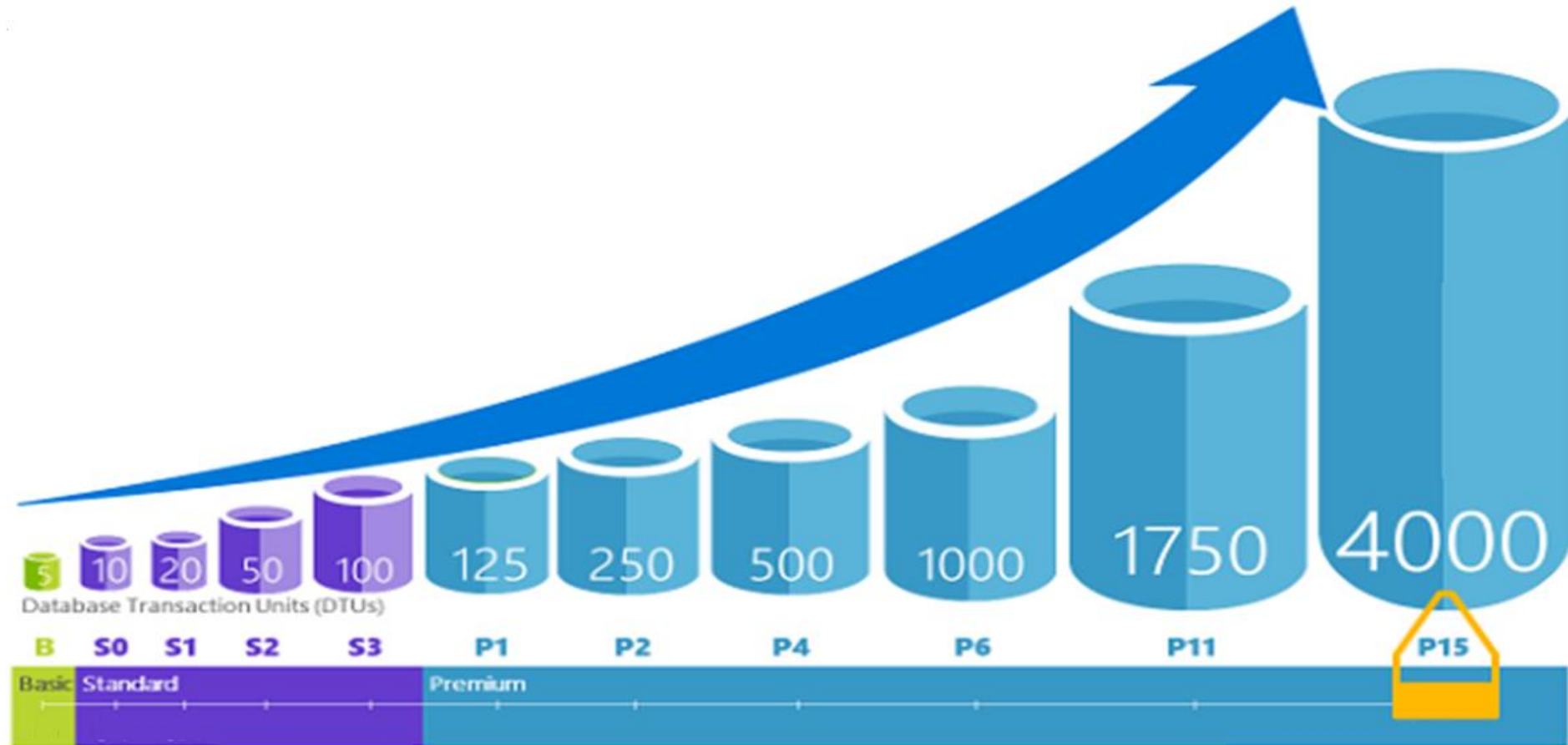
Purchasing models available for Azure SQL Database deployment:

Purchasing model/ Deployment model	DTU based	vCore based
Single Database	✓	✓
Elastic Pool	✓	✓
Managed Instance	✗	✓
Hyperscale service tier (single databases)	✗	✓

Overview Service Tiers



Database Transaction Units (DTUs)



DTU-based model: Service Tiers

	Basic	Standard									Premium					
		S0	S1	S2	S3	S4	S6	S7	S9	S12	P1	P2	P4	P6	P11	P15
Built for	Light transactional workloads	Medium transactional workloads									Heavy transactional workloads					
Available SLA	99.99%															
Database max. size	2 GB	250 GB			1 TB									4 TB		
Point-in-time restore ("oops" recovery)	Any point within 7 days	7-35 days (7 days by default)														
Business continuity	Active geo-replication, up to four readable secondary backups															
Security	Auditing, row-level security, dynamic data masking, Advanced Threat Protection															
Performance objectives	Transactions per hour	Transactions per minute									Transactions per second					
Database transaction units (DTUs)	5	10	20	50	100	200	400	800	1,600	3,000	125	250	500	1,000	1,750	4,000


\$
\$\$\$

[Resource limits for single databases using the DTU-based purchasing model](#)

Changing Performance Levels (DTU)

PowerShell

- Set-AzSqlDatabase

REST

- Update database

Azure CLI

- az sql db update

T-SQL

- ALTER DATABASE ... MODIFY
(EDITION = ...)

Service and compute tier

Select from the available tiers based on the needs of your workload. The vCore model provides a wide range of configuration controls and offers Hyperscale and Serverless to automatically scale your database based on your workload needs. Alternately, the DTU model provides set price/performance packages to choose from for easy configuration. [Learn more](#)

Service tier

DTUs [Compare DTU options](#)

5 (Basic)

Data max size (GB)

DTU-based purchasing model

- Basic (For less demanding workloads)
- Standard (For workloads with typical performance requirements)
- Premium (For IO-intensive workloads)

Changing Performance Levels (vCore)

PowerShell

- Set-AzSqlDatabase

REST

- Update database

Azure CLI

- az sql db update

T-SQL

- ALTER DATABASE ... MODIFY (EDITION = ...)

Service and compute tier

Select from the available tiers based on the needs of your workload. The vCore model provides a wide range of configuration controls and offers Hyperscale and Serverless to automatically scale your database based on your workload needs. Alternately, the DTU model provides set price/performance packages to choose from for easy configuration. [Learn more](#)

Service tier

General Purpose (Scalable compute and storage options) ▾

Compute tier

vCore-based purchasing model

General Purpose (Scalable compute and storage options)

Hyperscale (On-demand scalable storage)

Business Critical (High transaction rate and high resiliency)

DTU-based purchasing model

Basic (For less demanding workloads)

Standard (For workloads with typical performance requirements)

Premium (For IO-intensive workloads)

up to 80 vCores, up to 408 GB memory

[Change configuration](#)

Compute Hardware

Select the hardware configuration based on confidential computing hardware depends on

Hardware Configuration

Save money

Already have a SQL Server License? Save with a license you already own with Azure Hybrid Benefit. Actual savings may vary based on region and performance tier. [Learn more](#)

☐ Yes ☒ No

vCores [Compare vCore options](#)



2

Data max size (GB) ⓘ



32

Changing Compute Tier and Hardware (vCore)

Service and compute tier

Select from the available tiers based on the needs of your workload. The vCore model provides a wide range of configuration controls and offers Hyperscale and Serverless to automatically scale your database based on your workload needs. Alternately, the DTU model provides set price/performance packages to choose from for easy configuration. [Learn more](#)

Service tier

General Purpose (Scalable compute and storage options) ▼

[Compare service tiers](#) ↗

Compute tier

- ☒ **Provisioned** - Compute resources are pre-allocated. Billed per hour based on vCores configured.
- ☐ **Serverless** - Compute resources are auto-scaled. Billed per second based on vCores used.

Compute Hardware

Select the hardware configuration based on your workload requirements. Availability of compute optimized, memory optimized, and confidential computing hardware depends on the region, service tier, and compute tier.




Hardware Configuration

Gen5

up to 80 vCores, up to 408 GB memory

[Change configuration](#)

vCore-based purchasing model: Provisioned compute tier

Service tier	 General purpose		 Business critical		 Hyperscale
Best for	Most budget-oriented workloads		Critical business applications with high IO requirements.		VLDB OLTP and HTAP workloads with highly scalable storage and read-scale requirements.
Deployment option	Single / Elastic Pools Managed Instance		Single / Elastic Pools Managed Instance		Single
Compute tiers	Gen5: 2 to 80 vCore Fsv2-series*: 72 vCore Serverless: 0.5 to 16 vCore		Gen5: 4 to 80 vCore	Gen5: 2 to 80 vCore M-series*: 128 vCore	Gen5: 4 to 80 vCore
Storage	Premium remote		Local SSD		Local SSD Cache
	5GB – 4TB per instance	32GB – 16TB per instance	5GB – 4TB per instance	32GB – 16TB per instance	Scale from 5GB to 100TB of storage in 1GB increments
In-Memory	Not supported		Supported		Not supported
Read-write IO	~2ms for all data access		<0.5ms for all data access		<0.5ms for hot data access ~2ms otherwise
Availability	1 replica, no read-scale replicas		3 read replicas, zone-redundant HA	3 replicas, 1 read-scale replica, zone-redundant HA	Primary read/write replica + up to 4 read replicas
Backups	RA-GRS, 7-35 days (7 days by default)		RA-GRS, 7-35 days (7 days by default)		LRS, ZRS, RA-GRS, 7-35 days (7 days by default)

For latest information reference: <https://azure.microsoft.com/en-us/pricing/details/sql-database/>

* Fsv2-series and M-series are currently in preview.

Choose from hardware generations

	Gen 5	Fsv2-series	M-series	DC-Series
Hardware	Intel E5-2673 v4 (Broadwell) 2.3 GHz processors, fast eNVM SSD vCore=1 LP (hyper-thread)	Intel Xeon Platinum 8168 (SkyLake) processors	Intel Xeon E7-8890 v3 2.5 GHz processors	Intel® XEON E-2288G processors. Featuring Intel Software Guard Extension (Intel SGX))
Performance levels	1 to 80 vCores	72 vCores (1 vCore = 1 hyper-thread)	128 vCores (1 vCore = 1 hyper-thread)	Provision up to 8 vCores (physical)
Memory	5.1 GB per vCore for provisioned compute Up to 24 GB per vCore for serverless compute	1.9 GB per vCore	29 GB per vCore	4.5 GB per vCore
Storage	Up to 4TB remote SSD storage Up to 4TB local SSD storage	Up to 4TB remote SSD storage	Up to 4TB local SSD storage	Up to 4TB remote SSD storage

- Balance performance requirements and price with two hardware generations
- Match your on-premises application behavior
- Fsv2, M, and DC series are Generally available but in limited regions

vCore-based purchasing model: Serverless compute tier



On-demand flexible scale

Operate at the true rhythm of your business.

Adapts compute resources to the workload without sacrificing performance.

Automatically pauses and resumes.



Cost-effective

Pay for performance. Period.

Pay only for compute resources you consume, on a per-second basis.

Further optimize costs with configurable compute thresholds.



Fully managed & intelligent
Focus on your applications, not your infrastructure

Fully-managed and intelligent database service.

Built-in 99.99% availability.

Best for unpredictable and intermittent workloads on single databases, such as:



Dev/test



Line of Business



E-commerce

Provisioned compute and serverless meet different needs

Optimize compute provisioning and billing for your workload

Databases with provisioned compute...

Provision compute resources upfront.

Bill on an hourly basis.

Common scenarios

Workloads with regular and substantial compute utilization.

Multiple databases with bursty usage patterns that can be consolidated into a single server and use *elastic pools* for better price optimization.



Serverless databases...

Scale up or down to meet workload requirements, instead of pre-provisioning.

Bill on a per-second basis.

Common scenarios

Workloads with unpredictable and intermittent usage patterns or performance requirements .

Workloads where the requirements are unknown, and you can delegate compute sizing to the service.



Serverless price to performance with per-second billing

Compute resources scale dynamically up or down based on workload requirements.

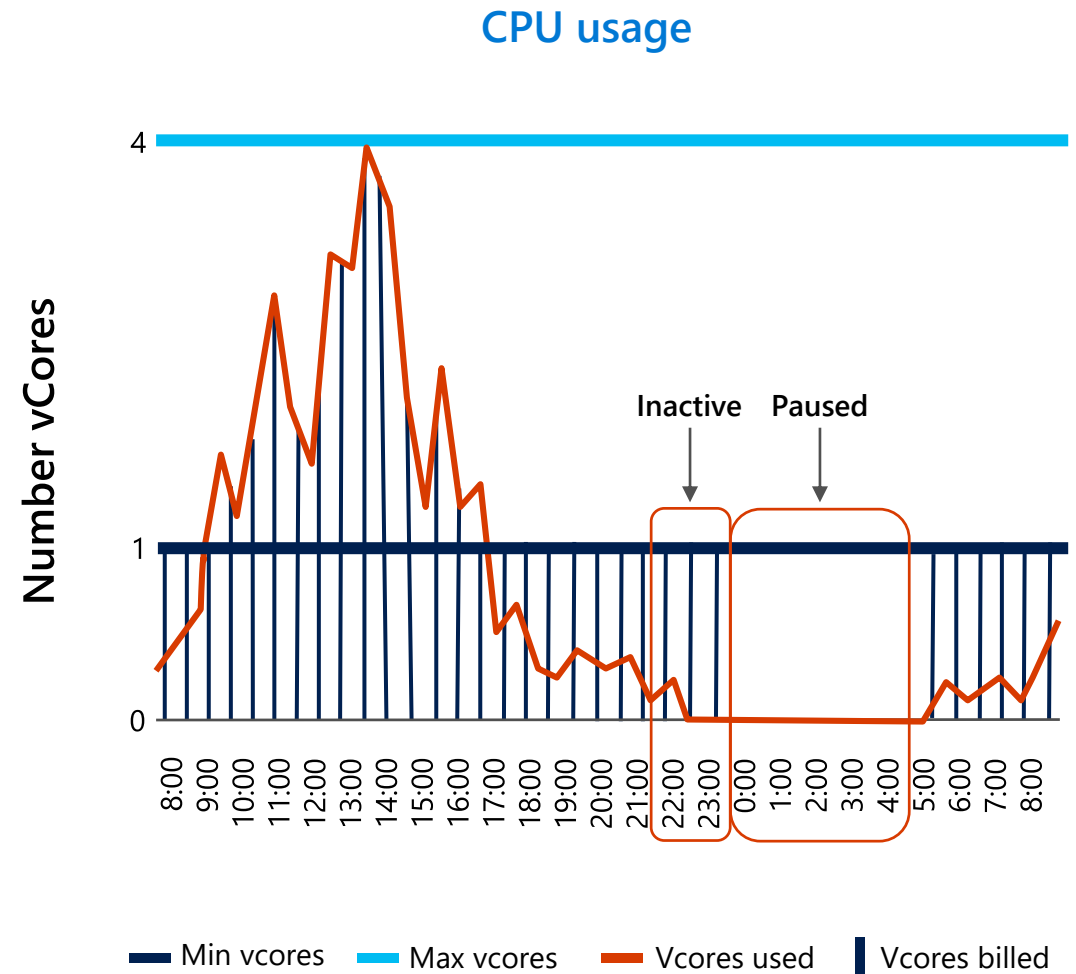
Configure minimum and maximum vCores to define the range of available compute capacity.

Use auto-pause delay to define the time period the dataset must be inactive before pausing.

The database is automatically resumed when the next login or other activity occurs.

Pay for compute based on the vCores and memory used per second, with lowest billing based on configured vCore minimum.

When the database is paused, the compute cost is zero and only storage costs are incurred.



Lesson 2: How to create Azure SQL Database

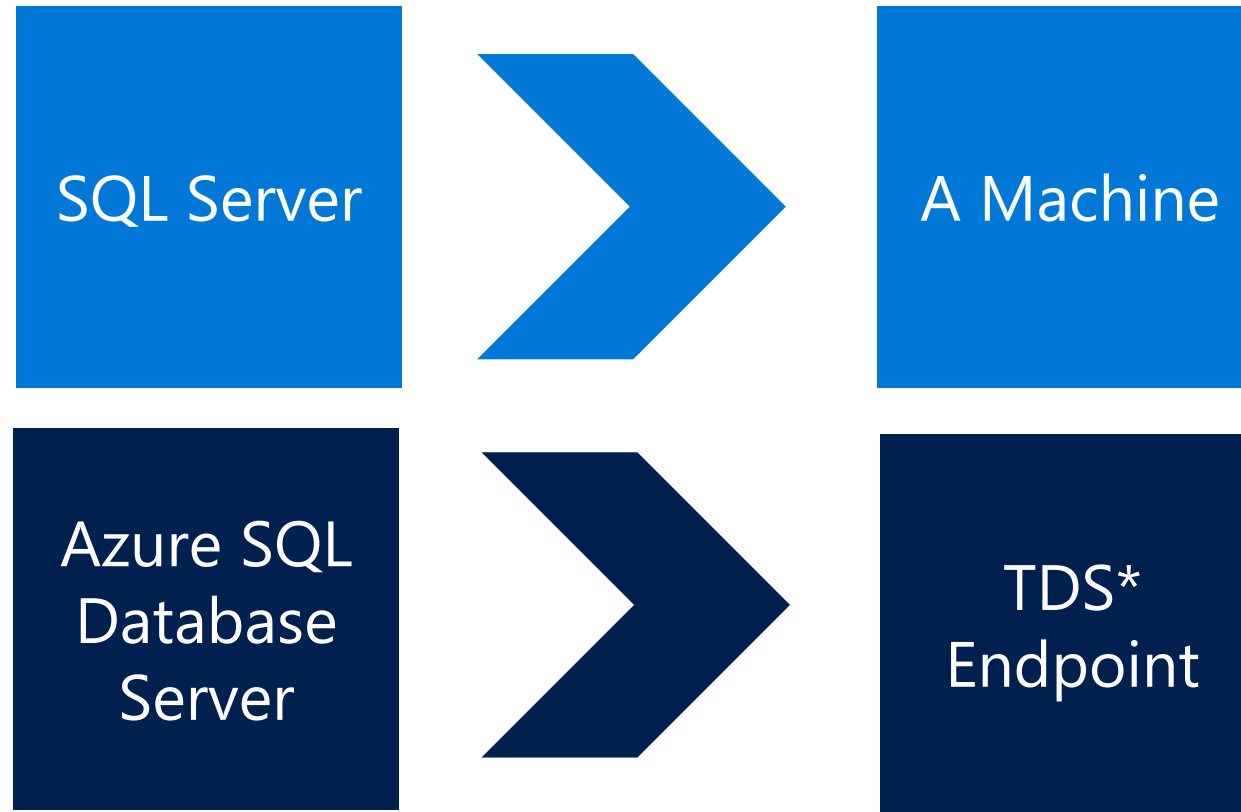
Objectives

After completing this learning, you will be able to:

- Know which prerequisites are needed before you can create an Azure SQL Database.
- Create your first Azure SQL Database.



Azure SQL Database Server is not a machine...



*TDS = Tabular Data Stream

Server Provisioning

Service head that contains databases

Connect via Fully Qualified Domain Name

Initially contains only a **master** database

Create SQL Database Server

Microsoft

Project details

Select the subscription to manage deployed resources and costs. Use resource groups like folders to organize and manage all your resources.

Subscription * ⓘ PFE Subscription ▼

Resource group * ⓘ (New) AzureSQLDatabaseRG ▼
[Create new](#)

Server details

Enter required settings for this server, including providing a name and location.

Server name * dbssql essentials ✓
.database.windows.net

Location * (US) East US ▼

Authentication

Select your preferred authentication methods for accessing this server. Create a server admin login and password to access your server with SQL authentication, select only Azure AD authentication [Learn more](#) using an existing Azure AD user, group, or application as Azure AD admin [Learn more](#), or select both SQL and Azure AD authentication.

Authentication method

☒ Use SQL authentication

☐ Use only Azure Active Directory (Azure AD) authentication

☐ Use both SQL and Azure AD authentication

Server admin login * sqlserveradmin ✓

Password * ✓

Confirm password * ✓

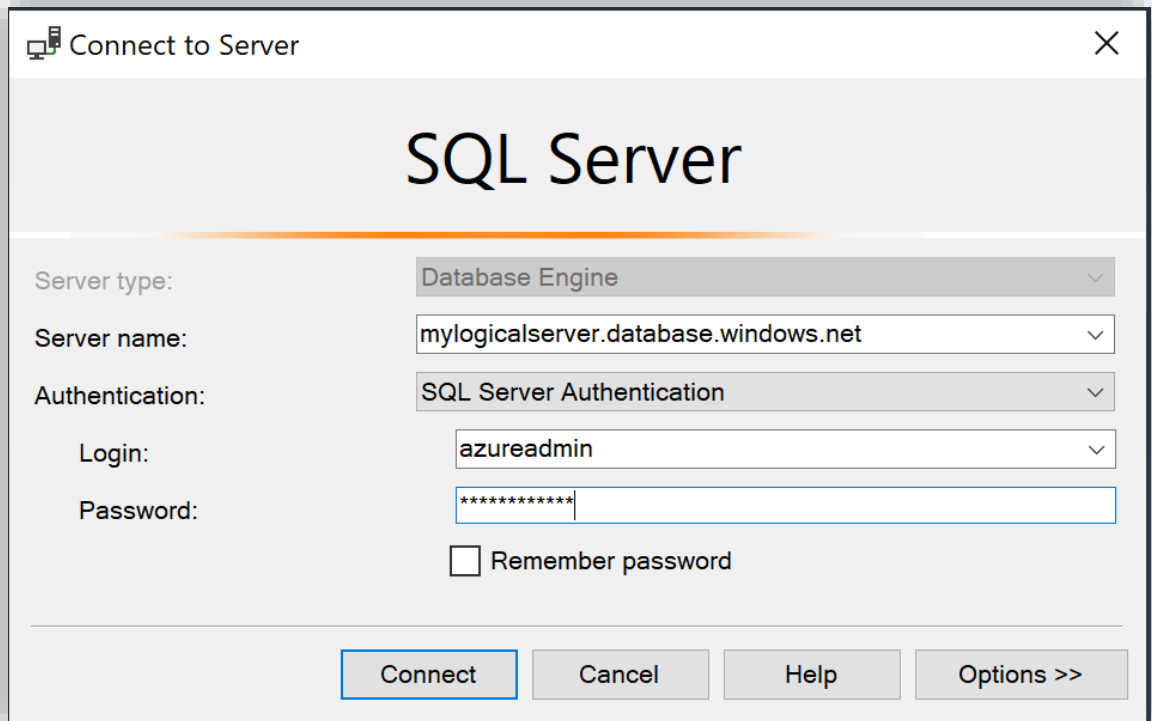
[Review + create](#) [Next : Networking >](#)

SQL Server Management Studio

Download
the latest
version of
SSMS.

Get the fully
qualified
domain
name of
your Azure
SQL Server.

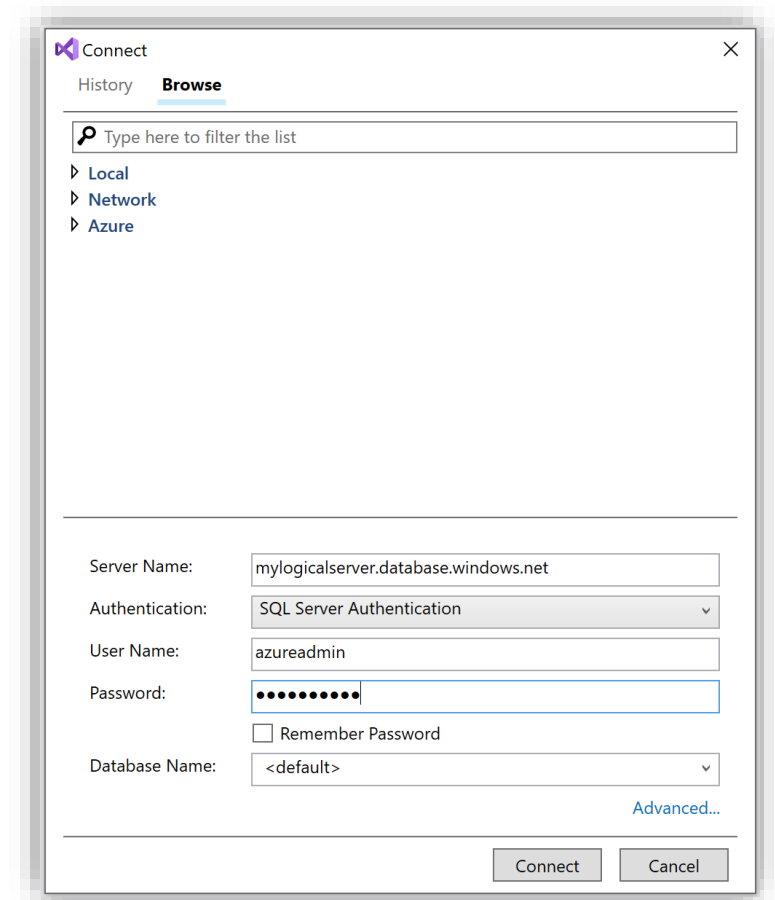
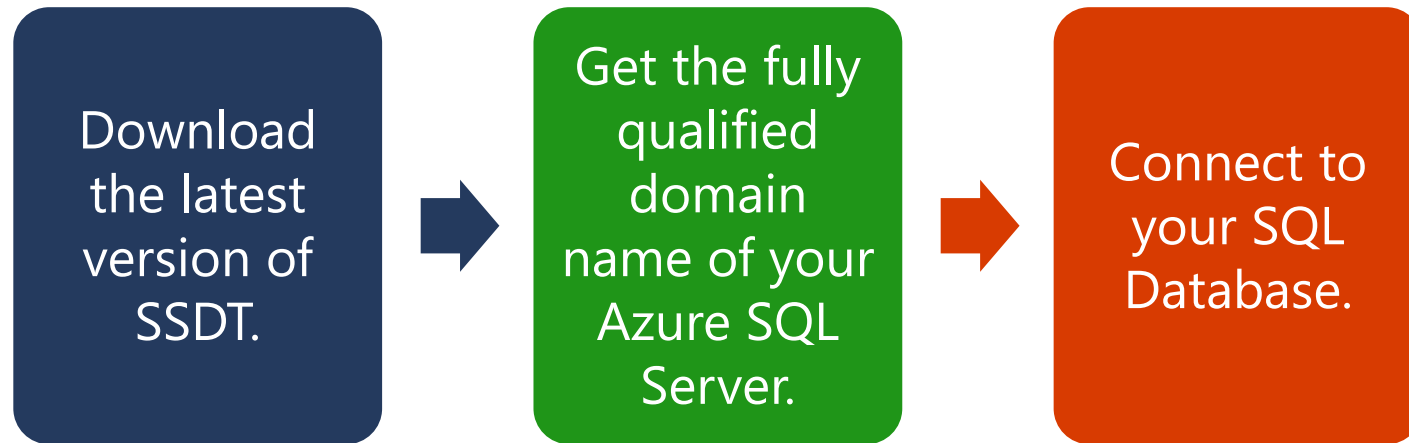
Connect to
your SQL
Database.



The screenshot shows the 'Connect to Server' dialog box with the following fields and options:

- Server type:** Database Engine
- Server name:** mylogicalserver.database.windows.net
- Authentication:** SQL Server Authentication
- Login:** azureadmin
- Password:** (masked with asterisks)
- ☐ Remember password
- Buttons:** Connect, Cancel, Help, Options >>

SQL Server Data Tools

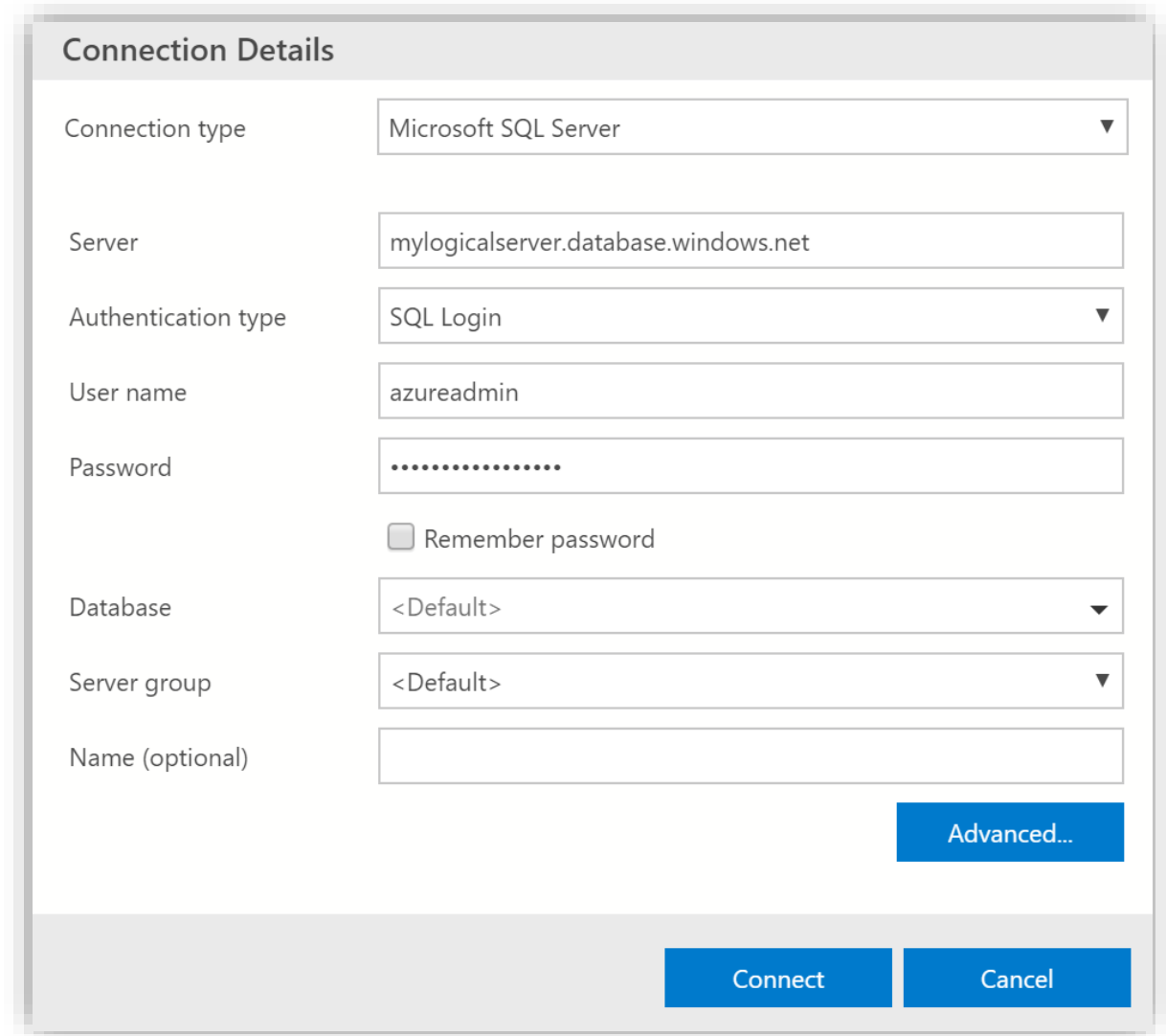


Azure Data Studio

Download the latest version of Azure Data Studio.

Get the fully qualified domain name of your Azure SQL Server.

Connect to your SQL Database.

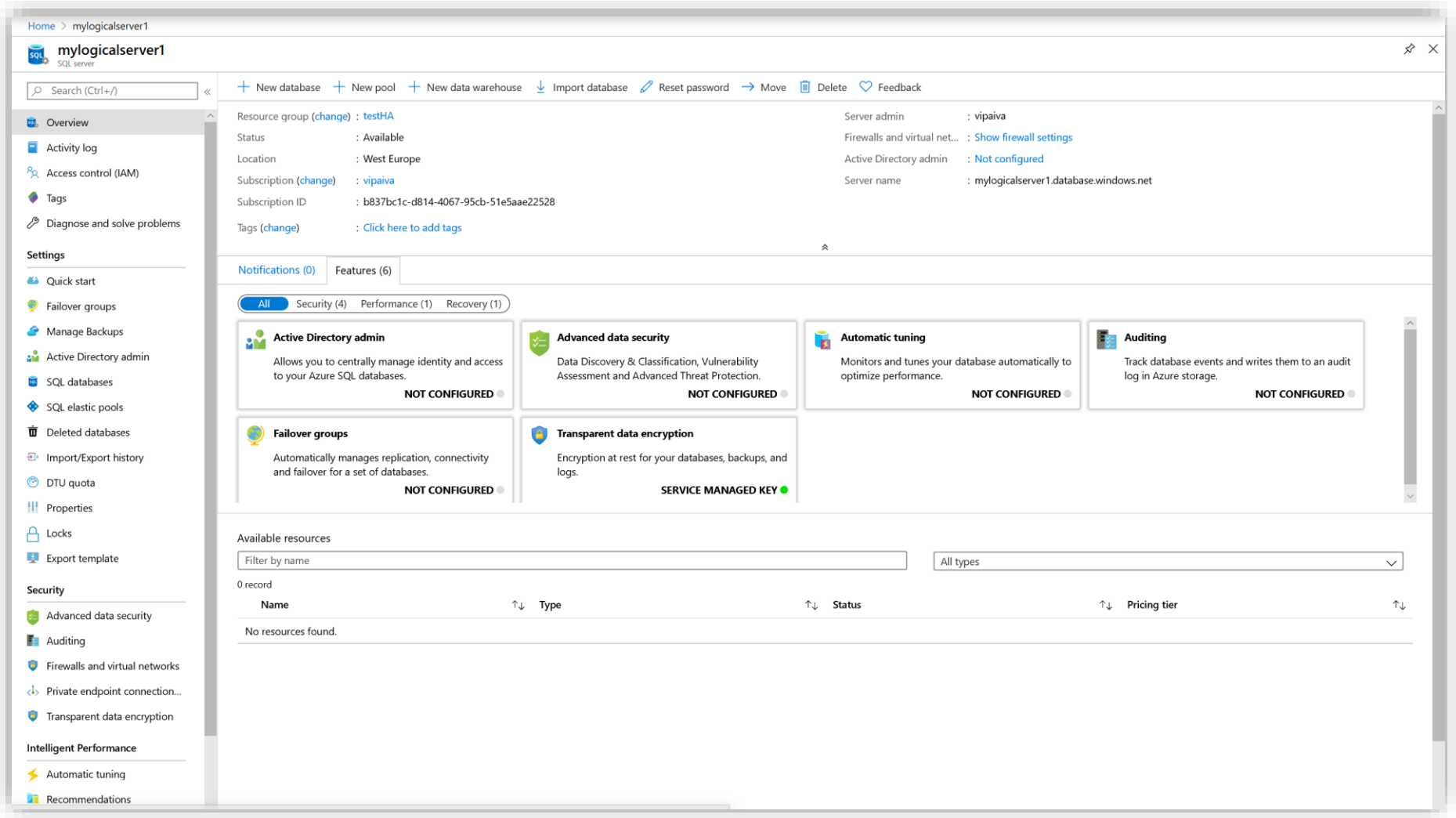


The screenshot shows the 'Connection Details' dialog box in Azure Data Studio. It contains the following fields and options:

- Connection type:** A dropdown menu set to 'Microsoft SQL Server'.
- Server:** A text box containing 'mylogicalserver.database.windows.net'.
- Authentication type:** A dropdown menu set to 'SQL Login'.
- User name:** A text box containing 'azureadmin'.
- Password:** A text box with masked characters (dots). Below it is a checkbox labeled 'Remember password' which is currently unchecked.
- Database:** A dropdown menu set to '<Default>'.
- Server group:** A dropdown menu set to '<Default>'.
- Name (optional):** An empty text box.

At the bottom right of the dialog, there are three buttons: 'Advanced...' (in a blue box), 'Connect' (in a blue box), and 'Cancel' (in a blue box).

Azure Portal



Demonstration

Create your first Azure SQL Database

- Create a new server, configure the firewall rules and create an Azure SQL Database (DTU based).



Lesson 3: Working with Managed Instances

Azure SQL **Managed Instance**



SQL Server on Azure Virtual Machines

Best for lift and shift and workloads requiring OS access

Infrastructure-as-a-Service



Azure SQL Managed Instance

Best for modernizing existing apps

Platform-as-a-Service



Azure SQL Database

Best for supporting modern cloud apps



Azure SQL Edge

Best for extending apps to IoT edge

Edge Computing

Azure SQL Managed Instance release?

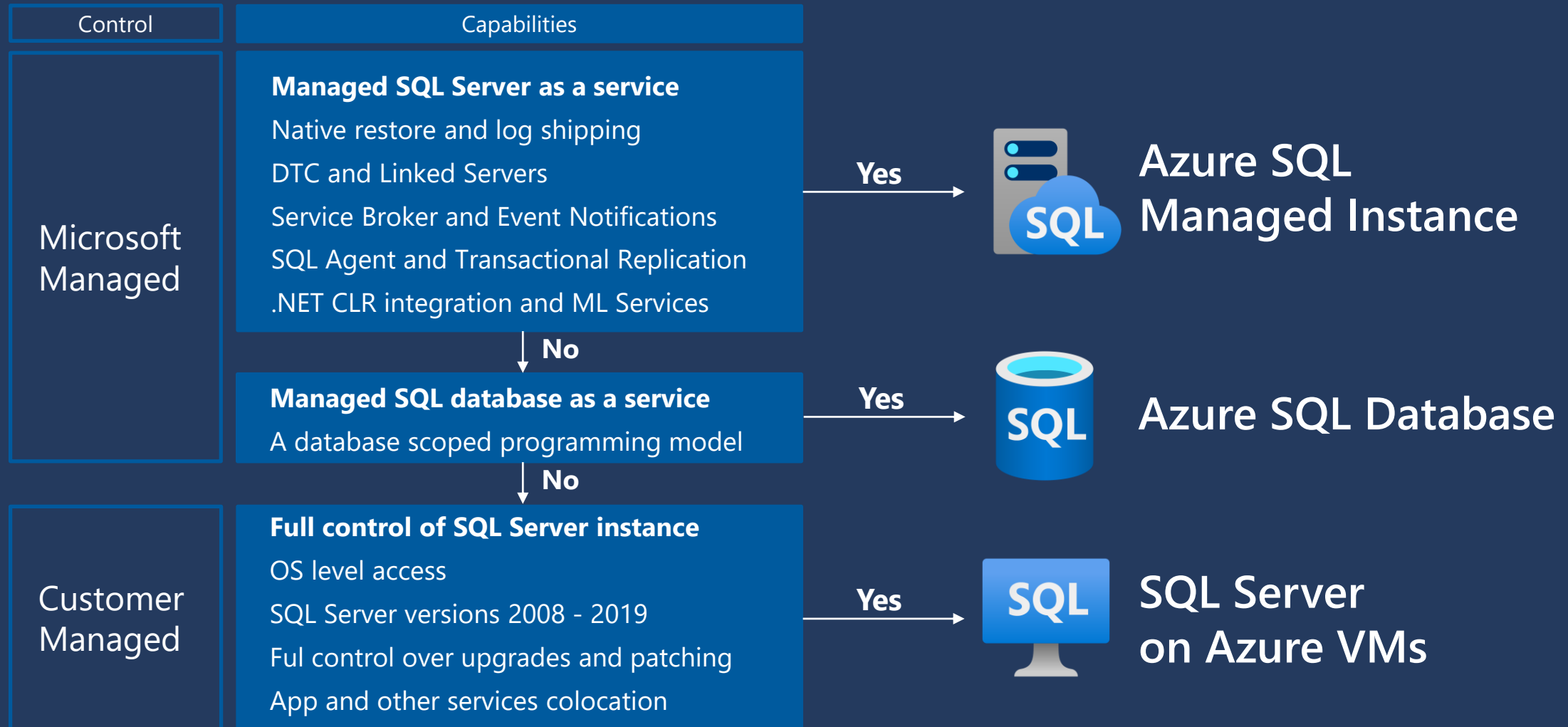


Oct 1st, 2018 – GA of General Purpose

Dec 4th, 2018 – GA or Business Critical

Azure SQL Database launched in 2010

Which Azure SQL offering is right for you?



Service tiers

General purpose (GP) service tier

Great for most business workloads.

Remote storage
IOPS
\$
Built-in HA

 P 16TB

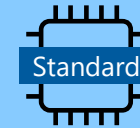
Business critical (BC) service tier

For workloads that require low latency, In-Memory, readable secondary.

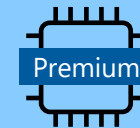
Local SSD storage
IOPS++
\$\$\$
Built-in HA
In-Memory

 P  S  S  R 16TB

Hardware options



Standard series
80 vCores
5 GB per vCore



Premium series
80 vCores
7 GB per vCore

Memory optimized
64 vCores
13.6 GB per vCore

Service tiers

General purpose (GP) service tier

Great for most business workloads.

Remote storage
IOPS
\$
Built-in HA

 P 16TB

Business critical (BC) service tier

For workloads that require low latency, In-Memory, readable secondary.

Local SSD storage
IOPS++
\$\$\$
Built-in HA
In-Memory

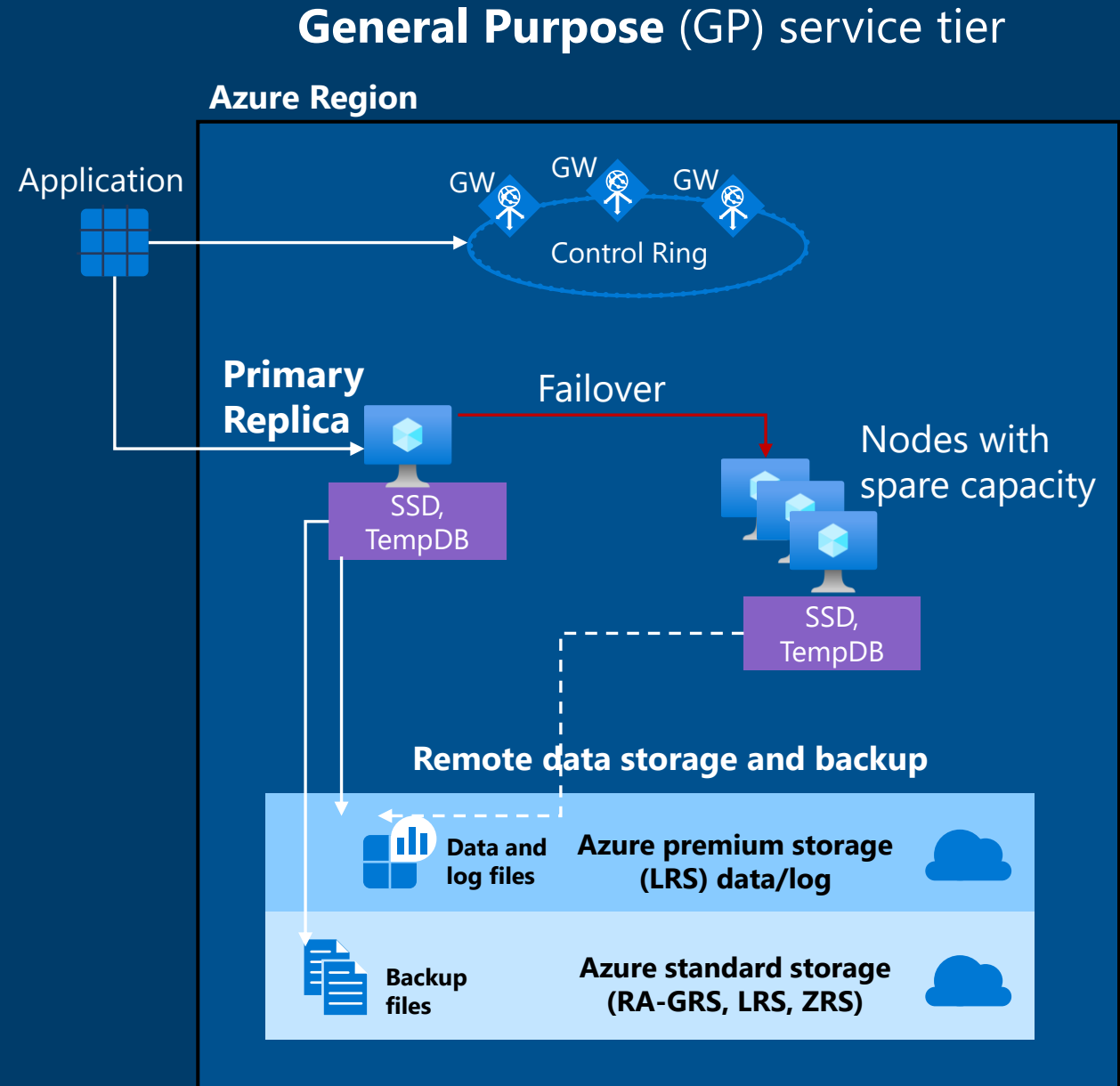
 P  S  S  R 16TB

Resource limits

Memory
Max Log Size
I/O throughput and latency
Size of TempDB
Max concurrent workers
Backup Retention

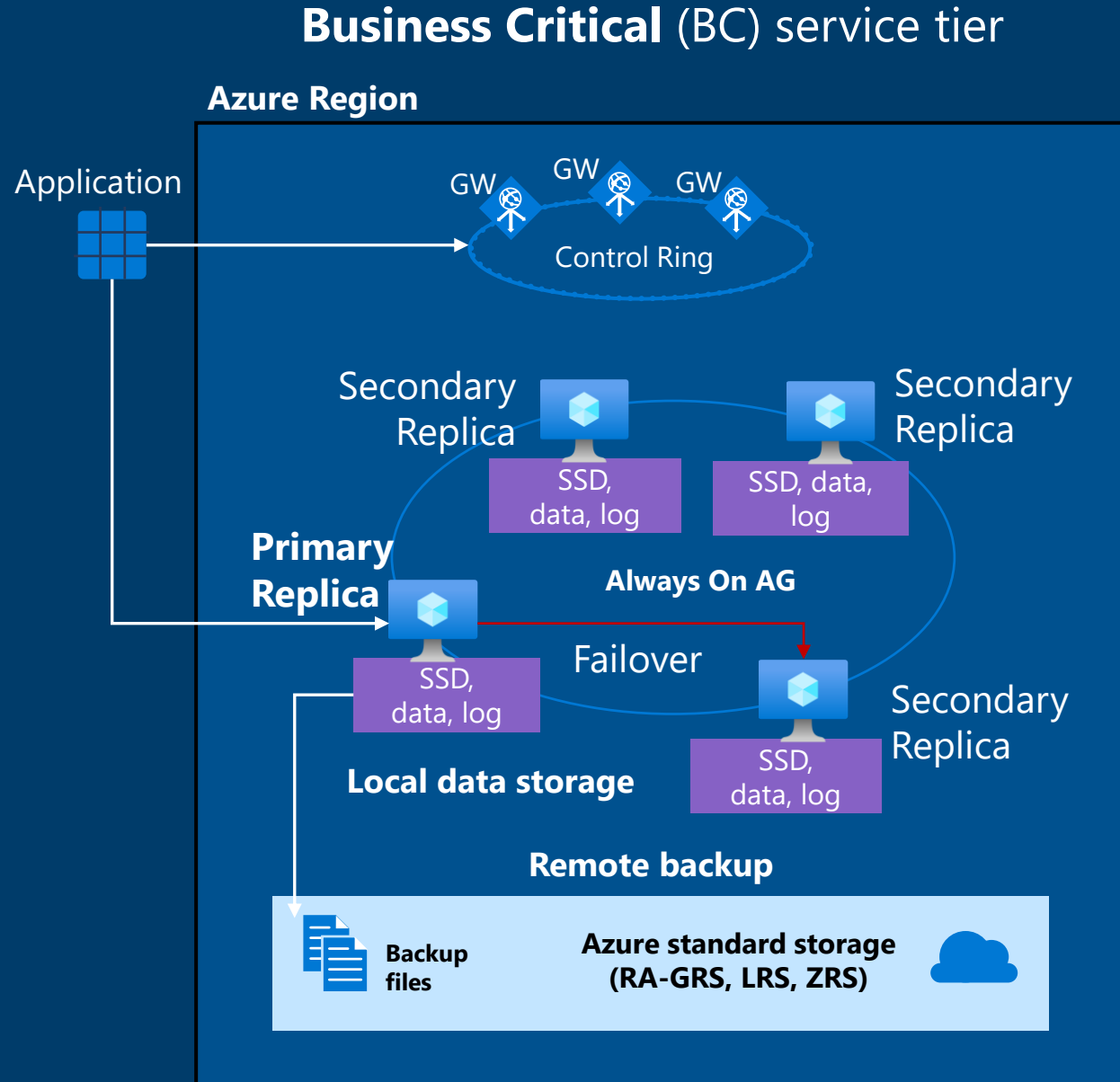
General Purpose High Availability

- Behaves like Failover Cluster Instance (FCI)
- Remote storage provides data redundancy within a datacenter
- Backup files are in a different location with geo-redundancy
- Failover decisions based on SQL and Service Fabric
- Recovery time depends on spare capacity
- Connectivity redirection built-in



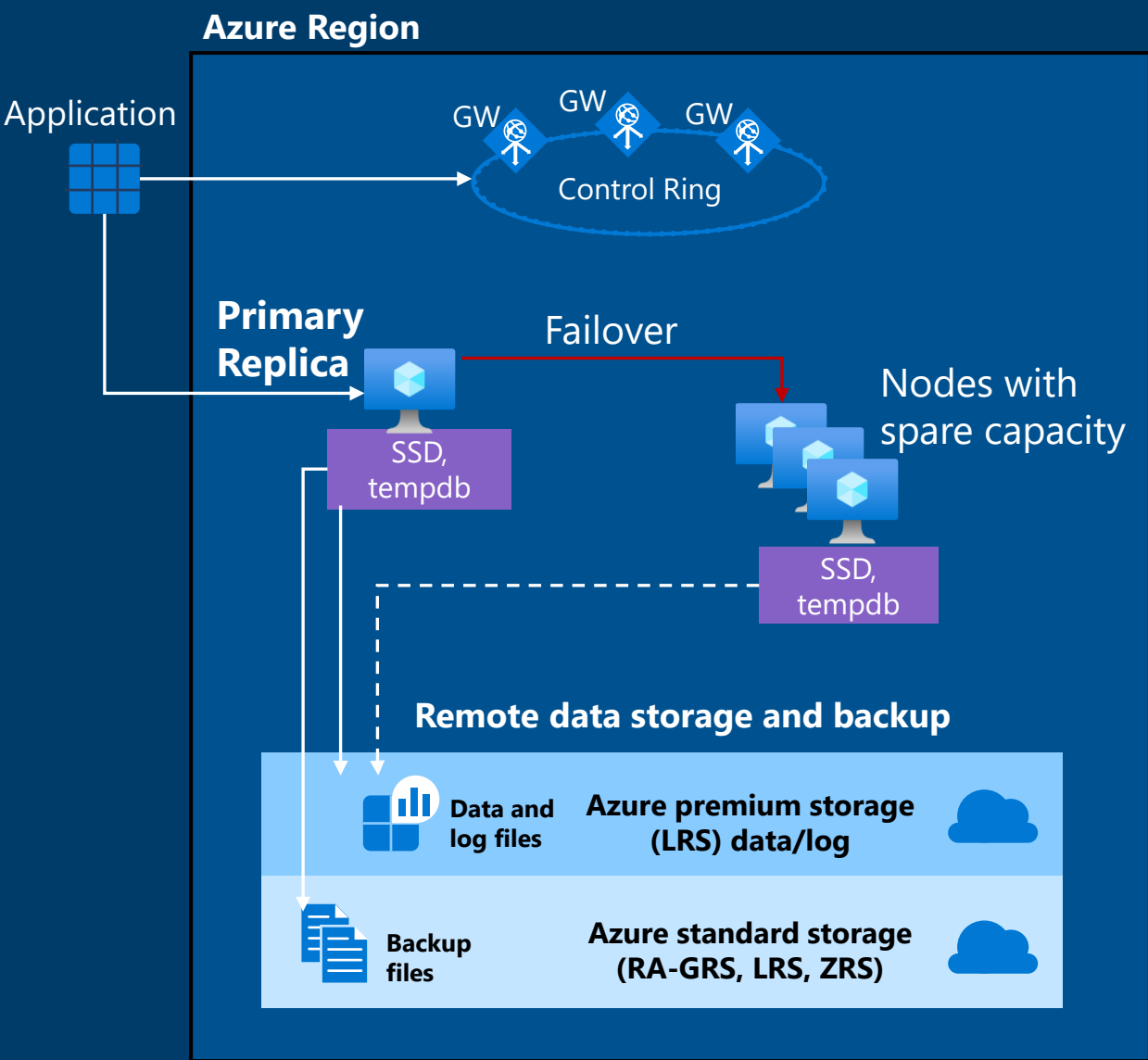
Business Critical High Availability

- Based on Always On Availability Groups
- 3 secondary replicas automatically created
- Four replicas kept available
- Backup files in a different location with geo-redundancy
- At least one secondary must sync for commits
- Automatic failover based on SQL and Service Fabric
- Recovery time extremely fast
- Connectivity redirection built-in
- Read Scale-Out from one of the replicas

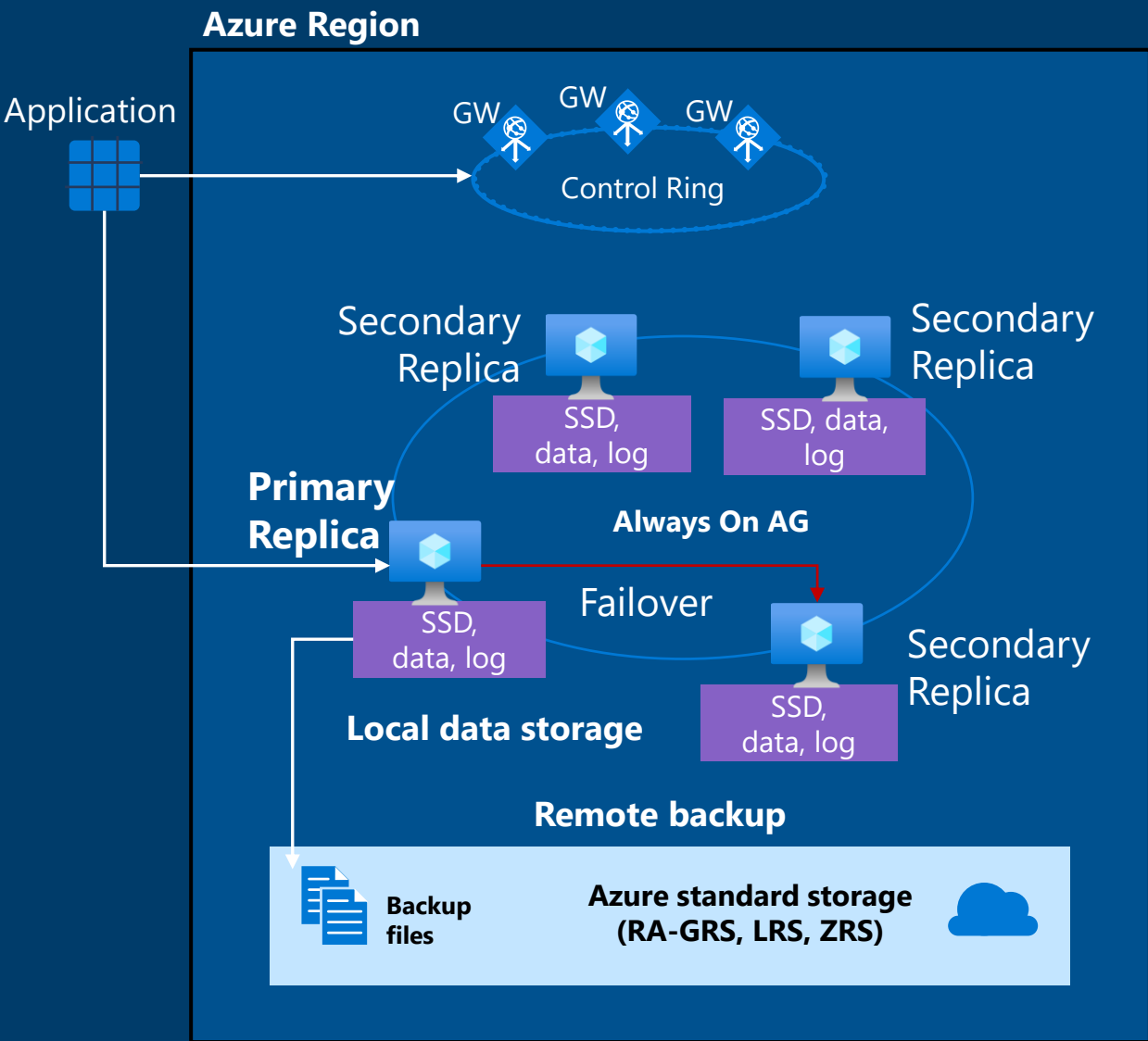


Side by side comparison

General Purpose (GP) service tier



Business Critical (BC) service tier



SQL Managed Instance Hardware Generations

Standard-series (Gen 5)	Premium-series	Premium-series Mem Optimized
<ul style="list-style-type: none">• CPU: Intel Broadwell, Skylake and Cascade Lake, 2.3-2.5 GHz• vCore range: 4 – 80• Memory / vCore: 5.1 GB• Max instance memory: 408 GB• Max instance storage<ul style="list-style-type: none">• General Purpose: 16 TB• Business Critical: 4 TB	<ul style="list-style-type: none">• CPU: Latest 3rd Gen Intel 8370C (Ice Lake), 2.8 GHz• vCore range: 4 – 80• Memory / vCore: 7 GB• Max instance memory: 560 GB• Max instance storage<ul style="list-style-type: none">• General Purpose: 16 TB• Business Critical: 5.5 TB	<ul style="list-style-type: none">• CPU: Latest 3rd Gen Intel 8370C (Ice Lake), 2.8 GHz• vCore range: 4 - 64• Memory / vCore: 13.6 GB• Max instance memory: 870 GB• Max instance storage<ul style="list-style-type: none">• General Purpose: 16 TB• Business Critical: 16 TB

Deploy, Connect, Configure



Deploy

Choose region, service tier, vCores, and Max Storage
You choose Max Storage for instance based on possible max size
Choose hardware options NEW
Service-aided subnet configuration



Connect

Inside the virtual network with Private IP
Outside using public endpoint/port with NSG



Configure

Configure outside of SQL with the portal or CLI
Change tier, vCores, max storage, maintenance windows NEW
Configure inside SQL with T-SQL or SSMS



What's different?

No OS or file system access
No manual restarts or SQL Server Config Manager
Tempdb managed
Some global trace flags allowed



Evergreen version of SQL



Get rid of perpetual SQL
major version upgrades

This is the LAST SQL
Server upgrade that
you ever perform



Newest / Azure-only
features

Leverage latest SQL
Server innovation
available as “cloud-first”

NEW: Database format alignment with SQL Server 2022



Fully-managed for DBA productivity



Industry-leading high availability (99.99%, financially backed up)



Industry-leading support by SQL Server Engineering team 24x7



Geo-replicated automatic-backups with built-in point-in-time restore



Configurable short and long-time retention



Easy to configure, auto-managed disaster recovery 60+ Azure regions



Automatic full stack software updates without downtime



Built-in compliance



Advanced Threat Protection



Monitoring at scale and automatic tuning

When SQL Managed Instance **might not** be an optimal choice?



- When 3rd party vendors **did not certify / support** their apps for Azure SQL
- When customers require **strict control** over all aspects of their platform: OS access, SQL Server version, patching cadence, ability to install 3rd party components side-by-side SQL Engine, etc.
- When customers want to **fully customize** every single aspect of their environment



Do not miss to use **Azure SQL on Virtual Machines** as the next best choice, optimally positioned for future modernization into Azure SQL Managed Instances!

Creation Decisions – Hardware

Business Critical (BC) or General Purpose (GP)

- **BC** – For applications that require low-latency responses from the underlying SSD storage (1-2 ms in average), fast recovery if the underlying infrastructure fails, or need to off-load reports, analytics;
- **GP** – Most other production workloads that do not fit the description above

How many vCores?

- **Dev/test** – go as low as possible (4 vCores?)
- **Production** – depends on the needs

What hardware series?

- **Standard series** – most workloads
- **Premium series (storage optimized)** – storage heavy workloads
- **Premium series (memory optimized)** – computationally heavy workloads requiring a lot of memory

How much storage?

- However much you think your database and logs will take with a sizable buffer to accommodate peak traffic

Creation Decisions – Hardware IO Impact

Unfortunately, limit on the log rate is the price that must be taken to always ensure that the backups are taken.

Tips

For Business Critical: increase number of cores

For General Purpose: examine your storage!

	General Purpose	Business Critical
Data/Log IOPS	Up to 30-40 K IOPS per instance, 500 - 7500 per file	16 K - 320 K (4000 IOPS/vCore)
Log write throughput limit	3 MB/s per vCore Max 120 MB/s per instance 22 - 65 MB/s per DB	4 MB/s per vCore Max 96 MB/s per instance
Data throughput	100 - 250 MB/s per file	Not limited.

Creation decisions - Storage Speed

Tips:

- Make sure that you implement storage best practice guidelines for General Purpose such as pre-allocating the size of the files to get the better performance.
- Increasing data files or log file sizes might improve performance of your General-Purpose instance.

Learn more:

- Impact of log file size on General Purpose Managed Instance performance
- Increasing data files might improve performance on General Purpose Managed Instance tier

Disk Type	P10	P20	P30	P40	P50	P60
Max size [GB]	128	512	1024	2048	4096	8192
IOPS	500	2300	5000	7500	7500	12500
Throughput [MB/s]	100	150	200	250	250	480

Creation Decisions – Networking

Virtual Network and Subnet

- Select a virtual network that is empty so we can prepare it for you, or prepare it yourself to accommodate for special requirements (IP address range etc.)

Connection type – Proxy vs Redirect

- Proxy – All connections are using a proxy gateway component and you'd use this when you don't want to open ports 11000-11999
- Redirect – Clients establish connections directly to the node hosting the database and you will use this in most use cases

Public Endpoint

- Secure public endpoint provides the ability to connect to Managed Instance from anywhere on the Internet without using VPN and is for data communication (TDS) only

