



# 14 edycja konferencji SQLDay

9-11 maja 2022, WROCŁAW + ONLINE



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Tomasz Libera

# Azure SQL - HADR

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# AGENDA

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## 1. HADR – Introduction

Availability Sets | Availability Zones

## 2. Backups

## 3. HADR – Azure SQL

Active Geo-Replication | Auto failover groups

## 4. Link feature for Azure SQL Managed Instance

Supported scenarios | Prerequisites



# 1. HADR – Introduction

# High Availability – Disaster Recovery (HADR)

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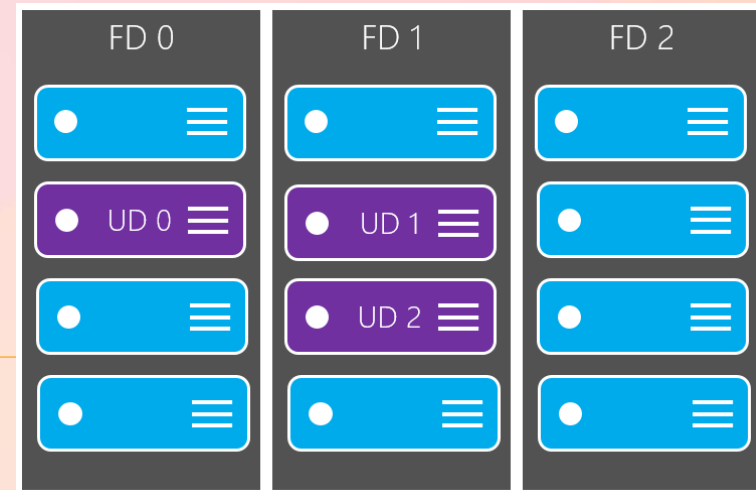
- **HADR**- allows to maximize availability for your databases, an umbrella term covering HA, DR or both.
- **High Availability (HA)** – instances or databases will be available (and reachable), with the least possible downtime (seconds/ minutes), in case of failure
- **Disaster Recovery (DR)**- instances or databases will be available recovered after failure (hours/ days)
- **Recovery Point Objective (RPO)** – How much (data) can I lose?  
(what point we can recover to)
- **Recovery Time Objective (RTO)** - How long to be operational  
(amount of time, the company expects to have database restored)

# Availability as Number of Nines

Availability	Availability class	Downtime per year	Downtime per month	Downtime per week	Downtime per day	
90% („one nine“)	1	36,5 days	72 h	16,8 h	2,4 h	
95%	1,5	18,25 days	36 h	8,4 h	1,2 h	
99%	2	3,65 days	7,2 h	1,68 h	14,4	
99,9%	3	8,76 h	43,8 m	10,1 m	1,44 m	
99,99%	4	52,56 m	4,38 m	1,01 m	1,44 s	Azure SQL Database/ Azure SQL MI
99,999%	5	5,26 m	25,9 s	6,05 s	864,3 ms	
99,9999%	6	31,5 s	2,59 s	604,8 ms	86,4 ms	
99,99999%	7	3,15 s	262,97 ms	60,48 ms	8,64 ms	
99,999999%	8	315,569 ms	26,297 ms	6,048 ms	0,864 ms	
99,9999999%	9	31,5569 ms	2,6297 ms	0,6048 ms	0,0864 ms	



# Availability Sets



- Two SQL Server VMs in an availability set or log shipping pair, never run on the same physical server (but could be the same data center)
- **Fault domains (FD)** are sets of servers within a data center, which use the same power source and network
- **Update domains (UD)** groups of virtual machines and underlying physical hardware that can be rebooted at the same time
- Availability sets and zones do not protect against OS/ RDBMS failure
- You cannot use Availability Sets AND Availability Zones (next slide)



# Availability Zones

Instance details

Virtual machine name \* ⓘ

Region \* ⓘ

Availability options ⓘ

Availability zone \* ⓘ

Security type ⓘ

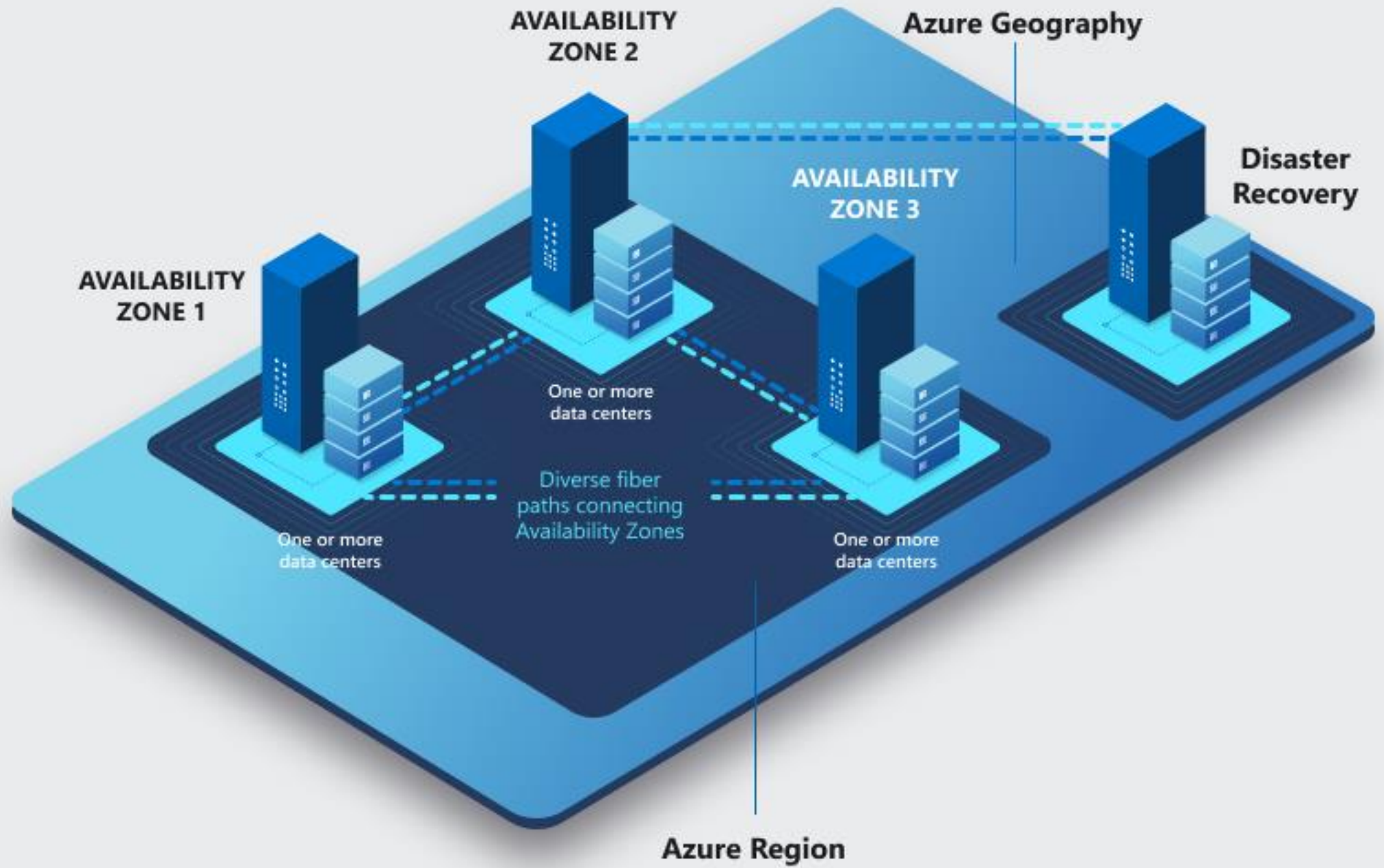
Image \* ⓘ

[See all images](#) | [Configure VM generation](#)

- Each Azure region consists of many data centers with low latency network connections between them
- When you deploy VM resources in a region that supports Availability Zones, you have the option to deploy into Zone 1,2, or 3
- Zone is a unique physical location, that is a data center, within an Azure region
- 2 VMs in the same Zone <> the same physical location
- You should test the latency between your VMs (usually < 1ms)
- **You can also deploy Azure SQL Database into Availability Zones**



# Availability Zones



# Azure cross-region replication pairings for all geographies

Regions are paired for cross-region replication based on proximity and other factors.

## Azure regional pairs

Geography	Regional pair A	Regional pair B
Asia-Pacific	East Asia (Hong Kong)	Southeast Asia (Singapore)
Australia	Australia East	Australia Southeast
Australia	Australia Central	Australia Central 2*
Brazil	Brazil South	South Central US
Brazil	Brazil Southeast*	Brazil South
Canada	Canada Central	Canada East
China	China North	China East
China	China North 2	China East 2
Europe	North Europe (Ireland)	West Europe (Netherlands)
France	France Central	France South*



## 2. Backups

# Azure SQL Database/MI backups

	SQL Database	SQL MI
Manual backups	--	Copy only backup backup to URL
Automatic backups	Database backups Full – Once a week Diff – every 12h Log – every 5-10 min (depending of log usage)	
LTR (long-term retention) backups	up to 10 years	



# SQL Database/MI backups

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- Cannot restore over existing database (Restore to new db)
- **Backup Integrity checks (automated)**
- Geo-restore of databases if primary region down
- Restore backups of deleted databases
- Azure portal/ PowerShell/ Azure CLI

## Point-in-time-restore

Specify how long you want to keep your point-in-time backups. [Learn more](#)

How many days would you like PITR backups to be kept? ⓘ

7

## Differential backup frequency

Specify how often you want differential backups to be taken. [Learn more](#)

Take a differential backup every:

12 Hours ▾

# Long-term retention (LTR) backup

- Up to 10 years
- Can then be restored as a new database
- Available for Azure SQL DB and Azure SQL MI
- Full backups are copied to different blobs for long-term storage
- Configuration of LTR
  - weekly backup retention (W)
  - monthly backup retention (M)
  - yearly backup retention (Y)
  - week of year (WeekOfYear)
- Any change to the LTR policy applies only to future backups

## Long-term retention

Specify how long you want to keep your long-term retention backups. You may choose to keep yearly backups for up to 10 years. [Learn more](#)

### Weekly LTR Backups

Keep weekly backups for:

### Monthly LTR Backups

Keep the first backup of each month for:

### Yearly LTR Backups

Keep an annual backup for:

Which weekly backup of the year would you like to keep?



# Demo 1

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- Automated backups
  - Restore during creation new database (AW2)
  - Restore database
  - Restore deleted database
  - Retention policies
- LTR backups
  - Retention policies





# 3. HADR – Azure SQL






# HADR IaaS vs PaaS

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- IaaS – SQL Server on Azure VM – similar to on-prem:
  - Failover Clustering
  - Always On Availability Groups
- PaaS – SQL Database/ SQL Managed Instance – build-in into feature, simple management, needs to be enabled



# HADR – SQL IaaS

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Feature Name	Protects
Always On Failover Cluster Instance (FCI)	Instance
Always On Availability Group (AG)	Database
Log Shipping	Database

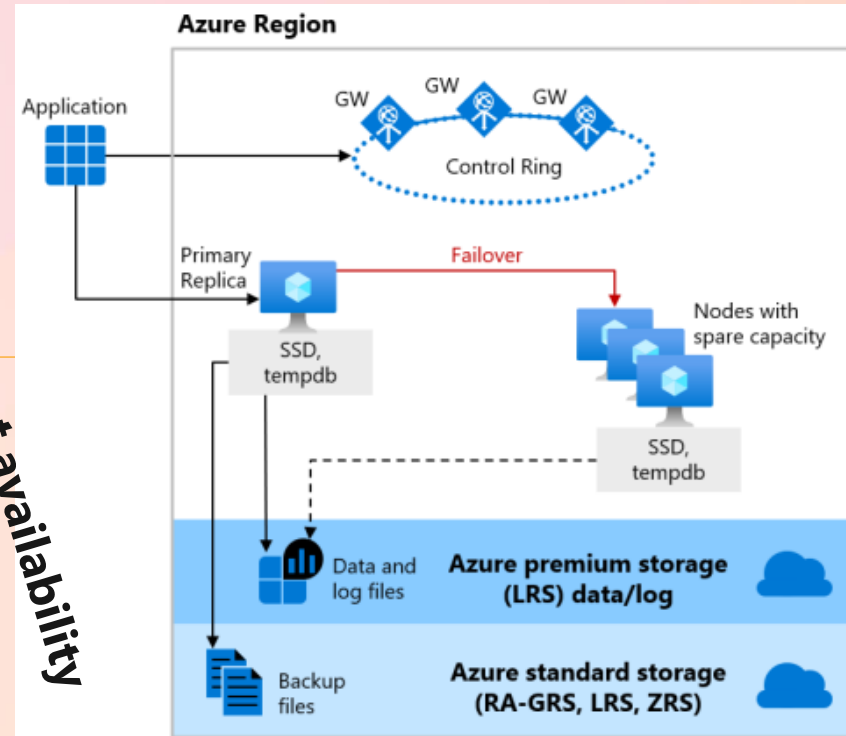


# High Availability

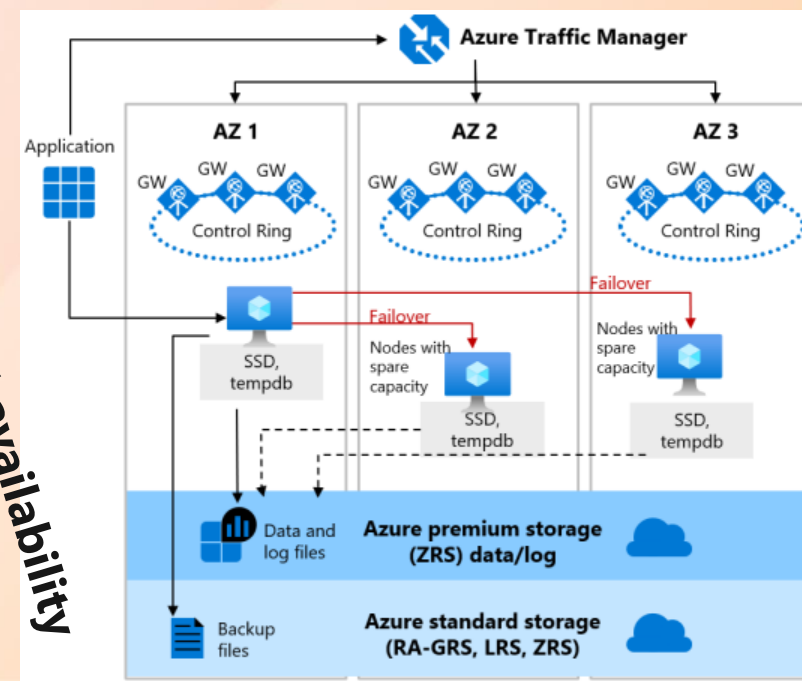
## General purpose

- Similar to Failover Cluster Instance
- **Compute layer** – sqlserver.exe process, cached data, columnstore pool
- **Data layer** – database files (mdf, ldf) in Azure Blob Storage (built-in data availability and redundancy feature)
- System upgrade/failure:
  - sqlservr.exe moved to another compute node
  - data is not affected by the move

locally redundant availability



zone redundant availability

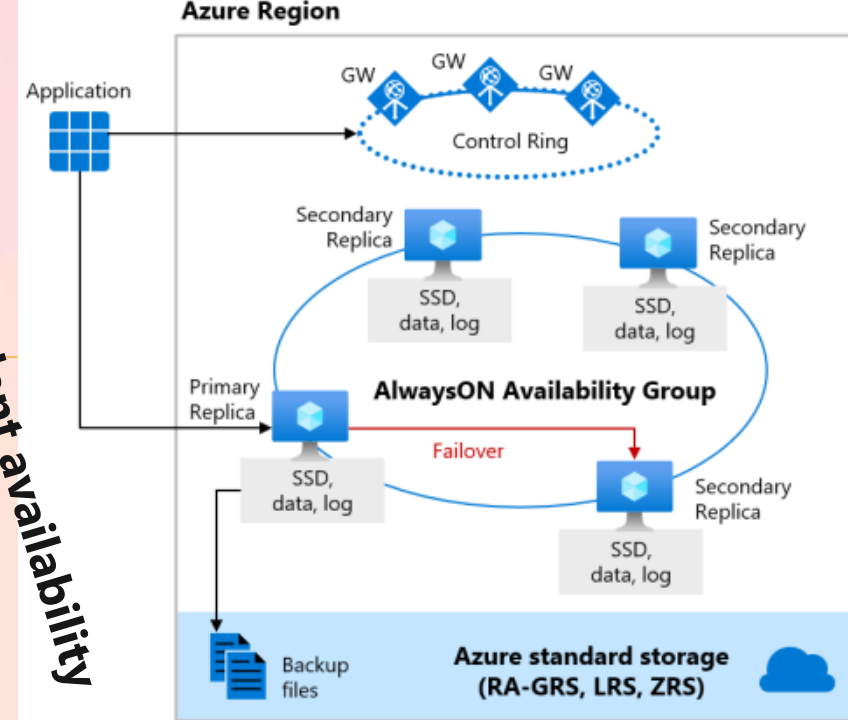




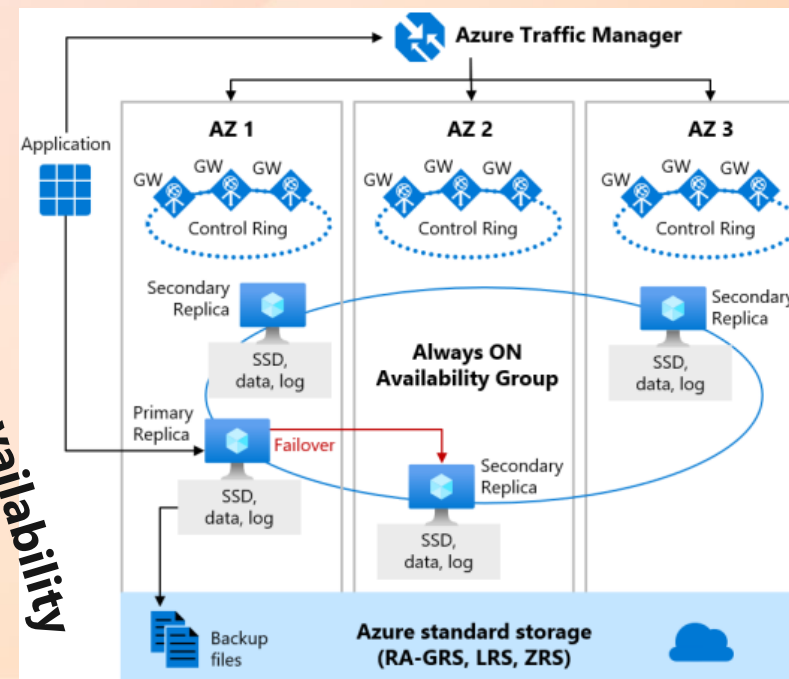
# High Availability Business Critical

- Similar to Always On Availability Group
- Integrates compute resources and storage on a single node
- 3 secondary replicas
- one secondary replica sync for commits

locally redundant availability



zone redundant availability

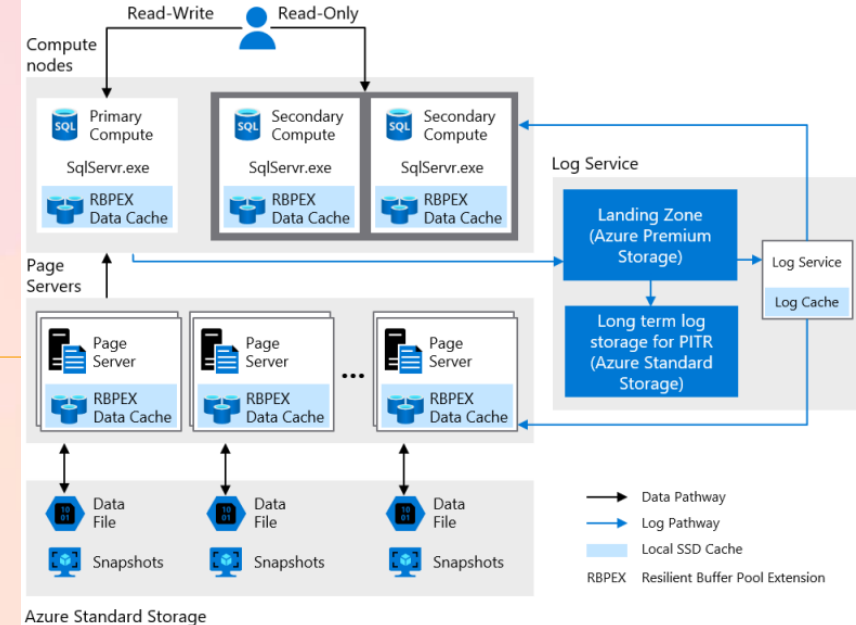




# High Availability Hyperscale

locally redundant availability

- Paired page servers
- Hyperscale available only for SQL Database
- Redundant log and data through Azure Storage
- Backup/Restore snapshots
- Log Service feeds replicas
- 0 to 4 secondary replicas for read scale and failover
- Recovery time depends on the existence of replicas



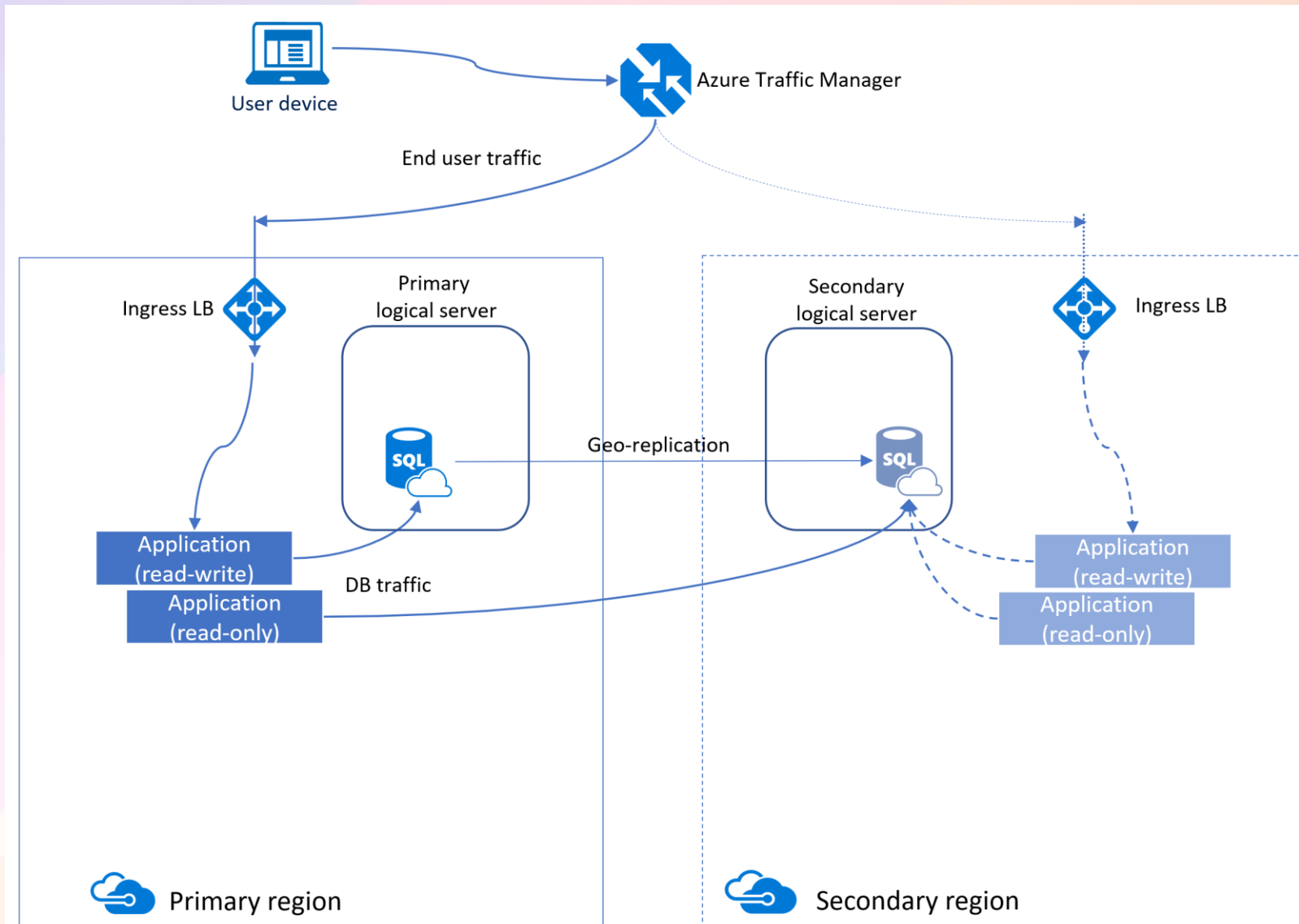


# Active Geo-Replication

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- Provide database redundancy within the same Microsoft Azure region or in different regions (geo-redundancy)
- Let you create a continuously synchronized readable secondary database for a primary database
- Asynchronously replicates committed transactions
- Supports:
  - up to 4 online secondaries
  - or up to 3 online secondaries and 1 offline secondary

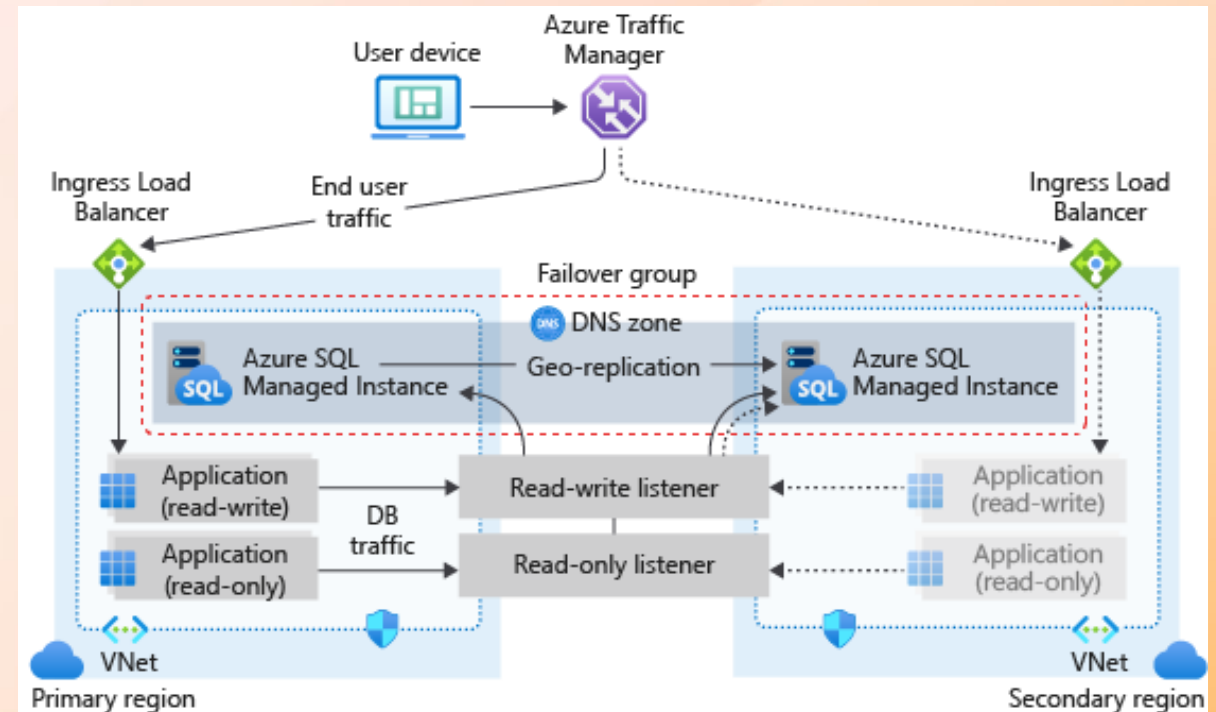
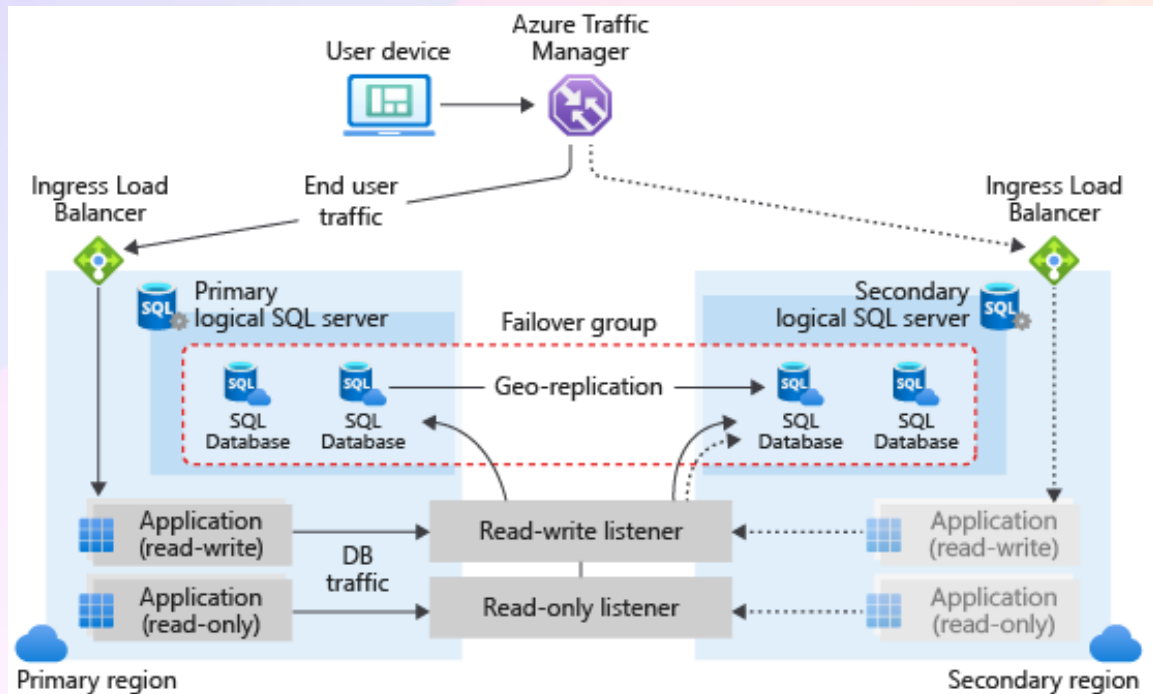
# Active Geo-Replication





# Auto-failover group

- Different regions
- Available in SQL Managed Instance







# Active Geo-Replication vs Auto Failover groups

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	Active geo-replication	Auto-failover groups
Automatic failover	No	Yes
Fail over multiple databases simultaneously	No	Yes
Update connection string after failover	Yes	No
Managed instance support	No	Yes
Can be in the same region as primary	Yes	No
Multiple replicas	Yes	No
Support read-scale	Yes	Yes

# Demo 2

- Configure active geo-replication and failover
- Configure auto-failover group

[+](#) Create replica [↺](#) Refresh [🗨](#) Feedback

Geo replicas for your database are listed below. Geo replicas reside on a different logical server from the primary and protect against regional failures or prolonged data center outage. [Learn more](#)

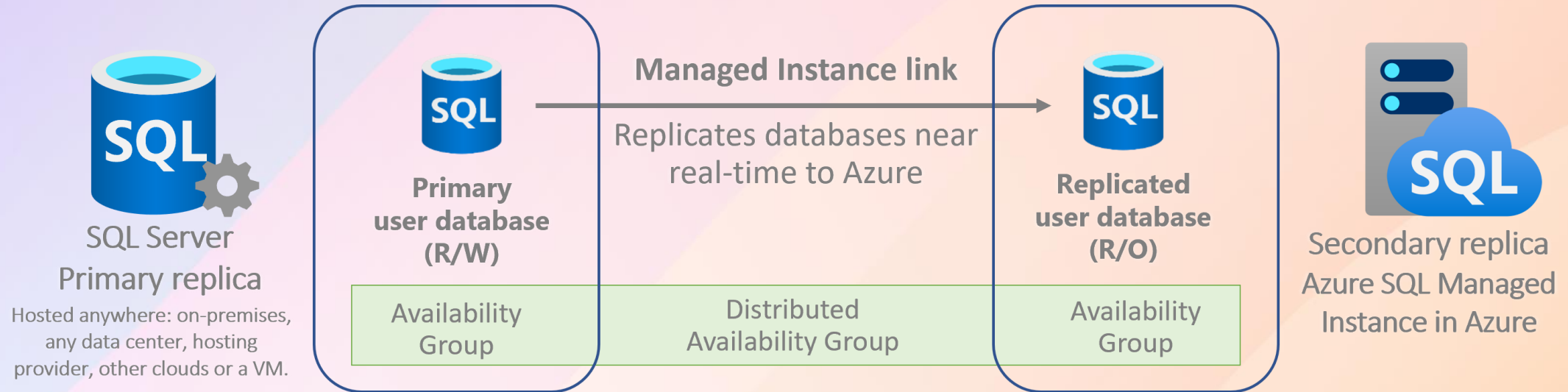
Name ↑↓	Server ↑↓	Region ↑↓	Failover policy ↑↓	Pricing tier ↑↓	Replica state ↑↓
▼ Primary					
<a href="#">AdventureWorks</a>	<a href="#">kursysqlpl</a>	West Europe	None	Standard S0: 10 DTUs	Online
▼ Geo replicas					
<a href="#">AdventureWorks</a>	<a href="#">kursysqlpl2</a>	East US		Standard S0: 10 DTUs	Readable
<a href="#">AdventureWorks</a>	<a href="#">kursysqlpl3</a>	East US		Standard S0: 10 DTUs	Readable

- [📌](#) Pin to dashboard
- [🛑](#) Stop replication
- [⚠](#) Forced failover



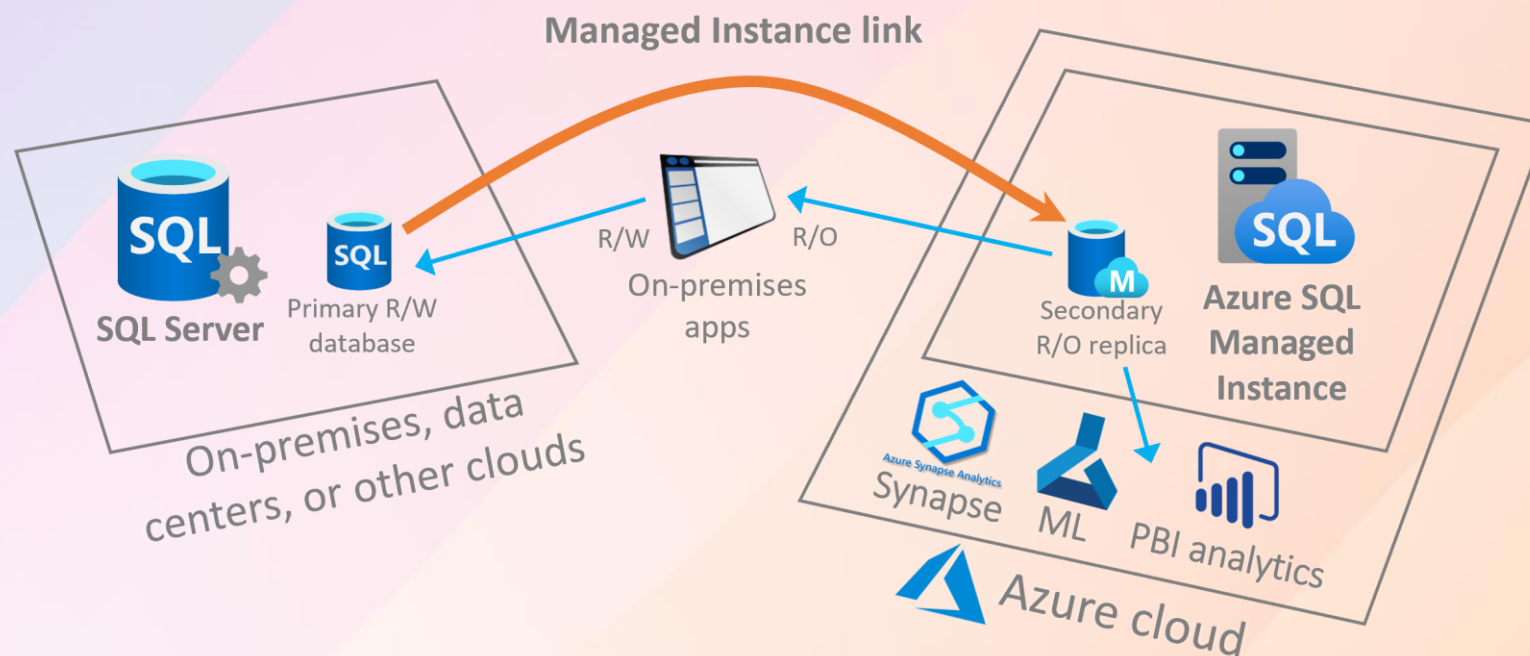
# 4. Link feature for Azure SQL Managed Instance

# Link feature for Azure SQL Managed Instance



- **Consolidation:** databases from multiple SQL Servers to a single SQL Managed Instance in Azure
- **Deconsolidation:** replicate databases from a single SQL Server to multiple managed instances
- 1 to 1 relationship between a database and a managed instance

# Supported scenarios



- Use Azure services without migrating to the cloud
- Offload read-only workloads to Azure
- Migrate to Azure

# Prerequisites

- Azure SQL Managed Instance (Azure SQL MI)
- SQL Server 2019 Ent/ Dev (15.0.4198.2+)
  - Release date: 01.2022
- SQL Server Management Studio (SSMS) 18.11.1
  - Release date: 08.03.2022
  - for GUI

Release	RTM (no SP)	Latest CU
<a href="#">SQL Server 2022</a> <b>Announced</b> SQL Server 16	<a href="#">Not released</a>	
<a href="#">SQL Server 2019</a> <b>SQL Server latest version</b> SQL Server 15 codename Aris Seattle Support end date: 2025-01-07 Ext. end date: 2030-01-08	<a href="#">15.0.2000.5</a>	<a href="#">CU15</a> (15.0.4198.2, January 2022) <div>Cumulative update 15 (CU15) for SQL Server 2019</div>

# Prepare environment

- Install CU15 (or higher) - 15.0.4198.2+
- Install SSMS 18.11.1
- Create database master key in the master database
- Enable availability groups feature (SQL Server Configuration Manager)
- Enable startup trace flags
  - -T1800: This trace flag optimizes performance when the log files for the primary and secondary replica in an availability group are hosted on disks with different sector sizes, such as 512 bytes and 4k.
  - -T9567: This trace flag enables compression of the data stream for availability groups during automatic seeding. The compression increases the load on the processor but can significantly reduce transfer time during seeding.

```
-- Microsoft SQL Server 2019 (RTM-CU15)
SELECT @@VERSION

-- Database master key in the master database
USE master

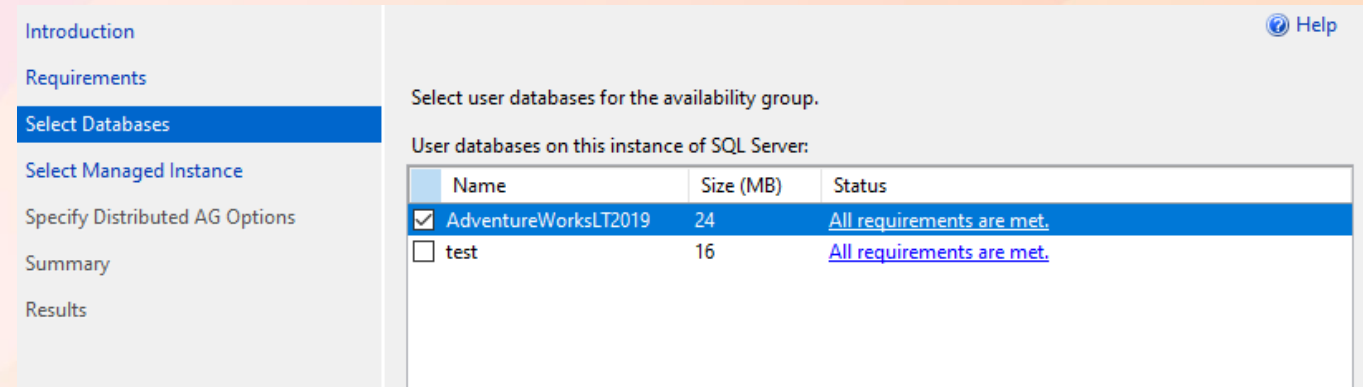
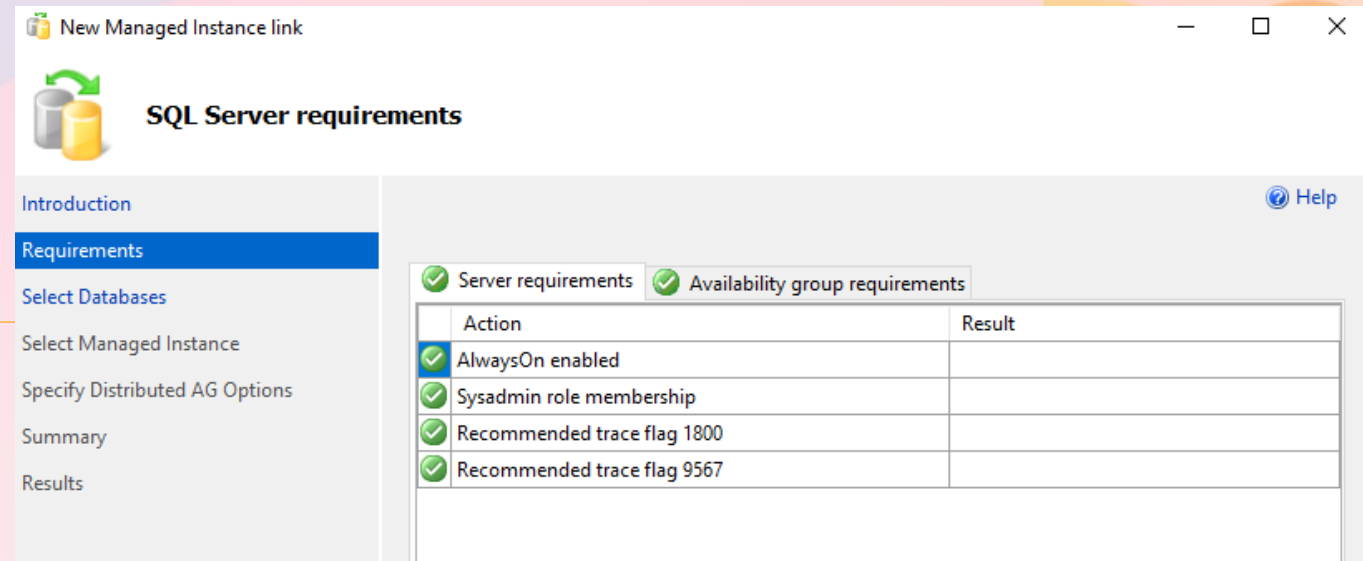
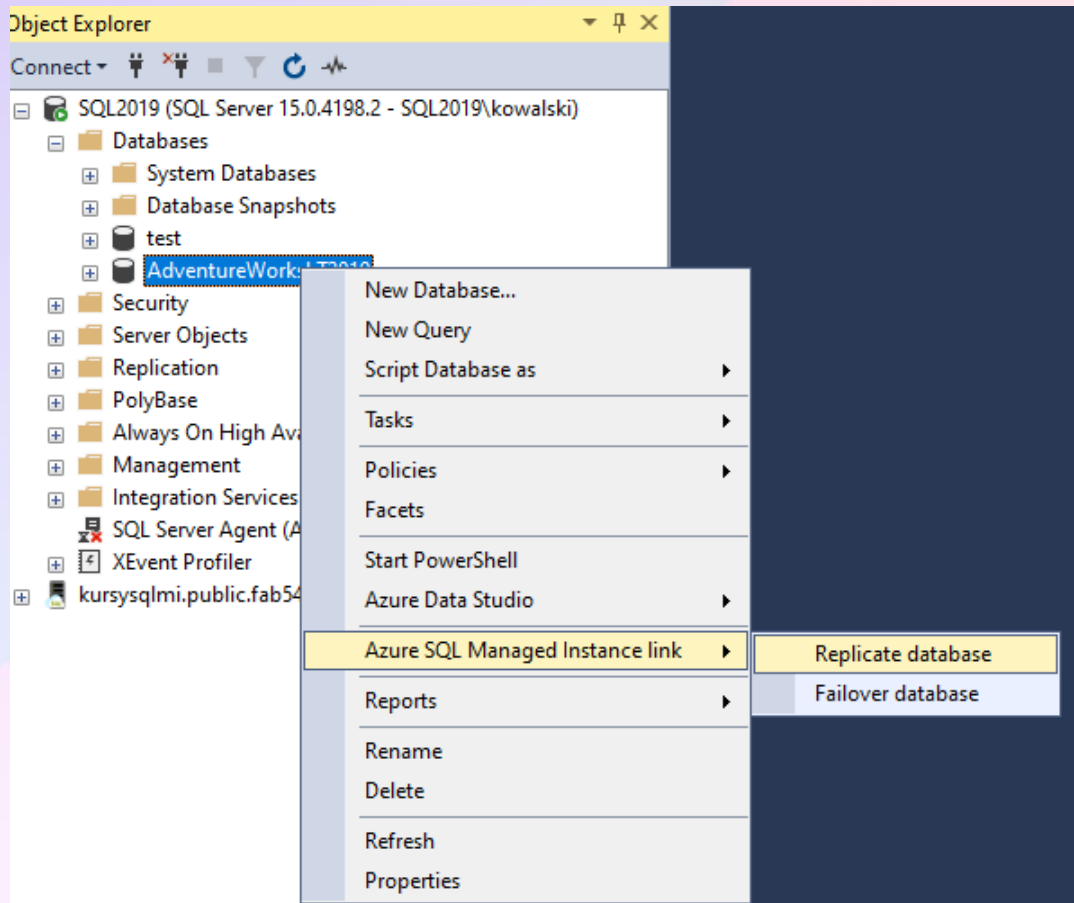
IF NOT EXISTS (SELECT * FROM sys.symmetric_keys WHERE name LIKE '%DatabaseMasterKey%')
CREATE MASTER KEY ENCRYPTION BY PASSWORD = 'P@$$word'

-- Enable availability groups feature
-- (Windows Server 2016 + SQL Server 2017)
SELECT SERVERPROPERTY('IsHadrEnabled')

-- Trace flags: T1800, T9567
DBCC TRACESTATUS
```



# Replicate database



<http://www.kursysql.pl/sqlday/>





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