SQLskills Immersion Event

IEAzure: Azure VMs and Azure SQL Database

Module 4: Azure SQL Database

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Overview

- Overview
- Features
- Missing options
- Azure pricing
- Creating Azure SQL Databases
- Maintenance considerations
- Automation
- Monitoring and alerting

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Platform as a Service (PaaS)

- **Complete modular environment, enable delivery from simple cloud-based apps to sophisticated, enterprise apps**
  - Allows you to focus on applications, not hardware
  - Support for full lifecycle: building, testing, deploying, management
  - Auto-scale to meet demand and save money
  - Integrated health, monitoring, and load balancing
  - Predictable performance and pricing, pay-as-you-go
  - Secure and compliant for your sensitive data
  - Supports geographically distributed development teams
  - Pre-coded application components built-in:
    - workflow, directory services, security, search, and more

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How Does SQL Server fit into PaaS?

- **Azure SQL Database, Elastic Pools, and Managed Instance are built on Microsoft's Platform as a Service**
- **Each product gets to take advantage of PaaS services and benefits**

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How Does SQL Server fit into PaaS?

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What is Azure SQL Database?

- **Azure SQL Database is a database-as-a-service**
  - SQL Database is a cloud relational database service built on Microsoft's Platform-as-a-Service
  - Predictable performance and pricing
  - Elastic database pool for unpredictable workloads
  - 99.99% availability built-in *99.995 Business Critical/Premium
  - Up to 100x performance improvements with support for In-Memory Columnstore queries
  - Improved monitoring and troubleshooting with Extended Events
  - Geo-replication and restore services for data protection
  - Supports existing SQL Server tools, libraries, and APIs
  - Scalability with minimal downtime
  - Secure and compliant for your sensitive data

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Azure SQL Database Momentum

- **4.5 million databases**
- **154 petabytes of databases**
- **421k subscriptions**
- **3 trillion batch request per day**
- **1.4 million transactions per second**
- **100 million queries analyzed per hour**

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Azure Data Services

IF YOU WANT...	USE THIS
A globally distributed multi-model database, with support for NoSQL choices, with industry-leading performance and SLAs	Azure Cosmos DB
A fully managed relational database that provisions quickly, scales on the fly, and includes built-in intelligence and security	Azure SQL Database
A fully managed, scalable MySQL relational database with high availability and security built in at no extra cost	Azure Database for MySQL
A fully managed, scalable PostgreSQL relational database with high availability and security built in at no extra cost	Azure Database for PostgreSQL
To host enterprise SQL Server apps in the cloud	SQL Server on Virtual Machines
A fully managed, elastic data warehouse with security at every level of scale at no extra cost	SQL Data Warehouse
Help migrating your databases to the cloud with no application code changes	Azure Database Migration Service
High throughput and consistent low-latency data access to power fast, scalable applications	Azure Cache for Redis
A NoSQL key-value store for rapid development using massive semi-structured datasets	Table Storage
A fully managed, scalable MariaDB relational database with high availability and security built in at no extra cost	Azure Database for MariaDB

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Features

- **Backups**
  - They are performed for you (but you perform restores)
  - Point-in-time restores
  - Retention is based on tier
    - Basic = 7 days; Standard = 35 days; Premium 35 days
  - Restores are to a new database
  - https://azure.microsoft.com/en-us/documentation/articles/sql-database-business-continuity/
  - Long-term backup retention up to 10 years
  - https://docs.microsoft.com/en-us/azure/sql-database/sql-database-long-term-backup-retention-configure

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Features

- **Dynamic Data Masking**
  - Prevent abuse of sensitive data by hiding/masking it from users
  - Limit access to sensitive data by controlling how the data appears
  - Easy configuration in the Azure Portal
  - Use T-SQL to configure masking rules
  - Policy-driven at the table and column level
  - Masking rules are applied in real-time to query results based on the defined policy
  - Predefined masking rules default, credit card, social security number, email, random, or custom string
  - No physical changes are made to the data

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Features

- **Dynamic Data Masking**
  - Existing application queries will not be affected
  - The sensitive data is masked in the result set
  - Masking rules apply to everyone except administrators and those you explicitly specify
  - DDM is complimentary to other security features and should be used in combination with other features
  - Encrypt sensitive data at rest (we'll cover this)
  - If the data is worth masking, it is worth auditing too (we'll cover this)
  - https://azure.microsoft.com/en-us/documentation/articles/sql-database-dynamic-data-masking-get-started/

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Features

- **Row-Level Security**
  - Control access of specific rows in a database table
  - Can restrict row-level access based on a user's identity
  - Helps prevent unauthorized access when multiple users share the same tables, or implement connection filtering in multitenant applications
  - Implement RLS using T-SQL statements
  - Access restriction logic is located in the database tier
  - https://msdn.microsoft.com/en-us/library/dn765131.aspx

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Demo

Enabling and using Dynamic Data Masking and Row-Level Security

Features

- **Always Encrypted**
  - Provides a separation between those that own the data and those who can view the data
  - Client-side column encryption
  - Allows clients to encrypt sensitive data inside client applications and not reveal the encryption keys to the Database Engine
  - Can ensure sensitive data never appears as plaintext inside the system
  - Only client applications or app servers that have access to the keys can access plaintext data
  - Encryption keys are stored in the Azure Key Vault
  - No application changes – just connection string
  - https://msdn.microsoft.com/en-us/library/mt163865.aspx

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Features

- **Always Encrypted**
  - Client-side encryption
    - Sensitive data and related encryption keys are never revealed to the database engine
  - Encryption transparency
    - Client driver transparently encrypts query parameters and decrypts encrypted results
  - Queries on encrypted data
    - Support for equality comparison on columns encrypted using deterministic encryption
  - Limitations
    - Reduced functionality of queries on encrypted columns – only allow for equality comparisons
    - Data needs to be moved out of the database for initial encryption and key rotation, this can be time consuming and prone to network errors

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Features

- **Transparent Data Encryption**
  - Real-time encryption and decryption of the database, backups, and transaction log files at rest
  - Encryption keys managed by Azure or bring your own key
  - Encrypts the storage of an entire database by using a symmetric key
  - Enabled by default
  - Initially released with SQL Server 2008 Enterprise Edition
  - https://msdn.microsoft.com/en-us/library/dn948096.aspx

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Features

- **Geo-replication**
  - Available in all tiers
  - Provides a readable replica database (secondary) in a different region
  - Support for up to four readable secondaries on servers in different regions
  - Designed for write-intensive applications with aggressive recovery requirements
  - Can load balance reads against secondaries
  - Manage using REST API, PowerShell, or Azure Portal
  - Estimated Recovery Time (ERT)
    - Auto-failover group 1 hour – Manual failover 30 seconds
  - Recovery Point Objective (RPO) <5 s

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Features

- **Geo-replication**
  - Automatically or manually failover a group of databases using failover groups
  - Allows cross-region isolation quickly and with minimal data loss
  - Automatic DNS swap during failover
  - Does not require changing application code or connection strings
  - Can manually initiate failover or failback at any time
  - Each database is billed separately
  - https://docs.microsoft.com/en-us/azure/sql-database/sql-database-business-continuity

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Demo

Setting up geo-replication

Features

- **Elastic database pools**
  - Pool of resources (eDTUs, vCores, storage) that individual databases can auto-scale within set parameters
  - Helps maximize efficiency and management for multiple databases
  - Under heavy load, a database can consume more eDTUs/vCores to meet demand
  - Provisioning resources for an entire pool simplifies management tasks and cost rather than for each database
  - http://bit.ly/23fDp2d

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Features

- **In-memory support for Premium tier**
  - In-memory OLTP can dramatically improve throughput and latency on transactional processing workloads and can provide significant performance improvements.
  - A memory-optimized table is represented in active memory
  - http://bit.ly/1WLQoDy

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Features

- **Query Store**
  - Detailed historical information about all queries
  - Enables you to easily identify queries that are performing poorly
  - Keeps a history of each query, including its associated plans, run-time statistics, and information about resource consumption
  - Easily find performance differences caused by query plan changes
  - Query Store is a database-level feature and on by default
  - https://msdn.microsoft.com/en-US/library/dn817826.aspx
- **Erin Stellato's Pluralsight course: *SQL Server: Introduction to Query Store***
  - http://bit.ly/2nwld8Z

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Demo

Brief Intro to Query Store

Features

- **Automatic Tuning**
  - Index recommendations that have potential to improve query performance
  - Analyzes SQL database's usage history
  - One-click to enable
  - Provides CREATE INDEX and DROP INDEX recommendations that can be applied automatically
  - Can force plans automatically
  - Parameterize query and fix schema recommendations
  - Drop Index identifies unused and duplicate indexes (same indexed and included column, partition schema, and filters)
    - Unused = not used for a period of 93 days
  - Dropped indexes will be automatically re-created if there are some queries that run slower due to the absence of the index

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Features

- **Automatic Tuning**
  - Automatically created indexes are validated to make sure there is a positive gain to the workload, if not, it will revert the recommendation
    - Validation can take up to 72 hours by design
  - Manually applied recommendations can take up to 48 hours to be removed from the list of recommendations
  - Auto created indexes are immediately dropped when a related table or columns are dropped
  - Recommendations are applied during low-usage periods
  - https://docs.microsoft.com/en-us/azure/sql-database/sql-database-automatic-tuning

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Demo

Reviewing Auto tuning recommendations

Features

- **Threat Detection**
  - Allows customers to detect and respond to potential threats as they occur
  - Users receive alerts based upon suspicious activities, vulnerabilities, and more
  - Recommendations also provided to help investigate and mitigate the threat
- **Vulnerability Assessment**
  - Service that provides visibility into your security state
  - Provides steps to investigate, manage, and resolve vulnerabilities
  - The tool uses a knowledge base of rules that flag security vulnerabilities and deviations from known best practices

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Missing Options

- **Cross-database query support**
- **SQL Server Agent**
- **Database Mail**
- **Events and notifications**
- **SQL Server Trace / Profiler**
- **Trace flags and sp_configure**
- **SQL Server components**
- **Common HA solutions**

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Missing Options

- **Cross-database query support**
  - Azure SQL Database is designed for database isolation, it was built using a database scoped configuration programming model
  - Elastic query (in preview) can be used to provide a T-SQL ability to provide read-only querying of remote databases.
  - Elastic query is supported on both Standard and Premium tiers
  - Elastic query is primarily focused on providing result sets for reporting

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Missing Options

- **SQL Server Agent**
  - Does not exist
  - Use an on-premises SQL Server Agent
  - Use a VM running SQL Server
  - Elastic Jobs, currently in preview
  - Azure Automation
- **Database Mail**
  - Not supported
  - Alert rules can be added for certain metrics and notifications emailed
  - Leverage an Azure VM or on-premises instance

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Missing Options

- **Events and Notifications**
  - Events, event notifications, and query notifications are not supported
  - Alert rules can be added for certain metrics and notifications emailed
- **SQL Server Trace / Profiler**
  - Deprecated with SQL Server 2012
  - Was not built into Azure SQL Database
  - Instance level, it would capture instance level data, not database specific
- **Trace Flags and sp_configure**
  - Trace flags are also instance-level and not supported with Azure SQL Database
  - Anything requiring sp_configure and RECONFIGURE are not supported

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Demo

Creating an alert rule with email notifications

Missing SQL Server Components

- **SQL Server Reporting Services (SSRS)**
  - Can use on-premises or Azure VM (additional licensing)
  - Can use Power BI
- **SQL Server Integration Services (SSIS)**
  - Can use on-premises or Azure VM (additional licensing)
  - Can use Azure Data Factory

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Unsupported HA Solutions

- **Log shipping**
  - You can't log ship to an Azure SQL Database
  - You can log ship to an Azure VM running SQL Server
- **Database mirroring**
  - You can't mirror to an Azure SQL Database
  - You can mirror to an Azure VM running SQL Server
- **Availability groups**
  - You can't have a secondary database as an Azure SQL Database
  - You can setup a secondary to an Azure VM running SQL Server
- **Transactional replication**
  - Azure SQL Database can be a subscriber, not a publisher

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Service Tiers

- **Database Transaction Units (DTU) and Elastic Database Transaction Units (eDTUs)**
  - Basic
  - Standard
  - Premium
- **vCore - Singleton databases**
  - General Purpose
  - Business Critical
  - Serverless
  - *Hyperscale*
- **vCore - Elastic Pools**
  - General Purpose
  - Business Critical

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Pricing - DTU

- **DTU**
  - Database Transaction Unit
- **eDTU**
  - Elastic Database Transaction Unit
- **vCore**
  - New option for Azure SQL DB and Elastic Pools
- **DSU**
  - Database Stretch Unit
- **DTU and eDTU Calculator**
- **Azure support options**

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Pricing - DTU

- **DTUs – basic tier**
  - Best suited for small database supporting one single active operation at a time
  - 2GB database size limit with 5 DTU
  - Point in time restore 0 - 7 days back
  - Max concurrent workers = 30
  - Max concurrent sessions = 300

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Pricing - DTU

- **DTUs – standard tier**
  - Best suited for most cloud applications such as workgroup and web applications
  - Database size limits 100MB – 1TB
  - DTU ranges 10 - 3000
  - Point in time restore 0 - 35 days back
  - Max concurrent workers = 60 - 6000
  - Max concurrent sessions = 600 – 30,000

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Pricing - DTU

- **DTUs – premium tier**
  - Built for high transactional volume for applications requiring high-level business continuity
  - 500GB – 1TB database size limit – 4TB in certain regions
  - DTU ranges 125 – 4,000
  - Point in time restore 0 - 35 days back
  - Max concurrent workers = 200 – 6,400
  - Max concurrent sessions = 30,000

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vCore Based Service Tiers

Customers pay for

- Service tier + number of cores
- Type and amount of data storage
- Number of IO
- Backup storage (RA-GRS)
- The vCore-based model will exist alongside the DTU-based model
- Hyperscale
- Severless

	GENERAL PURPOSE		HYPERSCALE	BUSINESS CRITICAL	
Best for	Most business workloads. Offers budget oriented balanced compute and storage options		Data applications with large data capacity requirements and the ability to auto-scale storage and scale compute fluidly	OLTP applications with high transaction rate and low latency IO. Offers highest resilience to failures using several isolated AlwaysON replicas	
Compute tiers	Gen 5 hardware				
	Single/Elastic Pools	Managed Instance	Single database	Single/Elastic Pools	Managed Instance
	2 to 80 vCores	4, 8, 16, 24, 32, 40, 64, 80 vCores	2 to 80 vCores	2 to 80 vCores	8, 16, 24, 32, 40, 64, 80 vCores
Storage	Premium remote storage (per instance)		De-coupled storage with local SSD cache (per instance)	Super-fast local SSD storage (per instance)	
	Single/Elastic Pools	Managed Instance	Single database	Single/Elastic Pools	Managed Instance
	5GB – 4TB	32GB – 8TB	Up to 100TB	5GB – 4TB	32GB – 4TB**
Availability	1 replica, no read-scale		Configurable replicas, up to 15 read-scale	3 replicas, 1 read-scale, zone-redundant HA***	
Backups	RA-GRS, 7-35 days (7 days by default)		RA-GRS, 7-35 days (7 days by default), constant time PITR	RA-GRS, 7-35 days (7 days by default)	

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Hyperscale your database

Highly scalable service tier that adapts on-demand to your workload's needs, auto-scaling up to 100TB per database

Storage dynamically adapts to your workloads' needs, auto-scaling up to 100TB

Provision one or more additional compute nodes that can serve your read-only workload and use them as a hot-standby, in case of failover

Perform operations in constant time, regardless of the size of the data operation

Compute and storage resources scale rapidly and independently without sacrificing performance

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Hyperscale Database Restore

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Serverless Compute Tier

- Automatically scales compute based on workload demand and bills for the amount of compute used per second
- Pause databases during inactive periods, only storage is billed, resumes when activity returns

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Serverless Compute Tier

- Configure minimum and maximum vCores, up to 40 for range of compute
- Autopause delay is configurable to define the period of time the database must be inactive before it is automatically paused
- Cost is based on the summation of the compute and storage cost
- In general, the host running the serverless databases should have enough capacity to satisfy the resource demand without interruption
- Azure SQL Serverless Auto Scale - Tim Radney (sqlskills.com)

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Pricing - vCore

- General Purpose service tier, business applications with typical performance and HA requirements
- Azure Premium remote storage up to 4TB
  - 5-7 ms write latency, 5-10 ms read latency
- vCores:
  - Gen 5: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 24, 32, 40, 80*
- 5.1GB per core
- Tempdb size 32GB – 384GB
- Maximum database size 4TB
- IOPS 500 - 7,000 IOPS, IOPS grow with storage size

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Pricing - vCore

- Business Critical service tier, business applications with high performance and HA requirements
- Azure Premium remote storage up to 1TB
  - 5-7 ms write latency, 5-10 ms read latency
- vCores:
  - Gen 5: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 24, 32, 40, 80*
- Gen 5 ram 5.1GB per core
- Temdpb size 32GB – 384GB
- Maximum database size 1TB
- IOPS 5000 - 200,000 IOPS, IOPS grow with storage size

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Pricing - eDTU

- **eDTUs**
  - Basic pool – 2GB max storage per database
  - Standard pool – 1024GB max storage per database
  - Premium pool – 1024GB max storage per database
  - Included storage per pool = pool size for standard tier
  - Included storage per pool increases as eDTU limit increase for premium tier
  - 1024GB database limit size

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Pricing - DSU

- **DSUs**
  - Uses Azure SQL Database to dynamically stretch warm and cold transactional data
  - Compute billed as DSU, storage billed as Standard Disk rates
  - Expensive

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Pricing

- **DSU pricing**

DSU	Monthly Price	DSU	Monthly Price
100	$1,860	1,000	$18,600
200	$3,720	1,200	$22,320
300	$5,580	1,500	$27,900
400	$7,440	2,000	$37,200
500	$9,300	3,000	$55,800
600	$11,160	6,000	$111,600

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Pricing

- **Azure Support Options**
  - All include @AzureSupport, Azure forums, self-help, unlimited 24/7 billing and subscription support, and Azure Service Dashboard

Plans	Included	Developer	Standard	Pro Direct	Premier
Range of support	Microsoft Azure	Microsoft Azure	Microsoft Azure	Microsoft Azure	All MS products
Unlimited 24/7 tech	-	Business Hours	✓	✓	✓
Non-MS tech on Azure	-	✓	✓	✓	✓
Max severity	-	C	A	A	A
Initial response time	-	< 8 hours	< 2 hours	< 1 hour	< 15 min or < 1 hour
Monthly cost	Included	$29/mo	$300/mo	$1000/mo	Contact MS

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Creating an Azure SQL Database

- **Azure Portal – add SQL Database**
  - Database Name
  - Subscription
  - Resource group
  - Select source – blank, sample, from previous Azure SQL DB backup
  - Server
  - Pool?
  - Pricing Tier
  - Collation

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Creating an Azure SQL Database

- **SSMS – create database statement**
  - DB_NAME
  - Edition Basic, Standard, Premium,….
  - Service objective – S0, S1, S2, S3, P1, P2,…..
- **PowerShell**
  - Connect to your Azure Subscription
  - Full management to create containers, databases, query database, configure firewall rules, etc
- **Azure Data Studio**
  - Runs on Windows, macOS, and Linux
  - Cross-platform database tool

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Demo

Review current pricing for various tiers and sizes, create an Azure SQL Database using the Azure Portal and SSMS, HyperScale options, Serverless

Maintenance Considerations

- **Index fragmentation**
  - Fragmentation still occurs in Azure SQL Databases
  - Rebuild
  - Reorganize
  - Process to rebuild/reorganize
- **Statistics**
  - Statistics still get skewed and out of date
  - Index rebuilds update index column statistics
  - Index reorganizations do not update any statistics
  - Manual process to update statistics
- **DBCC CHECKDB**
  - I recommend you still manually run contrary to anything you've read
  - https://azure.microsoft.com/en-gb/blog/data-integrity-in-azure-sql-database/

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Automation

- **Local SQL Servers**
  - Linked Servers – connect to an Azure SQL Database using a linked server to run any normal maintenance, data manipulations, etc
  - Database Maintenance Plans – you can schedule database maintenance plans to connect to an Azure SQL Database as a data source
- **PowerShell**
  - You can use PowerShell to do just about anything within Azure
  - Any common task can be automated using PowerShell

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Automation

- **Azure Services**
  - Create an Azure Automation account
  - Create a new run book or choose from a library of existing run books
- **Elastic Job agents (preview - still)**
  - Define an elastic pool with a database
  - Create jobs to run again individual, a group, or all databases in the pool
  - Create and manage jobs easily through the PowerShell API

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Monitoring Options – Azure Portal

- **Monitor dashboard**
  - Defaults to DTU percentage and last hour of activity
  - Currently limited metrics available
  - No ability to create custom metrics
- **Alerts**
  - No default alerts configured
  - Currently 33 alert rule metrics available
  - Email notifications and web hooks available
- **Resource Health dashboard**
  - Health issues inside the Azure platform
  - More granular than Service Health dashboard

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Demo

Monitor and Resource Health dashboards

Monitoring Options

- **SentryOne – DB Sentry**
  - Complete performance tool
  - Monitor performance
  - Provides a benchmark
  - DTU usage over time

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Demo

SentryOne dashboard

Key Takeaways

- Azure SQL Database is an enterprise-ready database-as-a-service platform
- Azure SQL Database is feature rich and secure
- Some things you are used to with the box version of SQL Server are not available, not supported, or have another cloud solution
- There are a number of pricing options depending on performance tier, elastic pools, or stretch databases
- Statistics and index maintenance is still applicable to Azure DB
- Numerous options exist for handling automation, even though SQL Agent isn't available
- Monitoring is available with built in dashboards and alerts

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Review

- Overview
- Features
- Missing options
- Azure pricing
- Creating Azure SQL Databases
- Maintenance considerations
- Automation
- Monitoring and alerting

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References

- Backups
  - http://bit.ly/1UJTI1Z
- Dynamic Data Masking
  - http://bit.ly/1eG7Que
- Row-Level Security
  - http://bit.ly/20NRQKI
- Always Encrypted
  - http://bit.ly/1M8ukA6
- Transparent Data Encryption
  - http://bit.ly/1P0REoa
- Geo-replication
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