


**SQLskills *presenting* for
QCPASS SQL Server User Group
13th March 2019**

**A Tour Through Azure SQL Database
and Azure SQL Managed Instance**

Tim Radney
Tim@SQLskills.com



- Team of world-renowned SQL Server experts:
 - Paul S. Randal (@PaulRandal)
 - Glenn Berry (@GlennAlanBerry)
 - Jonathan Kehayias (@SQLPoolBoy)
 - Kimberly L. Tripp (@KimberlyLTripp)
 - Erin Stellato (@ErinStellato)
 - Tim Radney (@TRadney)
- Instructor-led training: Immersion Events (US, UK, and Ireland)
- Online training:  <http://pluralsight.com/>
- Consulting: health checks, hardware, performance, upgrades
- Remote DBA: system monitoring and troubleshooting
- Conferences: PASS Summit, SQLintersection
- Become a SQLskills Insider
 - <http://www.sqlskills.com/Insider>



2019 Classes and Services

- 2019 classes in Chicago (April/May)
 - IEPTO1/2: Immersion Events on Performance Tuning – Parts 1 and 2
 - IE0: Accidental/Junior DBA
 - IEAzure: Azure SQL Database, Azure VMs, And Azure MI
 - IEPowerBI: PowerBI, PowerBI Report Server, SSRS
 - IEUpgrade: Upgrading/Migrating to SQL Server 2017
 - IECAG: Clustering and Availability Groups
 - IEPML: Practical Machine Learning
- Online, live Immersion Events through the year
 - Query Store, Columnstore, Transactions/locking/blocking, Query performance, Upgrade, Very-large tables and partitioning
- In-depth, instructor-led, technical training for SQL Server
- For more information: <https://www.sqlskills.com/schedule/>
- New client discount: US\$2,995 flat rate on first single-instance health check
- For more information: <https://www.sqlskills.com/services/>

pluralsight

- Email paul@SQLskills.com with the subject line: **User Group Pluralsight code** to get a FREE (no catches, no credit card) 30-day trial of our 175+ hours of SQLskills content on Pluralsight
- For example:
 - <https://app.pluralsight.com/library/courses/sqlserver-logging/table-of-contents>
 - 7 hours on logging, recovery, and the transaction log (Paul)
 - <https://app.pluralsight.com/library/courses/sqlserver-indexing-for-performance>
 - 7 hours on indexing (Kimberly)
 - <https://www.pluralsight.com/courses/sqlserver-understanding-using-azure-sql-database>
 - 2 hours on Azure SQL Database (Tim)

2018 Classes and Services

Training

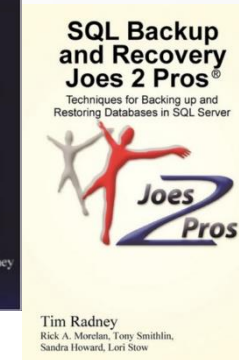
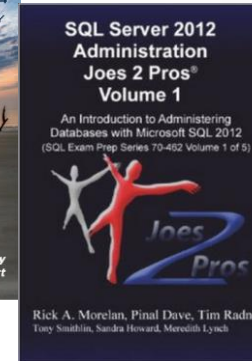
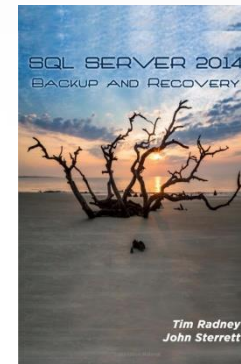
- In-depth, instructor-led, technical training for SQL Server
 - Held in the US (Chicago, IL and Bellevue, WA), the UK, Ireland, and Australia
- Online, LIVE, Immersion Events through the year
 - US\$699 each or US\$1,749 combo
 - Always announced first, and with a special discount, in our Insider newsletter
 - <https://www.sqlskills.com/Insider>
- For more information: <https://www.sqlskills.com/training/>

Consulting

- New client discount: US\$2,995 flat rate on first single-instance health check
- For more information: <https://www.sqlskills.com/services/>

Author/Instructor: Tim Radney

- Consultant/Trainer/Speaker/Author
- Principal Consultant, SQLskills.com
 - Email: Tim@SQLskills.com
 - Blog: <https://www.SQLskills.com/blogs/Tim>
 - Blog: <http://www.timradney.com>
 - Twitter: @TRadney
- Microsoft Data Platform MVP
- Chapter Leader "Columbus GA SQL Users Group"
- PASS Regional Mentor "South East USA"
- Outstanding PASS Volunteer
- Regular presenter at worldwide conferences on administration, disaster recovery, performance tuning, and Azure
- Friend of Red Gate
- (I also like electronics, aquaponics, farming chickens, crops, and tilapia)



Overview

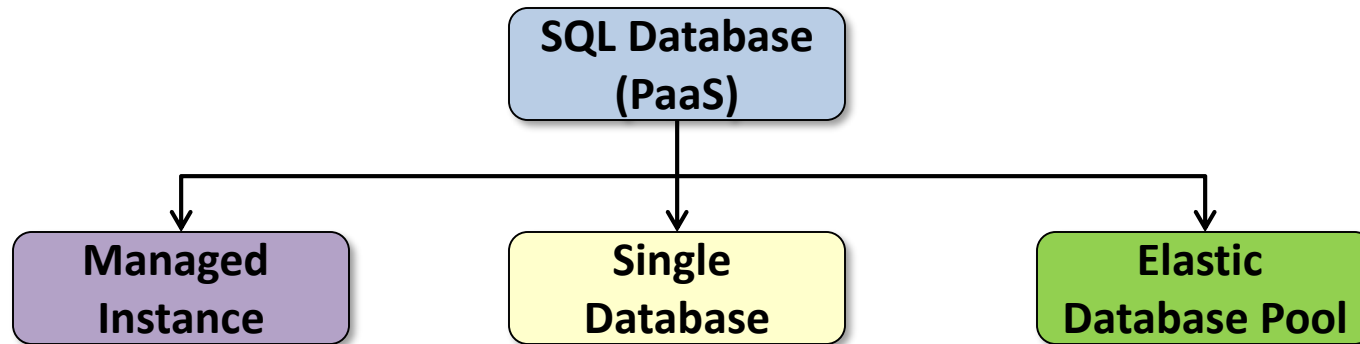
- What is Platform as a Service (PaaS)?
- Platform as a Service benefits
- Azure SQL Database
- Elastic Pools
- Azure SQL Database Managed Instance
- What sets Managed Instance apart?

What is Platform as a Service?

- Azure Cloud Services
 - Allows you to focus on applications, not hardware
 - Support for full lifecycle: building, testing, deploying, managing, updating
 - 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

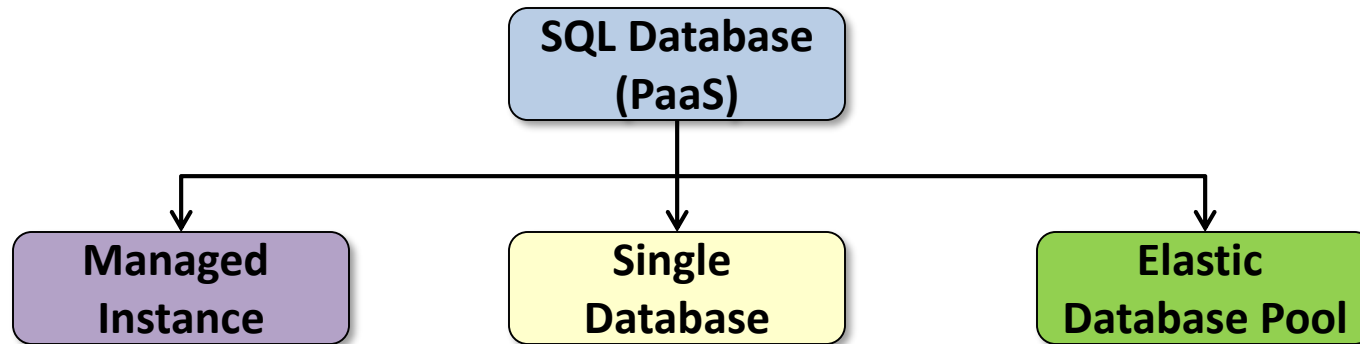
Platform as a Service

- 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



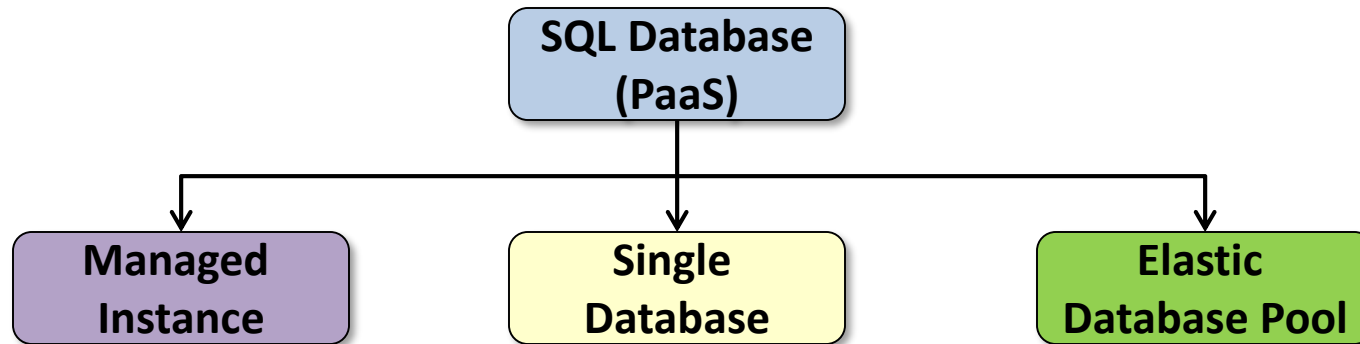
Platform as a Service

- 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



Platform as a Service

- 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



Platform as a Service Benefits: Security

- Dynamic Data Masking
 - Can limit access to sensitive data by controlling how the data appears
 - Masking rules can be defined on particular columns
 - No physical changes are made to the data
 - <https://azure.microsoft.com/en-us/documentation/articles/sql-database-dynamic-data-masking-get-started/>
- Row-Level Security
 - Can restrict row-level access based on a user's identity
 - Access restriction logic is located in the database tier
 - <https://msdn.microsoft.com/en-us/library/dn765131.aspx>

Platform as a Service Benefits: Security

- Always Encrypted
 - 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
 - <https://msdn.microsoft.com/en-us/library/mt163865.aspx>
- Transparent Data Encryption
 - Real-time encryption and decryption of the database, backups, and transaction log files at rest
 - Encrypts the storage of an entire database by using a symmetric key
 - Supports Azure Key Vault integration
 - <https://msdn.microsoft.com/en-us/library/dn948096.aspx>

Platform as a Service Benefits: Security

- Threat Detection
 - Allows customers to detect and respond to potential threats as they occur
 - Users receive alerts based on suspicious activities, vulnerabilities, and more
 - Recommendations 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
- Azure Active Directory integration
 - Allows you to centrally manage identities of database users and other Microsoft services
 - Azure Active Directory supports multi-factor authentication

Platform as a Service Benefits: Security

- Many compliance certifications
 - DoD Provisional Authorizations at Impact Levels 5, 4, and 2
 - FIPS 140-2 – US Federal Info Processing Standards
 - HIPPA/HITECH – Health Care
 - ISO 22301, 27001, 27017, 27018
 - PCI DSS – Payment Card industry
 - CJIS – US Criminal Justice Information Services
 - Spain ENS – National Security Framework
 - UK Cyber Essentials PLUS – cyber-security threats
 - EU Model Clauses
 - And many more
- Azure Trust Center <http://bit.ly/2lKjwzK>

Platform as a Service Benefits: Data Protection

- Automated Backups
 - They are handled for you; you handle restores
 - Point-in-time restores
 - Retention is based on tier
 - *Basic* = 7 days; *Standard, Premium, Managed Instance* = 35 days
 - Restores are to a new database
 - <https://azure.microsoft.com/en-us/documentation/articles/sql-database-business-continuity/>
- Built-in High Availability
 - Storage replication, failure detection, and failover are fully automated and function without humans
 - Failovers are fully automated without loss of any committed data
 - Routing of connections is dynamically managed

Platform as a Service Benefits: Data Protection

- Geo-replication
 - Available in all tiers for Azure SQL Database
 - Private Preview for Managed Instance
 - Provides a replica database (secondary) in a different region
 - Estimated Recovery Time (ERT) <30s with a Recovery Point Objective (RPO) <5s
 - Can replicate storage, Azure VMs, and more
 - <http://bit.ly/1McsB0y>

Platform as a Service Benefits: Performance

- In-memory support for Azure DB Premium tier and Managed Instance
 - A memory-optimized table is represented in active memory
 - <http://bit.ly/1WLQoDy>
- Performance recommendations – auto tuning
 - Index recommendations that have potential to improve query performance
 - Analyzes SQL database's usage history
 - Allows for automatic FORCE PLAN
 - Allows for automatic CREATE INDEX
 - Allows for automatic DELETE INDEX
 - Parameterize query and fix schema recommendations
 - <http://bit.ly/1HikabH>

Platform as a Service Benefits: Performance

- 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
 - Query Store is a database-level feature, enabled by default on SQL DB
 - <https://msdn.microsoft.com/en-US/library/dn817826.aspx>
- Erin Stellato's Pluralsight course: *SQL Server: Introduction to Query Store*
 - <http://bit.ly/2nwld8Z>

Azure SQL Database

- Azure SQL Database is a 'database as a service'
 - SQL Database is a cloud relational database service
 - Predictable performance and pricing
 - Elastic database pool for unpredictable workloads
 - 99.99% availability built-in
 - Geo-replication and restore services for data protection
 - Supports existing SQL Server tools, libraries, and APIs
 - Scalability with minimal effort
 - Secure and compliant for your sensitive data

Azure SQL Database: On-premises Differences

- 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
- Cross-database queries
 - Not supported
 - Elastic Query?

Azure SQL Database: On-premises Differences

- 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

Azure SQL Database: On-premises Differences

- 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

Azure SQL Database: On-premises Differences

- 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

Azure SQL Database: Pricing

- Database Transaction Units – DTU
 - Bundled measure of compute, storage, and I/O resources
 - Basic Tier – very small workloads
 - 5 DTU
 - Standard storage
 - Standard Tier – low, medium, and high CPU workloads, standard I/O
 - 10 DTU – 3000 DTU
 - Standard storage
 - Premium Tier – medium and high CPU workloads, intense I/O
 - 150 DTU – 4000 DTU
 - Premium storage (orders of magnitude faster)

Azure SQL Database: Pricing

- vCore
 - General Purpose – most business workloads
 - 1 to 80 vCore, Gen 4 and Gen 5 CPUs
 - Ram = 5.5 to 7GB per core
 - 500 IOPS per vCore with 7,000 Max IOPS
 - No In-Memory support
 - Business Critical –business workloads with higher HA requirement
 - 1 to 80 vCore, Gen 4 and Gen 5 CPUs
 - Ram = 5.5 to 7GB per core
 - 5,000 IOPS per vCore with 200,000 Max IOPS
 - In-Memory support

Azure SQL Database: Tuning Differences

- Instance level settings you can't change
 - tempdb
 - Cost threshold for parallelism
 - Max degree of parallelism
 - Min and max server memory
 - Optimize for ad hoc workloads
 - Anything requiring sp_configure and RECONFIGURE
- DBCC FREEPROCCACHE not supported

Pricing

- Azure Hybrid Benefit – convert on-premises license with SA to vCore General Purpose licenses
 - 1 Standard Edition licenses = 1 vCore General Purpose
 - 1 Enterprise licenses = 4 vCore General Purpose
 - <https://azure.microsoft.com/en-us/pricing/hybrid-benefit/>
 - Azure Hybrid Benefit for SQL Server provides SQL Server Enterprise Edition customers with Software Assurance four cores in the cloud for every one core they own on-premises when selecting the Managed Instance General Purpose option.

Azure SQL Database: Tuning Options

- Throw hardware at it; increase DTU size
- Tune your workloads; with minor changes, your existing workload scripts should work.
 - File statistics
 - <http://www.sqlskills.com/blogs/paul/how-to-examine-io-subsystem-latencies-from-within-sql-server/>
 - sys.master_files does not exist, modify to use sys.databases
 - File statistics over time
 - <http://www.sqlskills.com/blogs/paul/capturing-io-latencies-period-time/>
 - sys.master_files does not exist, modify to use sys.databases

Azure SQL Database: Tuning Options

- With minor changes, your existing workload scripts should work
 - Wait statistics
 - <http://www.sqlskills.com/blogs/paul/wait-statistics-or-please-tell-me-where-it-hurts/>
 - sys.dm_os_wait_stats contains wait statistics for the container your database is in, use sys.dm_db_wait_stats for database specific data
 - Waits over a period of time
 - <http://www.sqlskills.com/blogs/paul/capturing-wait-statistics-period-time/>
 - Change os to db,
- Getting started tuning performance in Azure SQL Database
 - <http://bit.ly/1pHB7dn>
- Glenn Berry DMVs – includes Azure SQL Database
 - <https://www.sqlskills.com/blogs/glenn/category/dmv-queries/>

Azure SQL Database: Use Cases

- Great for single use database applications
 - Many web applications fit here
- SaaS vendors that have a database per client
- New projects/products where the developers can build a single database back-end

Azure SQL Database Elastic Pools

- Elastic database pools
 - Pool of resources (eDTUs) that individual databases can auto-scale within set parameters
 - Under heavy load, a database can consume more eDTUs to meet demand
 - Provisioning resources for an entire pool simplifies management tasks rather than for each database
 - Pricing in based on eDTU or vCore model
 - vCore has General Purpose and Business Critical
 - Same as singleton database for sizing and pricing
 - <http://bit.ly/23fDp2d>

Azure SQL Database Elastic Pools: Pricing

- eDTUs
 - Basic pool: 2GB max storage per database
 - Standard pool: 250GB max storage per database
 - Premium pool: 500GB max storage per database
 - Monthly price estimates based on 744 hours per month
- vCore
 - General Purpose Gen 4: 1 vCore = 100 DB limit, 2 vCore = 200 DB limit, 4+ vCore = 500 DB limit
 - General Purpose Gen 5: 2 vCore = 200 DB limit, 4+ vCore = 500 DB limit
 - Business Critical Gen 4: 2 vCore = 50 DB limit, 4+ vCore = 100 DB limit
 - Business Critical Gen 5: 2 vCore = 50 DB limit, 4+ vCore = 100 DB limit

Elastic Pool: Use Cases

- An Elastic Pool is the solution for customers that have to manage larger numbers of Azure SQL Databases
- Allows for managing a pool of resources for many databases rather than micro-managing singleton databases
- SaaS customers have been able to migrate from managing singleton databases to Elastic Pools with a cost savings of over \$48k per year
- Most clients have seen a net benefit of offering Azure SQL databases more DTU scale when they need it, so more resources available to the workloads, and overall cost savings. It's a win-win

Azure SQL Database Managed Instance

- Introduced at Build in Spring 2017, Public Preview on March 6th 2018, GA on October 1st 2018 – General Purpose, GA December 1st 2018 – Business Critical
- Bridges the Azure gap between Azure SQL Database and SQL Server on an Azure VM
- Managed Instance is built on an instance-scoped programming model
 - Makes Managed Instances more compatible with on-premises SQL Server
- Single and elastic databases are built on a database-scoped programming model

Managed Instance

- The goal is to provide close to 100% surface area compatibility with on-premises SQL Server
- Supports backward compatibility to SQL Server 2008 databases
- Direct migration from SQL Server 2005 databases are supported, compatibility levels will be updated to SQL Server 2008

What Sets Managed Instance Apart?

- Provides an entire SQL Server instance experience
 - All the databases within the instance are on the same server
 - Full support for cross-database queries
 - This is important for many applications
- Global temp tables are supported
 - Azure SQL DB just recently started supporting global temp tables
- SQL Server Agent built in
 - No Agent support was a huge drawback for many customers in Azure SQL DB, had to use Azure Automation, Elastic Jobs, PowerShell, on-premises

What Sets Managed Instance Apart?

- Service Broker
 - Message-based communication platform
 - Not available in Azure SQL Database
- Transactional Replication
 - Can be a publisher or subscriber
 - Snapshot Replication
- Change Data Capture
- SQL Server Auditing
- Common Language Runtime (CLR)
- Database Mail
- COPY_ONLY native backup, URL-based backups

Managed Instance Additional Features

- Managed Instance Auditing
 - Tracks database events and writes them to an audit log in your Azure storage account
 - Helps maintain regulatory compliance, gain insight into discrepancies, and understand database activity
- Data encryption in motion
 - Uses Transport Layer Security to encrypt data in motion

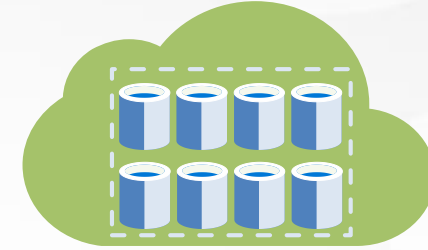
Monitoring Azure SQL Managed Instance



- Majority of SQL Server DMVs available
 - System Info and Feature Usage information
 - Instance and Database level configuration and performance
 - Data and Log Space Usage, tempdb
 - Wait statistics, sys.dm_exec_requests, sys.dm_exec_query_stats, virtual file stats, missing indexes, and more
 - Troubleshooting Information
 - Ring Buffer Information, Extended events, sys.dm_os_performance_counters
 - Azure SQL Database Managed Instance specific DMVs
 - sys.dm_feature_switches
 - sys.dm_cloud_database_resource_stats
 - sys.dm_cloud_database_wait_stats
 - sys.dm_db_resource_stats
 - sys.resource_stats_raw
 - sys.resource_usage
 - sys.dm_os_job_object
 - sys.dm_db_missing_index_group_stats_query
 - sys.dm_internal_resource_governor*
 - sys.dm_hadr_fabric*
 - *And more..*

What's Not Available

- OS Level Access
- Restarting SQL Service / Agent
- Provides Engine Only
- No MDS/DQS
- SSIS -> ADFv2
- SSRS -> VM or PBI
- Linked Servers (Only to SQL Server)
- DTC Across Instances
- Database Snapshots
- Database Maintenance Plans
- File Stream
- File Tables
- Extended Procs
- PolyBase
- Stretch Database
- Log Shipping
- AlwaysOn FCI or AGs
- Policy Based Management/MDW



References: SQL Database Features

Managed Instance: Technical Specs

- General Purpose service tier, business applications with typical performance and HA requirements
- Azure Premium remote storage up to 8TB
- Up to 100 databases per instance
- vCores: Gen 4: 8, 16, 24; Gen 5: 8, 16, 24, 32, 40, 64, 80
 - Processors Intel E5-2673 v3 (Haswell) 2.4 GHz
Intel E5-2673 v4 (Broadwell) 2.3 GHz
- Minimum storage 32GB Max storage 8TB
- Maximum database size 4TB
- IOPS 500-7,500 per data file, IOPS grow with storage size

Managed Instance: Technical Specs

- Business Critical service tier, business applications with high performance and HA requirements
- Azure Premium local storage up to 4TB
- Up to 100 databases per instance
- vCores: Gen 4: 8, 16, 24; Gen 5: 8, 16, 24, 32, 40, 64, 80
 - Processors Intel E5-2673 v3 (Haswell) 2.4 GHz
Intel E5-2673 v4 (Broadwell) 2.3 GHz
- Minimum storage 32GB Max storage 4TB
- Maximum database size 4TB
- Super fast storage
 - Reference:** <https://docs.microsoft.com/en-us/azure/sql-database/sql-database-managed-instance-resource-limits>
- Three secondary replicas for HA: read scale out replica plus two secondary replicas

Managed Instance: Pricing

- Azure Hybrid Benefit – convert on-premises license with SA to MI licenses
 - 8 Standard Edition licenses = 1 Managed Instance General Purpose (8 vCore)
 - 2 Enterprise licenses = 1 Managed Instance General Purpose (8 vCore)
 - <https://azure.microsoft.com/en-us/pricing/hybrid-benefit/>
 - Azure Hybrid Benefit for SQL Server provides SQL Server Enterprise Edition customers with Software Assurance four cores in the cloud for every one core they own on-premises when selecting the Managed Instance General Purpose option.

Managed Instance: Use Cases

- When you need more than singleton or elastic pools can provide, but still want a managed environment, features such as:
 - Cross database query
 - SQL Server Agent
 - Database Mail
 - Service Broker, and more
- Managed Instance GA pricing should be somewhat comparable with IaaS. For example, a D16 (16 vCPU, 64GB RAM) with three P40 disk is approx. \$3,348 while a Gen 4 (16 vCore, 112GB RAM) instance with 6TB of storage would be approx. \$3,109.88.
 - However, Managed Instance means you don't have to worry about patching the OS or SQL Server, and you have built in HA with a non-readable secondary. You have to build that out yourself in IaaS and pay for the compute.

Key Takeaways

- Azure SQL Database is a cost efficient database-as-a-service platform
- Elastic pools are a great option for using a pool of resources for larger groups of Azure SQL Databases to simplify management and save cost
- Managed Instance bridges the gap between on-premises SQL Server and Azure SQL Database offering instance level functionality
- Regardless of your platform, you are still responsible for index and statistics maintenance. Microsoft has stated publicly that they do various checks for corruption, but they also allow the customer to run DBCC CHECKDB so that is a choice you can make;
<https://azure.microsoft.com/en-us/blog/data-integrity-in-azure-sql-database/>

Summary

- What we covered
 - What is Platform as a Service (PaaS)?
 - Platform as a Service benefits
 - Azure SQL Database
 - Elastic Pools
 - Azure SQL Database Managed Instance
 - What sets Managed Instance apart?

Thank you!
tim@sqlskills.com
@tradney

