Azure SQL Database
Monitoring & Performance Tuning
Level 100

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Julie Koesmarno

MCSE Data Platform, MCSE Business Intelligence
SQL Server Age: 12 and still learning!
Speaker, Blogger (@MsSQLGirl)

Past: Microsoft Most Valuable Professional (MVP)
Technical Editor for Applied Business Intelligence
Data Wrangler, SQL/BI Consultant, Trainer

Now: Senior Program Manager at Microsoft (7 months)
Recently shipped Public Preview XEvents for Azure SQL DB

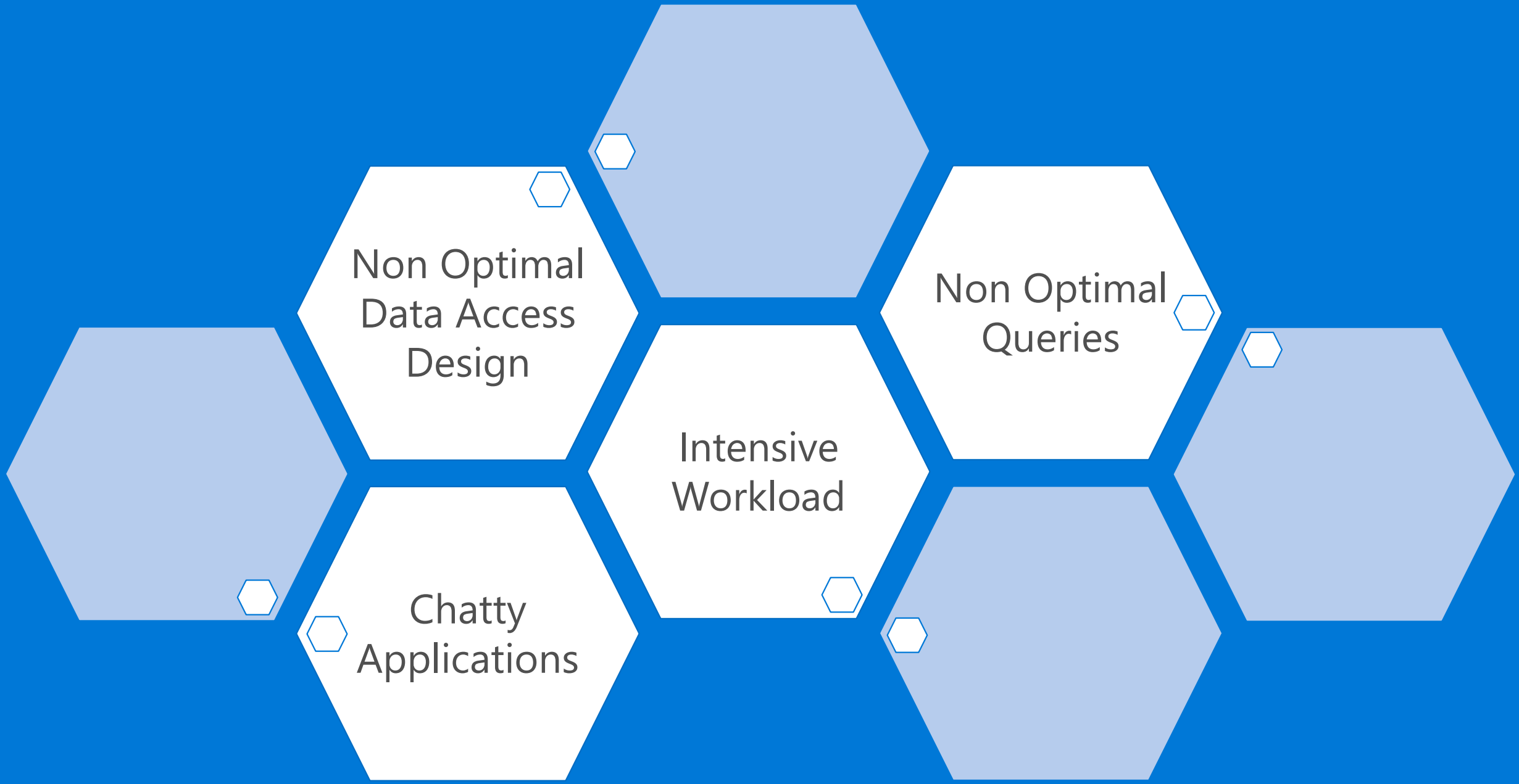
Agenda

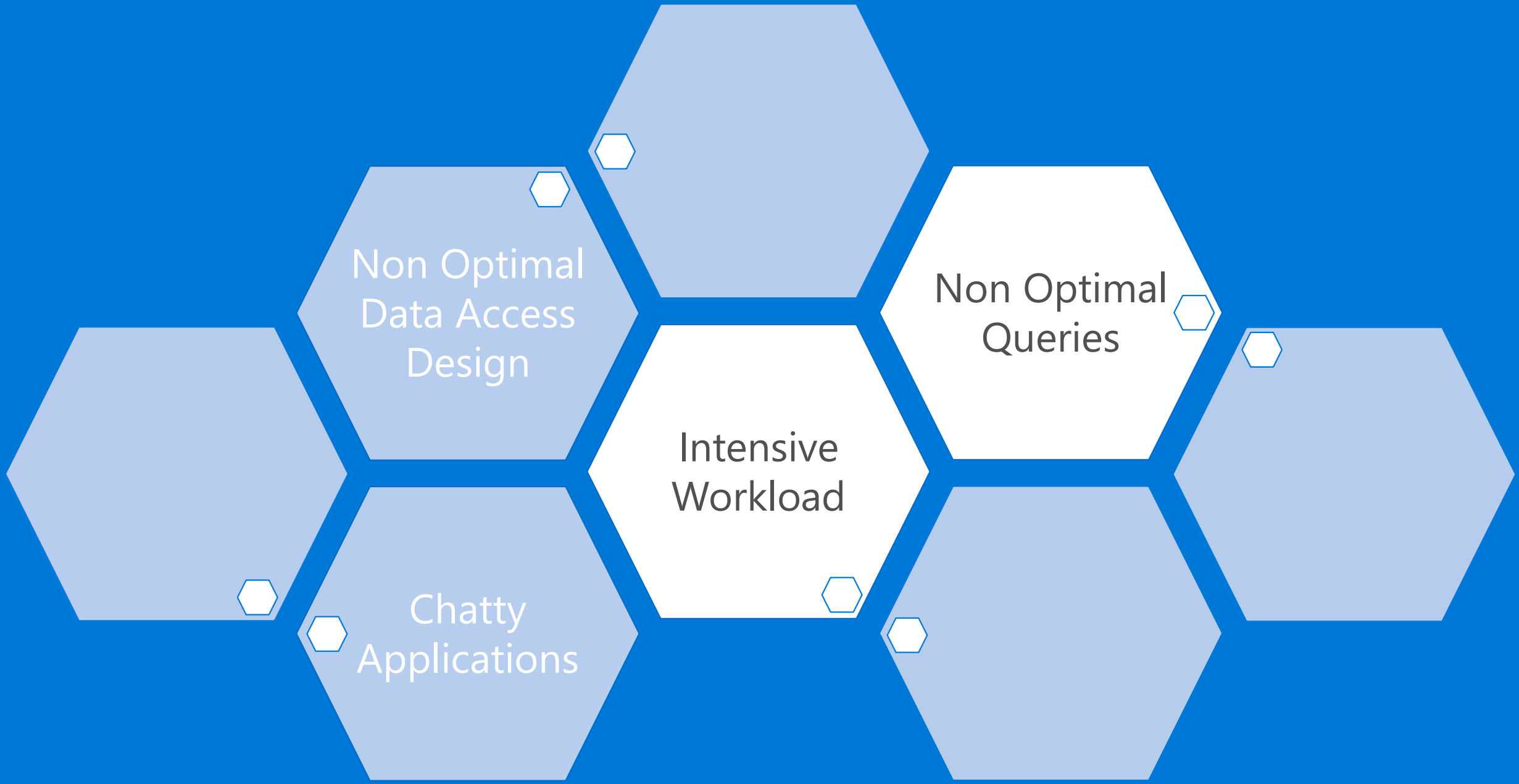
- Common Causes of Performance Issues
- Know your DTUs
- “Throw All The Hardware At It” vs “Fix The Code”

Common Causes

The Needs For Monitoring and Performance Tuning

- Common Causes of Performance Issues
- Know your DTUs
- "Throw All The Hardware At It" vs "Fix The Code"


Non Optimal Data Access Design
Non Optimal Queries
Intensive Workload
Chatty Applications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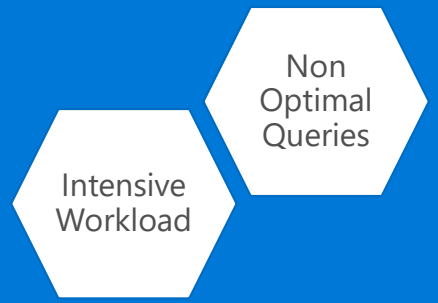


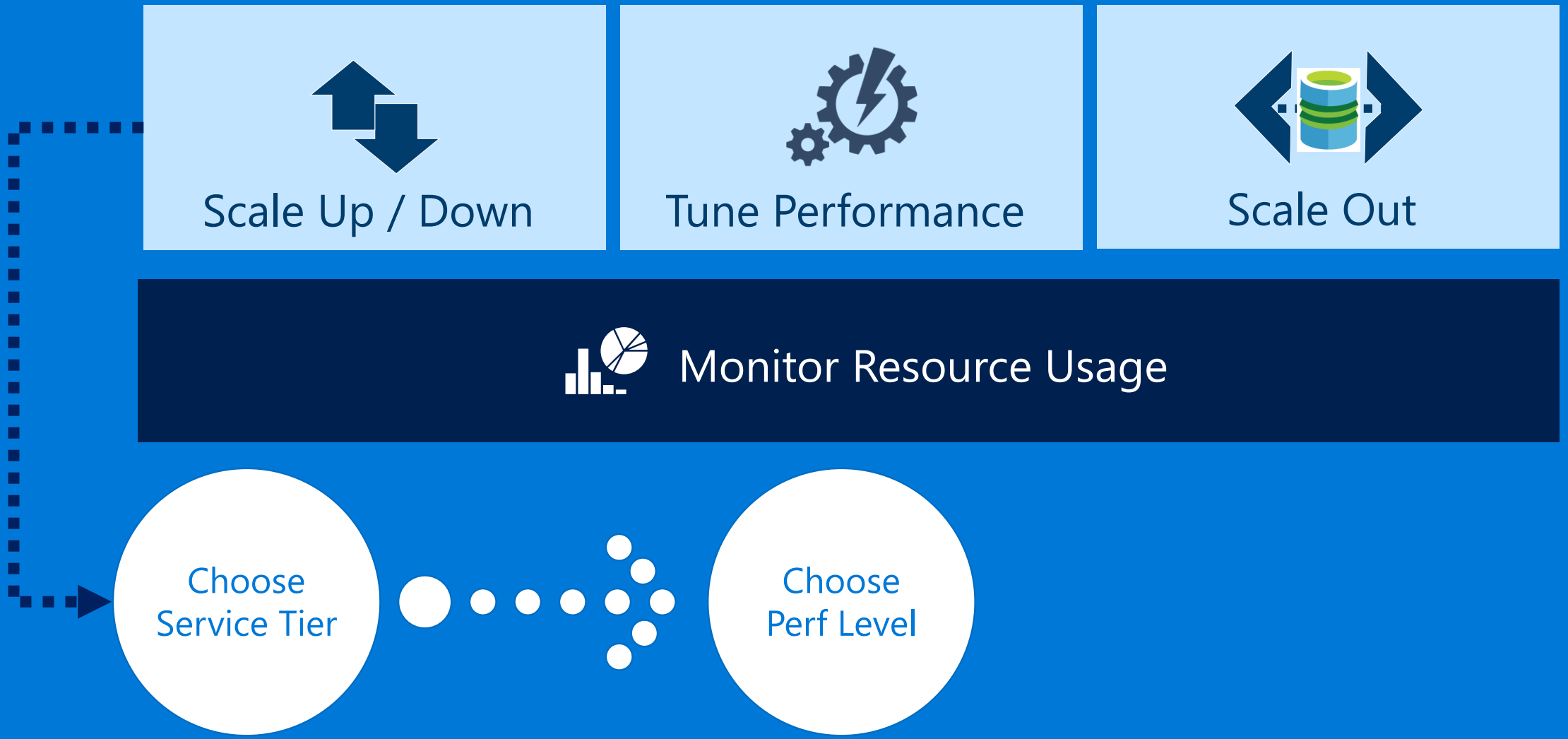
Size matters!

… so does monitoring it

Azure SQL DB Life Cycle

Non Optimal Queries

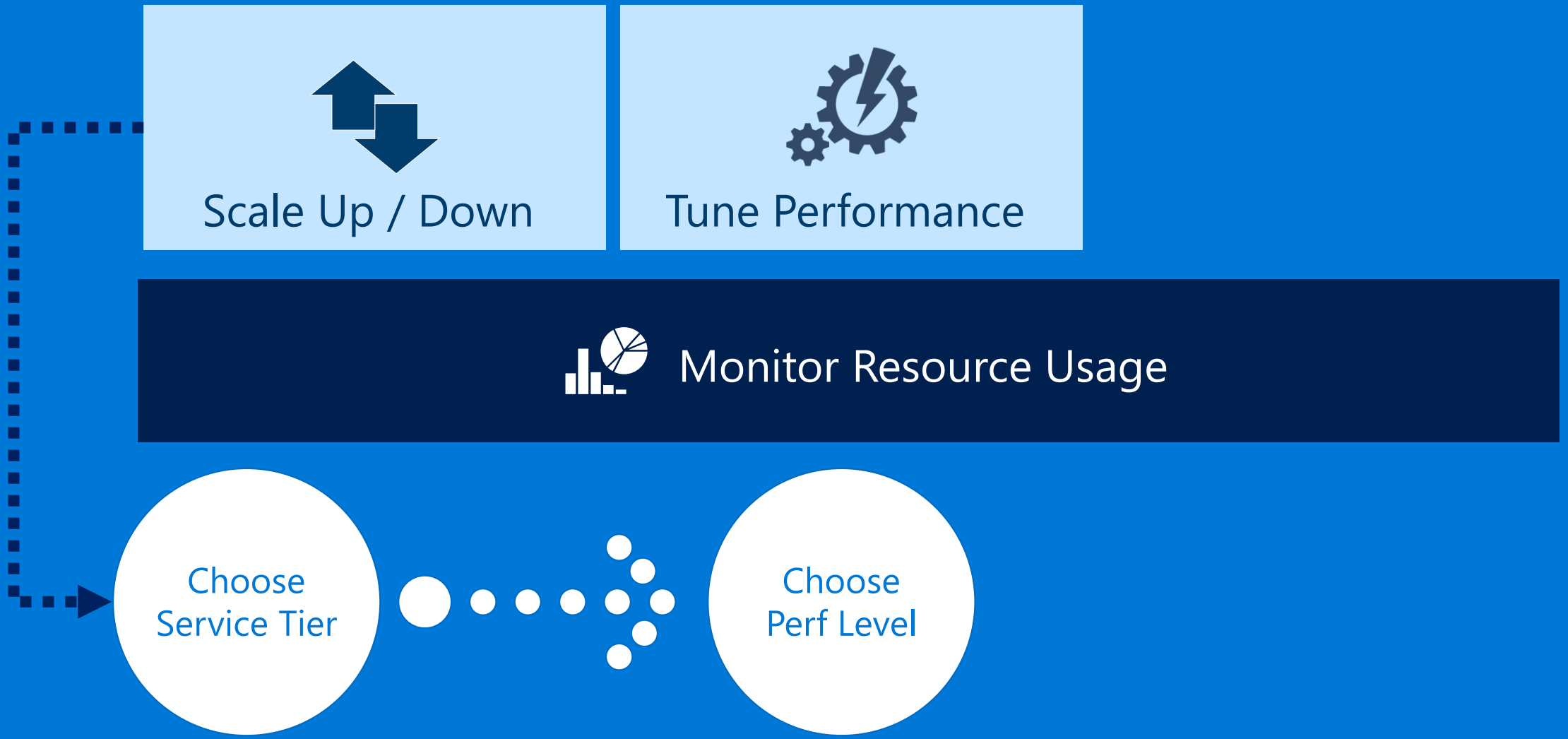
Intensive Workload



Scaling Up: Elastic Pool Life Cycle

Non Optimal Queries

Intensive Workload

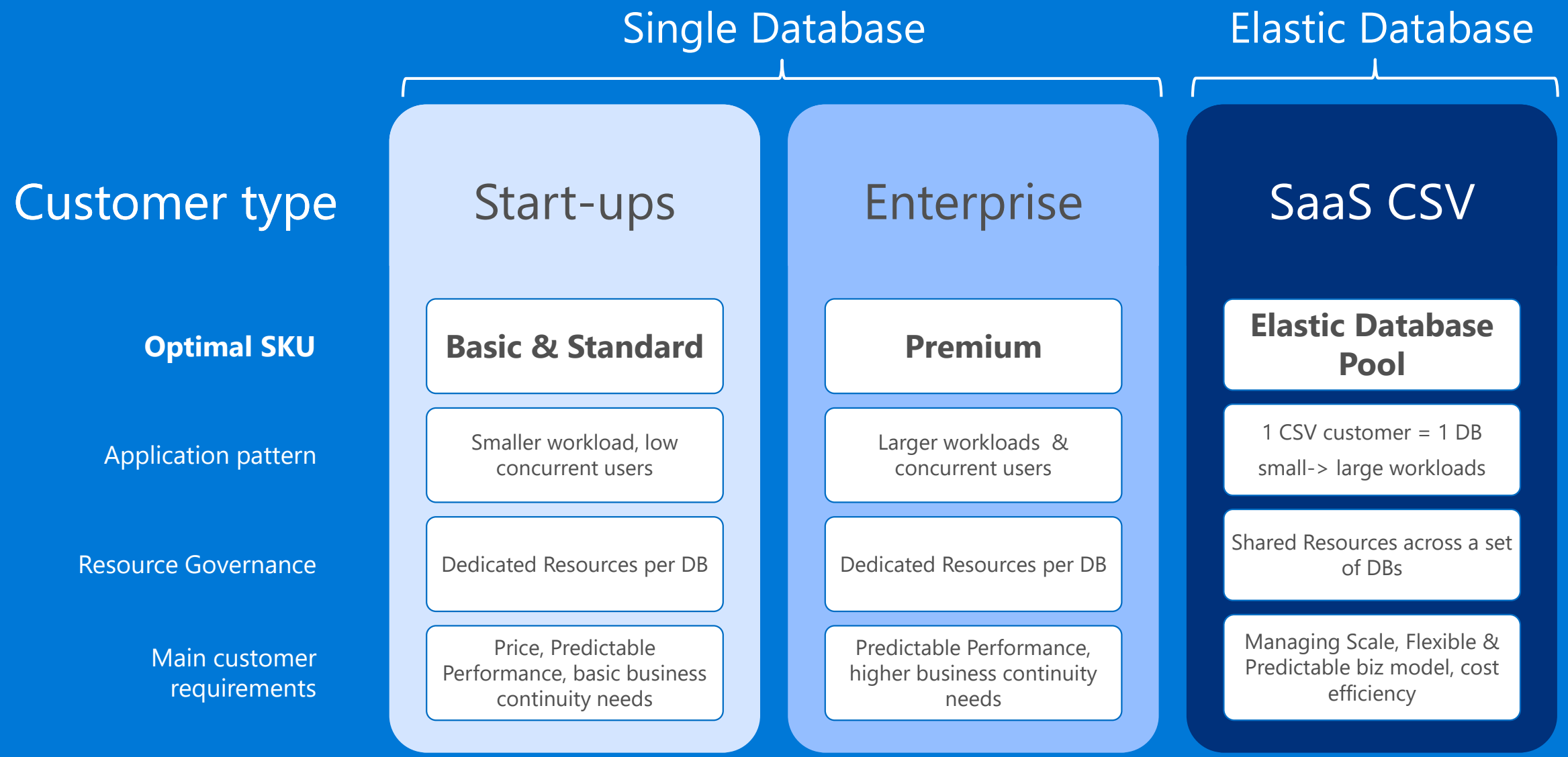


Size Does Matter!

Know your DTUs

- Common Causes of Performance Issues
- Know your DTUs
- “Throw All The Hardware At It” vs “Fix The Code”

Users, Needs & SKUs



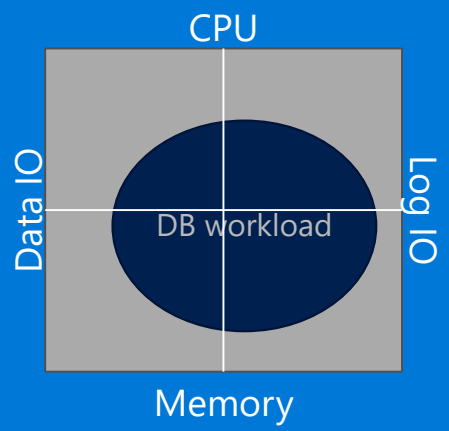
SQL DB Service tiers & Performance Levels

	Basic	Standard	Premium
Availability SLA	99.99%		
Security	Auditing		
Scalability	Elastic Scale, client-side scale out (preview)		
Point-in-time Restore	Any point within 7 days	Any point within 14 days	Any point within 35 days
Business Continuity	Geo-Restore	Standard Geo-Replication	Active Geo-Replication
Database Max Size	2 GB	250 GB	500 GB
Available performance levels Database Throughput Units (DTUs, eDTUs)	Basic: 5 Basic Elastic Pool : 100 -> 1200	S0: 10 S1: 20 S2: 50 S3: 100 Standard Elastic Pool: 100 ->1200	P1: 125 P2: 250 P4: 500 P6: 1000 P11: 1750 Premium Elastic Pool: 125->1500
SQL Server compat	**Near 100%**		

Choose a service tier that is right for your business requirements

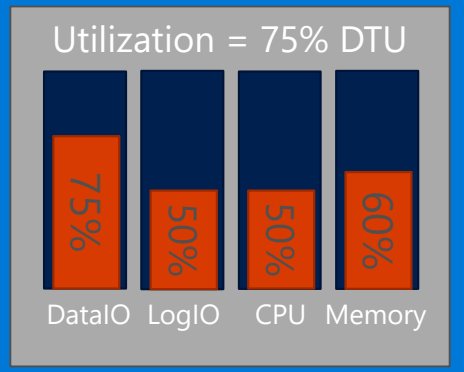
Database Throughput Unit – DTU/eDTU

Bounding Box



Monitoring

% of current Performance Level



- Database performance levels are measured with DTUs (eDTUs)
  - Represents the relative power (resources) assigned to a database
  - Allows for comparison of the power across performance levels
  - Abstraction from the underlying hardware
  - Blended measure of CPU, DataIO, LogIO and memory(indirect measure)

Understanding DTU measures

DTU = Max of (CPU, DataIO, LogIO) usage

- Indicator of the resource that is pushing towards the limit
- Expressed as a percentage of the limit.
  - e.g. 80% DTU usage = one or more of the underlying resources is consuming 80% of the limit.

What happens when DTU limit is hit?

- Latencies for the requests increase
  - Requests can timeout
- Requests can start piling up as new requests come in
  - Concurrent request limit for DB is reached. New requests get rejected with error

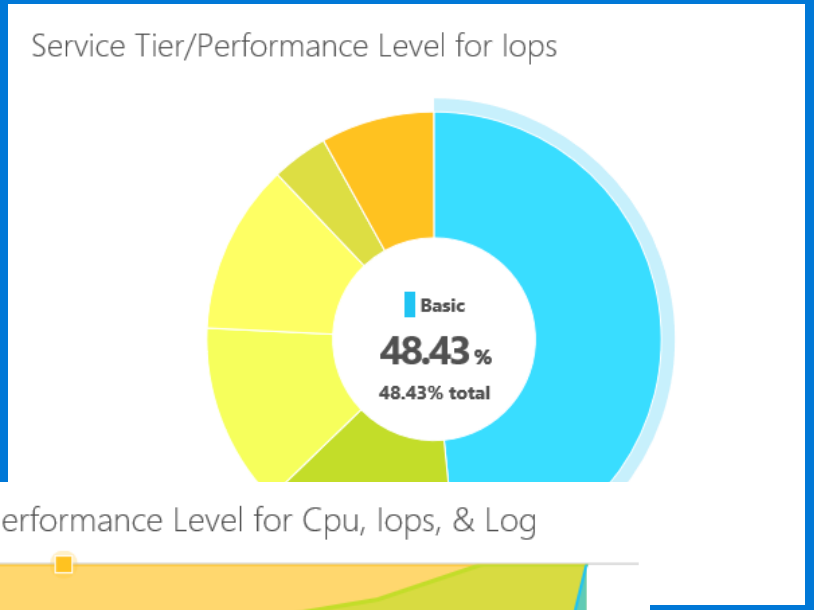
From On-Prem Workload to SQL DB DTU

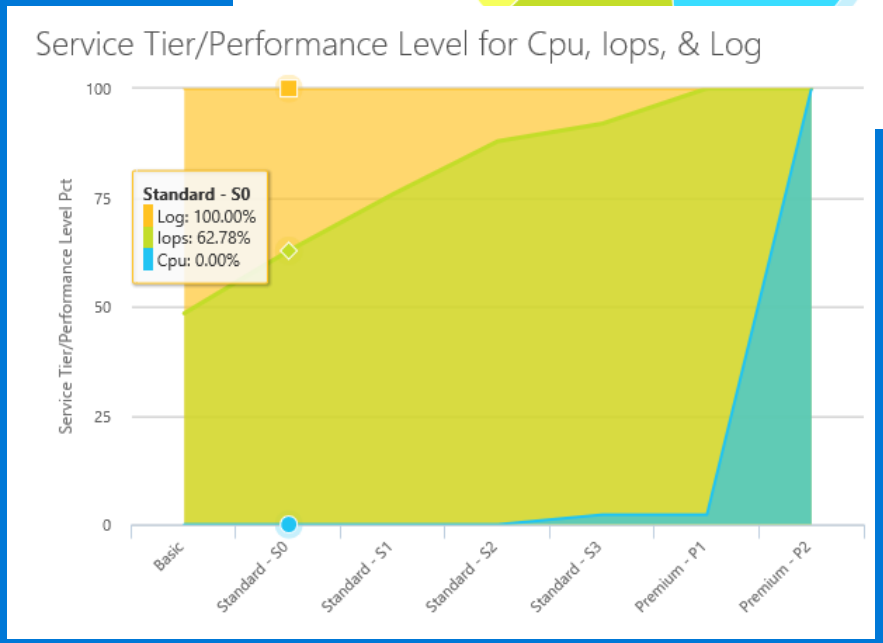
DTU Calculator

Estimates which Service Tier / Performance Level, based on

- Number of Cores
- Counters:
  - Total % Processor Time
  - Disk Reads/sec
  - Disk Read Bytes/Sec
  - Disk Write Bytes/sec
  - Database's Log Bytes / Sec

http://dtucalculator.azurewebsites.net/Home/Calculate





Scale Up

For Intensive Workload

- Common Causes of Performance Issues
- Know your DTUs
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Database Resource Monitoring

DTU, Storage consumption

- Can drill down to CPU, DataIO, LogIO consumptions
- Percentages relative to performance level

Accessible though Azure Portal

- Allows to configure alerting!

DMVs for T-SQL querying

- <Masterdb> sys.resource_stats
  - **Averages over 5 minutes, History up to 14 days**
- <userdb> sys.dm_db_resource_stats
  - **Averages over 15 seconds, Previous hour's data**

Other resources to keep track of

- Concurrent Requests, concurrent sessions

RecifeDB

SQL Database

Settings | Open in Visual ... | Copy | Restore | Export | Delete

Essentials

Resource group
demo-group

Status
Online

Location
Southeast Asia

Subscription name
Windows Azure Internal Consumption_548...

Subscription ID
d6e6bc0a-e1aa-46aa-b4ee-4c0200fdf67e

Server name
demo-pool-server.database.windows.net

Pricing tier
Elastic Premium

Elastic pool
PremiumPool

Server version
V12

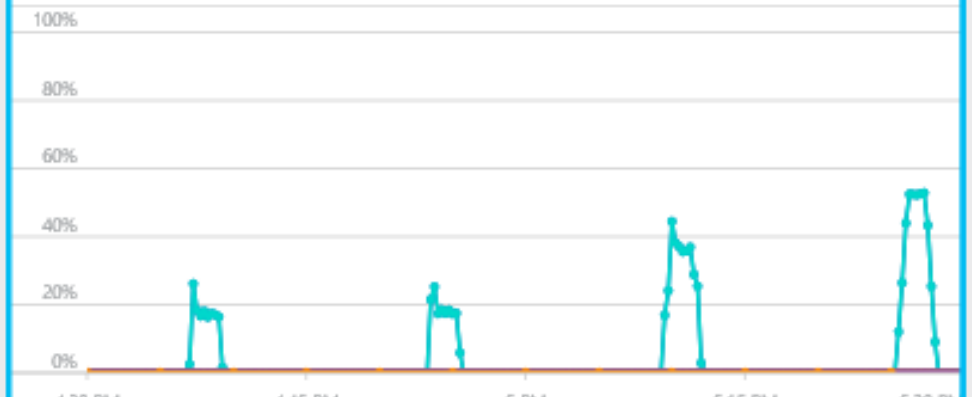
Connection strings
Show database connection strings

All settings →

Monitoring

CPU percentage, DTU percentage and 3 more metrics past hour

Edit

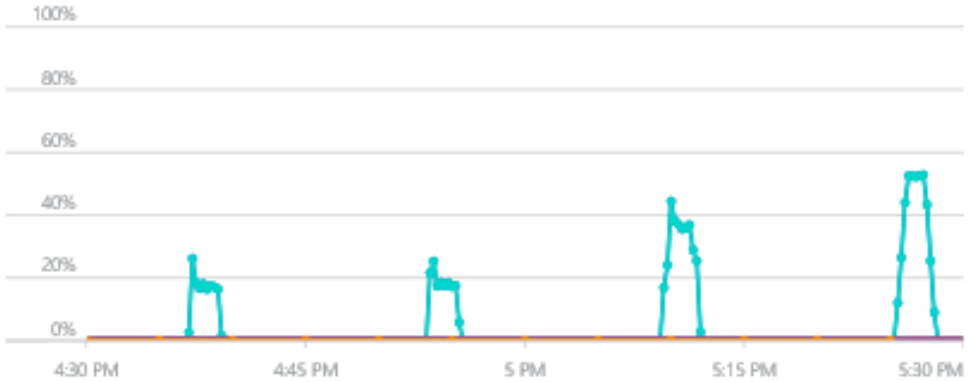


CPU PERCENTAGE 4.41 %
DTU PERCENTAGE 4.41 %
DATA IO PERCENTAGE 0 %
LOG IO PERCENTAGE 0 %

Metric

Add alert | Diagnostic settings | Edit chart

CPU percentage, DTU percentage and 3 more metrics past hour



CPU PERCENTAGE 4.41 %
DTU PERCENTAGE 4.41 %
DATA IO PERCENTAGE 0 %
LOG IO PERCENTAGE 0 %

METRIC	AVERAGE	MINIMUM	MAXIMUM	TOTAL
CPU percentage	4.41%	0%	52.85%	--
DTU percentage	4.41%	0%	52.85%	--
Data IO percenta...	0%	0%	0%	--
Log IO percentage	0%	0%	0%	--
Storage percenta...	0.15%	0.15%	0.15%	--

Alerts

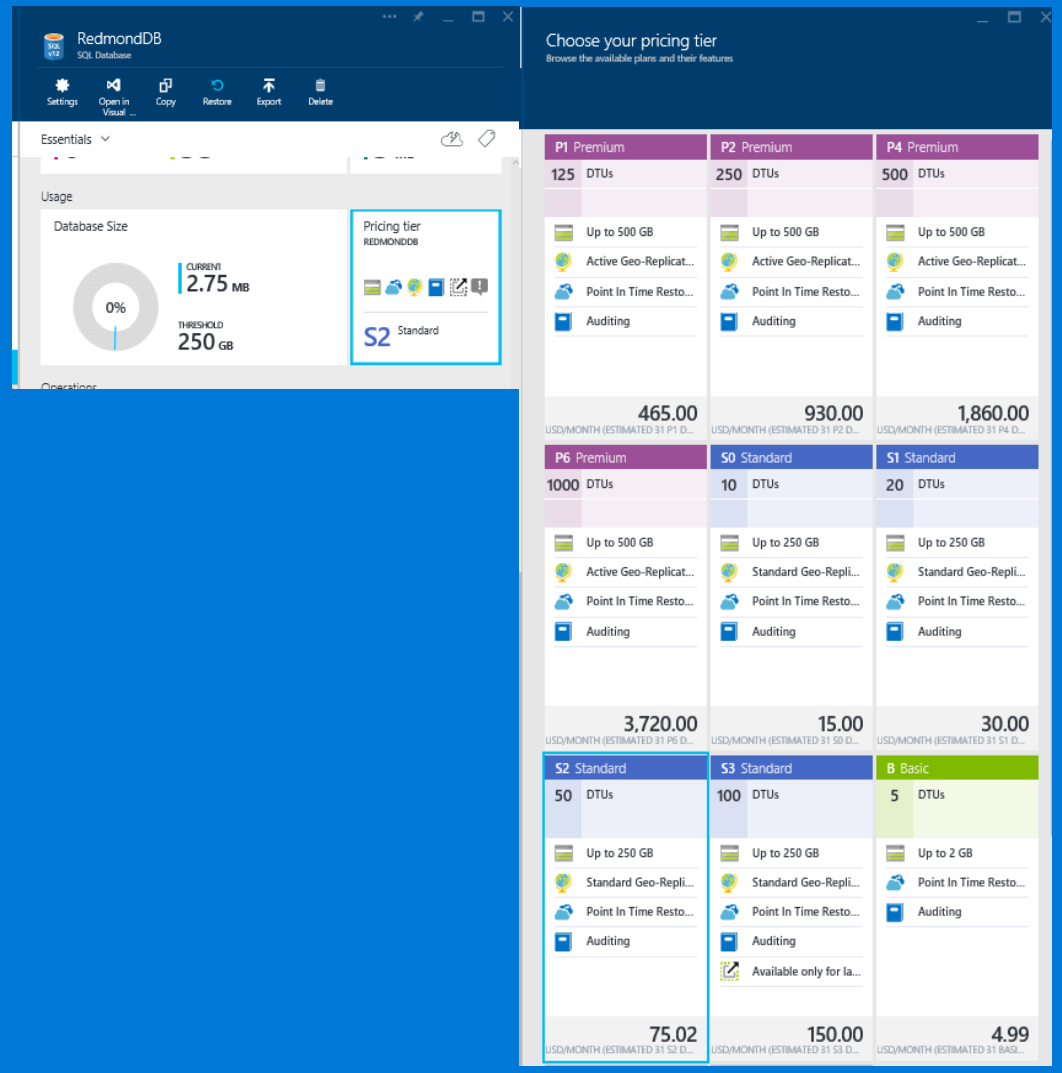
NAME	CONDITION	LAST ACTIVE

You haven't created any alert rules.

Changing database performance level

- Can be size of database operation
- Database is on-line during the change

- Can be accomplished through
  - Azure Portal
  - PowerShell - Set-AzureSqlDatabase
  - REST - Update Database / ServiceLevelObjectiveId
  - T-SQL
    - ALTER DATABASE … MODIFY (EDITION = …)



Scale Out

For Intensive Workload

- Common Causes of Performance Issues
- Know your DTUs
- "Throw All The Hardware At It" vs "Fix The Code"

Elastic database pool concepts

"Elastic database pool provides large scale SaaS CSVs a simple cost effective solution to achieve performance goals for a group of databases with widely varying and unpredictable usage patterns."

Resource allocation - Elastic Database throughput units (eDTUs)

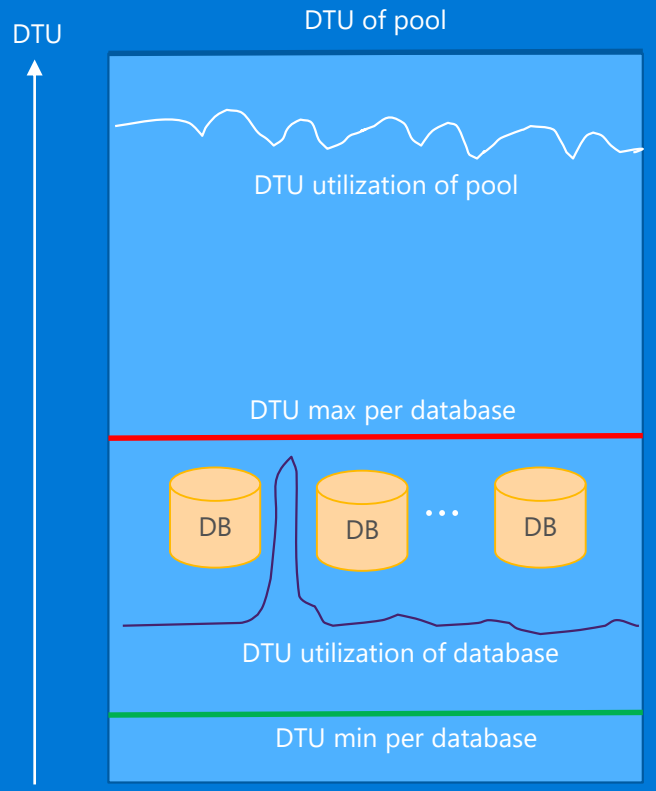
- Shared across databases in the pool
- Corresponds to the aggregate utilization of its concurrently active databases.
- Storage limit per pool is tied to the pool eDTU

Performance settings

- Choose eDTU for the pool.
- Choose eDTU max cap and min reserved for the databases.

Pricing

- Pay for eDTU of the pool.
- Pay for database existence.



Elastic Pools: Friction free scaling

Relationship of servers and pools

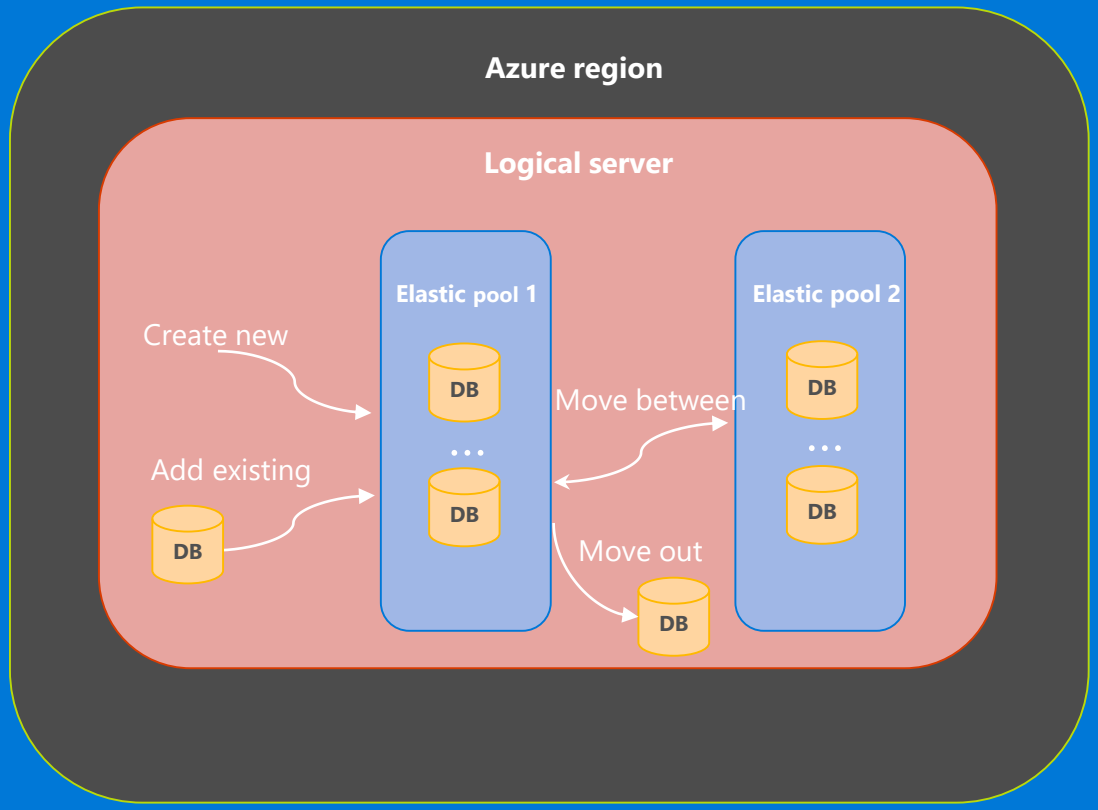
- A pool is contained by a single server.
- A server can contain multiple pools.

Setting performance goals is friction free

- Create new database in a pool
- Add/Move databases from a pool
- Resize a pool or its per database settings

Changing performance settings is online

- Portal, T-SQL, REST and Powershell APIs



Recommended Elastic database pools

SQL SERVER

Based on the current databases within your server, we would recommend creating these elastic database pools. Select the pool you'd like to create now

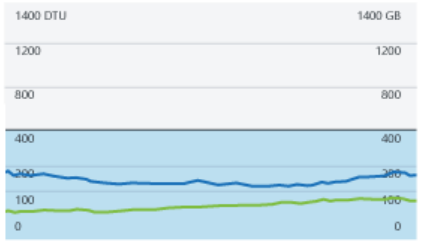
PRICING TIER	DATABASES	POOL EDTU	MONTH SAVINGS
Elastic Standard	30	400	XXX USD
Elastic Standard	27	400	XX USD
Elastic Premium	20	700	X USD

Elastic database pool

NAME

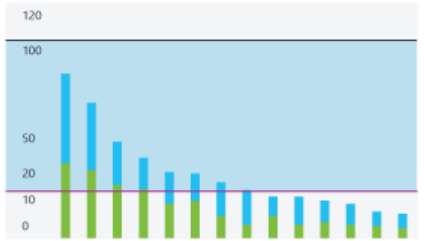
RecommendedStandardPool1

Elastic Pool Settings



POOL EDTU 400 | POOL GB 400 | EDTU UTIL 0 | GB UTIL 0

Elastic database settings



EDTU MIN 10 | EDTU MAX 100 | EDTU AVG 0 | EDTU PEAK 0

DATABASE COST	$10 X 30 DBs = $300.00
EDTU COST	$2.00 X 400 EDTU = $800.00
TOTAL COST	$1100.00 USD/MONTH (ESTIMATED 30 DAYS)

Databases

Search by database name

NAME	PRICING TIER	PEAK DTU	AVG DTU	RECOMMENDED
Retail_122	Standard S1	XX	XX	Yes
Retail_111	Standard S1	XX	XX	Yes
Retail_059	Standard S1	XX	XX	Yes
Retail_235	Standard S1	XX	XX	Yes
Retail_200	Standard S1	XX	XX	Yes
Retail_099	Standard S1	XX	XX	Yes
Retail_152	Standard S1	XX	XX	Yes
Retail_212	Standard S1	XX	XX	Yes
Retail_103	Standard S1	XX	XX	Yes
Retail_065	Standard S1	XX	XX	Yes
Retail_010	Standard S1	XX	XX	Yes
Retail_054	Standard S1	XX	XX	Yes
Retail_168	Standard S1	XX	XX	Yes
Retail_261	Standard S1	XX	XX	Yes
Retail_021	Standard S1	XX	XX	Yes

Add part to start board

Create

Index Advisor

For Non-Optimal Queries

- Common Causes of Performance Issues
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NEW
HOME
BROWSE ALL
NOTIFICATIONS
ACTIVE
BILLING

ONLINE

AdventureWorks2012

SQL Database

Settings | Open in Visual ... | Copy | Restore | Export | Delete

Essentials

Usage

Database Size

CURRENT
94.38 MB

THRESHOLD
250 GB

Pricing tier

ADVENTUREWORKS2012

S0 Standard

Operations

Auditing

Enable and setup Auditing

Events

Alert rules

0

Active now	0
Enabled	0

Dynamic Data Masking (preview)

Index advisor

5 new index recommendations

Creating	1
Completed	2

Geo Replication

Configure Geo-Replication

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0.04%

CURRENT 94.38 MB

THRESHOLD 250 GB

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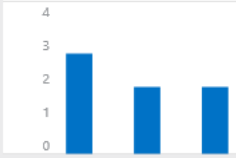

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Recommended indexes

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HIGH IMPACT	Table3	[Col7], [Col9]	05/13/2015 16:58:59
HIGH IMPACT	[Action]	[user_id], [action_id],	07/08/2015 17:36:32
SUBSTANTIAL IMPACT	[UserProfile]	[user_profile_id], [user_id], [user_picture]	07/08/2015 17:20:49
MODERATE IMPACT	Table5	Col3, Col1, Col4, Col11	01/15/2015 15:32:29
LOW IMPACT	[UserInfo]	[user_id],	07/08/2015 17:20:09

View discarded index recommendations (0)

Index operations

STATUS	TABLE	INDEXED COLUMNS	CREATED TIME
Verifying	[SalesOrderDetail]	[SpecialOfferId], [OrderQty], [UnitPrice], [UnitPriceDiscount]	03/23/2015 20:36:14
Reverted	users	surname, name, age	07/08/2015 14:03:32
Success	Person	[FirstName], [LastName], [MiddleName], [Suffix]	02/03/2015 15:29:08

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Index details
dbo.Table3

Create index | Discard index | View script

Use Create Index command to schedule index creation by the service. Index creation process typically takes about 48 hours. Upon index creation we measure the performance impact of the index, provide reports and revert index automatically. Learn more

Estimated impact

IMPACT
HIGH IMPACT

SPACE USAGE INCREASE
10.31 MB

INDEX CREATION DURATION
00:00:15

Index details

INDEX KEY COLUMNS (1)

[Col7]

INCLUDED COLUMNS (1)

[Col9]

ndations

	INDEXED COLUMNS	CREATED TIME
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[Col9]

View script

```
1 CREATE NONCLUSTERED INDEX [[nci_wi_Table3_94A1F1FC-AEDE-40B1-9A9F-68ED3DCFB53D]]] ON dbo.Table3
  ([Col7]) INCLUDE ([Col9]) WITH (ONLINE = ON)
```

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dbo.Table3

Create index | Discard index | View script

You have chosen to create an index...
Submit create index request?

Yes | No

reports and revert index automatically. Learn more

Estimated impact

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HIGH IMPACT

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10.31 MB

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00:00:15

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[Col7]

INCLUDED COLUMNS (1)

[Col9]

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AdventureWorks2012
SQL Database

Settings | Open in Visual ... | Copy | Restore | Export | Delete

Essentials

Usage

Database Size

0.04%

CURRENT 94.38 MB

THRESHOLD 250 GB

Pricing tier
ADVENTUREWORKS2012

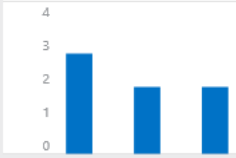
S0 Standard

Operations

Auditing

Enable and setup Auditing

Events



Alert rules

0

Active now	0
Enabled	0

Dynamic Data Masking (preview)

Index advisor

4 new index recommendations

Creating	2
Completed	2

Geo Replication

Configure Geo-Replication

Index recommendations
AdventureWorks2012

Feedback

Recommended indexes

IMPACT	TABLE	INDEXED COLUMNS	CREATED TIME
HIGH IMPACT	[Action]	[user_id], [action_id],	07/08/2015 17:36:32
SUBSTANTIAL IMPACT	[UserProfile]	[user_profile_id], [user_id], [user_picture]	07/08/2015 17:20:49
MODERATE IMPACT	Table5	Col3, Col1, Col4, Col11	01/15/2015 15:32:29
LOW IMPACT	[UserInfo]	[user_id],	07/08/2015 17:20:09

View discarded index recommendations (0)

Index operations

STATUS	TABLE	INDEXED COLUMNS	CREATED TIME
Pending	Table3	[Col7], [Col9]	07/29/2015 17:53:27
Verifying	[SalesOrderDetail]	[SpecialOfferId], [OrderQty], [UnitPrice], [UnitPriceDiscount]	03/23/2015 20:36:14
Reverted	users	surname, name, age	07/08/2015 14:03:32
Success	Person	[FirstName], [LastName], [MiddleName], [Suffix]	02/03/2015 15:29:08

Vladimir Ivanovic
MICROSOFT

NEW
HOME
BROWSE ALL
NOTIFICATIONS
ACTIVE
BILLING

ONLINE

AdventureWorks2012
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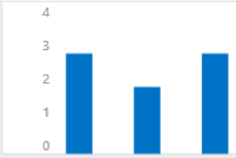

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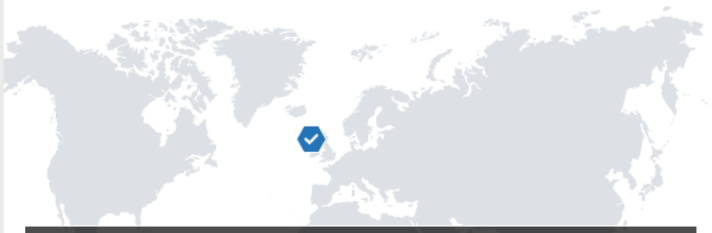

Configure Geo-Replication

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Success	Person	[FirstName], [LastName], [MiddleName], [Suffix]	02/03/2015 15:29:08

Index details
Person.Person

Remove index | View script

STATUS
Success

Actual impact

REPORTED SPACE USAGE INCREASE
21.81 MB

DURATION OF INDEX CREATION
01:20:00

IMPROVED QUERIES COUNT
2

REGRESSED QUERIES COUNT
0

DIFFERENCE IN DTU UTILIZATION
-0.39 (42.22%) DTU

Index details

INDEX KEY COLUMNS (2)

[FirstName]

[LastName]

INCLUDED COLUMNS (2)

[MiddleName]

[Suffix]

Index Advisor

Query Store

For Non-Optimal Queries

- Common Causes of Performance Issues
- Know your DTUs
- "Throw All The Hardware At It" vs "Fix The Code"

When performance is not good…

Web site is down

Database is not working

Temporary perf. issues

Impossible to predict / root cause

DB upgraded

Regression caused by new bits

Plan choice change can cause these problems

Query Store

Query Store is a "flight data recorder" for DB workload

- Database level feature. Records data in user database
- In preview for Azure SQL Database

Accumulates history and statistics about each query

- Includes query plans, resource consumption and run-time statistics

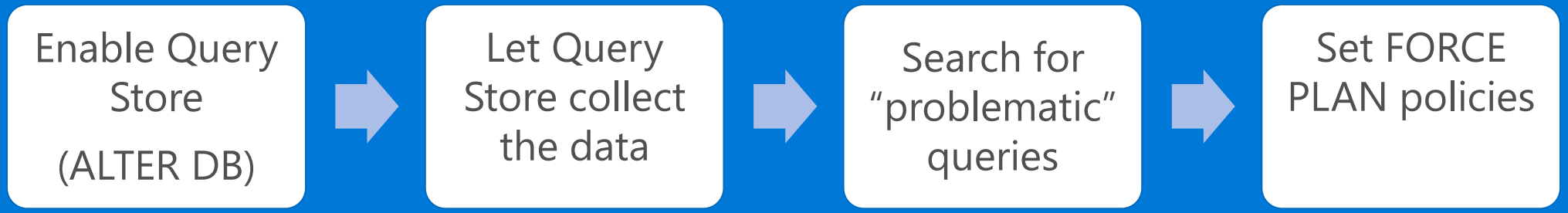
Greatly simplifies query performance troubleshooting

- Insights into plan changes, resource consumption
- Allows forcing a specific plan

Use of T-sql to enable query store

- ALTER DATABASE AdventureWorks SET QUERY_STORE = ON;
- Query stats are stored in user DB. Access through built-in views and stored procedures

Query Store - Performance Troubleshooting



Use of T-sql to enable query store

```
ALTER DATABASE AdventureWorks SET QUERY_STORE = ON;
```

Stored procedures plan forcing and other operations

```
EXEC sp_query_store_force_plan @query_id = 48, @plan_id = 49;
```

MSDN documentation has example queries used for performance troubleshooting

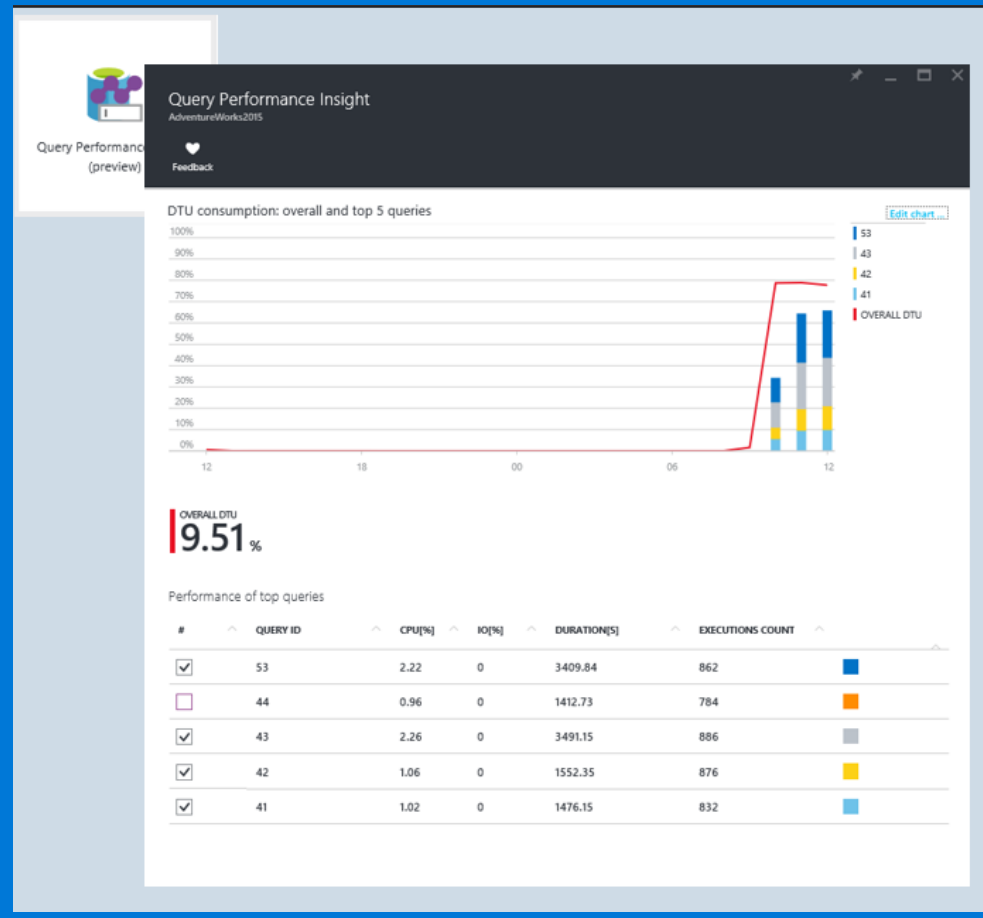
Query Performance Insight

For Non-Optimal Queries

- Common Causes of Performance Issues
- Know your DTUs
- "Throw All The Hardware At It" vs "Fix The Code"

Query Performance Insight (in Preview)

- Get Insight into resource consumption
  - Understand “Where my DTUs are being spent?”
  - Drill down and identify top resource consuming queries
    - Get DTU consumption by top consuming queries
    - Get Query Metrics
    - Get Query Text
- Portal based interactive experience
- Programmatic access through REST API



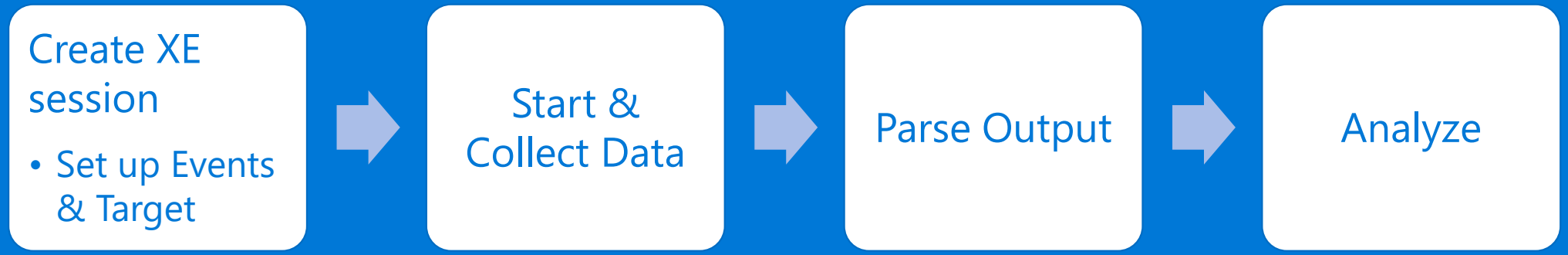
Extended Events

For Non-Optimal Queries

- Common Causes of Performance Issues
- Know your DTUs
- "Throw All The Hardware At It" vs "Fix The Code"

Extended Events (XEvents)

- General event handling system
- Non-intrusive way of monitoring
- Database scoped
- Public Preview in Azure SQL DB (exists in SQL Server since 2008)
  - **Use the latest SQL Server 2016 SSMS:**
    https://msdn.microsoft.com/en-us/library/mt238290.aspx



Events, Targets & DMVs available for SQL DB

- Events
  - wait_info
  - sql_statement_starting
  - sql_statement_completed
  - **error_reported**
  - fulltextlog_written
  - login / logout
  - missing_column_statistics
  - missing_join_predicate

… many more (~40 events supported in Public Preview)

Full list can be queried through DMV

```
SELECT * FROM sys.dm_xe_objects
WHERE object_type ='event'
```

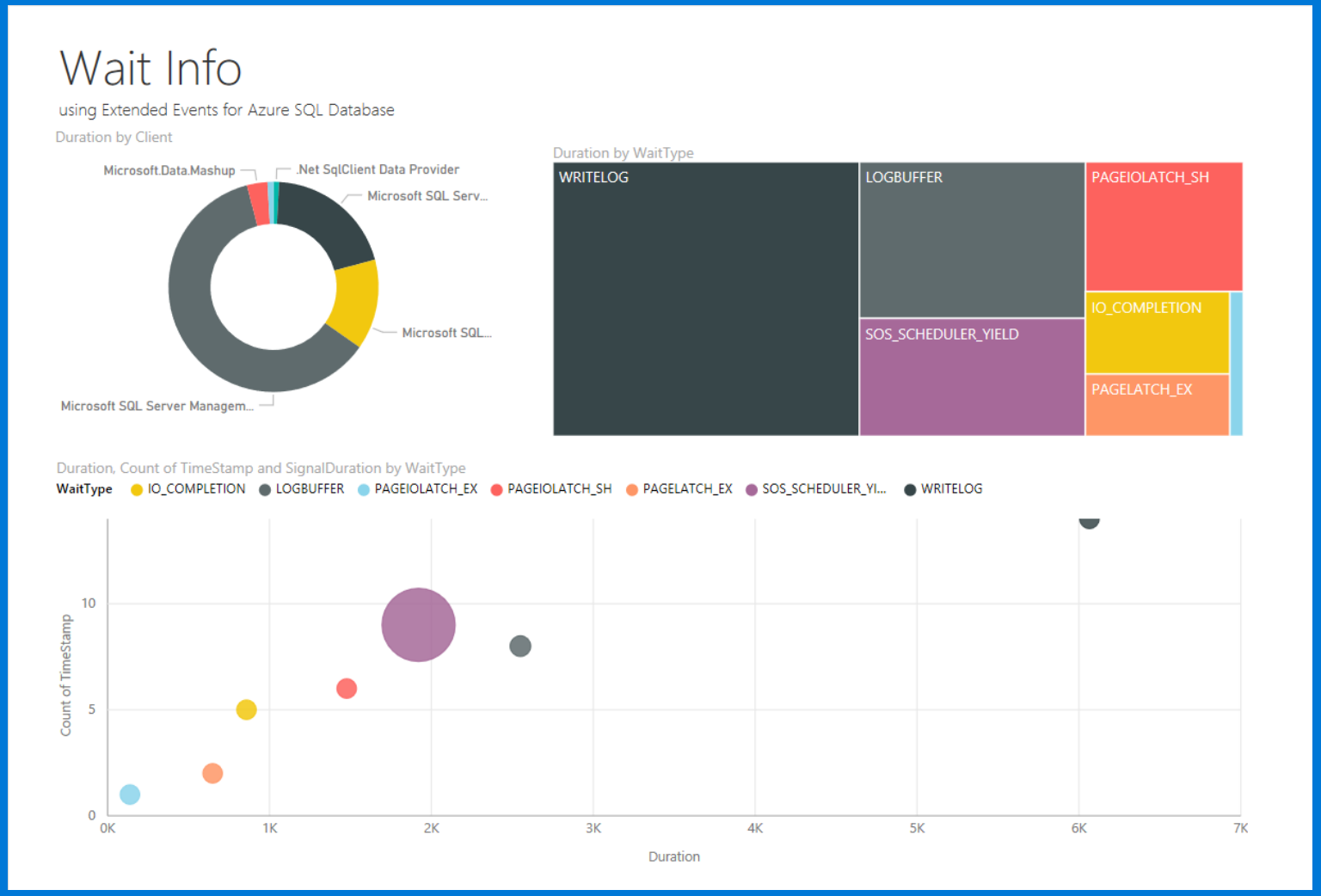
- Targets
  - Ring Bufffer
  - Event Counter
  - Azure Blob Storage

- Useful DMVs
  - sys.dm_xe_database_sessions
  - sys.dm_xe_database_session_events
  - sys.dm_xe_database_session_event_actions
  - ….

Examples of XEvents based reporting

More ideas on how to consume XEL blob file: Using Extended Events on Azure SQL Database

http://www.mssqlgirl.com/using-extended-events-on-azure-sql-database.html



DMVs

For Non-Optimal Queries

- Common Causes of Performance Issues
- Know your DTUs
- "Throw All The Hardware At It" vs "Fix The Code"

Dynamic Management Views (DMVs)

- DMVs are database-scoped
- Most SQL Server DMVs are exposed in SQL Database also
- Real-time troubleshooting of certain conditions is not possible
- Lots of on-line resources from SQL community for troubleshooting

Session Related DMVs

DMV	Scenario
sys.dm_exec_connections	Active connections to the database
sys.dm_exec_sessions	Active sessions to the database
sys.dm_exec_requests	Active requests to the database

Transaction Related DMVs

DMV	Scenario
sys.dm_tran_active_transactions	Active user transactions to the database
sys.dm_tran_database_transactions	Active transactions in the database
sys.dm_tran_session_transactions	Active transactions in the session

Execution Related DMVs

DMV	Scenario
sys.dm_db_missing_index_details	Missing indexes that would increase the query performance.
sys.dm_db_missing_index_columns	Missing table columns for a given index.
sys.dm_db_missing_index_groups	Missing indexes are contained in a specific missing index group, excluding spatial indexes.
sys.dm_db_missing_index_group_stats	Groups of missing indexes, excluding spatial indexes.
sys.dm_db_index_usage_stats	Information about the usage of an index.
sys.dm_db_index_physical_stats	Information about the physical layout for a given index (space consumption etc).
sys.dm_db_index_operational_stats	Information about the performance for a given index.
sys.dm_exec_procedure_stats	Usage of stored procedures in the database.
sys.dm_exec_trigger_stats	Usage of triggers in the database.
sys.dm_exec_query_memory_grants	Queries waiting for memory before they can be executed.
sys.dm_exec_cached_plans	Execution plans that are currently in the case.
sys.dm_db_partition_stats	Information about the storage of tables/indexes
sys.dm_db_wait_stats	Waits in the database (new DMV specific to SQL Database)
sys.dm_tran_locks	Active locks in the database

3rd Party Support

3rd Party Tool (Beta – to be announced late Jan 2016)

Azure SQL Dashboard

Top SQL

Event Manager Calendar

Checkpoints

- Common Causes of Performance Issues
- Know your DTUs
- “Throw All The Hardware At It” vs “Fix The Code”

Session Take-aways

Know your requirements – Match the size accordingly

2 common causes for Performance Issues:

- Intensive Workload:
  - Scale Up – choose the right SKU
  - Scale Out – sharding, elastic pools, elastic jobs
- Non-optimal queries - Use Monitoring & diagnostic tools
  - Index Advisor
  - Query Store
  - Query Performance Insights
  - Extended Events
  - DMVs

you cannot optimize
what you don’t measure

Reference

Scale Up/Down:

- Elastic Pool Reference - http://bit.ly/1MV2Gc3

Performance Tuning

- Index Advisor - http://bit.ly/1HikabH

Monitoring

- Query Store - http://bit.ly/1QXpiaX
- Query Performance Insight - http://bit.ly/1QXpiaX
- Extended Events in SQL Database - http://bit.ly/1L8dPUn
- Using XEvents on Azure SQL Database - http://bit.ly/1jW7q5p
- SQL Database Monitoring with DMVs - http://bit.ly/1MV2d9x

DTU Calculator: http://dtucalculator.azurewebsites.net/Home/Calculate

We want to hear from you!

Contact me –
jukoesma@Microsoft.com

thank you