

Azure SQL Data Warehouse

Overview



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Agenda

Data Warehousing Solutions

Azure SQL Data Warehouse

Any Size, Any Data

Massive Parallel Processing Concepts

Table Geometries

Azure Portal



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Agenda

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Agenda

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Microsoft Data Warehousing Solutions

SQL Server	Analytics Platform System	Azure SQL Data Warehouse
Scalable and reliable symmetric multiprocessing (SMP) and non unified memory architecture (NUMA) platforms for data warehousing on any hardware	Appliance for high-end massively parallel processing (MPP) data warehousing, on premises	Cloud Data Warehouse for high-end massively parallel processing (MPP) data warehousing
Ideal for data marts or small to mid-sized enterprise data warehouses (EDWs)	Ideal for high-scale or high-performance data marts and EDWs	Ideal for high-scale or high-performance data marts and EDWs in the Cloud
Software only	Data warehouse appliance (fully-integrated software and hardware)	Full Cloud Service from Microsoft in the Microsoft Cloud (PaaS)
10s of TB	10s of TB – 6 PB (PDW – compressed) 24 TB – 1.2 PB (Hadoop – uncompr.)	10s of GB – PBs (compressed)

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To tap into these new opportunities, needed for a modern business analytics platform, a platform that delivers the following:

1. The ability to project the experiences for applications and data to the complete range of form factors in an appropriate and rich way delivers new insights to all users via familiar tools, wherever they are – and on nearly any device. And delivered as part of your productivity suite so that you can empower all users with self-service capabilities through familiar tools designed with new user expectations in mind.
2. New capabilities in how you discover, combine, and collaborate with your data and the world's data to harnesses the power of all data. Where information is delivered to you based on who you are, who you're with, where you are and what you're doing. Bringing the right data, to the right person, at the right time to make the right decision.
3. Finally, a modern business analytics platform must embrace the new scope, new scale, and new diversity of the data to really be in a position to manage and process any data of any size, Big Data and Small Data. Fully embracing the cloud to be able to do this anywhere, whether it be in my data center, a private cloud, or in the public cloud. This is what we mean by Any Data, Any Size, Anywhere.

This is the Microsoft strategy to help Microsoft's customers maximize their business opportunities and Microsoft is confident there is no other vendor in the industry with the vision or the assets necessary to deliver on it.

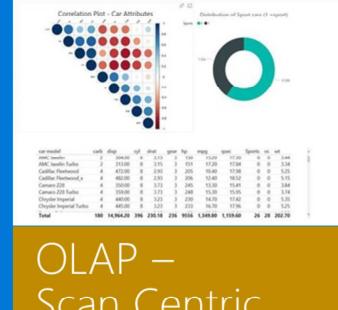
DBMS - Use Cases



OLTP – Seek Centric Workloads



ODS – KPI Dashboards



OLAP – Scan Centric Workloads



Big Data – Unstructured Data

SQL Server SMP

Analytics Platform System

Azure SQL Data Warehouse

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The location, degree of overlap of the product boxes at the bottom are subjective.

Key Points:

The MPP DWH engine doesn't work well in the seek-centric OLTP space, or on small data sets

SMP has trouble with larger scan-centric workloads or massive volumes of data

DMBS (Database Management System)

OLTP (Online Transaction Processing)

ODS (Operational Data Store)

KPI (Key Performance Indicators)

SMP (Symmetric Multiprocessing)

OLAP (Online Analytical Processing)

Agenda

Data Warehousing Solutions

Azure SQL Data Warehouse

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Table Geometries

Azure Portal



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Azure SQL Data Warehouse (SQL DW)

What is it?

Multi-tenant, cloud-based data warehouse 'Platform as a Service' offering which elastically scales on demand.

Advantages

Separates storage and compute for elastic scale requirements regardless of data volume.
Enables pause\resume approach for ad-hoc workloads

Disadvantages

On-going maturity enhancement.
Slightly different codebase support compared to APS and SQL Server.
Different architecture to APS but shares same MPP Engine.
It is for that reason not 'APS in the cloud'.

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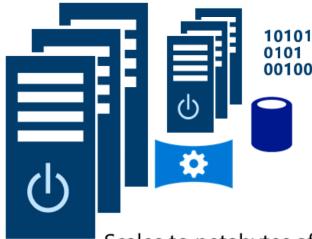
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<https://azure.microsoft.com/en-us/services/sql-data-warehouse/>

What is "Azure SQL Data Warehouse"

A relational data warehouse-as-a-service (PaaS), fully managed by Microsoft.
Industries first elastic cloud data warehouse with enterprise-grade capabilities.
Support your smallest to your largest data storage needs while handling queries up to 100x faster.

Elastic scale & performance



Scales to petabytes of data

Massively Parallel Processing

Instant-on compute scales in seconds

Query Relational / Non-Relational



Powered by the Cloud

Get started in minutes

Integrated with Azure ML, PowerBI & ADF

Enterprise Ready



Market Leading Price & Performance



Simple billing compute & storage

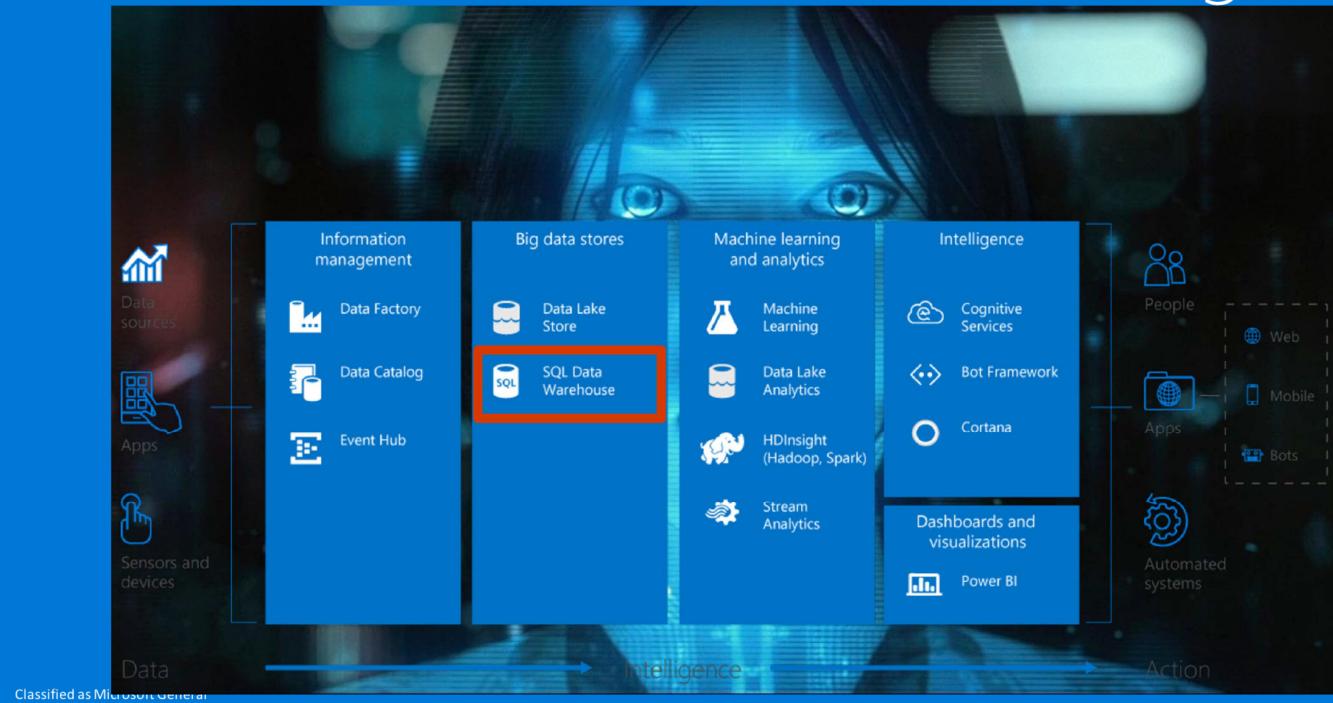
Pay for what you need, when you need it with dynamic pause

Bring DW to the Cloud without rewriting

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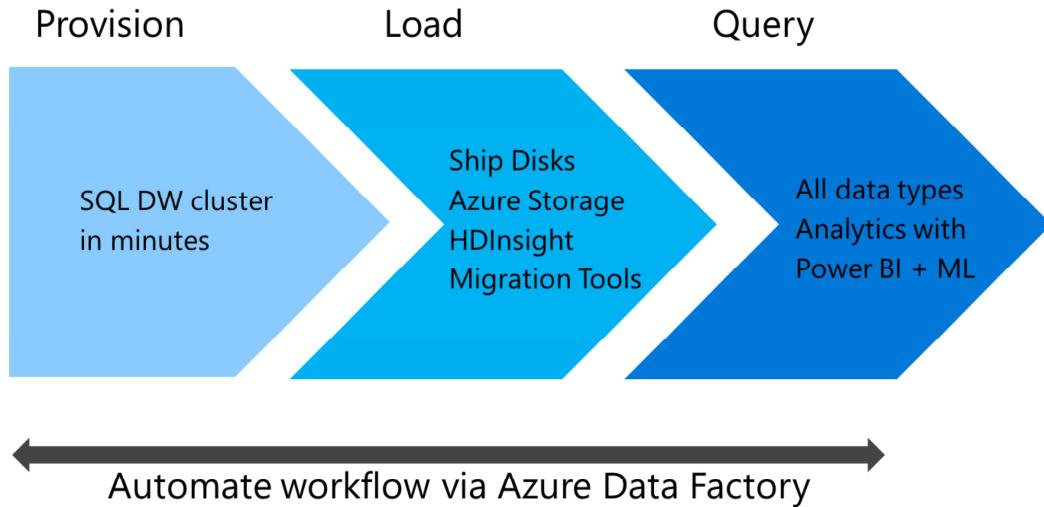
<https://azure.microsoft.com/en-us/documentation/articles/sql-data-warehouse-overview-workload/>

Azure SQL DW and Cortana Intelligence



<https://www.microsoft.com/en-us/cloud-platform/cortana-intelligence-suite>

Rapidly deploy and gain insights

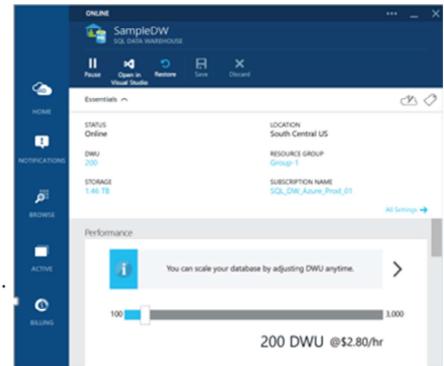


Rapidly deploy and gain insights

Spin up for heavy workloads, cycle down for daily activity.

Buy time to insight based on what you need, when you need it.

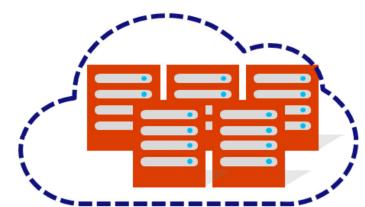
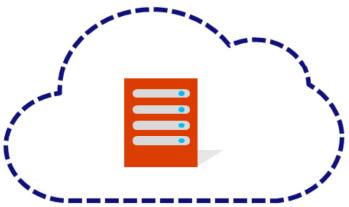
Choose the combo of compute and storage that meets your needs.



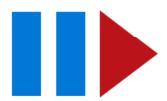
Resize in
<1 Minute

From Any Size to
Any Size

On-Demand
Compute



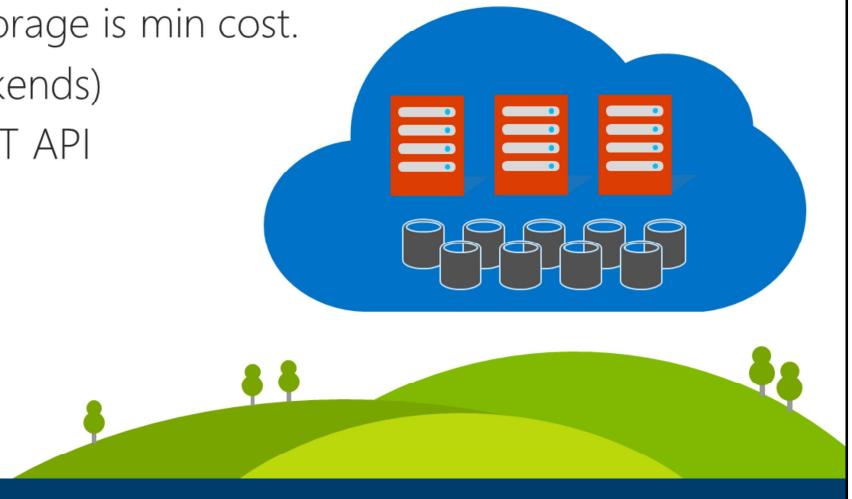
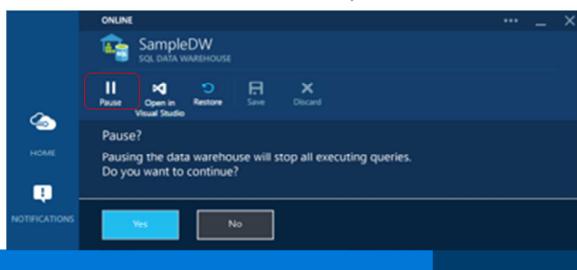
When Paused, Pay only for Storage



Use it only when you need it – no reloading / restoring of data

Save Costs with Dynamic Pause and Resume

- When paused, cloud-scale storage is min cost.
- Policy-based (i.e. Nights/weekends)
- Automate via PowerShell/REST API
- Data remains in place



<https://azure.microsoft.com/en-us/pricing/details/sql-data-warehouse/>

<https://azure.microsoft.com/en-us/documentation/articles/sql-data-warehouse-manage-compute-overview/>

Agenda

Data Warehousing Solutions

Azure SQL Data Warehouse

Any Size, Any Data

Massive Parallel Processing Concepts

Table Geometries

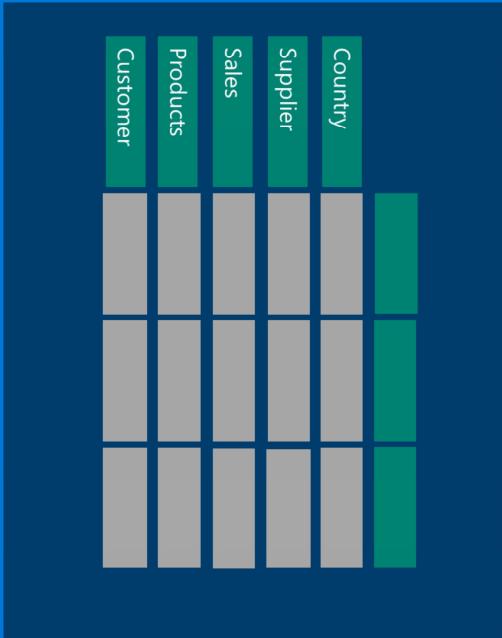
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Any Size: Next-Generation Performance



Fast Data Query Processing

Columnstore Provides Dramatic Performance

- Updateable and clustered columnstore index (CCI)
- Stores data in columnar format
- Memory-optimized for next-generation performance
- Updateable to support bulk and/or trickle loading



Up to
100x faster



Up to 15x
compression



Save time
and costs



Real-time
data warehouse

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CCI is still a little new to most customers! – so we explain it in details. – It was also new in SQL Server 2014!!

➔ CCI was first in MPP SQL already 2012 and came then to SQL Server 2014!

In SQL Server 2012 there was only a "NON-Clustered" version of the "Column Store" available which is not comparable to "Clustered Column Store" (CCI)!

"NON-Clustered Column Store" is not available in MPP SQL! (It was Read Only and so was using it a management overhead. Such a concept is not applicable for PB scale.)

<https://azure.microsoft.com/en-us/documentation/articles/sql-data-warehouse-tables-index/>

Is Azure SQL Data Warehouse complimentary
to Analytics Platform System?

YES

Why? SQL DW enables customers with an APS-based workload
or dataset to leverage a cloud-based MPP engine and cloud-
based analytics and support a hybrid architecture or eco-system

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Will “Azure SQL Data Warehouse”
replace “Analytics Platform System”?

NO

Why? Microsoft has two SQL Server MPP DWH offerings; one in the cloud and one on-premises. APS has roadmap beyond AU4 (AU5 is currently in planning phase).
This is very important to understand.

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Is Azure SQL Data Warehouse pitched as the equivalent of “APS in the cloud”?

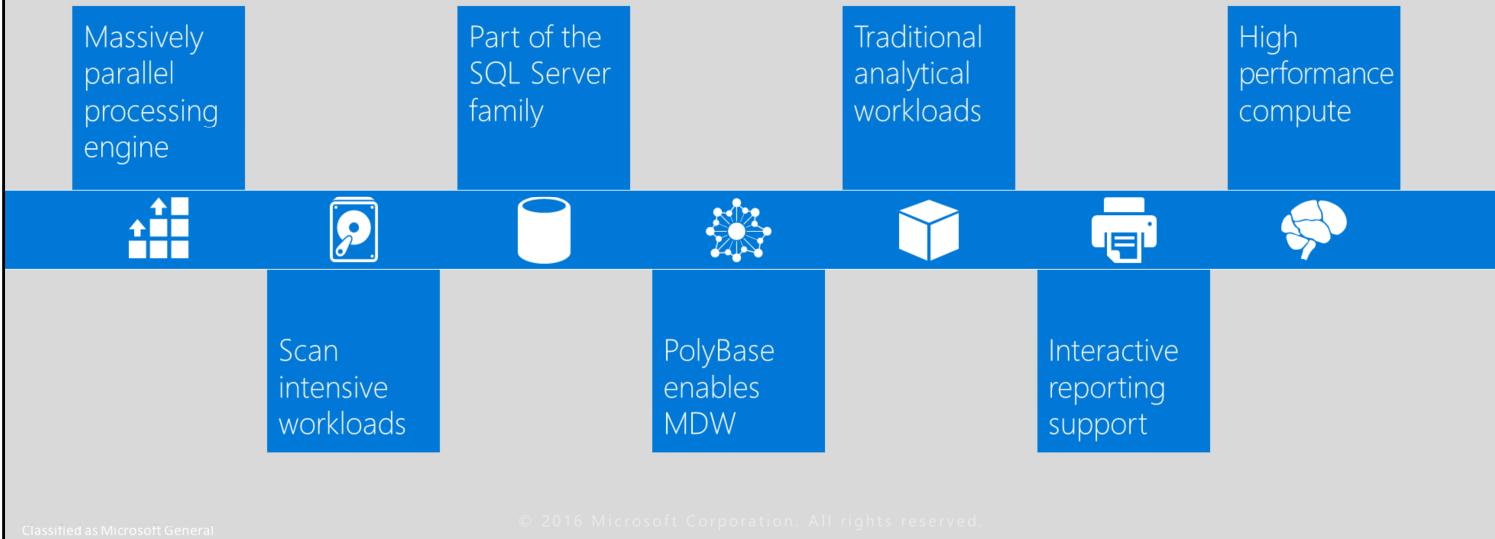
NO

Why? Architecture, surface area, networking, DMV's differ.

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So what do SQL DW and APS have in common?

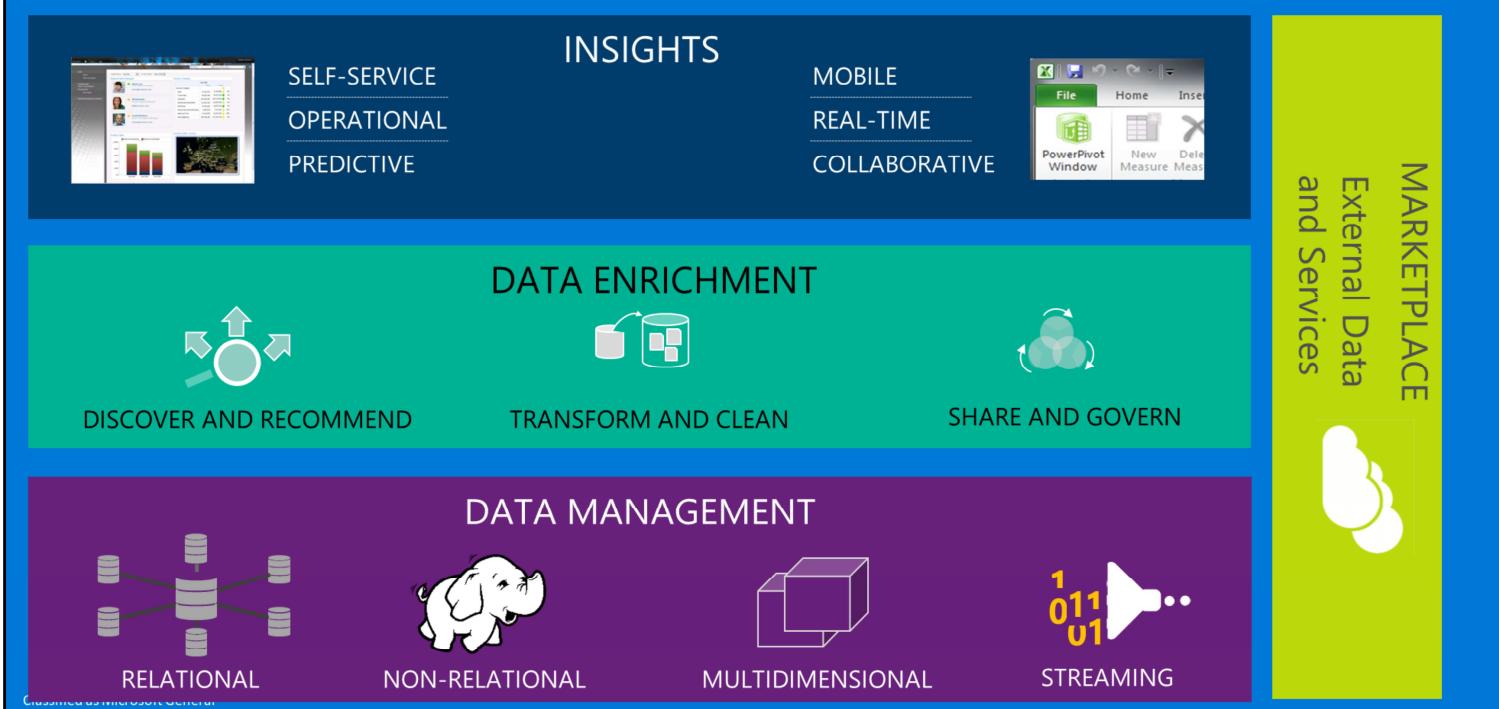


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MDW (Management Data Warehouse)

Microsoft End-To-End Data Warehouse



Internet of Things (IoT) - Microsoft

With Microsoft, you can do the following:

- Build on what already works
- Lean on trusted support and expertise
- Unlock innovation with a cohesive platform and skilled partners

→ Microsoft's Analytics Platform System and Azure SQL Data Warehouse are the perfect backbone for storing IoT-data

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With Microsoft, you can do the following:

Build on what already works.

Microsoft can help you create an intelligent system to capture opportunities simply by building on your existing investments—and get you started today.

Lean on trusted support and expertise.

Microsoft is an industry leader with a clear vision for what the Internet of Things means to business. Microsoft has the right devices, the right tools, the right solutions and the right partners to take your business to the next level with the Internet of Your Things.

Unlock innovation with a cohesive platform and skilled partners.

Microsoft has a global ecosystem of partners who are experts in putting technology to work on your company's challenges—device manufacturers to build the next generation of devices and leading software vendors and systems integrators who can help you develop a compelling solution to make your vision a reality. Microsoft can connect you with all the pieces you need to create the Internet of Your Things. Together with our partners, we have the technology and the experience to transform your business, right now.

<https://azure.microsoft.com/en-us/documentation/articles/sql-data-warehouse-integrate-azure-stream-analytics/>

Positioning - Summary

APS

- On-premises
- Cloud-enabled
- Mission-critical (24x7x365)
- Local to DWH applications
- Traditional customer thinking
- Leverages true hub & spoke approach
- Existing case studies
- Scale out works well for aggressive data-orientated customers
- The on-prem data lake enabler
- Hybrid upsell supports SQL DW and HDI
- Includes Data Management Gateway for surfacing data into PowerBI
- Leverages customer investments in SQL Server (+SA) licensing



SQL DW

- Cloud-based
- Dev/test/exploratory (on-demand)
- Local to cloud-born data
- Supports hub & spoke approach for PaaS and IaaS offerings
- Better than non-relational platforms for interactive reporting
- Integrates with ADF, ML and other Azure services
- License-free approach – designed as a service offering rather than an investment
- Fast elastic scale up and down
- Hybrid upsell and integration supports APS or on-premises investment



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Hybrid scenarios which work well

Both Analytics Platform System and Azure SQL Data Warehouse have a Massively Parallel Processing (MPP) engine with high computing power which is optimized for scan-intensive workloads. Here are a few scenarios where they can be leveraged together.



Test/Dev

Test new ideas in SQL DW before rolling out to production in APS



Archive

Offload cold data to blob storage for any workload execution



Governance

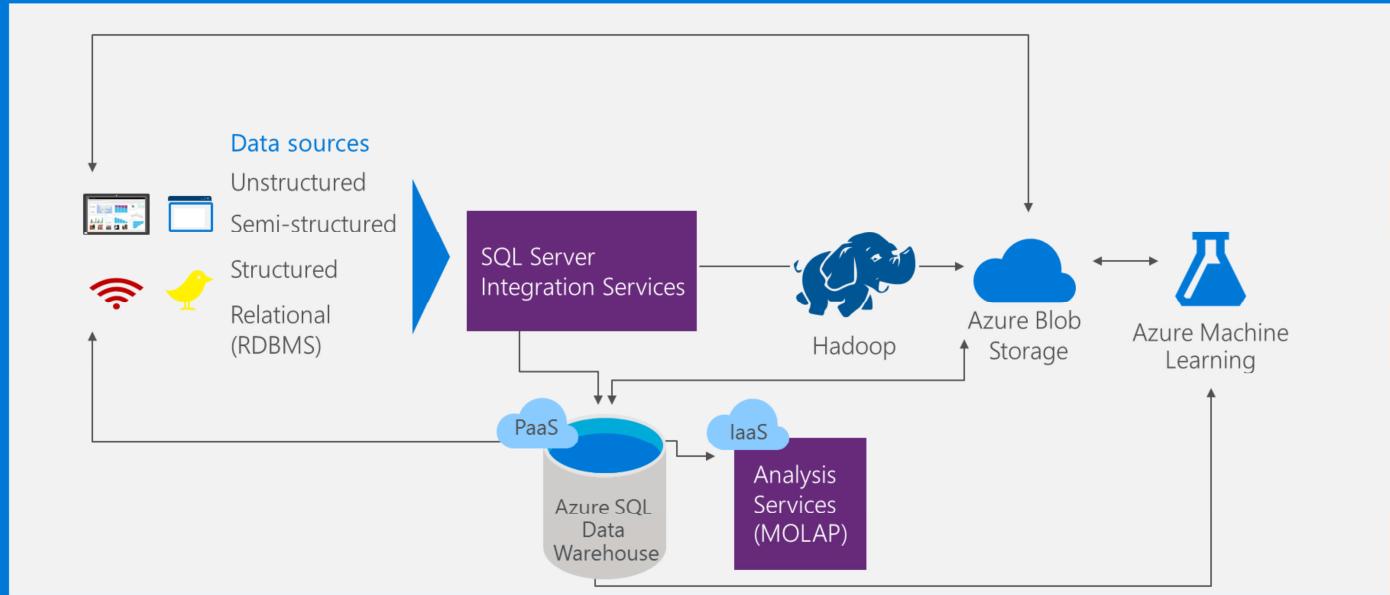
Store data in APS that company policy prohibits being in the cloud



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A simple perspective



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Agenda

Data Warehousing Solutions

Azure SQL DW

Any Size, Any Data

Massive Parallel Processing Concepts

Table Geometries

Azure Portal



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What is MPP?

MPP stands for "MASSIVE PARALLEL PROCESSING"

- A divide and conquer strategy
- Take one big problem & break it up & execute it individually
- Team approach "Many hands make light work"

Requires

- A method for scheduling tasks
- A communication plan to maximise efficiency
- A distribution method for exchange of goods

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<https://azure.microsoft.com/en-us/documentation/articles/sql-data-warehouse-overview-what-is/>

SCALE UP vs OUT

UP

- Diminishing returns
- Non-linear costs at scale
- Parallel execution hard
- Low-mid complexity
- High concurrency
- Shared everything

OUT

- Linear scale (6PB+)
- Incremental cost
- Parallel execution by default
- Complex queries
- Medium concurrency
- Shared nothing

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UP is most common

SINGLE BOX – SHARES MEMORY, I/O & CPU

- Increasing resources = bigger more powerful server
- Tuning becomes highly specialized at scale
- Can handle singleton selects well

Challenges of MPP /OUT

- **Data Locality** - AUTOMATED DATA MOVEMENT
- Concurrency – 32 Queries

The power of MPP

SMP/NUMA

Multiple CPUs are used to complete individual processes simultaneously

All CPUs share the same memory (SMP) OR different Groups of CPUs use different sets of memory on the same machine (NUMA)

All SQL Server implementations up until now have been SMP/NUMA

Massively parallel processing (MPP)

Multiple Nodes (computers) get utilized to process a single task

Many separate CPUs running in parallel across multiple nodes to execute a single task

Each set of CPUs has its own memory

Applications must be segmented, using high-speed communications between nodes

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SMP/NUMA:

- All packaged SQL Server implementations up until now have been SMP and/or NUMA
- SQL Server is highly optimized for NUMA architectures
- This shared architecture can have trouble in high concurrency, large scanning workloads

SMP (Symmetric Multiprocessing)

NUMA (Non-uniform memory access)



SQL DW = Scale OUT

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Image to help bring the conversation back to MPP Databases ready for the next slides

Concepts

- Logical layer
- Physical layer
- Distributed query engine
- Lots of machines!

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Logical Layer

- Holds application metadata
- Does not persist application data
- Receives intermediate results
- Performs final aggregation

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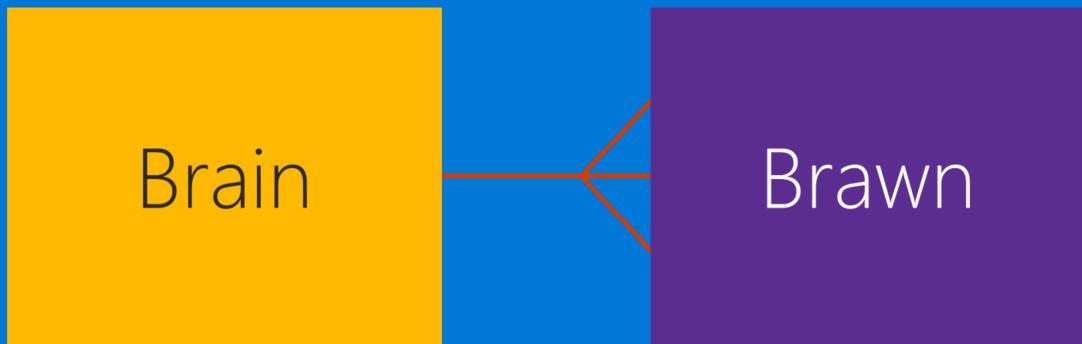
Physical Layer

- Persists application data
- Performs query steps as instructed

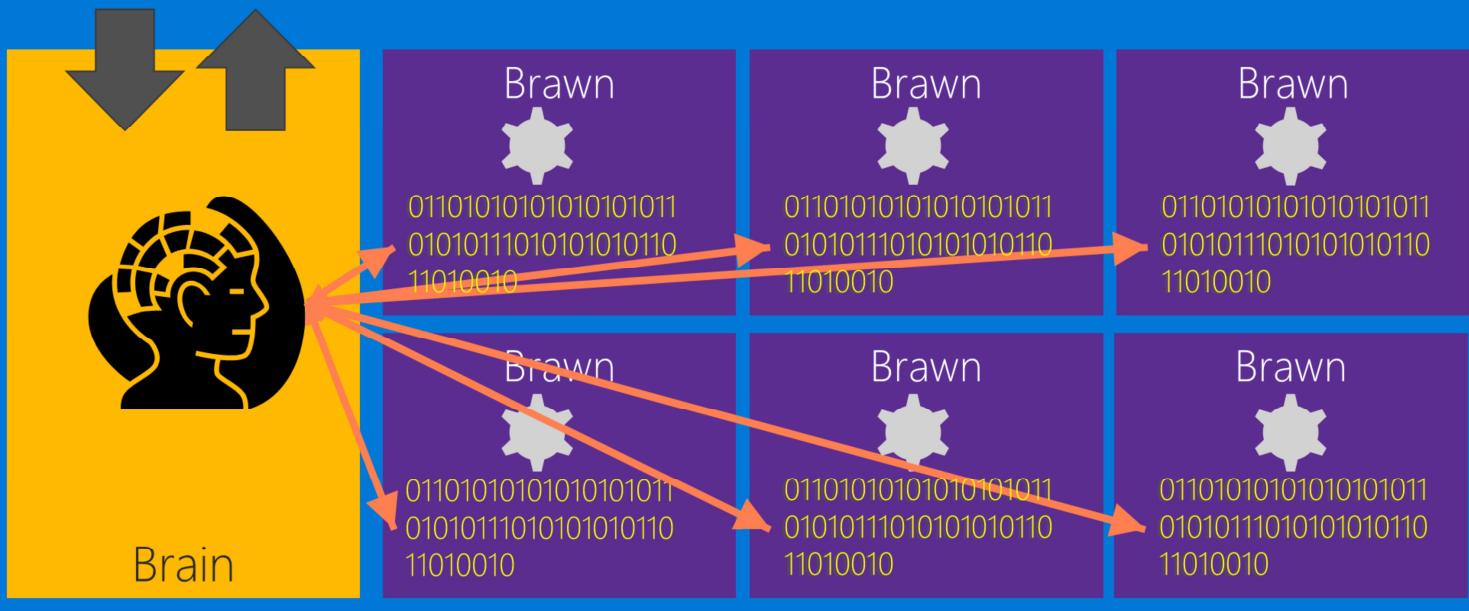
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Logical vs Physical



Brain vs. Brawn



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- MPP is often a single master system (one brain) with multiple slaves (lots of brawn)
- Therefore only one Control Node
- Brain
- Brawn
 - does most of the data processing work
 - Final Computation can happen on Brain but not always
 - Holds the data

Brain

- Accepts requests from user
- Interprets requests for scale out
- Optimises requests
- Orchestrates actions / steps
- Final computation
- Returns result

- Runs SQL Server
- Stores metadata
- Performs final computation

One Brain

Requires distributed
query engine

Brawn (muscle)

Performs the heavy lift

- Accepts requests from brain

Is a highly tuned SMP System

- Optimises requests from brain

Lots of
Brawn

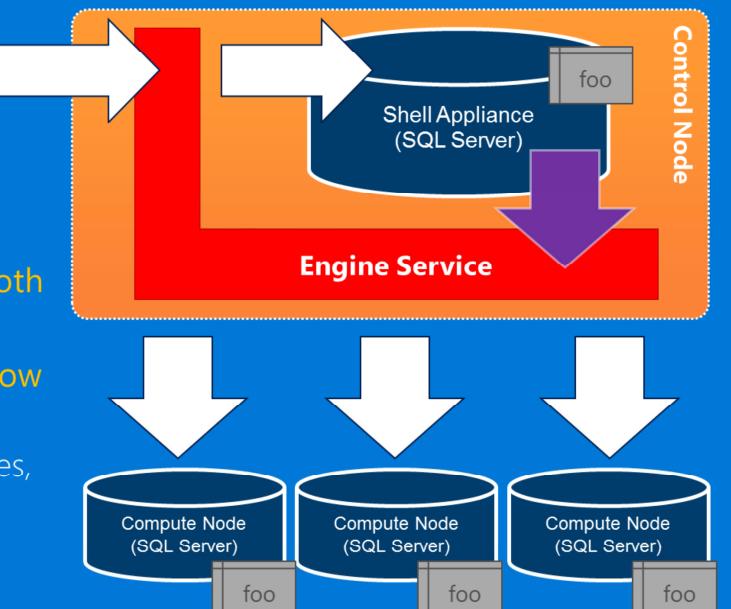
Executes query against the data

No direct user interaction

Uses SQL Server

MPP SQL Control Architecture

- Azure SQL DW uses SQL Server on the Control node to run a “shell appliance”
- Every database with all its objects exists in the shell appliance as an empty “shell,” lacking the user data (which sits on all the compute nodes)
- Every DDL operation is executed against both the shell and the compute nodes
- Large parts of basic RDBMS functionality now provided by that shell
 - Authentication and authorization of queries, but also the full security system
 - Schema binding
 - Metadata catalog



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DDL (Data Definition Language)

Agenda

Data Warehousing Solutions

Azure SQL Data Warehouse

Any Size, Any Data

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Table Geometries

Azure Portal



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Data Distribution Concept

Defined:

"The process of distributing or spreading out ..."

Why Distribute Data

- Divide & conquer: lots of small queries to solve
- Evenly spreading the data leads to even use of the appliance resources

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Distributed Data = Buckets of Water



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Each distributed data location = a bucket of data

Each bucket is called a distribution

Each distribution:

- maps to a physical table
- allocated physical space
- contains all rows that have the same distribution value

Consequences of data distribution

Good for scalability

- Data is spread (distributed) across servers

Introduces overheads

- Data is not all in the same place!
- Don't know where specific values are located
- May need to move the data then process it

MPP SQL Table Geometries

Distributed:

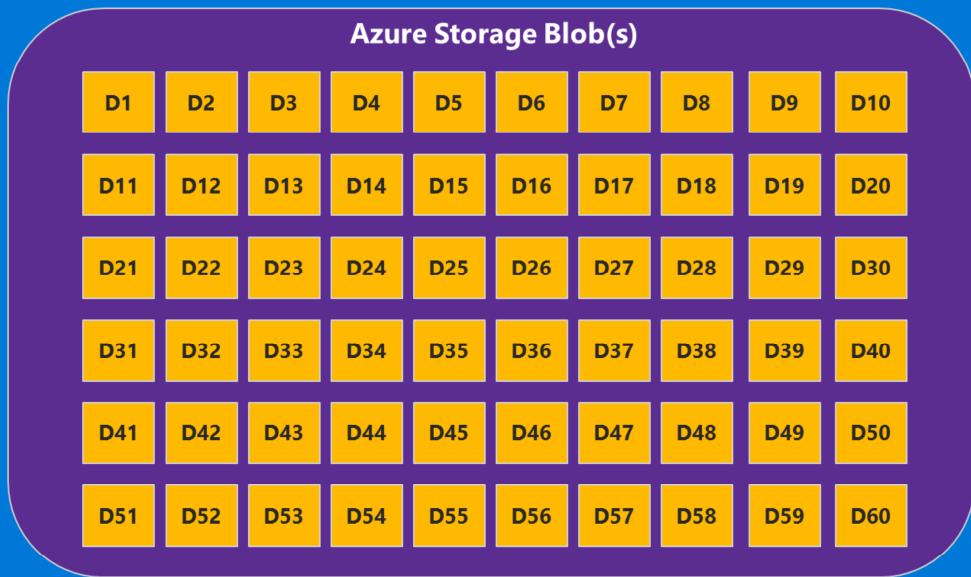
A table structure that is distributed across all MPP nodes of the Data Warehouse Database

HASH: where the value of a single column gets hashed to define the distribution number where the records will get inserted

ROUND_ROBIN: where the records are distributed in a "round robin" manner across all distributions ([new in AU4](#))

Distributions

```
CREATE TABLE myTable (column Defs)
WITH ( DISTRIBUTION = HASH (id));
```



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Agenda

Data Warehousing Solutions

Microsoft Azure SQL DW

Any Size, Any Data

Massive Parallel Processing Concepts

Table Geometries

Microsoft Azure Portal



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Microsoft Azure Portal

The screenshot shows the Microsoft Azure Portal homepage. On the left, a vertical navigation bar includes links for HOME, NOTIFICATIONS, BROWSE, ACTIVE, and BILLING. A yellow 'PREVIEW' ribbon is at the top. The main area features a world map titled 'Service health AZURE' with green dots indicating healthy regions. To the right is a 'Tour' section with a lightbulb icon and the text 'Welcome to Azure'. Below the map are sections for 'Marketplace' (with icons for various services like SQL, Kudu, Cloudera), 'Billing' (showing 'CURRENT CHARGES 0.00 USD' and 'SUBSCRIPTIONS 3'), 'Help + support', 'Portal settings', 'Feedback', and 'Azure Portal'.

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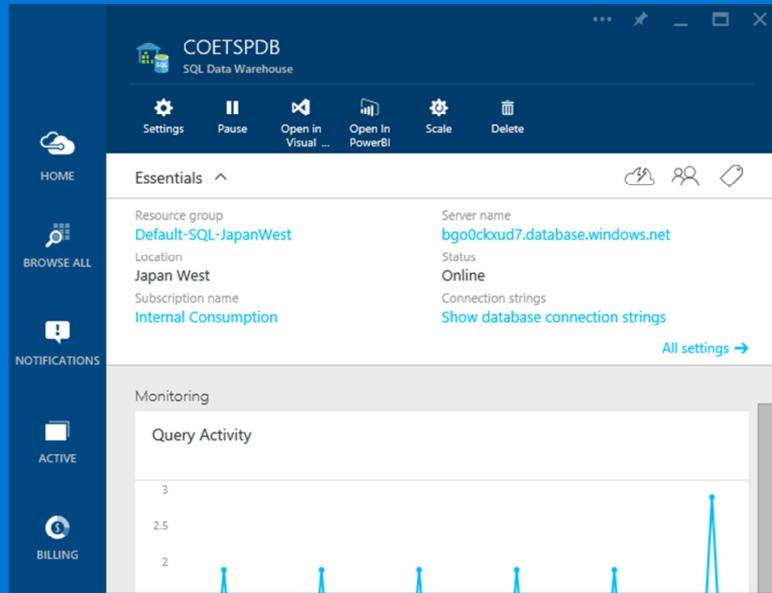
<https://ms.portal.azure.com/>

Subscribe to Azure SQL DW

The screenshot shows the Azure Marketplace interface. On the left, a sidebar lists categories like Home, Notifications, Browse, Active, and Billing. The 'Data + analytics' category is highlighted with a red box. The main area displays a search bar and a list of services. One service, 'SQL Data Warehouse', is shown with its details: Name (SampleDW), Performance (200 DWU @ \$2.80/hr), and options for 'Empty Data Warehouse' and 'From Restore Point'. At the bottom right of the service card, there is a large blue 'Create' button with a red arrow pointing to it.

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Managing a Azure SQL DW database



- Monitor
- Pause / Resize
- Delete
- Open with PowerBI

Monitoring – Query Activity

Summary

TUE JUL 14 06:00:00 PDT 2015 JUL 14 12:00:00 PDT 2015 JUL 14 18:00:00 PDT 2015

TOTAL	ACTIVE	CUED
50	0	0

QUERIES

QUERY ID	LOGIN	START TIME	DURATION	PROGRESS	STATUS
QID47613	hevandv	Wed Jul 1...	00:00:37.30	1	Completed
QID47616	hevandv	Wed Jul 1...	00:00:33.98	1	Completed
QID47589	hevandv	Wed Jul 1...	00:00:30.61	1	Completed
QID47583	hevandv	Wed Jul 1...	00:00:29.64	1	Completed
QID47580	hevandv	Wed Jul 1...	00:00:28.26	1	Completed
QID47675	hevandv	Wed Jul 1...	00:00:22.76	1	Completed
QID47627	hevandv	Wed Jul 1...	00:00:19.39	1	Completed
QID47579	hevandv	Wed Jul 1...	00:00:18.34	1	Completed

QID47613 Query Details

Query Text

```
1 insert bulk [Henk].[lineitem_cci]([l_orderkey] bigint,[l_partkey] int,[l_suppkey] int,[l_linenumber] int,[l_quantity] float,[l_extendedprice] float,[l_discount] float,[l_tax] float,[l_returnflag] char(1) collate SQL_Latin1_General_CI_AS,[l_linenstatus] char(1) collate SQL_Latin1_General_CI_AS,[l_shipdate] datetime,[l_commitdate] datetime,[l_receiptdate] datetime,[l_shipinstruct] char(25) collate SQL_Latin1_General_CI_AS,[l_shipmode] char(10) collate SQL_Latin1_General_CI_AS,[l_comment] varchar(132) collate SQL_Latin1_General_CI_AS)with(TABLOCK,CHECK_CONSTRAINTS)
```

Query Plan

Query Steps

S...	OPERATION	LOCATION	START TIME	DURATION	STATUS
0	ReturnOperation	Compute	Tue Jul 14...	11:24:03	Running

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Settings

- Monitoring of settings only
- Connection strings examples
 - Ado.net
 - ODBC (works also with Node.JS applications)
 - PHP
 - JDBC

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The screenshot shows the Microsoft Azure portal interface. On the left, there's a sidebar with options like HOME, BROWSE ALL, NOTIFICATIONS, ACTIVE, BILLING, and HELP. The main area shows a 'Microsoft Azure > COETSPDB > Settings > Properties' view. In the center, under 'Essentials', it shows a resource group 'Default-SQL-JapanWest', location 'Japan West', and subscription name 'Internal Consumption'. Below that is a 'Monitoring' section with 'Query Activity' and 'DWU Usage' metrics. To the right, there's a 'Properties' section with a search bar, a 'Scale' button, and a 'Show database connection strings' link. A red box highlights the 'Properties' link. Another red box highlights the 'All settings' link in the 'Properties' section. A third red arrow points to the 'Show database connection strings' link in the top right of a modal window titled 'Database connection strings' for 'COETSPDB'. This modal lists connection strings for various drivers: ADO.NET, ODBC (Includes Node.js), PHP, and JDBC. The ADO.NET section contains the following connection string:

```
Driver={SQL Server Native Client 11.0};Server=tcp:bgo0ckxud7.database.windows.net,1433;Database=COETSPDB;User ID=wwwsqlazuredw@bgo0ckxud7;Pwd={your_password_here};Encrypt=yes;TrustServerCertificate=no;Connection Timeout=30;
```

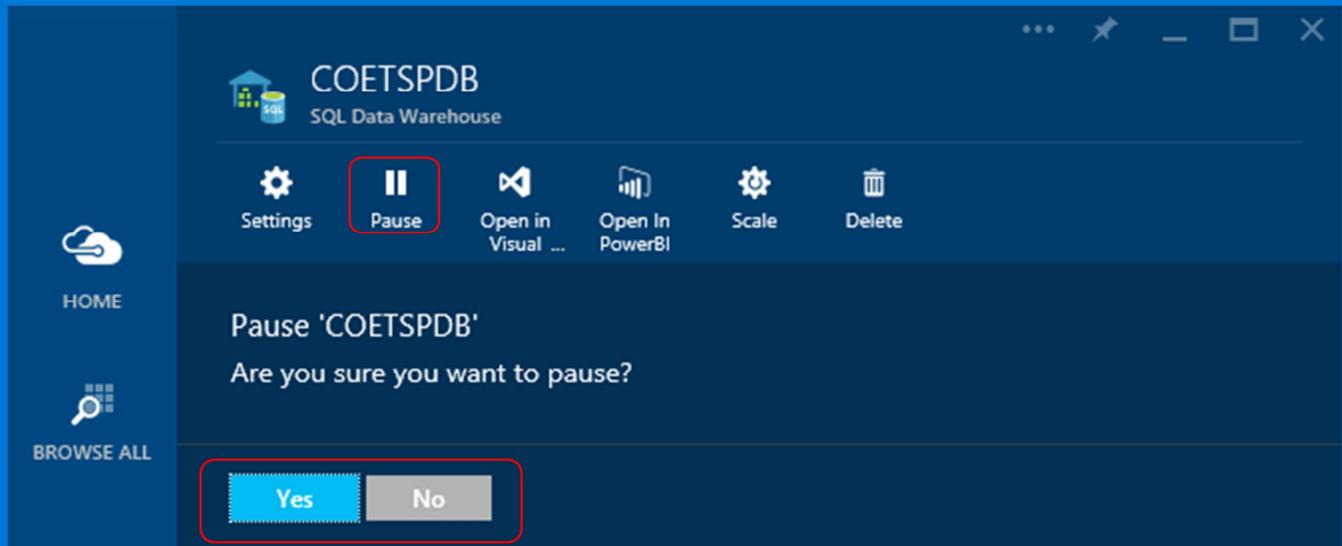
Driver={SQL Server Native Client 11.0};Server=tcp:bgo0ckxud7.database.windows.net,1433;Database=COETSPDB;User ID=wwwsqlazuredw@bgo0ckxud7;Pwd={your_password_here};Encrypt=yes;TrustServerCertificate=no;Connection Timeout=30;

The Microsoft Driver for Node.js for SQL Server, provides connectivity to Microsoft SQL Server from Node.js applications.

Sample for Node.js:

```
// Query with explicit connection
var sql = require('node-sqlserver');
var conn_str = "Driver={SQL Server Native Client 11.0};Server=(local);Database=AdventureWorks2012;Trusted_Connection={Yes}";
```

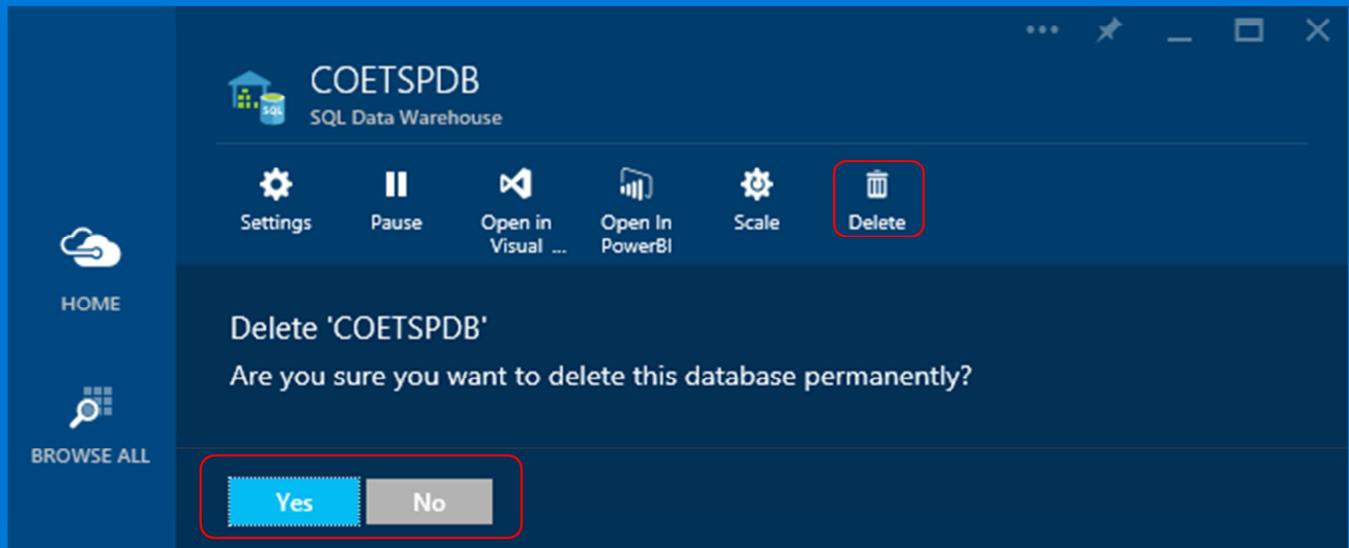
Pausing a Azure SQL DW database



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Deleting a Azure SQL DW database



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Firewall Settings

The screenshot shows the Microsoft Azure portal interface for managing a SQL Data Warehouse named 'COETSPDB'. The 'Firewall Settings' tab is selected. On the left, there's a 'Monitoring' section with a 'Query Activity' chart showing spikes in activity over time. The main area displays connection strings and firewall rules.

Connection Strings:

- Server name: bg00ckxud7.database.windows.net
- Status: Online
- Subscription name: Internal Consumption

Firewall Settings:

Rule Name	Start IP	End IP
All	0.0.0.0	255.255.255.254

Get Visual Studio:

Visual Studio 2013 with Update 4 and SQL Server Tooling is required for this feature to work.

IF VS 2013 IS INSTALLED,
[Get the latest update](#)

IF VS 2013 IS NOT INSTALLED, GET IT:
[Community \(Free\)](#)
[Express For Web \(Free\)](#)
[Express for Windows Desktop \(Free\)](#)
[Professional](#)
[Premium](#)
[Ultimate](#)

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Scaling SQL DW – just move the slider

Current options:

- 100,200 ...1000 DWU (per 100 increments)
- 1200, 1500, 2000 DWU

The screenshot shows the Azure portal interface for scaling a SQL Data Warehouse. On the left, there's a sidebar with 'HOME', 'BROWSE ALL', and 'NOTIFICATIONS'. The main area shows a 'TSPDB' resource under 'SQL Data Warehouse'. A 'Scale' button is highlighted with a red box. In the center, the 'Scale' blade is open, showing a 'Performance' section with a slider set to 2000 DWU, which is also highlighted with a red box. The text '2000 DWU @\$14.00/hr' is displayed below the slider.

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Notification log

Microsoft Azure > Audit logs > UpdateDatabase

Audit logs

Filter

Microsoft.OperationalInsights/register/a...	i	Succeeded	/subscriptions/0cef2328-a507-4ae0-a088-76aa36... ...servers/bgo0cloud7/databases/COETSPDB	6 d ago	
Update SQL database	i	Succeeded	...servers/bgo0cloud7/databases/COETSPDB	6 d ago	
Microsoft.Sql/servers/databases/pause/a...	i	Accepted	...servers/bgo0cloud7/databases/TSPDB	6 d ago	
Update SQL database	i	Succeeded	...servers/bgo0cloud7/databases/COETSPDB	6 d ago	
Update SQL database	i	Succeeded	...servers/bgo0cloud7/databases/COETSPDB	6 d ago	
Microsoft.Sql/servers/databases/resume/a...	i	Accepted	...servers/bgo0cloud7/databases/TSPDB	6 d ago	
Update SQL database	i	Succeeded	...servers/bgo0cloud7/databases/COETSPDB	6 d ago	
UpdateDatabase	i	Started	...servers/bgo0cloud7/databases/COETSPDB	6 d ago	
Update SQL database	i	Failed	...servers/bgo0cloud7/database/COETSPDB	6 d ago	
UpdateDatabase	i	Failed	...servers/bgo0cloud7/databases/COETSPDB	6 d ago	
Update SQL database	i	Failed	...servers/bgo0cloud7/databases/COETSPDB	6 d ago	
UpdateDatabase	i	Failed	...servers/bgo0cloud7/databases/COETSPDB	6 d ago	

DESCRIPTION: Update SQL Database COETSPDB on Server bgo0cloud7: Change edition from 'DW1500' to 'DW1000'. by: hevandv@microsoft.com
 LEVEL: Informational
 STATUS: Started
 TIME: Thu Jul 9 06:27:25 PDT 2015

Update SQL database
 COETSPDB

EVENT: Update SQL database
 LEVEL: Informational
 STATUS: Succeeded
 TIME: Thu Jul 9 06:38:04 PDT 2015
 CALLER: hevandv@microsoft.com
 CORRELATIONID: Sc2b55a1-b400-48b9-8c3a-437cbd9cc090
 RESOURCE: COETSPDB (Microsoft.Sql/databases)

EVENT LEVEL STATUS TIME

Update SQL database Succeeded 6 d ago

Update SQL database Accepted 6 d ago

Update SQL database Started 6 d ago

Resizing DWU's completes within seconds

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Demo: Create a SQL Data Warehouse

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<https://azure.microsoft.com/en-us/documentation/articles/sql-data-warehouse-get-started-provision>

Lab: Create a SQL Data Warehouse

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<https://azure.microsoft.com/en-us/documentation/articles/sql-data-warehouse-get-started-provision>