



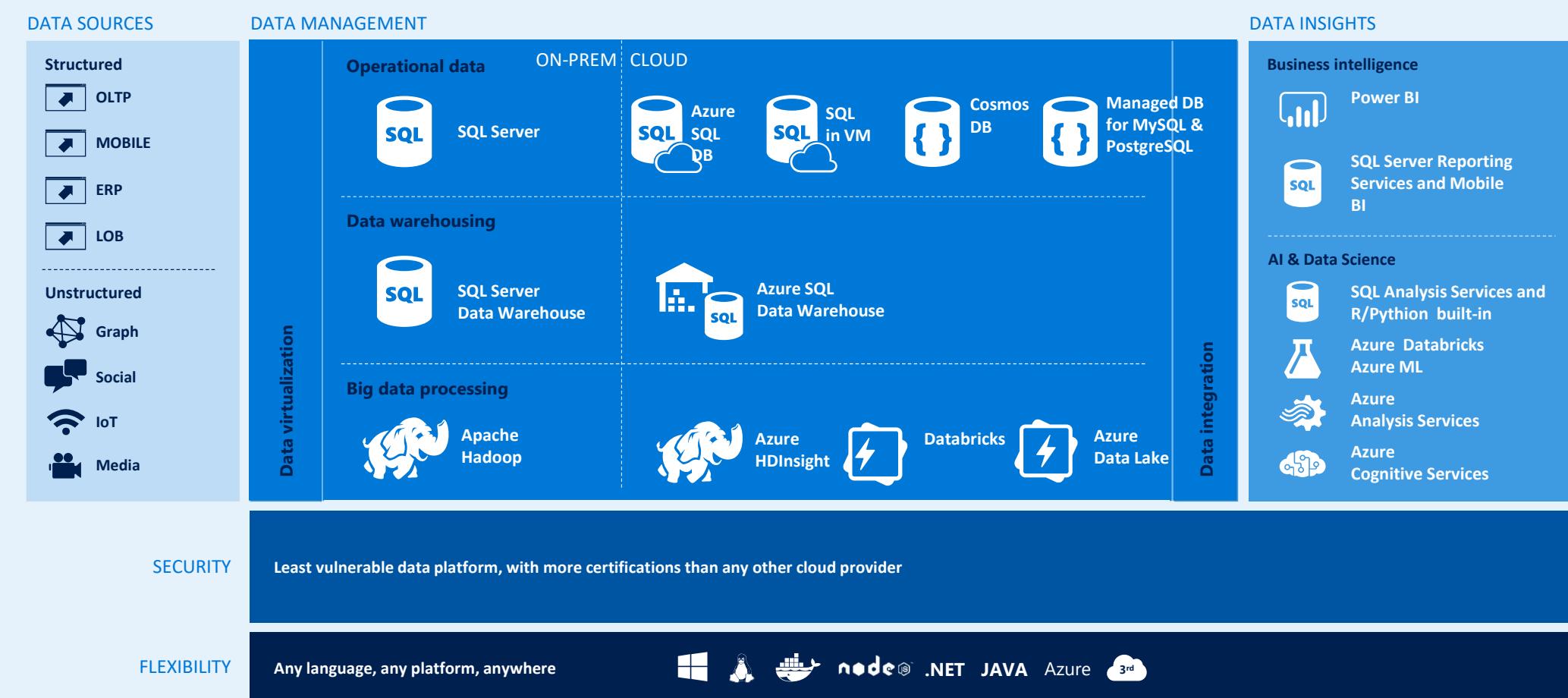
Revolutionize your business with Microsoft Data Platform

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Big Data & AI
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Agenda

- 8:30-9:00-Kickoff
- 9:00-9:45-Overview of Data platform and ADF concepts
- 9:45-11:00-Lab 1 - Setting up environment, Q&A
- 11:00-11:15-Break
- 11:15-12:00-Azure Datawarehouse concepts
- 12:00-1:00-Lunch
- 1:00-3:00-Lab2 - End to End pipeline batch pipeline, Q&A
- 3:00-3:15- Break
- 3:15-4:00-Stream Analytics and Databricks Delta
- 4:00-5:00-Lab 3, Q&A

Microsoft View on modern data estate



Recent Gartner Magic Quadrants

Microsoft is the only vendor presented in all 3 leader magic quadrants

Figure 1. Magic Quadrant for Operational Database Management Systems



Operational Data

Figure 1. Magic Quadrant for Analytics and Business Intelligence Platforms



BI and Analytics Platform

Figure 1. Magic Quadrant for Data Management Solutions for Analytics

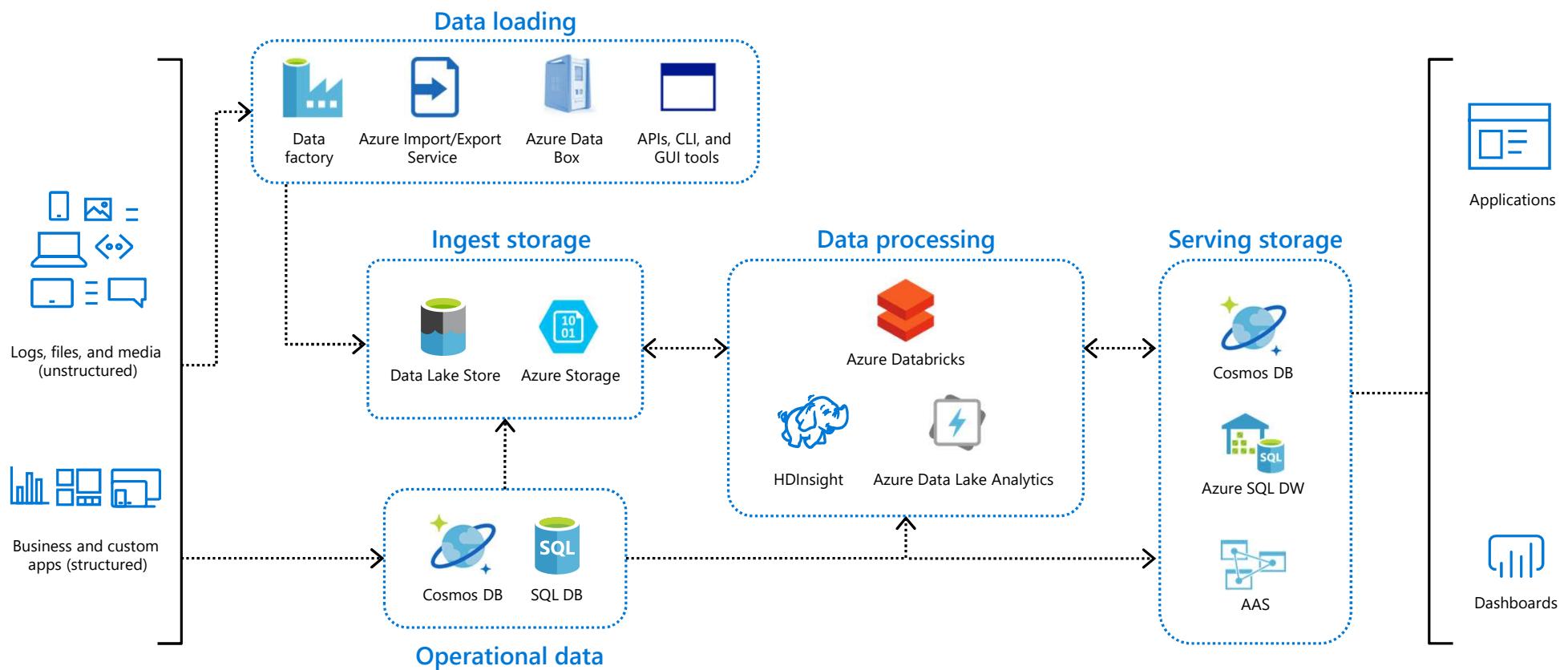


Data Management for
Analytics (DW)

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Analytics in Azure

Loading and preparing data for analysis with a data warehouse



Introduction to Azure Data Factory

Azure Data Factory

A fully-managed data integration service in the cloud



PRODUCTIVE

- ✓ Drag & Drop UI
- ✓ Codeless Data Movement



HYBRID

- ✓ Orchestrate where your data lives
- ✓ Lift SSIS packages to Azure



SCALABLE

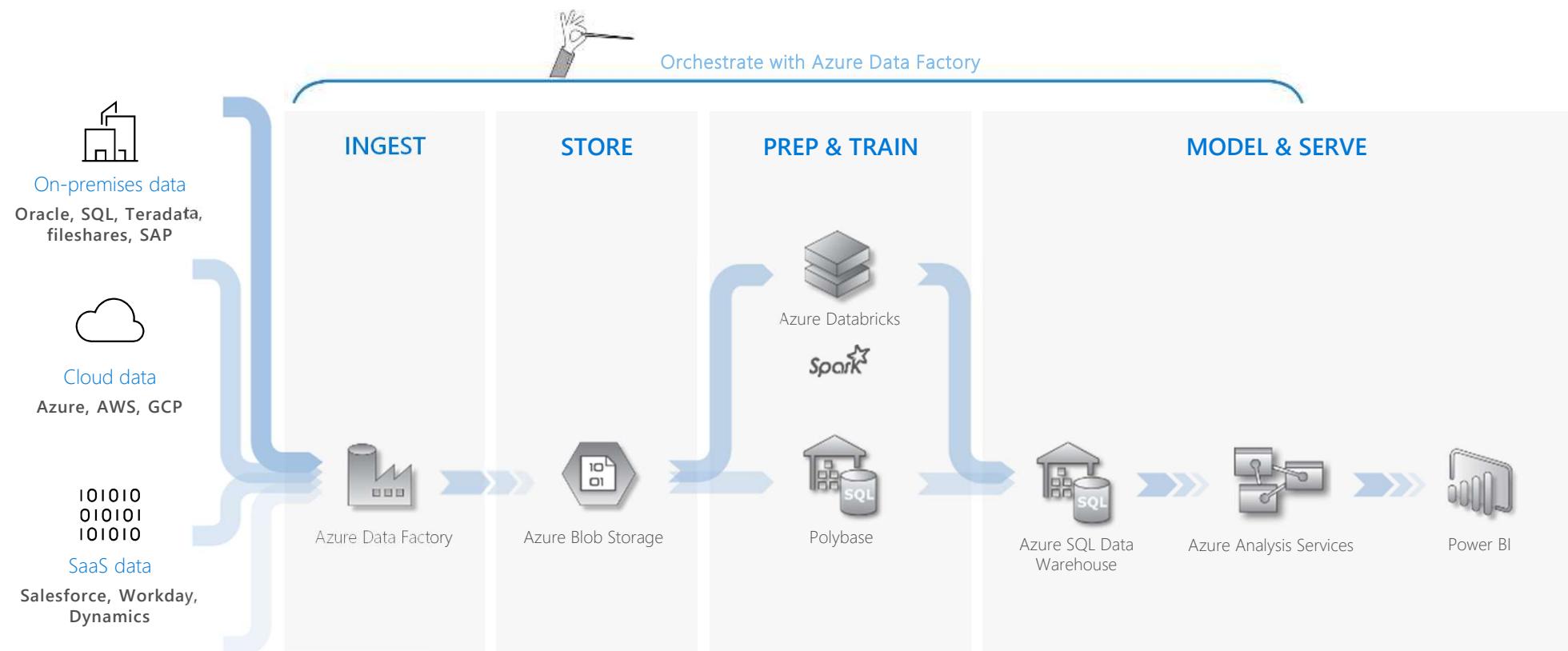
- ✓ Serverless scalability with no infrastructure to manage



TRUSTED

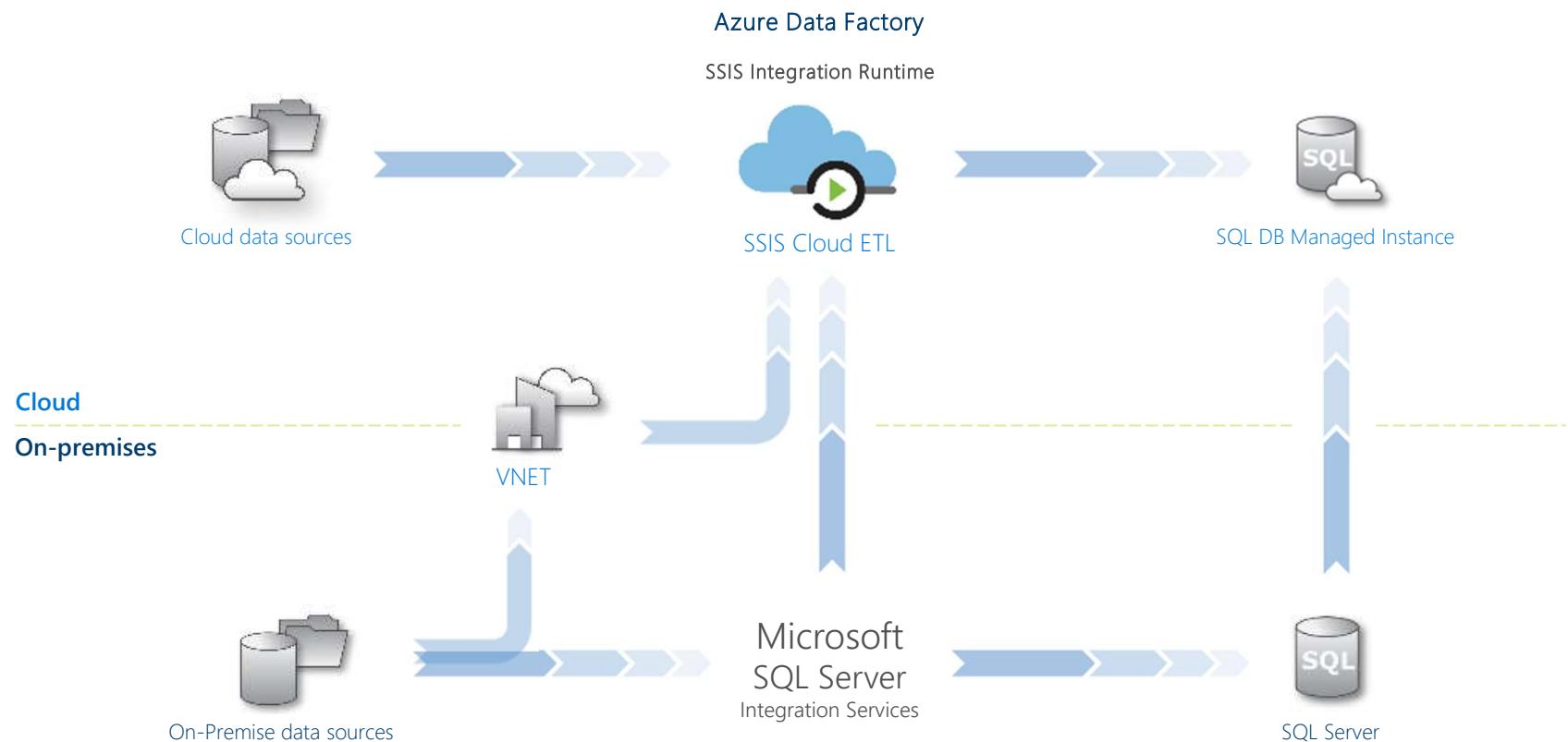
- ✓ Certified compliant Data Movement

Modernize your enterprise data warehouse at scale



Microsoft Azure also supports other **Big Data** services like Azure HDInsight, Azure SQL Database and Azure Data Lake to allow customers to tailor the above architecture to meet their unique needs.

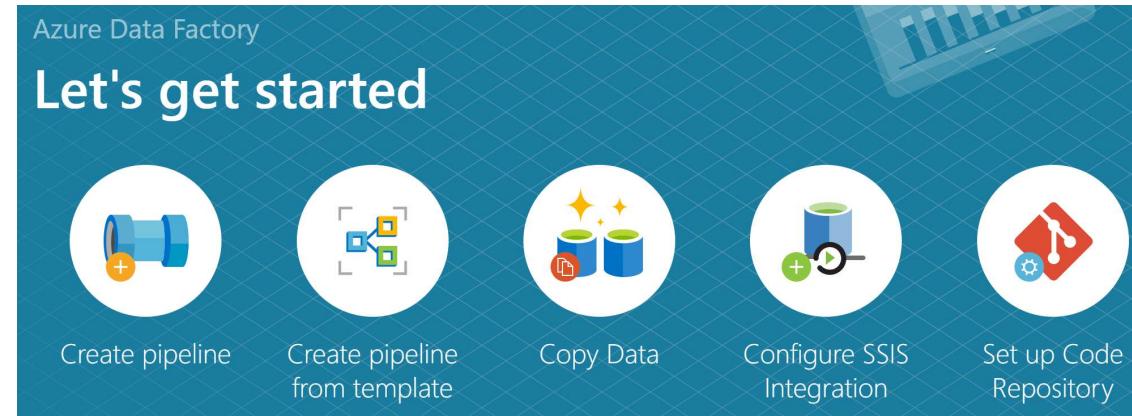
Lift your SQL Server Integration Services (SSIS) packages to Azure



Hybrid and Multi-Cloud Data Integration



Azure Data Factory



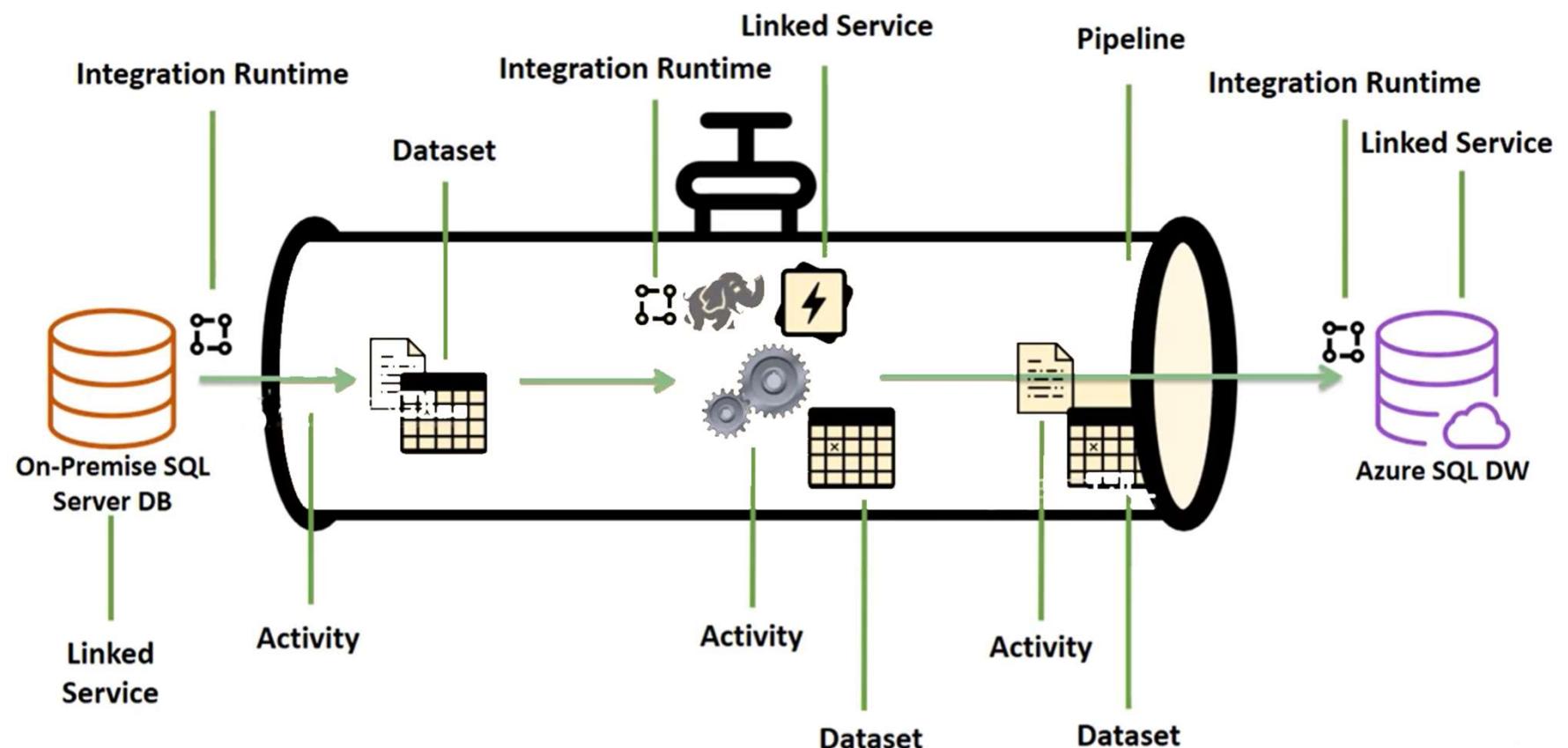
Screenshot of the Azure Data Factory UI. The top navigation bar includes "sqlabdf", "Data Factory", "Publish All 1", "Validate All", "Refresh", "Discard All", and "ARM Template". The main area shows "Factory Resources" with "Pipelines" (1) selected. A dropdown menu for "pipeline1" is open, showing options like "Activities", "Set up Code Repository", and "Search Activities". The pipeline editor on the right displays a "Copy Data" activity named "Copy Data1" with a red circle indicating an error. The pipeline structure is as follows:

```
graph TD; Start(( )) --> CopyData1[Copy Data1]; CopyData1 --> End(( ));
```

Activity details for "Copy Data1":

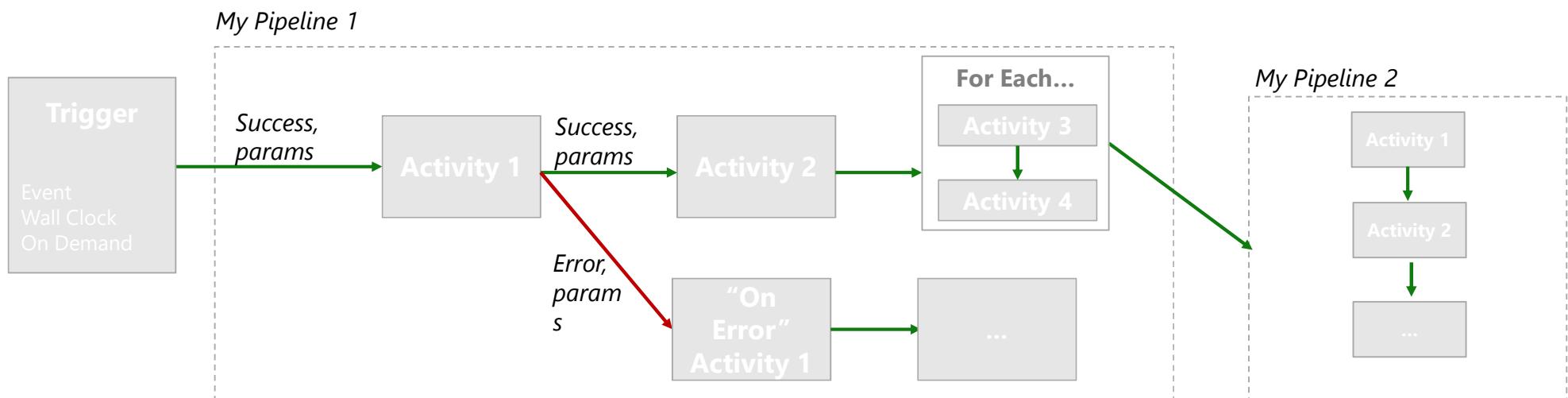
- Source: Batch Service
- Destination: Databricks
- Activities:
 - Notebook
 - Jar
 - Python

Azure Data Factory

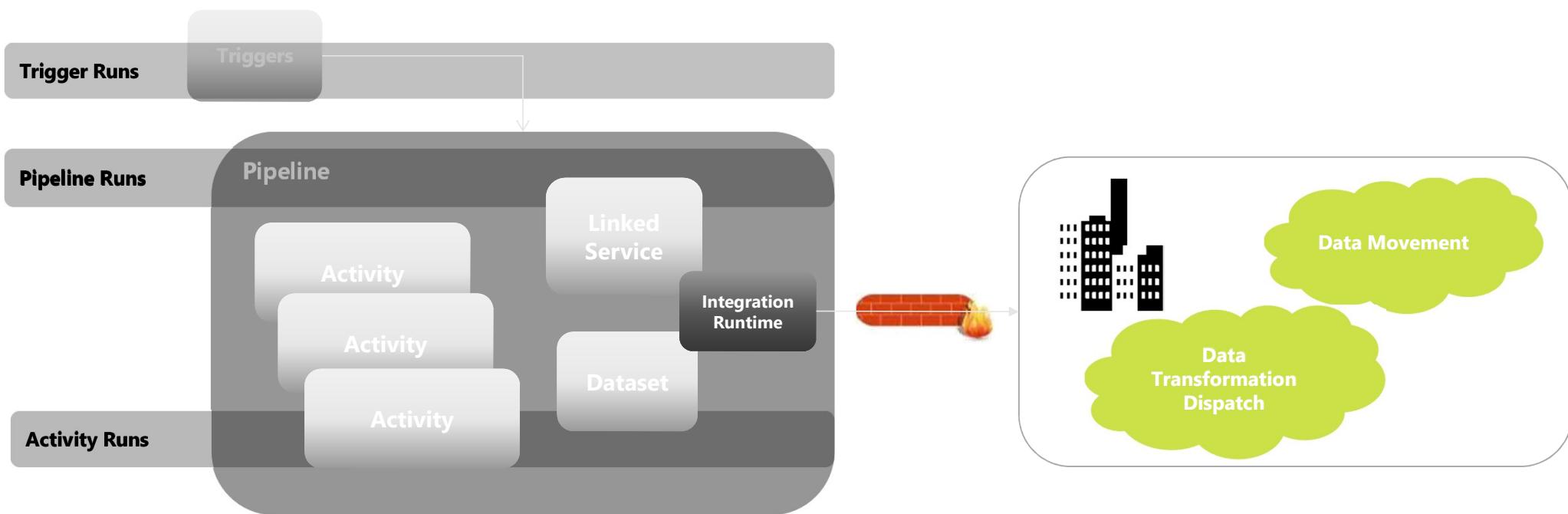


Control Flow Introduced in Azure Data Factory

Coordinate pipeline activities into finite execution steps to enable looping, conditionals and chaining while separating data transformations into individual data flows



Azure Data Factory Updated Flexible Application Model

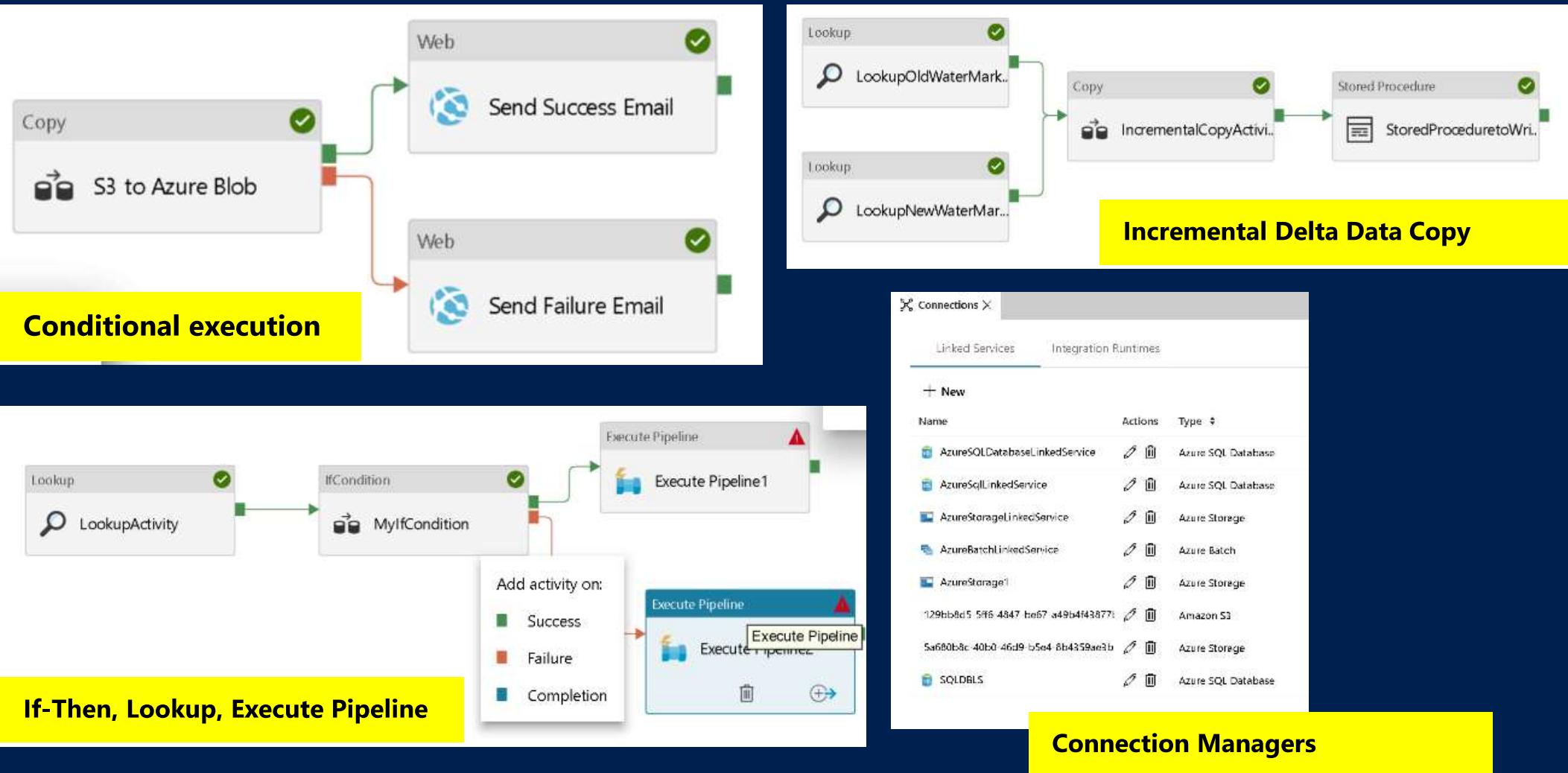


New ADF V2 Concepts

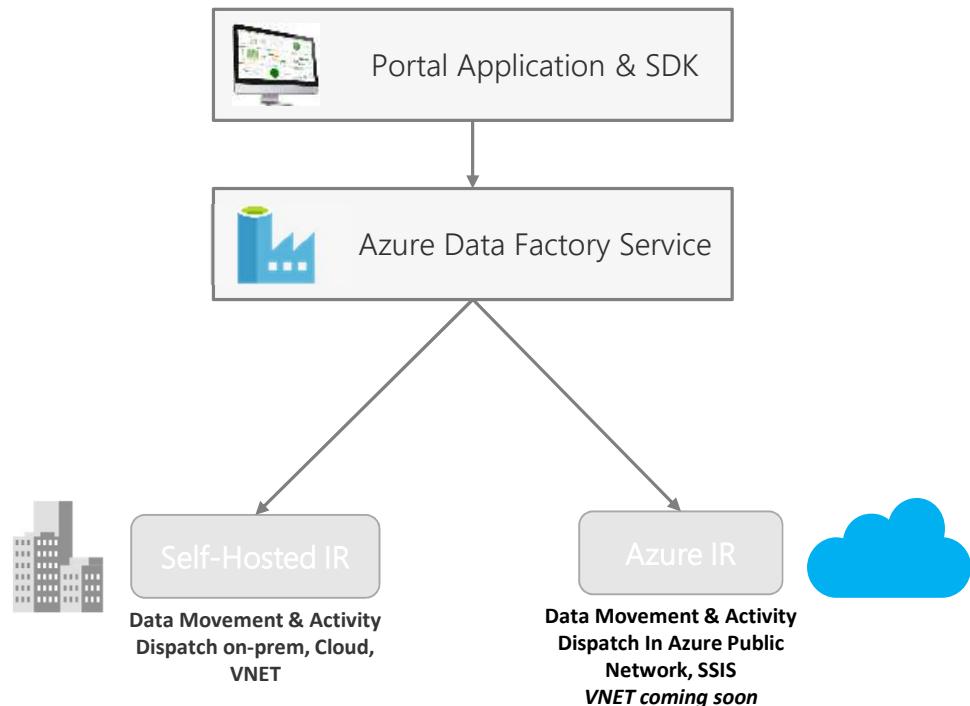
Concept	Description	Sample
Control Flow	Orchestration of pipeline activities that includes chaining activities in a sequence, branching, conditional branching based on an expression, parameters that can be defined at the pipeline level and arguments passed while invoking the pipeline on demand or from a trigger. Also includes custom state passing and looping containers, i.e. For-each, Do-Until iterators.	{ "name":"MyForEachActivityName", "type":"ForEach", "typeProperties":{ "isSequential":true }, "items": "@pipeline().parameters.mySinkDatasetFolderPathCollection", "activities": [{ "name":"MyCopyActivity", "type":"Copy", "typeProperties":{ ... } }] }
Runs	A Run is an instance of the pipeline execution. Pipeline Runs are typically instantiated by passing the arguments to the parameters defined in the Pipelines. The arguments can be passed manually or properties created by the Triggers.	POST <a href="https://management.azure.com/subscriptions/<subId>/resourceGroups/<resourceGroupName>/providers/Microsoft.DataFactory/factories/<dataFactoryName>/pipelines/<pipelineName>/createRun?api-version=2017-03-01-preview">https://management.azure.com/subscriptions/<subId>/resourceGroups/<resourceGroupName>/providers/Microsoft.DataFactory/factories/<dataFactoryName>/pipelines/<pipelineName>/createRun?api-version=2017-03-01-preview
Activity Logs	Every activity execution in a pipeline generates activity start and activity end logs event	
Integration Runtime	Replaces DMG as a way to move & process data in Azure PaaS Services, self-hosted or on prem or IaaS Works with VNets Enables SSIS package execution	Set-AzureRmDataFactoryV2IntegrationRuntime -Name \$integrationRuntimeName -Type SelfHosted
Scheduling	Flexible Scheduling Wall-clock scheduling Event-based triggers	"type": "ScheduleTrigger", "typeProperties": { "recurrence": { "frequency": <>Minute, Hour, Day, Week, Year>>, "interval": <>int>>, // optional, how often to fire (default to 1) "startTime": <>datetime>>, "endTime": <>datetime>>, "timeZone": <>default UTC>>, "schedule": { // optional (advanced scheduling specifics) "hours": [<>0-24>>], "weekDays": [<>Monday-Sunday>>], "minutes": [<>0-60>>], "monthDays": [<>1-31>>], "monthlyOccurrences": [{ "day": <>Monday-Sunday>>, "occurrence": <>1-5>> }] } } }

New ADF V2 Concepts

Concept	Description	Sample
On-Demand Execution	Instantiate a pipeline by passing arguments as parameters defined in a pipeline and execute from script / REST / API.	Invoke-AzureRmDataFactoryV2PipelineRun -DataFactory \$df -PipelineName "Adfv2QuickStartPipeline" -ParameterFile .\PipelineParameters.json
Parameters	<p>Name-value pairs defined in the pipeline. Arguments for the defined parameters are passed during execution from the run context created by a Trigger or pipeline executed manually. Activities within the pipeline consume the parameter values.</p> <p>A Dataset is a strongly typed parameter and a reusable/referenceable entity. An activity can reference datasets and can consume the properties defined in the Dataset definition</p> <p>A Linked Service is also a strongly typed parameter containing the connection information to either a data store or a compute environment. It is also a reusable/referenceable entity.</p>	Accessing parameters of other activities Using expressions <code>@parameters("{name of parameter}")</code> <code>@activity("{Name of Activity}").output.RowsCopied</code>
Incremental Data Loading	Leverage parameters and define your high-water mark for delta copy while moving dimension or reference tables from a relational store either on premises or in the cloud to load the data into the lake	<pre>name": "LookupWaterMarkActivity", "type": "Lookup", "typeProperties": { "source": { "type": "SqlSource", "sqlReaderQuery": "select * from watermarktable" } }</pre>
On-Demand Spark	Support for on-demand HDI Spark clusters, similar to on-demand Hadoop activities in V1	<pre>"type": "HDInsightOnDemand", "typeProperties": { "clusterSize": 2, "clusterType": "spark", "timeToLive": "00:15:00",</pre>
SSIS Runtime	Lift & shift, deploy, manage, monitor SSIS packages in the cloud with SSIS Azure IR Service in Azure Data Factory	Start-AzureRmDataFactoryV2IntegrationRuntime -DataFactoryName \$DataFactoryName -Name
Code-free UI	Build end-to-end data pipeline solutions for ADF without writing code or JSON	



ADF Integration Runtime (IR)



- ADF compute environment with multiple capabilities:
 - Activity dispatch & monitoring
 - Data movement
 - SSIS package execution
- To integrate data flow and control flow across the enterprises' hybrid cloud, customer can instantiate multiple IR instances for different network environments:
 - On premises (similar to DMG in ADF V1)
 - In public cloud
 - Inside VNet
- Bring a consistent provision and monitoring experience across the network environments

↔ Command & Control

↔ Data Flow



UX & SDK

Authoring | Monitoring/Mgmt

Azure Data Factory Service

Scheduling | Orchestration | Monitoring

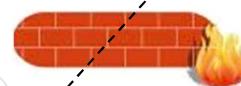
Azure Cloud

PaaS Cloud Host

Integration Runtime

Installable Agent

Integration Runtime



On Premises Apps & Data



TERADATA



cloudera

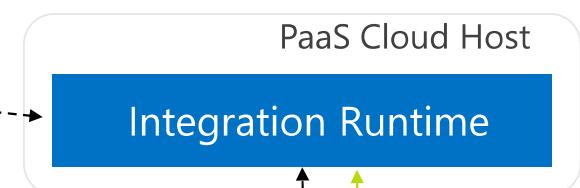
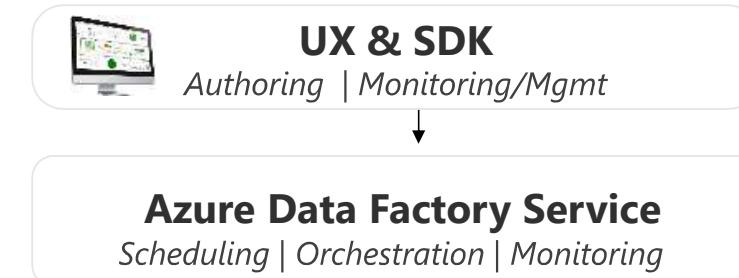


ORACLE

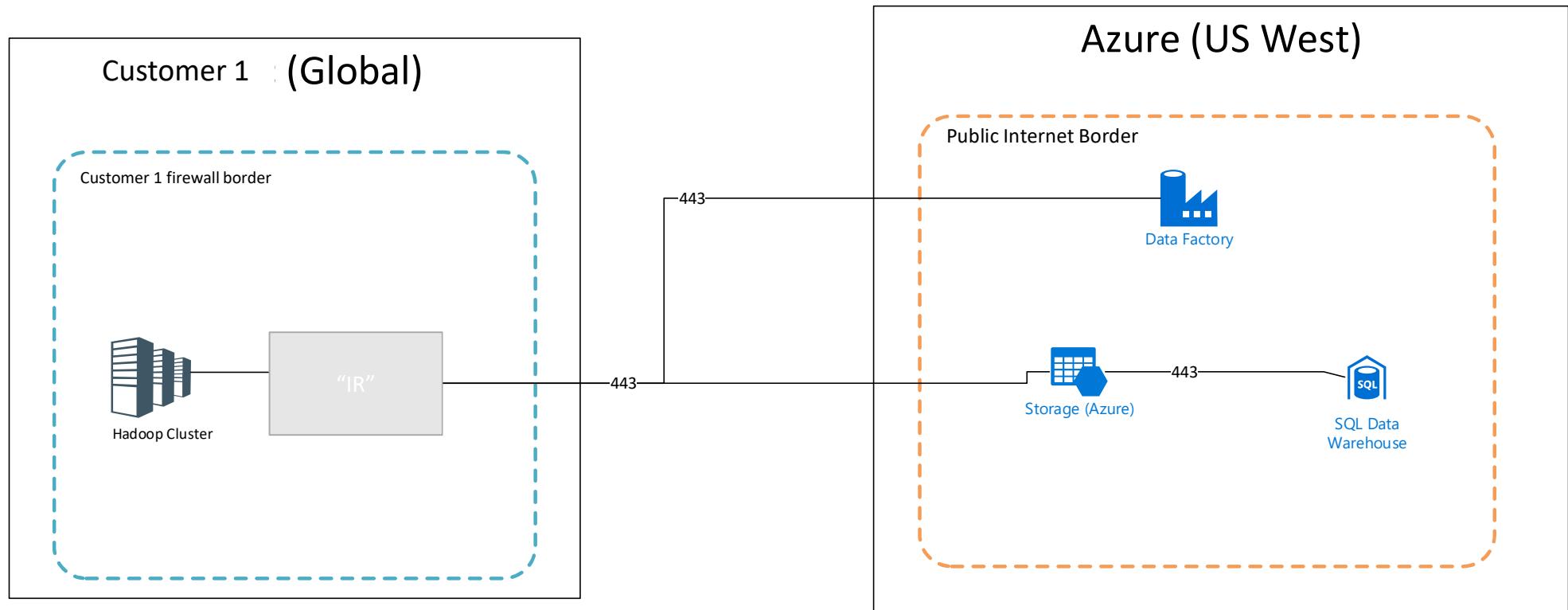
Cloud Apps, Svcs & Data



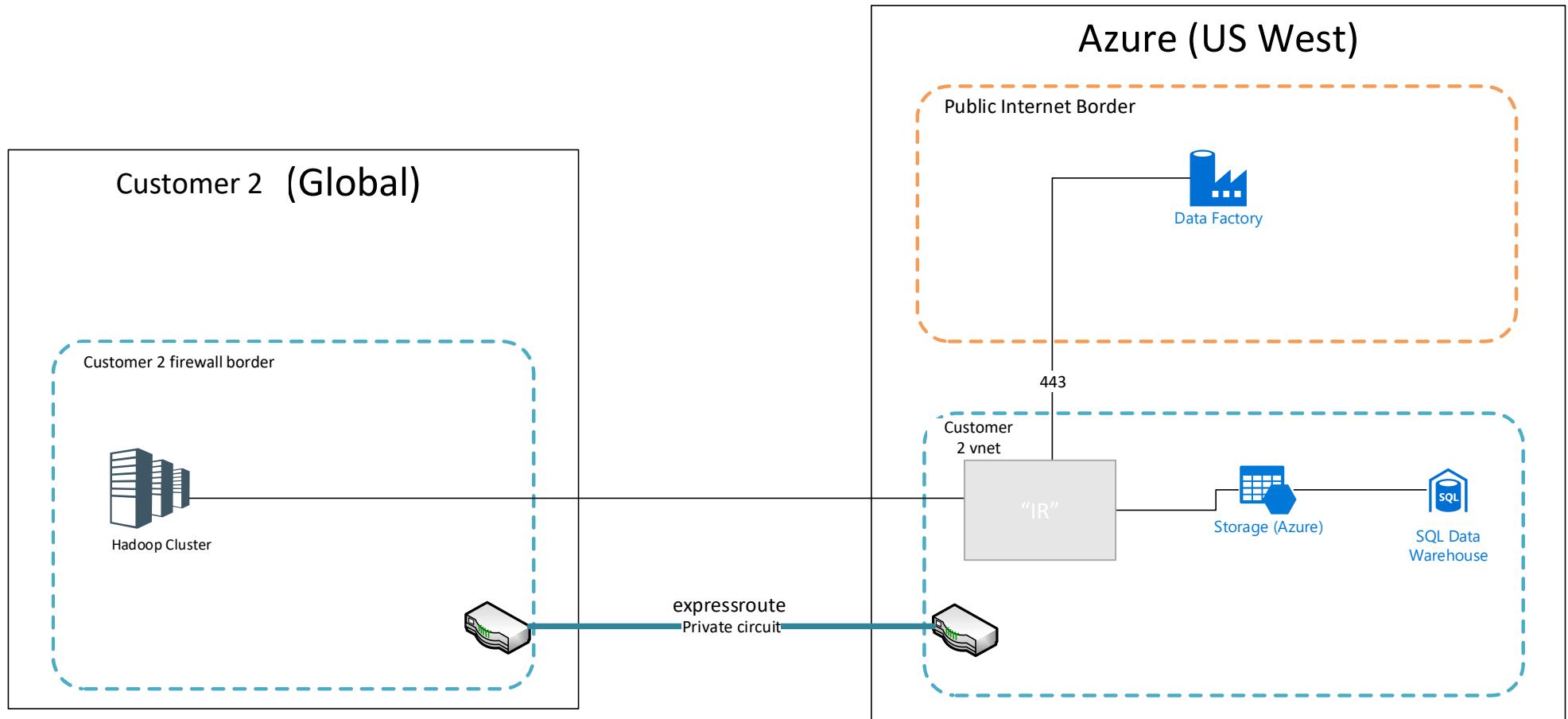
Adobe



AZURE DATA FACTORY "INTEGRATION RUNTIME" DEPLOYED ON PREMISES FOR TRANSFORMATION AND THEN MOVED TO CLOUD



AZURE DATA FACTORY "INTEGRATION RUNTIME" DEPLOYED INSIDE VNET



Integration Runtime Setup

X

Integration Runtime is the native compute used by ADF to execute or dispatch activities. Choose what integration runtime to create based on required capabilities.



Perform data movement and dispatch activities to external computes.



Lift-and-shift existing SSIS packages to execute in Azure.

Integration Runtime Setup

Choose the network environment of the data source/destination or external compute the integration runtime will connect to for data movement or dispatch activities:



Public Network ⓘ



Private Network ⓘ

Integration Runtime Setup

X

ADF manages the integration runtime in Azure to connect to required data source/destination or external compute in public network. The compute resource is elastic allocated based on performance requirement of activities.

Name *

ⓘ

integrationRuntime3

Description

Enter description here...

Type

Azure

Region *

Central US

Orchestration

Units: Activity Runs

Activity Run: Single run or re-run of an activity or trigger

Where the activity is orchestrated	Price
Azure Integration Runtime (Public Network environment)	0 – 50K runs: \$.55/1k runs 50K+ runs: \$.50/1k runs
Self-Hosted Integration Runtime (Private Network environment)	\$.75/1K runs

Data Movement

Units: DMU

DMU: Unit of measure used to copy data from source to sink

	Price
Azure Integration Runtime (Public Network environment)	\$0.125/hr
Self-Hosted Integration Runtime (Private Network environment)	\$0.05/hr

Inactive Pipelines (Pipelines not associated with a trigger with zero runs for a week) : \$.20 / week

Azure Integration Runtime for SSIS

VM	Price for Standard Edition \$/hr	Price for Enterprise Edition \$/hr
A4 v2 (4core)	\$0.420	\$0.956
A8 v2 (8core)	\$0.862	\$1.935
D1 v2 (1core)	\$0.296	\$0.832
D2 v2 (2core)	\$0.397	\$0.933
D3 v2 (4core)	\$0.599	\$1.136
D4 v2 (8core)	\$1.199	\$2.271

The ADF Azure-SSIS IR is a fully-managed service to execute your SSIS packages. You can specify the VM type and the number of nodes for your dedicated IR environment. Note that you have to pay for a SQL Azure DB instance separately in order to host the SSIS catalog in the cloud. If you are using the Azure Data Factory to move data outside Azure network, you are required to pay for the amount of the data egress.

Note that these VM prices are discounted rates from the list prices of SQL Server VMs.

Enterprise SKUs for SSIS will not be available during public preview.

Scenario 1: Data movement across different data sources

Suppose you have a pipeline that has:

1. Copy Activity 1 moves data from On-Premises SQL Server to Azure Blob to be consumed later by a customized application
2. Copy Activity 2 moves data from Azure Blob to Azure SQL Database

Assume that the copy from On-Premises SQL Server to Azure Blob takes 2 hours. And the copy from Azure Blob to Azure SQL Database takes 1 hour with 2 DMUs. The pipeline is executed 30 times in a month.

Copy from On-Premises SQL Server to Azure Blob:

Data Movement: 30 activity runs X 2 hours duration for every run X \$0.05 = \$3

Activity Runs on Self-Hosted Integration Runtime (30 runs) + \$.75

Subtotal = \$3.75

Copy from Azure Blob to Azure SQL Database:

30 activity runs X 1 hour duration for every run X 2 DMUs x \$.125 = \$7.50

Activity Runs on Azure Integration Runtime (30 runs) + \$0.55

Subtotal = \$8.05

Total Price (per month) \$3.75 + \$8.05 = \$11.80

Scenario 2: Orchestrating data transformation activities on compute services

Suppose you have a pipeline that has:

1. Spark Activity to run Spark application on an Azure HDInsight cluster in Azure Virtual Network
2. Azure Data Lake Analytics U-SQL Activity to execute U-SQL on Azure Data Lake Analytics

Assume the pipeline was executed for 30 times in one month.

Spark Activity Data Movement \$0

Activity Runs on Self-Hosted Integration Runtime (30 runs) + \$.75

Subtotal = \$.75

Azure Data Lake Analytics U-SQL Activity Data Movement \$0

Activity Runs on Azure Integration Runtime (30 runs) + \$.55

Subtotal = \$.55

Total Price (per month) **\$1.30**

Scenario 3: Lift & Shift SSIS Packages

Suppose you have set up a SQL Server Standard and SSIS on a local 4-cores physical machine to run your daily ETL workload. Your ETL workload includes 100 SSIS packages and each of these packages takes about 5 mins to run. These packages are executed once daily and it requires about 8 hours each day to complete all the packages.

In order to lift and shift your SSIS package execution to Azure Data Factory, you need to provision the SSIS dedicated Integration Runtime via the Azure Data Factory portal

During the provision, you need to select the VM Type that match closely to the compute power you use on-premises. In this example, we will choose the A4 v2 type and 1 node to match the compute power on-premises. You are also required to create a SQL Azure Database instance for hosting the SSIS catalog on Azure.

We choose the S0 Standard for this example. SSIS Integration Runtime is a dedicated pool so the compute resource is dedicated only for you (not shared with other user). You can choose to keep the dedicated integration runtime pool 24/7 available or you can choose to spin it up and down

Integration Runtime Dedicated for 24/7	Cost
SSIS Integration Runtime – A4 v2	\$0.42 / hr
X 1 node	
X 24 hours / day (dedicated pool)	
X 31 days / month	
SSIS Integration Runtime 24/7 cost =	\$312.48 / month
SQL Azure for SSIS Catalog – S0	\$0.02 / hr
X 24 hours / day	
X 31 days / month	
SQL Azure for SSIS Catalog Cost =	\$15.03 / month
Total monthly cost to run SSIS ETL workload	\$327.51 / month

Integration Runtime Dedicated for the execution time only	Cost
SSIS Integration Runtime – A4 v2	\$0.42 / hr
X 1 node	
X 8 hours / day (dedicated pool)	
X 31 days / month	
SSIS Integration Runtime 24/7 cost =	\$104.16 / month
SQL Azure for SSIS Catalog – S0	\$0.0202 / hr
X 24 hours / day	
X 31 days / month	
SQL Azure for SSIS Catalog Cost =	\$15.03 / month
ADF to orchestrate the start / stop SSIS Integration runtime	
2 custom activities – start / stop IR	2 activity runs / day
X 31 days / month	
Total ADF Activity Cost	\$.55 / month for 1 – 1000 runs
Total monthly cost to run SSIS ETL workload	\$119.74 / month

Graphical user interface tools

A side-by-side comparison of the capabilities and features

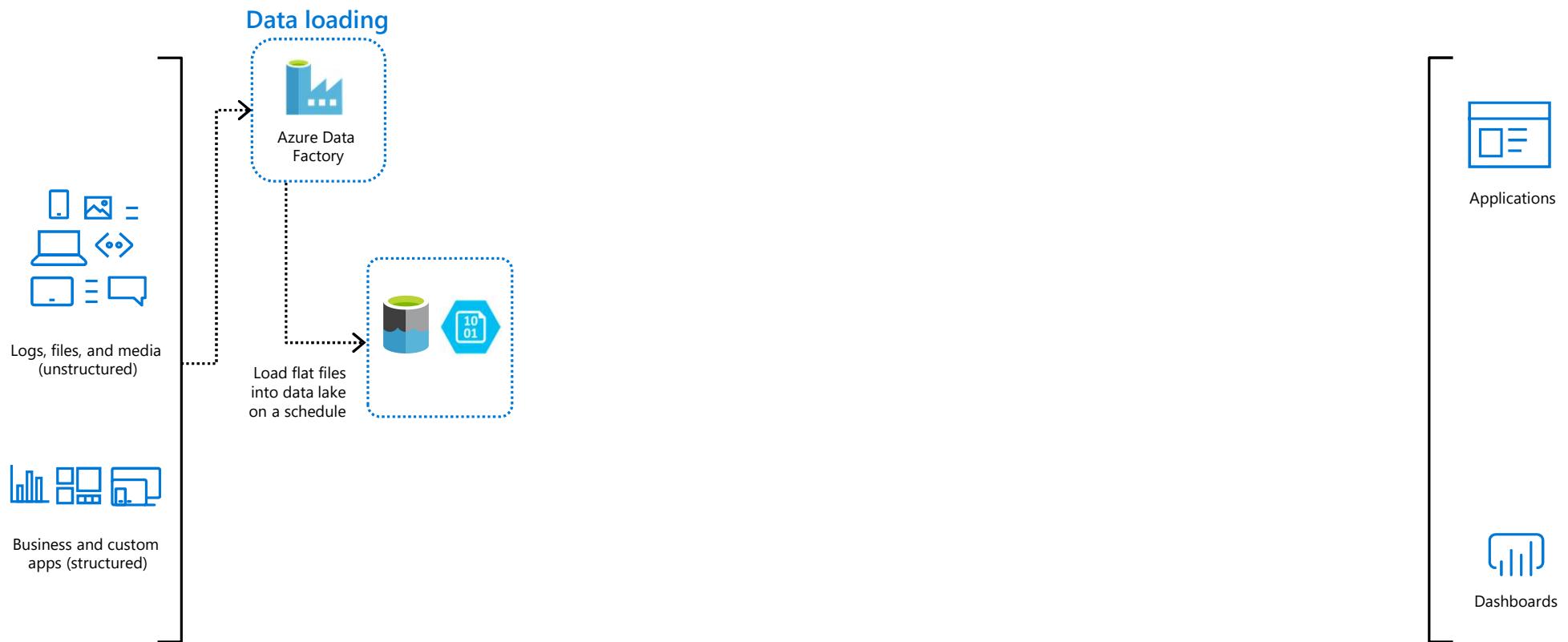
	Azure Storage Explorer	Azure Portal*	Azure Data Factory
Copy to and from relational database	No	No	Yes
Copy to blob storage	Yes	No	Yes
Copy from blob storage	Yes	No	Yes
Copy to data lake store	No	No	Yes
Copy from data lake store	No	No	Yes
Upload to blob storage	Yes	Yes	Yes
Upload to data lake store	Yes	Yes	Yes
Orchestrate data transfers	No	No	Yes
Custom data transformations	No	No	Yes

* Azure Portal in this case means using the web-based exploration tools for blob storage and data lake store. This excludes using the portal for other services, such as Azure Data Factory.

Introduction to Azure Storage

Data warehousing pattern in Azure

Loading data into ingest storage



File storage

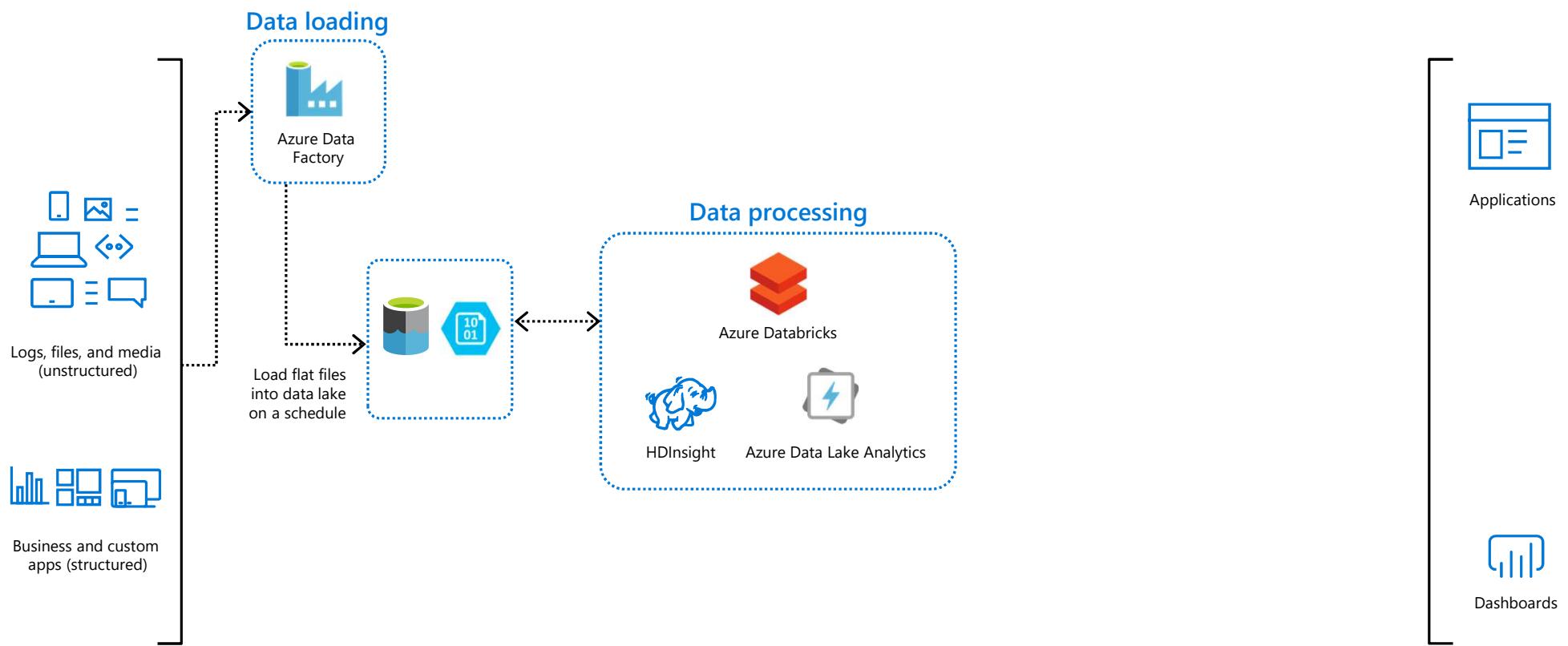
A side-by-side comparison of the capabilities and features

	Azure Data Lake Store	Azure Blob Storage containers
Purpose	Optimized storage for Big Data analytics workloads	General purpose object store for a wide variety of storage scenarios
Structure	Hierarchical file system	Object store with flat namespace
API	REST API over HTTPS	REST API over HTTP/HTTPS
Analytics workload performance	Optimized performance for parallel analytics workloads, high throughput and IOPS	Not optimized for analytics workloads
Size limits	No limits on account sizes, file sizes, or number of files	Max 500 TB per account and 4.75 TB per file
Geo-redundancy	Locally-redundant (multiple copies of data in one Azure region)	Locally redundant (LRS), globally redundant (GRS), and read-access globally redundant (RA-GRS). See Azure Storage replication for more information
Service state	Generally available	Generally available
Regional availability	Some regions	All regions

Introduction to Azure Databricks

Data warehousing pattern in Azure

Loading data into ingest storage

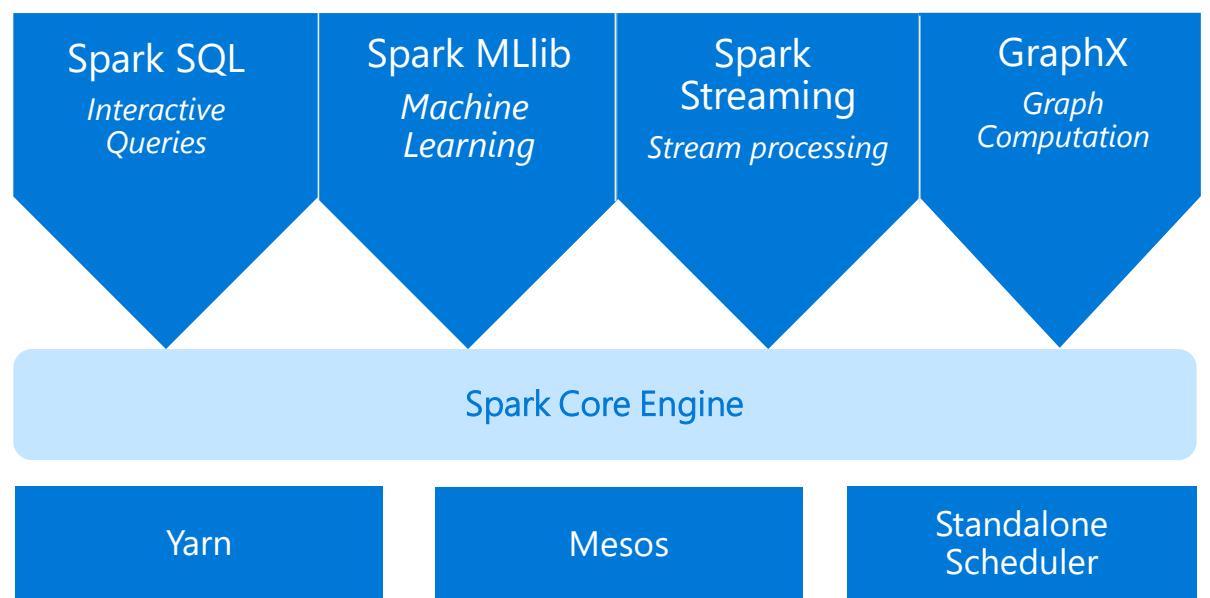


Apache Spark

An unified, open source, parallel, data processing framework for Big Data Analytics

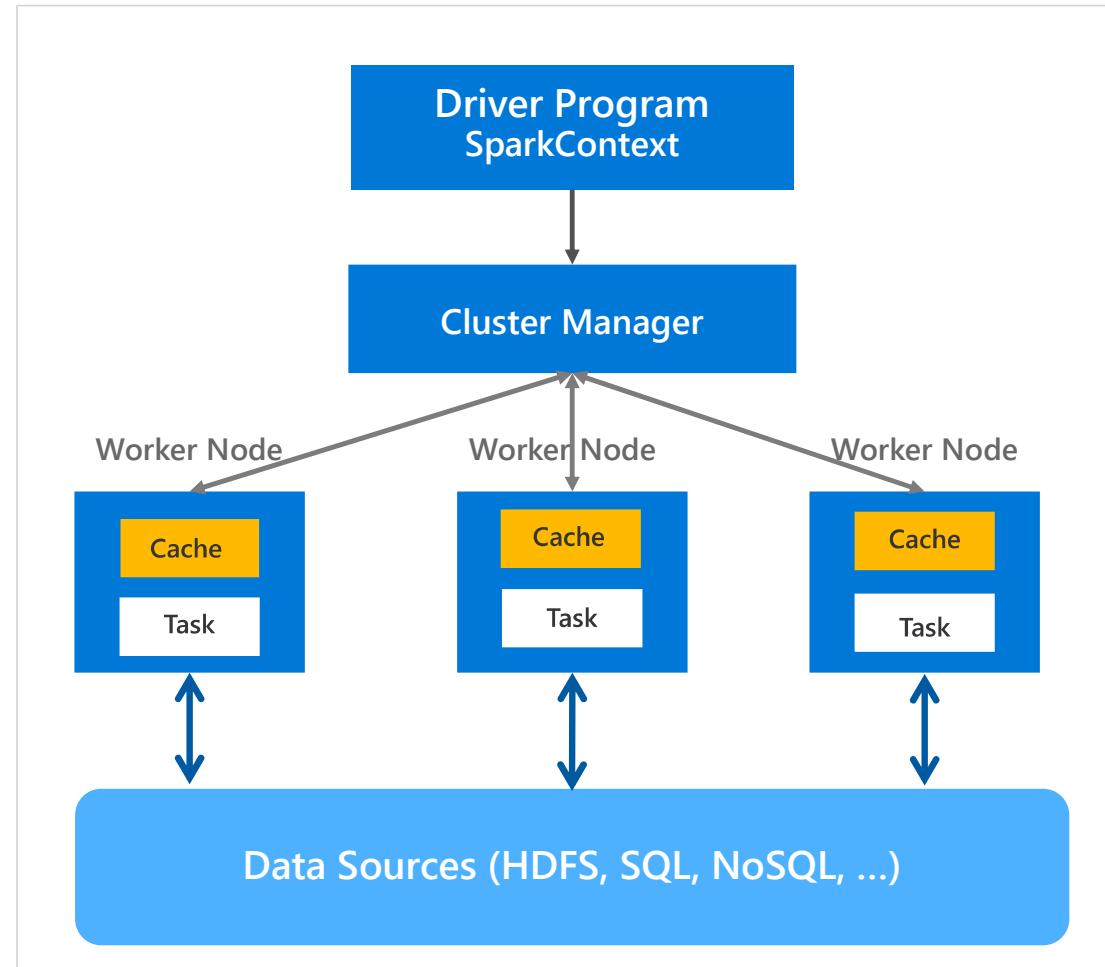
Spark Unifies:

- Batch Processing
- Interactive SQL
- Real-time processing
- Machine Learning
- Deep Learning
- Graph Processing



General Spark Cluster Architecture

- 'Driver' runs the user's 'main' function and executes the various parallel operations on the worker nodes.
- The results of the operations are collected by the driver
- The worker nodes read and write data from/to Data Sources including HDFS.
- Worker node also cache transformed data in memory as RDDs (Resilient Data Sets).
- Worker nodes and the Driver Node execute as VMs in public clouds (AWS, Google and Azure).



Data Engineering system requirement

Data Management



Big Data



Fast Data



Schema Mgmt



Data Consistency



Fast Reads

Platform Management



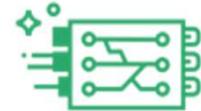
Resource Estimation



Failure Recovery



Automatic Upgrades



Distributed Framework



Elastic Scalability



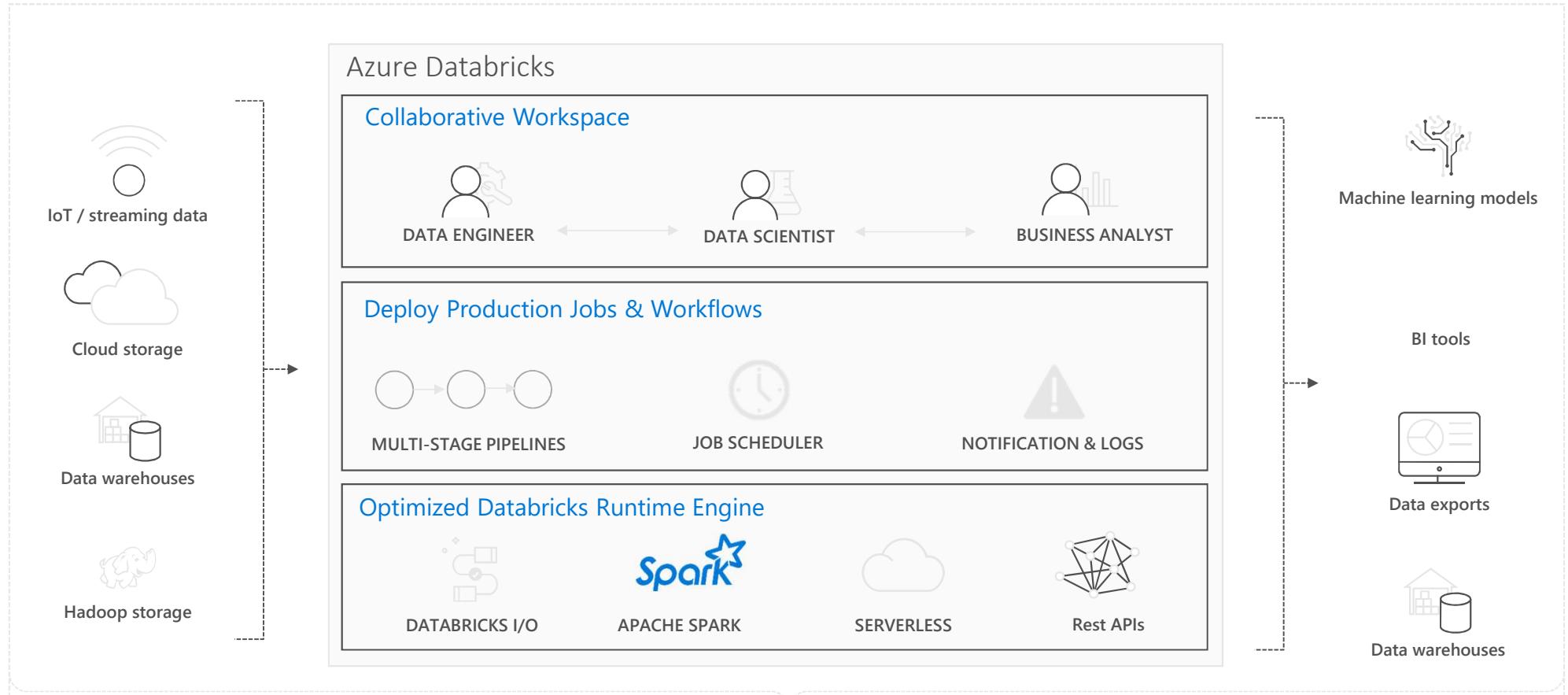
Tooling & Integration

Infrastructure Management



Managed as a Service

Databricks



© Microsoft Corporation

Enhance Productivity

Build on secure & trusted cloud

Scale without limits

Provisioning Azure Databricks Workspace

- Azure Databricks is provisioned directly from the Azure Portal like any other Azure service
 - In contrast, with other clouds, it has to be provisioned through the Databricks portal.
 - With Azure Databricks, the Azure Portal offers a unified portal to provision and administer Azure Databricks as well as other Azure services.
- Any Azure user with the appropriate subscription and authorization can provision Azure Databricks service*.
 - There is no need for a separate Databricks account

The screenshot shows two consecutive steps in the Azure Portal:

Step 1: Provisioning the Azure Databricks Service

The first window is titled "Azure Databricks Service". It contains fields for provisioning:

- Workspace name: mytestworkspace
- Subscription: Azure conversion - External
- Resource group:
 - Create new: mytestresgroup
 - Use existing
- Location: East US 2

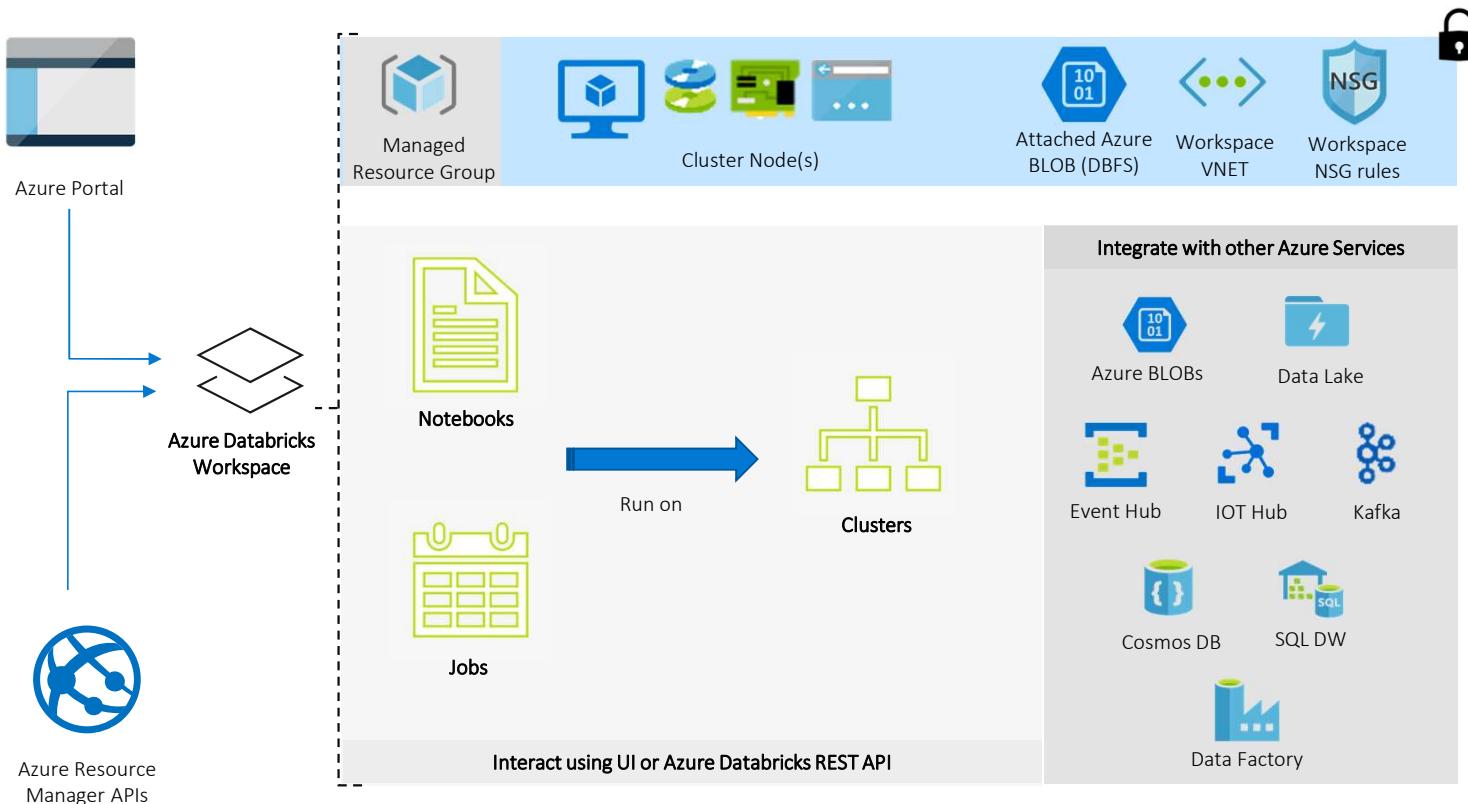
Step 2: After provisioning is complete

The second window is titled "mytestworkspace" and shows the Azure Databricks service dashboard. It includes:

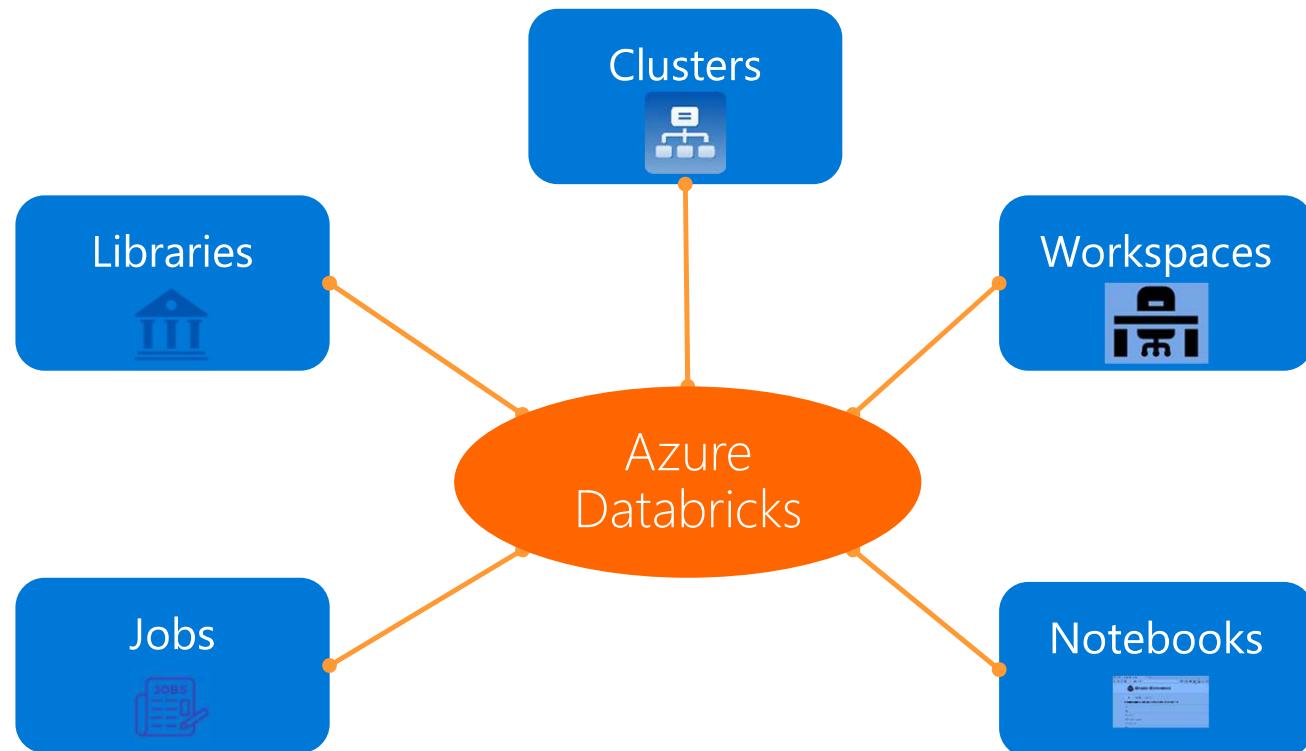
- Overview, Activity log, Access control (IAM), Tags, Settings, Automation script, SUPPORT + TROUBLESHOOTING, New support request.
- Resource group: mytestresgroup
- Subscription ID: 15c5cb6e-191a-40ea-9f69-08207a17fe97
- URL: https://eastus2.azuredatabricks.net
- Managed Resource Group: databricks-rg-mytestworkspace-va64qm...
- Icons for Initialize Workspace, Documentation, Getting Started, Import Data from File, Import Data from Azure Storage, Notebook, Admin Guide.

* During the current preview phase, the subscription has to be whitelisted.

Azure Databricks – Customer view



Azure Databricks Core Artifacts



Cluster Creation

- You can create two types of clusters – *Standard* and *Serverless Pool* (see next slide)
- While creating a cluster you can specify:
 - Number of nodes
 - Autoscaling and Auto Termination policy
 - Auto Termination policy
 - Spark Configuration details
 - The Azure VM instance types for the Driver and Worker Nodes

General Purpose	
Standard_D3_v2 (beta)	14.0 GB Memory, 4 Cores
✓ Standard_DS3_v2 (beta)	14.0 GB Memory, 4 Cores
Standard_DS4_v2 (beta)	28.0 GB Memory, 8 Cores
Standard_DS5_v2 (beta)	56.0 GB Memory, 16 Cores
Standard_D4s_v3 (beta)	16.0 GB Memory, 4 Cores
Standard_D8s_v3 (beta)	32.0 GB Memory, 8 Cores
Standard_D16s_v3 (beta)	64.0 GB Memory, 16 Cores
Memory Optimized	
Standard_DS11_v2 (beta)	14.0 GB Memory, 2 Cores
Standard_DS12_v2 (beta)	28.0 GB Memory, 4 Cores
Standard_DS13_v2 (beta)	56.0 GB Memory, 8 Cores
Standard_DS14_v2 (beta)	112.0 GB Memory, 16 Cores
Standard_DS15_v2 (beta)	140.0 GB Memory, 20 Cores
Standard_E4s_v3 (beta)	32.0 GB Memory, 4 Cores
Standard_F8s_v3 (beta)	64.0 GB Memory, 8 Cores

Create Cluster

New Cluster | [Cancel](#) | [Create Cluster](#) 2-8 Workers: 28.0-112.0 GB Memory, 8-32 Cores, 1.5-6 DBU
1 Driver: 14.0 GB Memory, 4 Cores, 0.75 DBU Cost \$0.55 per DBU

Cluster Name Please enter a cluster name

Cluster Mode Standard

Databricks Runtime Version [Learn more](#) Runtime: 5.3 (Scala 2.11, Spark 2.4.0)

Python Version [Learn more](#) 3 New The default Python version for clusters was changed

Autopilot Options

Enable autoscaling [?](#)

Terminate after minutes of inactivity [?](#)

Worker Type 14.0 GB Memory, 4 Cores, 0.75 DBU Min Workers Max Workers

Driver Type 14.0 GB Memory, 4 Cores, 0.75 DBU

Clusters: Auto Scaling and Auto Termination

Simplifies cluster management and reduces costs by eliminating wastage

When creating Azure Databricks clusters you can choose Autoscaling and Auto Termination options.

Autoscaling: Just specify the min and max number of clusters. Azure Databricks automatically scales up or down based on load.

Auto Termination: After the specified minutes of inactivity the cluster is automatically terminated.

Benefits:

- You do not have to guess, or determine by trial and error, the correct number of nodes for the cluster
- As the workload changes you do not have to manually tweak the number of nodes
- You do not have to worry about wasting resources when the cluster is idle. You only pay for resource when they are actually being used
- You do not have to wait and watch for jobs to complete just so you can shutdown the clusters

Create Cluster

New Cluster Cancel Create Cluster 2-8 Workers: 28.0-112.0 GB Memory, 8-32 Cores, 1.5-6 DBU
1 Driver: 14.0 GB Memory, 4 Cores, 0.75 DBU Cost \$0.55 per DBU

Cluster Name Please enter a cluster name

Cluster Mode Standard

Databricks Runtime Version Runtime: 5.3 (Scala 2.11, Spark 2.4.0)

Python Version 3 New The default Python version for clusters was changed from 2 to 3.

Autopilot Options

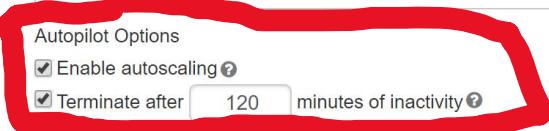
Enable autoscaling

Terminate after 120 minutes of inactivity

Worker Type Standard_DS3_v2 14.0 GB Memory, 4 Cores, 0.75 DBU

Min Workers 2 Max Workers 8

Driver Type Same as worker 14.0 GB Memory, 4 Cores, 0.75 DBU



Cluster Access Control

- There are two configurable types of permissions for Cluster Access Control:
 - *Individual Cluster Permissions* - This controls a user's ability to attach notebooks to a cluster, as well as to restart/resize/terminate/start clusters.
 - *Cluster Creation Permissions* - This controls a user's ability to create clusters
- Individual permissions can be configured on the Clusters Page by clicking on Permissions under the 'More Actions' icon of an existing cluster
- There are 4 different individual cluster permission levels: *No Permissions*, *Can Attach To*, *Can Restart*, and *Can Manage*. Privileges are shown below

Abilities	No Permissions	Can Attach To	Can Restart	Can Manage
Attach notebooks to cluster		x	x	x
View Spark UI		x	x	x
View cluster metrics (Ganglia)		x	x	x
Terminate cluster			x	x
Start cluster			x	x
Restart cluster			x	x
Resize cluster				x
Modify permissions				x



The screenshot shows the 'Actions' dropdown menu for a 'Default Cluster'. The 'Permissions' option is highlighted with a blue background and white text.

Permission Settings for: ntedemodbrstreamingdemoscript

Who has access:

admins (group)	Can Manage
all users (group)	Can Manage
Tom Smith (tom@company.com)	Can Manage

Add Users and Groups:

Jobs

Jobs are the mechanism to submit Spark application code for execution on the Databricks clusters

- Spark application code is submitted as a 'Job' for execution on Azure Databricks clusters
- Jobs execute either 'Notebooks' or 'Jars'
- Azure Databricks provide a comprehensive set of graphical tools to create, manage and monitor Jobs.



Creating and Running Jobs (1/2)

When you create a new Job you have to specify:

- The Notebook or Jar to execute
- Cluster: The cluster on which the Job execute. This could be an exiting or new cluster.
- Schedule i.e. how often the Job runs. Jobs can also be run one time right away.

The screenshot shows the Microsoft Azure Databricks portal interface. On the left, there is a sidebar with icons for Azure Databricks, Home, Workspace, Recent, and Data. The main area displays a job named "My Test Job".
Job Details:

- Job ID:** 12
- Task:** Select Notebook / Set JAR
- Cluster:** Driver: Standard_DS3_v2 (beta), Workers: Standard_DS3_v2 (beta), 126 GB, 3.3 (includes Apache Spark 2.2.0, Scala 2.11) [Edit](#)
- Schedule:** None [Edit](#)
Advanced ▾
Alerts: None [?](#)
- Maximum Concurrent Runs:** 1 [Edit](#)
- Timeout:** None [Edit](#)
- Retries:** None [Edit](#)
- Permissions:** [Edit](#)

Below the main job view, there are two pop-up windows:

- Schedule Job**: A dialog for setting a schedule. It shows "Every 2 hours starting at 01:02 US/Pacific". There is a checkbox for "Show Cron Syntax" and buttons for "Cancel" and "Confirm".
- Upload JAR to Run**: A dialog for uploading a JAR file. It includes fields for "Drop JAR here to upload", "Main class" (with placeholder "com.mycompany.MyClass"), and "Arguments" (with placeholder "arg1 arg2"). It also has "Cancel" and "OK" buttons.

Creating and Running Jobs (2/2)

When you create a new job you can optionally specify advanced options:

- Maximum number of concurrent runs of the Job
- Timeout: Jobs still running beyond the specified duration are automatically killed
- Retry Policy: Specifies if—and when—failed jobs will be retried
- Permissions: Who can do what with jobs. This allows for Job definition and management to be *securely shared* with others (see next slide)

The screenshot shows the Microsoft Azure Portal interface with the following components:

- Left Sidebar:** Includes links for Azure Databricks, Home, Workspace, Recent, and Data.
- Top Bar:** Shows "Microsoft Azure" and "PORTAL" along with a help icon and user profile.
- Main Content Area:** Displays "My Test Job" with "Job ID: 12". It lists the task as "Select Notebook / Set JAR" and the cluster as "Driver: Standard_DS3_v2 (beta), Workers: Standard_DS3_v2 (beta), 126 GB, 3.3 (includes Apache Spark 2.2.0, Scala 2.11) Edit". It also shows the schedule as "None Edit", alerts as "None", maximum concurrent runs as "1 Edit", timeout as "None Edit", retries as "None Edit", and permissions as "Edit".
- Bottom Left Modal:** "Set Retry Policy" dialog. It explains that failing jobs will be retried based on a policy. It has fields for "Retry at most" (set to "1 time") and "and wait" (set to "no time"), with a note about minimal interval between attempts. A checkbox for "Retry on timeouts" is checked. Buttons include "Cancel" and "OK".
- Bottom Right Modal:** "Permission Settings" dialog. It shows who has access: "admins (group)" with "Can Manage" and "Madhu Reddy (snapanalytx@outlook.com)" with "Is Owner". It has sections for "Add Users and Groups" and buttons for "Cancel" and "Save Changes".

Job Access Control

Enables job owners and administrators to grant fine grained permissions on their jobs

- With Jobs Access Controls job owners can choose which other users or groups can view results of the job.
- Owners can also choose who can manage runs of their job (i.e. invoke run now and cancel.)
- There are 5 different permission levels for jobs:
 - No Permissions
 - Can View
 - Can Manage Run
 - Is Owner and
 - Can Manage

Abilities	No Permissions	Can View	Can Manage Run	Is Owner	Can Manage (admin)
View job details and settings	Yes	Yes	Yes	Yes	Yes
View results, Spark UI, logs of a job run		Yes	Yes	Yes	Yes
Run now			Yes	Yes	Yes
Cancel run			Yes	Yes	Yes
Edit job settings				Yes	Yes
Modify permissions				Yes	Yes
Delete job				Yes	Yes
Change owner					Yes

Note: 'Can Manage' permission is reserved for administrators.

Viewing Jobs History

In the Azure Databricks Jobs Portal you can view:

- The list of currently running (Active) Jobs
- History of old Job runs (for up to 60 days)
- The output of a particular Job run (including standard error, standard output, Spark UI logs)

Microsoft Azure PORTAL

Run 6 of Evaluate

Started: 2017-09-28 09:00:00 Pacific Daylight Time
Duration: 26s
Status: Succeeded
Job ID: 1
Task: Notebook at /Users/fmartinezmiranda@outlook.com/ntedemoevaluationtest
Parameters:

- Dependent Libraries:
 - future - (PyPi) Remove

Cluster: ntedemodbrcluster10012017 (42 GB, Running, 3.2 (includes Apache Spark 2.2.0, Scala 2.11)) - View Spark UI / Logs

Output

```
%sh
#rm -rf /dbfs/CNTK
if [ ! -d "/dbfs/CNTK" ]; then
    mkdir /dbfs/CNTK
    cd /dbfs/CNTK
    wget "https://ntedemost9999.blob.core.windows.net/deployment/artifacts%2FcntkPayload.zip?
sr=&sv=2015-02-21&st=2017-09-01T17%3A32%3A19Z&se=2017-09-
30T18%3A32%3A19Z&sp=rw&sig=503EG%2BQb3%2BFudwAMqavJ94hE7TRd6wbDtgCLyfvVdfs%3D"
    unzip cntkPayload.zip
    rm cntkPayload.zip
else
    echo "Already exists"
fi

Already exists
Command took 0.07 seconds
```

Microsoft Azure PORTAL

Evaluate

Job ID: 1
Task: Notebook at /Users/fmartinezmiranda@outlook.com/ntedemoevaluationtest - Edit / Remove
Parameters: Edit
Dependent Libraries: Add

- future - (PyPi) Remove

Cluster: ntedemodbrcluster10012017 (42 GB, Running, 3.2 (includes Apache Spark 2.2.0, Scala 2.11)) Edit
Schedule: None Edit
Advanced ▾

Active runs

Run	Start Time	Launched	Duration	Spark	Status
Run Now / Run Now With Different Parameters					

Completed in past 60 days

Latest successful run (refreshes automatically)

Run	Start Time	Launched	Duration	Spark	Status
Run 11	2017-11-08 23:01:01 Pacific Standard Time	Manually	9s	Spark UI / Logs	Cancelled
Run 10	2017-09-28 09:13:42 Pacific Daylight Time	Manually	21s	Spark UI / Logs	Succeeded
Run 9	2017-09-28 09:12:33 Pacific Daylight Time	Manually	46s	Spark UI / Logs	Succeeded
Run 8	2017-09-28 09:03:05 Pacific Daylight Time	Manually	24s	Spark UI / Logs	Succeeded
Run 7	2017-09-28 09:01:26 Pacific Daylight Time	Manually	24s	Spark UI / Logs	Succeeded
Run 6	2017-09-28 09:00:00 Pacific Daylight Time	Manually	26s	Spark UI / Logs	Succeeded

Workspaces

Workspaces enables users to organize—and share—their Notebooks, Libraries and Dashboards

- Workspaces—sort of like Directories—are a convenient way to organize an user's Notebook, Libraries and Dashboards.
- Everything in a workspace is organized into hierarchical folders. Folders can hold Libraries, Notebooks, Dashboard or more (sub) folders.
 - Icons indicate the type of the object contained in a folder
- Every user has one directory that is private and unshared.
 - By default, the workspace and all its contents are available to users.
- Fine grained access control can be defined on workspaces (next slide) to enable *secure collaboration with colleagues*.

The screenshot shows the Microsoft Azure Databricks workspace interface. On the left is a sidebar with icons for Azure Databricks, Home, Workspace (which is selected), Recent, Data, and Clusters. The main area shows a list of objects under a workspace named "MyTestFolder". The objects include "Documentation", "Release Notes", "Training & Tutorials", "Shared", "Users", and several files and notebooks such as "ConfigureKafkaAccess", "InstallCNTK", "InstallODBC", "ModelEvaluationNotebook", "MyTestFolder", and "StreamingEvaluation". A sub-folder "MySubFolder" is also visible under "MyTestFolder".

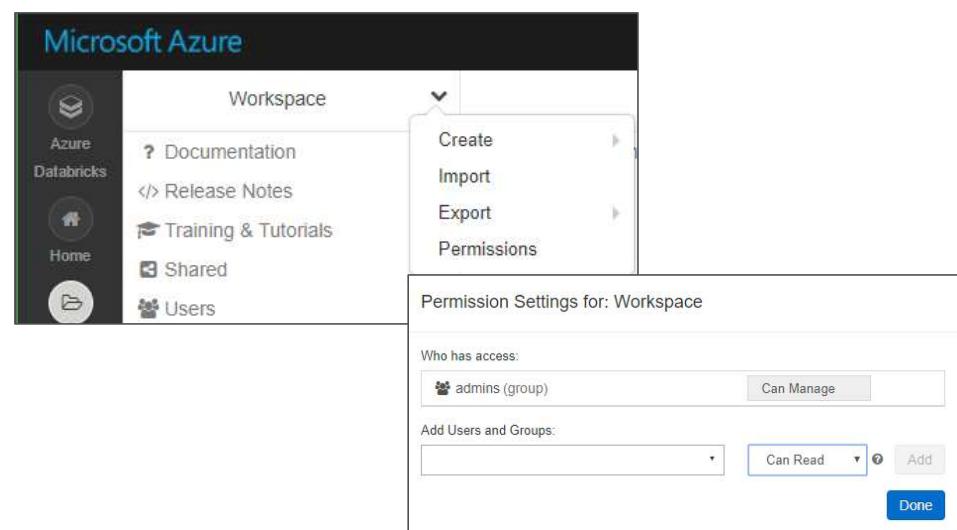
The screenshot shows the Microsoft Azure Databricks workspace interface with a context menu open over the workspace name "Workspace". The menu options are "Create", "Import", "Export", and "Permissions". Other items in the sidebar include "Azure Databricks", "Home", and "Clusters".

Workspace Operations

You can search the entire Databricks workspace

In the Azure Databricks Portal, via the Workspaces drop down menu, you can:

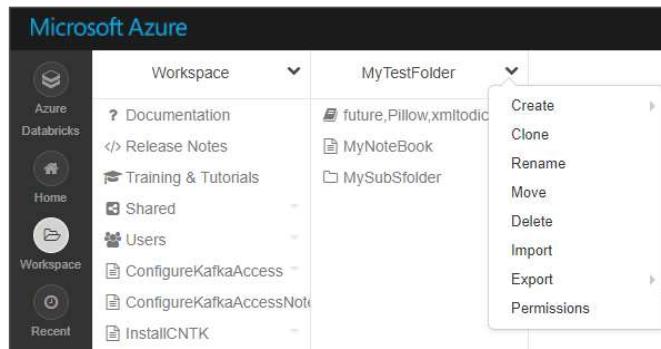
- Create Folders, Notebooks and Libraries
- Import Notebooks into the Workspace
- Export the Workspace to a database archive
- Set Permissions. You can grant 4 levels of permissions
 - Can Manage
 - Can Read
 - Can Edit
 - Can Run



Folder Operations & Access Control

In the Azure Databricks Portal, via the Folder drop down menu, you can:

- Create Folders, Notebooks and Libraries within the folder
- Clone the folder to create a deep copy of the folder
- Rename or delete the folder
- Move the folder to another location
- Export a folder to save it and its contents as a Databricks archive
- Import a saved Databricks archive into the selected folder
- Set Permissions for the folder. As with Workspaces you can set 5 levels of permissions: *No Permissions, Can Manage, Can Read, Can Edit, Can Run*



Abilities	No Permissions	Read	Run	Edit	Manage
Create items					<input checked="" type="checkbox"/>
Delete items					<input checked="" type="checkbox"/>
Move/rename items					<input checked="" type="checkbox"/>
Change permissions					<input checked="" type="checkbox"/>

Abilities associated with each permission level

Azure Databricks Notebooks Overview

Notebooks are a popular way to develop, and run, Spark Applications

- Notebooks are not only for authoring Spark applications but can be *run/executed directly* on clusters
 - Shift+Enter
 - click the ▶ at the top right of the cell in a notebook
 - Submit via Job
- Notebooks support fine grained permissions—so they can be *securely shared* with colleagues for collaboration (see following slide for details on permissions and abilities)
- Notebooks are well-suited for prototyping, rapid development, exploration, discovery and iterative development



Notebooks typically consist of code, data, visualization, comments and notes

Mixing Languages in Notebooks

You can mix multiple languages in the same notebook

Normally a notebook is associated with a specific language. However, with Azure Databricks notebooks, you can mix multiple languages in the same notebook. This is done using the language magic command:

- `%python` Allows you to execute python code in a notebook (even if that notebook is not python)
- `%sql` Allows you to execute sql code in a notebook (even if that notebook is not sql).
- `%r` Allows you to execute r code in a notebook (even if that notebook is not r).
- `%scala` Allows you to execute scala code in a notebook (even if that notebook is not scala).
- `%sh` Allows you to execute shell code in your notebook.
- `%fs` Allows you to use Databricks Utilities - dbutils filesystem commands.
- `%md` To include rendered markdown

Libraries Overview

Enables external code to be imported and stored into a Workspace

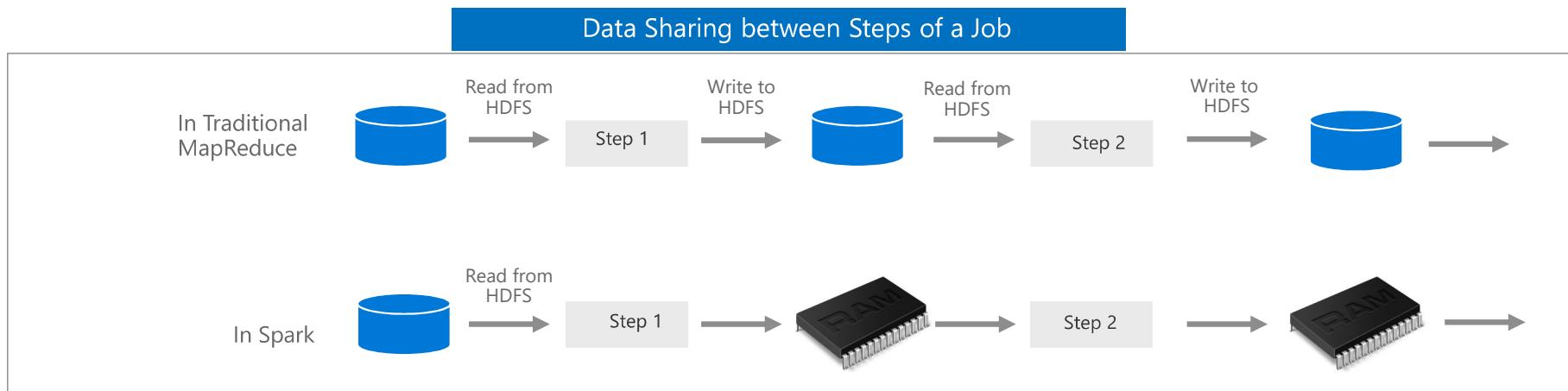
- Libraries are containers to hold all your *Python, R, Java/Scala* libraries.
- Libraries resides within workspaces or folders.
- Libraries are created by importing the source code
- After importing libraries are immutable—can be deleted or overwritten only.
- You can customize installation of libraries via [Init Scripts](#) by writing custom UNIX scripts
- Libraries can also be managed via the [Library API](#)

The image displays three separate screenshots of the Microsoft Azure Databricks portal's 'Create Library' interface, each showing a different way to import a library:

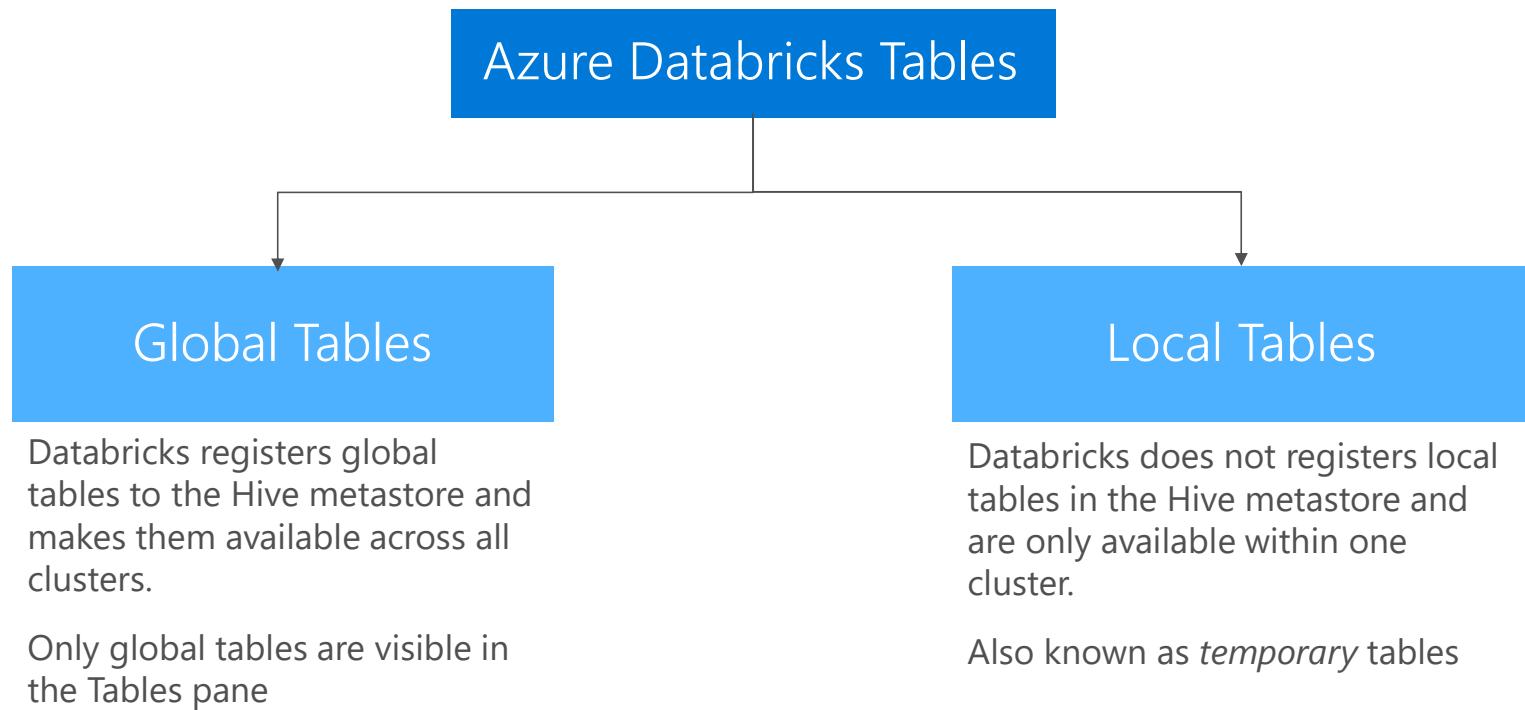
- Top Left (Python):** Shows the 'New Library' screen for Python. It includes fields for 'Language' (set to 'Upload Python Egg or PyPi'), 'PyPi Name' (e.g., simplejson==3.8.0), and 'Egg File'. A 'Create Library' button is at the bottom.
- Top Right (R):** Shows the 'New Library' screen for R. It includes fields for 'Source' (set to 'R Library'), 'Install from' (set to 'CRAN-like Repository'), 'Repository' (set to 'https://cloud.r-project.org'), and 'Package'. A 'Create Library' button is at the bottom.
- Bottom (Java/Scala):** Shows the 'New Library' screen for Java/Scala. It includes fields for 'Source' (set to 'Upload Java/Scala JAR'), 'Library Name' (e.g., My Library), and 'JAR File'. A 'Create Library' button is at the bottom.

What Makes Spark Fast ?

- **In-memory cluster computing:** Spark provides primitives for *in-memory* cluster computing. A Spark job can *load and cache* data into memory and query it repeatedly (iteratively) much quicker than disk-based systems.
- **Scala Integration:** Spark integrates into the [Scala](#) programming language, letting you manipulate distributed datasets like local collections. No need to structure everything as map and reduce operations
- **Faster Data-sharing:** Data-sharing between operations is faster as data is in-memory:
 - In (traditional) Hadoop data is shared through HDFS which is expensive. HDFS maintains three replicas.
 - Spark stores data in-memory *without any replication*.



Local & Global Tables



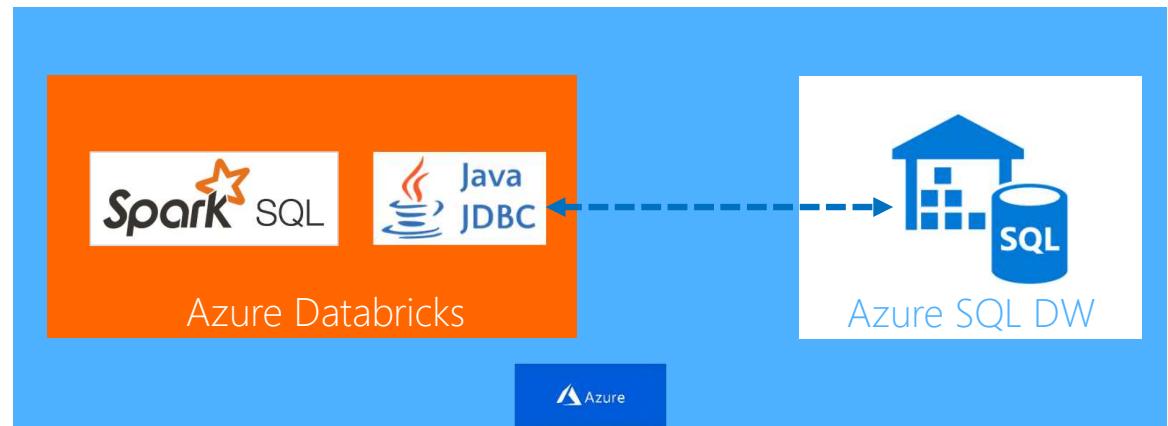
Azure SQL DW Integration

Integration enables structured data from SQL DW to be included in Spark Analytics



Azure SQL Data Warehouse is a SQL-based fully managed, petabyte-scale cloud solution for data warehousing

- You can bring in data from Azure SQL DW to perform advanced analytics that require both structured and unstructured data.
- Currently you can access data in Azure SQL DW via the [JDBC driver](#). From within your spark code you can access just like any other JDBC data source.
- If Azure SQL DW is authenticated via AAD then Azure Databricks user can seamlessly access Azure SQL DW.



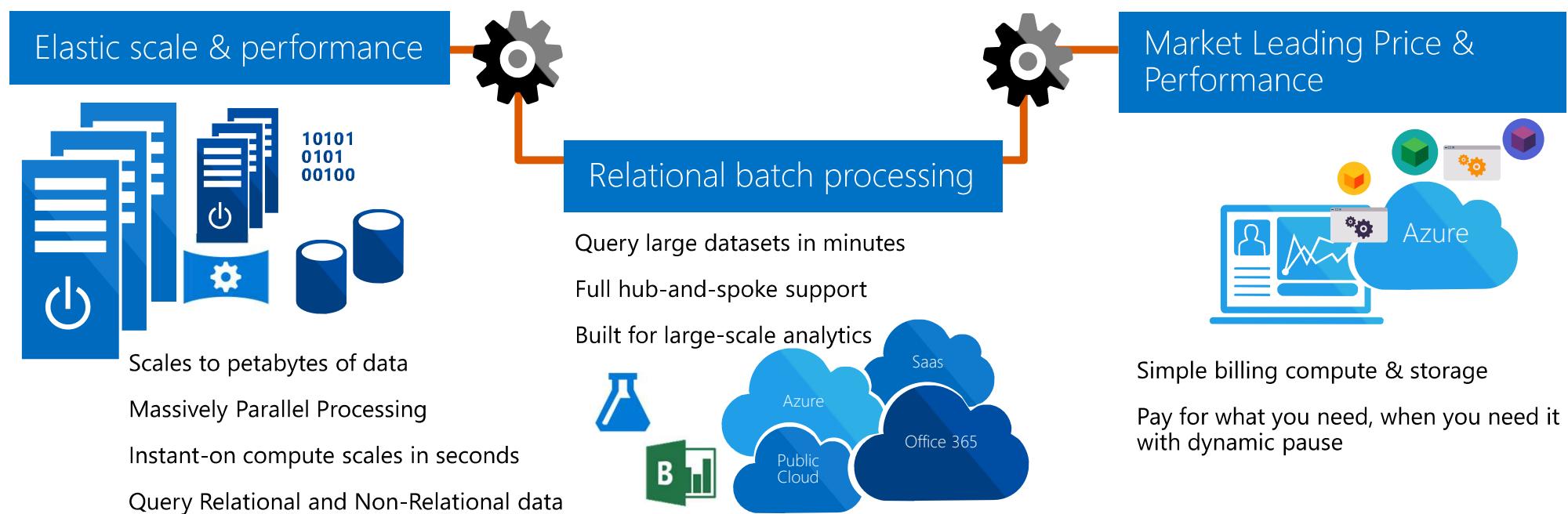
Batch data processing

A side-by-side comparison of general capabilities and features

	Azure Data Lake Analytics	HDInsight	Azure Databricks
Is a managed service	Yes	Yes	Yes
Auto-scaling	No	No	Yes
Supports pausing compute	No	No	Yes
Programmability	U-SQL	Python, Scala, Java, R, SQL	Python, Scala, Java, SQL, R
Programming paradigm	Mixture of declarative and imperative	Mixture of declarative and imperative	Mixture of declarative and imperative
Pricing model	Per job (by job run per hour times analytics unit used)	By cluster hour	By cluster hour

Introduction to Azure SQL data warehouse

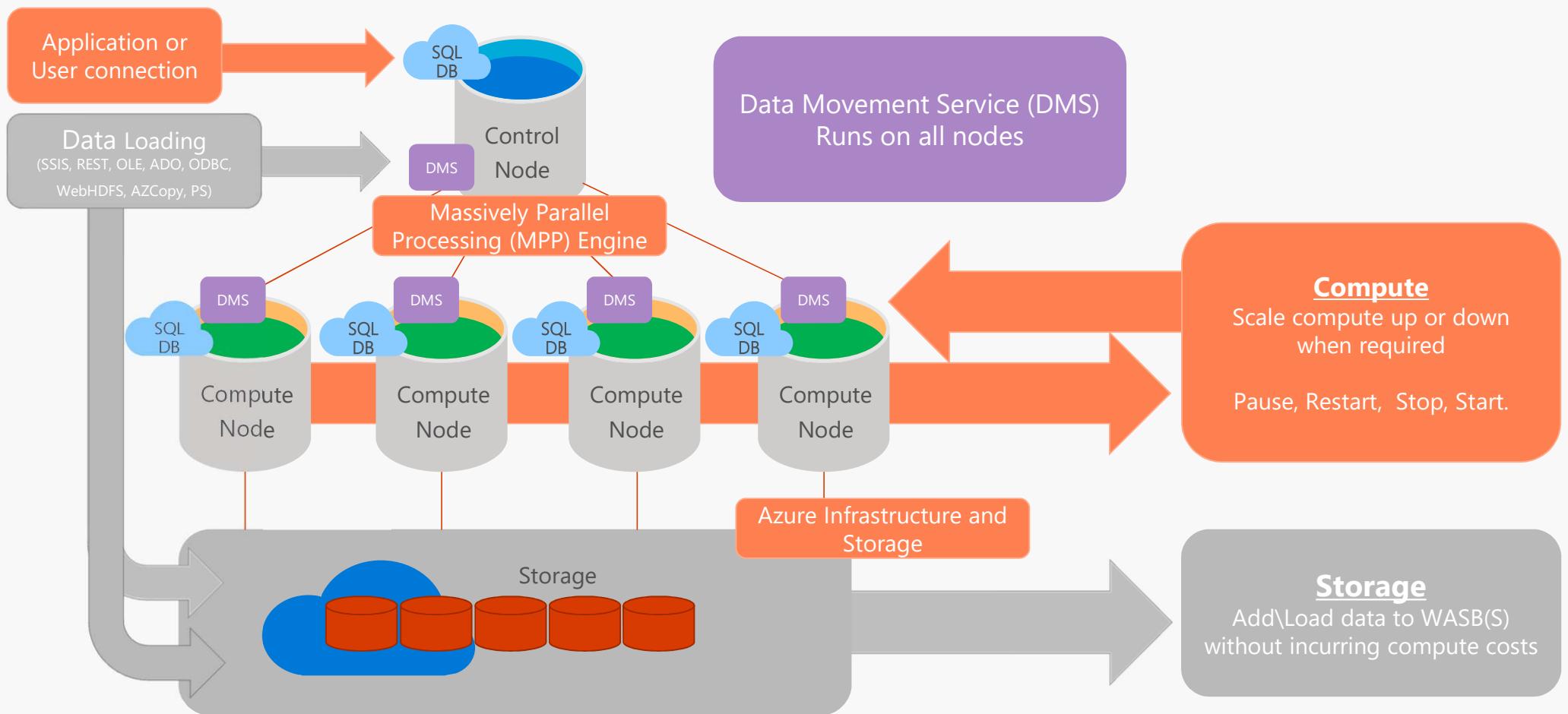
Azure SQL Data Warehouse



Sets it different..

- Separate compute from storage
- Independently scale compute
- Pause and resume workload
- Supports Rowstore & Columnstore
- Scale out = Distributed tables
- Local or Geo-redundancy
- Parallel Loading with PolyBase

Azure SQL Data Warehouse Architecture



Control node

- Accepts requests from user and transforms it into separate queries that run on each compute node in parallel
- Coordinates all of the data movement and computation required to run parallel queries
- Interprets requests for scale-out
- Orchestrates actions / steps
- Final computation
- Returns result

- ✓ Runs SQL Server
- ✓ Stores metadata, statistics
- ✓ Performs final computation

Requires distributed query engine

Compute node

- Power behind the SQL DW; Performs the heavy lift
 - Accepts requests from control node
- Is a highly tuned SMP System
 - Optimises requests from control node
- SQL Databases that store data
- Workers that run parallel queries on data

No direct user interaction

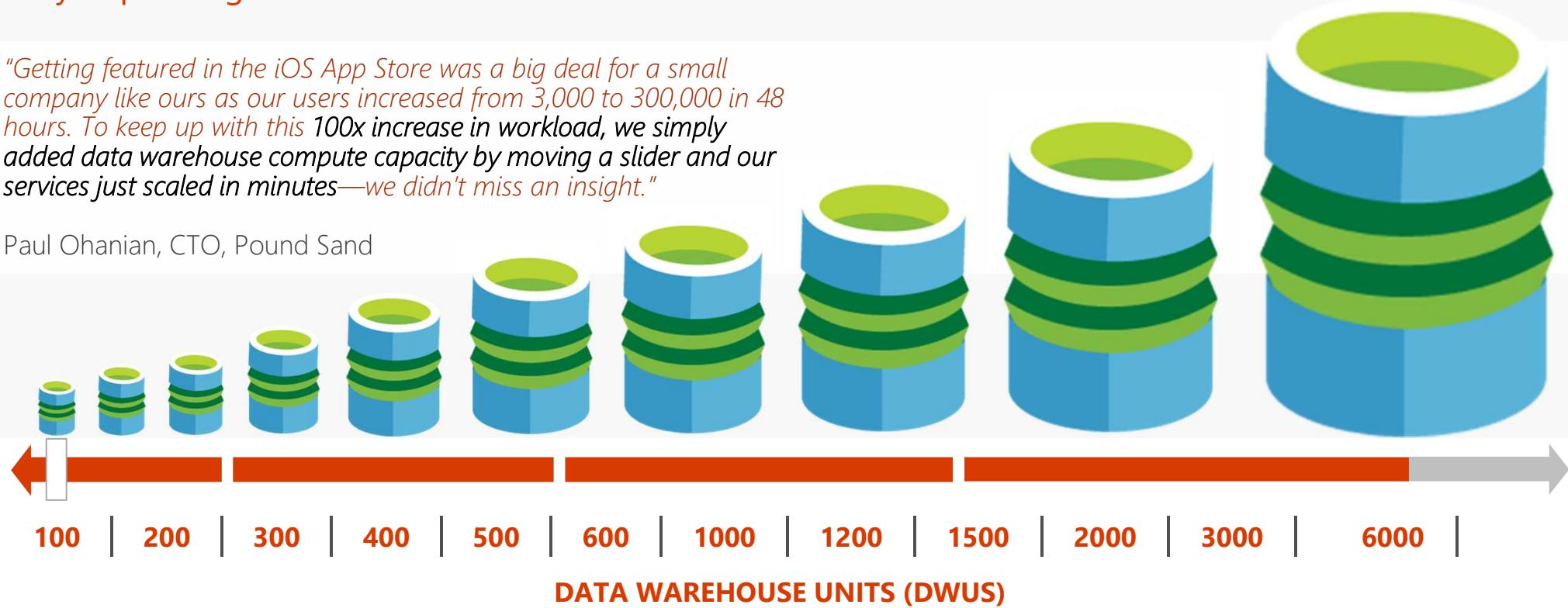
Uses SQL Server

Scale compute on the fly when you need it

Data Warehouse Units (DWUs) are a measure of reserved compute performance or 'power.' A customer's DWU needs can vary depending on the needs of their workload.

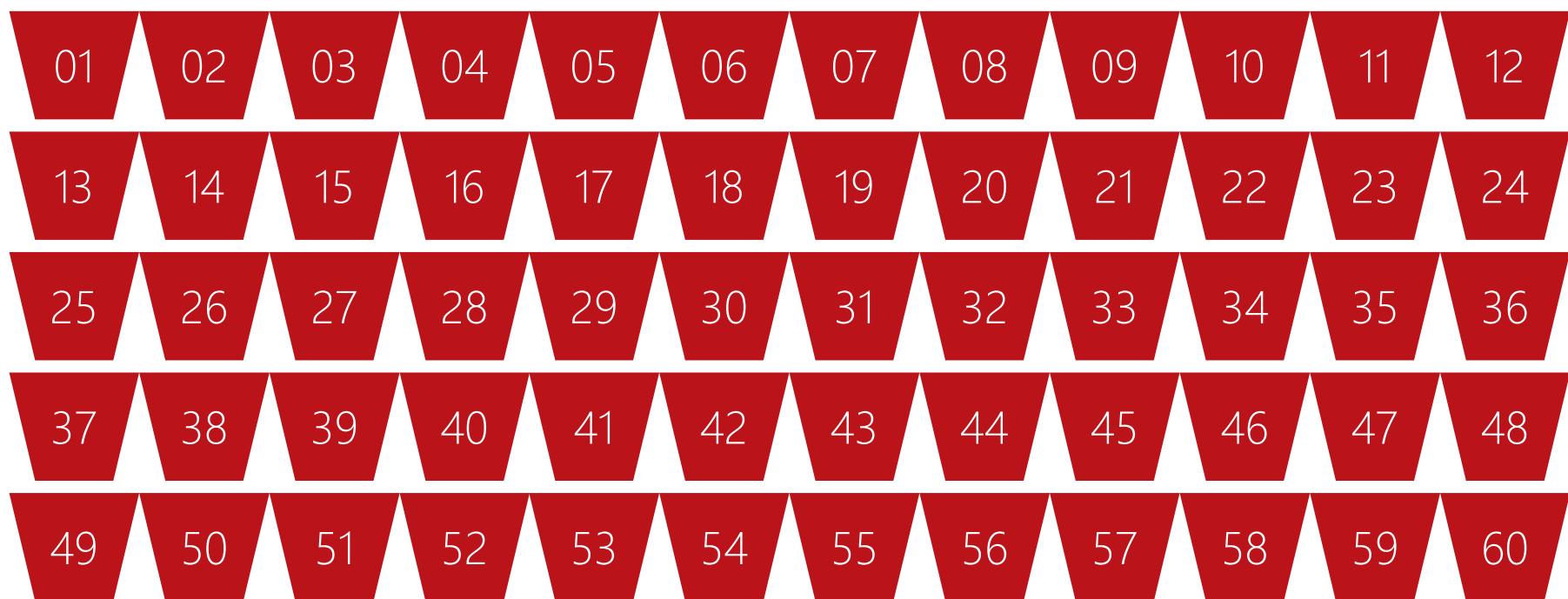
"Getting featured in the iOS App Store was a big deal for a small company like ours as our users increased from 3,000 to 300,000 in 48 hours. To keep up with this 100x increase in workload, we simply added data warehouse compute capacity by moving a slider and our services just scaled in minutes—we didn't miss an insight."

Paul Ohanian, CTO, Pound Sand



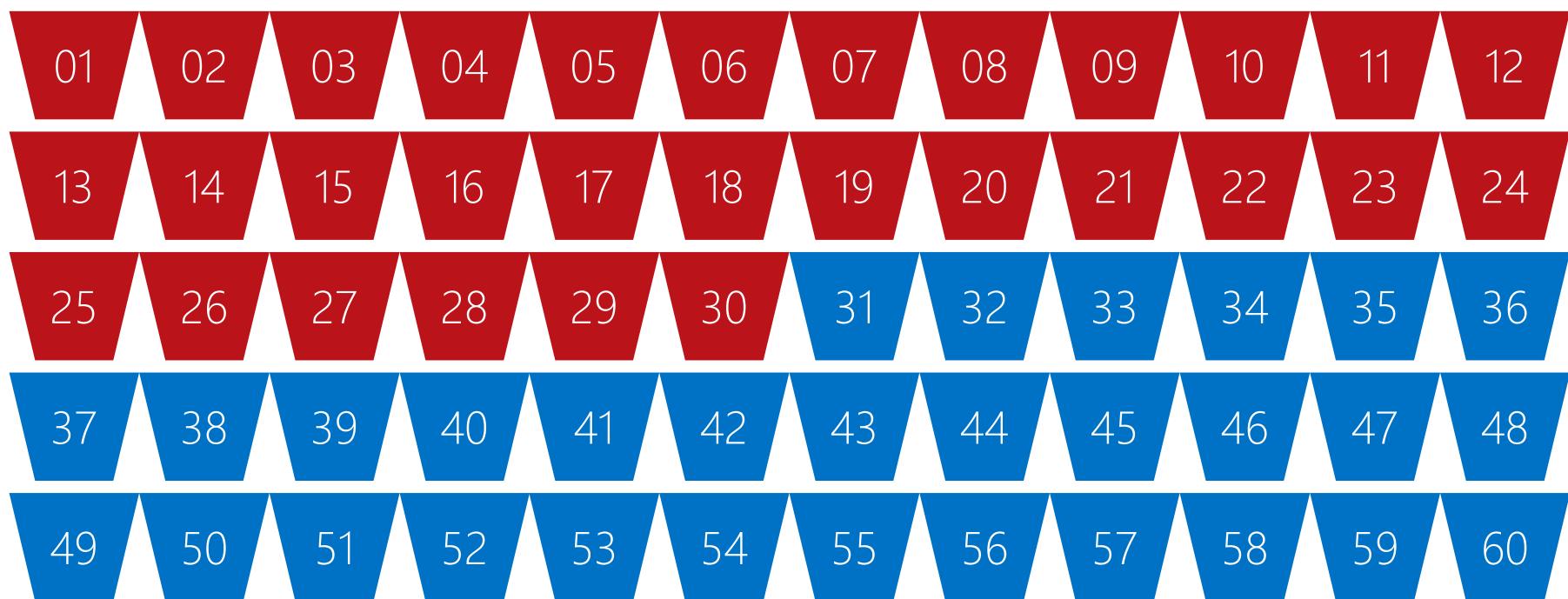
Mapping Compute in SQLDW

DW100

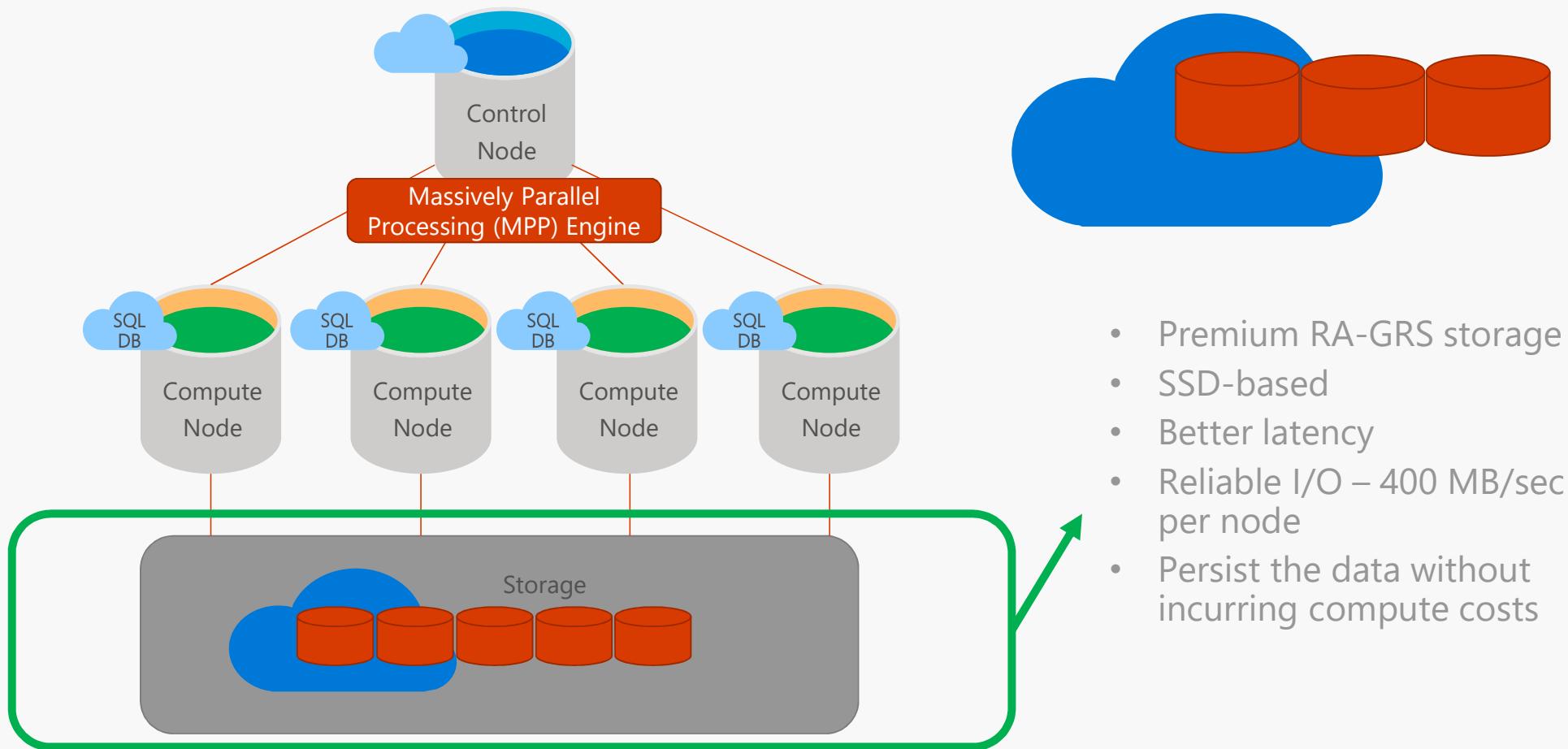


Mapping Compute in SQLDW

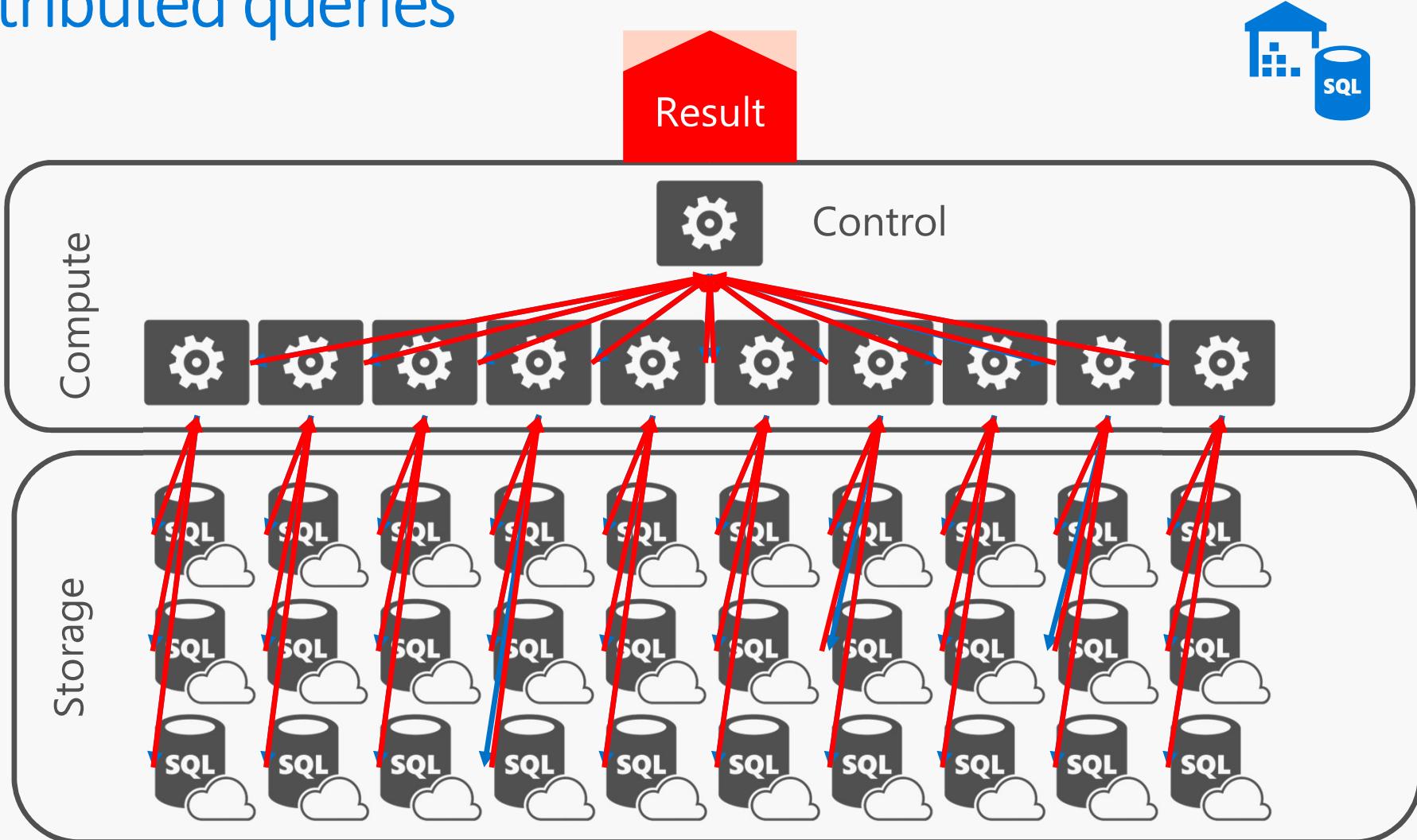
DW200



Azure SQL Data Warehouse – premium storage



Distributed queries



Distributed Data = Buckets of Water



Evenly spreading the data leads to even use application resources

Table Distribution Options

Hash Distributed

Data divided across nodes based on hashing algorithm

Same value will always hash to same distribution

Single column only

Round Robin (Default)

Data distributed evenly across nodes

Easy place to start, don't need to know anything about the data

Simplicity at a cost

Replicated

Data repeated on every node

Simplifies many query plans and reduces data movement

Best with joining hash table

Check for Data Skew,
NULLS, -1

Will incur more data movement at query time

Consumes more space
Joining two Replicated Table runs on one node

Optimizing with Indexes

Clustered Column Store (SQL DW Default)	Heap	Clustered Index
<ul style="list-style-type: none">Optimal choice for large tablesLimits scans to columns in the queryOptimal compressionSlower to load than HeapKeep partitions large enough to compress (> 1 million rows)	<ul style="list-style-type: none">Optimal choice for temporary or staging tablesFastest load performance	<ul style="list-style-type: none">Optimal for tables < 60M rowsSorting operation slows down load
Non-clustered Indexes		
<ul style="list-style-type: none">Use sparinglyOptimize single row lookupsWill slow down load		

The most secure and compliant cloud data warehouse

Enterprise Grade Security

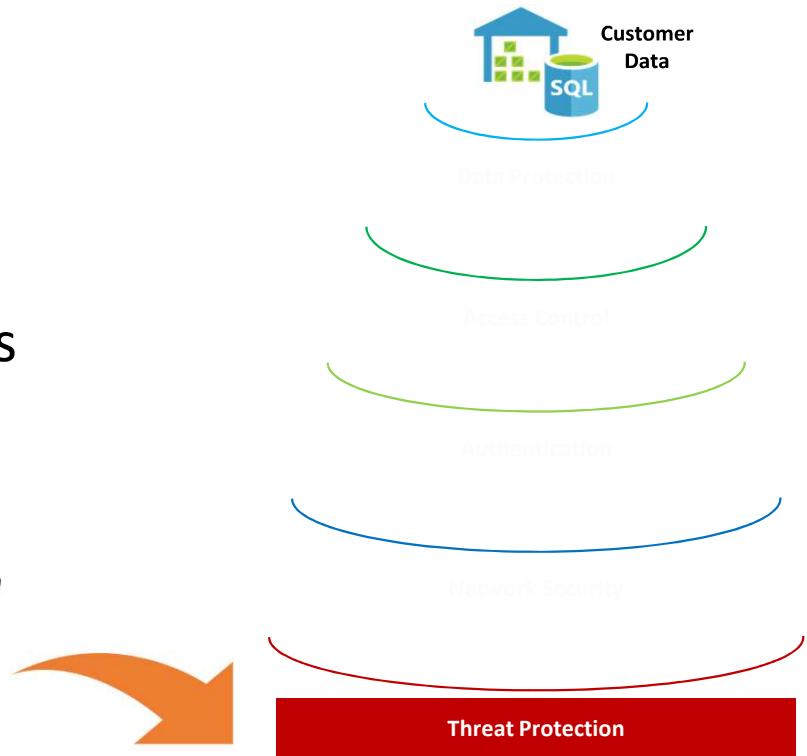


Industry Leading Security

Category	Feature	SQL Data Warehouse	Amazon Redshift	Snowflake	Google Big Query
Data Protection	Data In Transit	Yes	Yes	Yes	No
	Data encryption at rest (Service & User Managed Keys)	Yes	Yes	Yes	Yes
	Data In Use (Always Encrypted)	No	No	No	No
	Data Discovery and Classification	Yes (March 2019)	No	No	No
Access Control	Native Row Level Security	Yes	No	No	No
	Table and View Security (GRANT / DENY)	Yes	Yes	Yes	Yes
	Column Level Security	Yes	No	No	No
Authentication	SQL Authentication	Yes	Yes	Yes	No
	Native Azure Active Directory	Yes	No	Yes	No
	Integrated Security	Yes	Yes	Yes	Yes
	Multi-Factor Authentication	Yes	Yes	Yes	Yes
Network Security	Virtual Network (VNET)	Yes	Yes	Yes	Yes
	SQL Firewall (server)	Yes	Yes	Yes	No
Threat Protection	SQL Threat Detection	Yes	Yes	No	No
	SQL Auditing	Yes	Yes	No	Yes
	Vulnerability Assessment	Yes	Yes	No	No

Business Requirements

- How do I discover potential database vulnerabilities?
- How do my auditors know if my data is compliant?
- How do I monitor malicious activities?



SQL Vulnerability Assessment

Discover, track, and remediate security misconfigurations

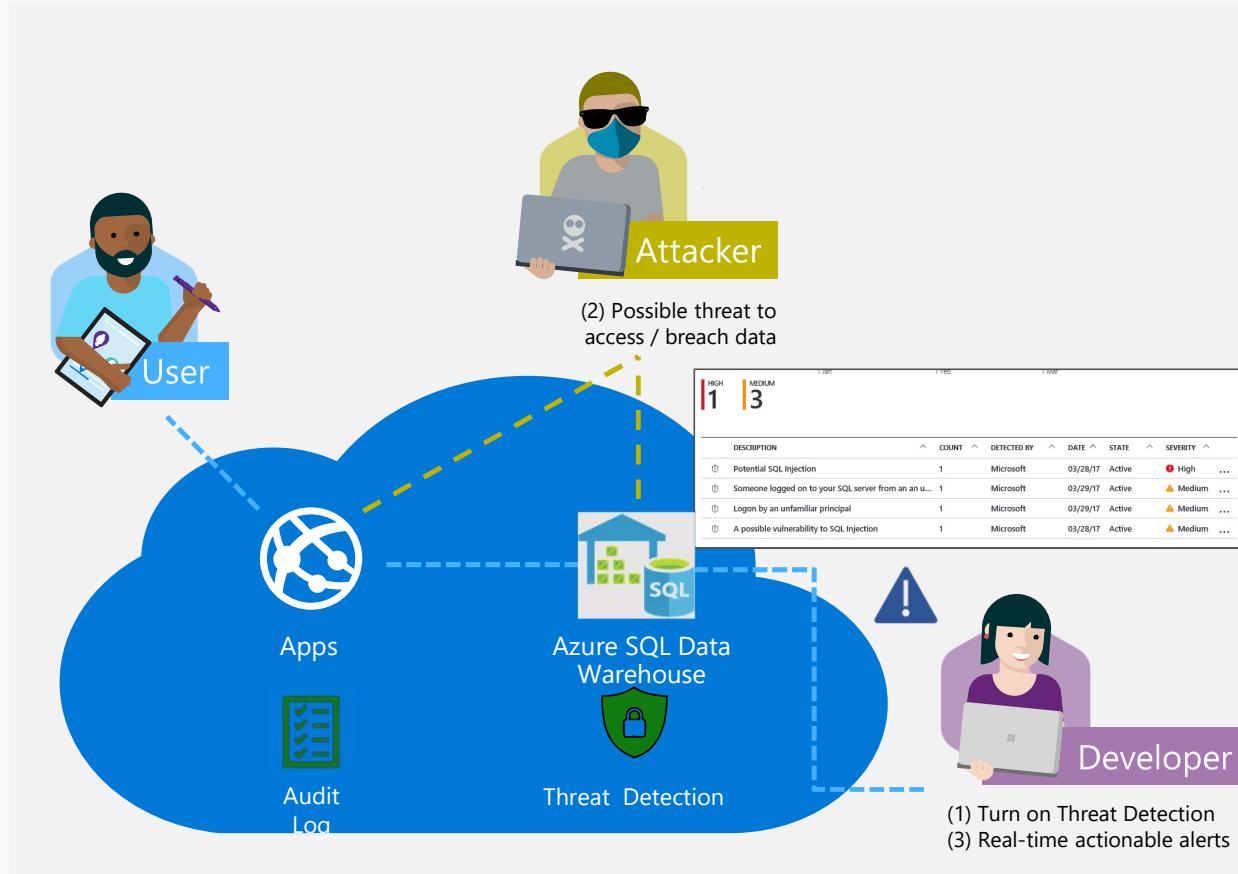
The screenshot shows the SQL Vulnerability Assessment interface. At the top, there are navigation links: Scan, Export Scan Results, Scan History, Settings, and Feedback. Below these are statistics: Total failing checks (1 with a red X), Total passing checks (40 with a green checkmark), Risk summary (High Risk: 1, Medium Risk: 0, Low Risk: 0), and Last scan time (Wed, 12 Sep 2018 22:26:04 UTC). The main area shows two tabs: Failed (1) and Passed (40), with the Passed tab selected. A search bar at the bottom allows filtering by ID or security check, category, and status.

ID	SECURITY CHECK	APPLIES TO
VA1288	Sensitive data columns should be classified	KavithaDWVATesting
VA1020	Server principal GUEST should not be a member of any role	KavithaDWVATesting

- ✓ Identify security misconfigurations
- ✓ Actionable remediation steps
- ✓ Security baseline tuned to your environment
- ✓ Manual/periodic scans
- ✓ Coherent reports for auditors

SQL Threat Detection

Detect unusual and harmful attempts to breach your data



- ✓ Detects potential SQL injection attacks
- ✓ Detects unusual access & data exfiltration activities
- ✓ Actionable alerts to investigate & remediate
- ✓ View alerts for your entire Azure tenant using Azure Security Center

How Threat Detection Works

Set up

The screenshot shows the 'shellfish - Advanced Threat Protection' blade in the Azure portal. Under 'THREAT DETECTION SETTINGS', the 'Advanced Threat Protection' switch is turned 'ON'. The 'Send alerts to' field contains 'johnsmith@smith.com' with the 'Email service and co-administrators' checkbox checked. Below this, there are sections for 'Storage details' and 'Threat Detection types' (set to 'All'). A note at the bottom encourages enabling Auditing for better threat investigation experience.

Alert

The screenshot shows an email from Microsoft Azure to Kavitha Jonnaku. The subject is 'Azure Database: Potential exploitation of application vulnerability to SQL i...'. The email is marked as 'HIGH SEVERITY'. The body of the email states: 'We detected a potential exploitation of application code vulnerability to SQL injection. This may indicate a SQL injection attack on database 'kjDWfordemos''. It includes a link to 'View recent alerts >' and a section titled 'Activity details' with detailed information about the threat, including the server, database, IP address, principal name, application, date, threat ID, potential causes, investigation steps, and remediation steps.

Explore

The screenshot shows the 'Audit record' blade for a SQL database. It displays a table of audit events with columns for 'TIMESTAMP', 'EVENT ID', 'SERVER NAME', 'DATABASE NAME', 'PRINCIPAL NAME', 'CLIENT IP', 'APPLICATION NAME', 'ACTION STATUS', 'FAILURE REASON', 'RESPONSE ROWS', and 'AFFECTED ROWS'. Below the table, a preview of the audit log is shown, displaying several rows of audit data with columns for 'Event ID', 'Timestamp', 'Severity', 'Source', 'Description', and 'Details'.

Threat Protection

SQL Data Classification, Discover, Classify, Protect & Track Access to Sensitive Data

The screenshot displays two windows from the GladAW service. The top window is titled 'Overview' and shows key metrics: Classified columns (10 / 109), Tables containing sensitive data (4 / 12), Unique information types (4). It includes two donut charts: 'Label distribution' (10 COLUMNS) and 'Information type distribution' (10 COLUMNS). The bottom window is titled 'Settings - Information protection' and shows a list of sensitivity labels under 'POLICY COMPONENTS'. The labels include:

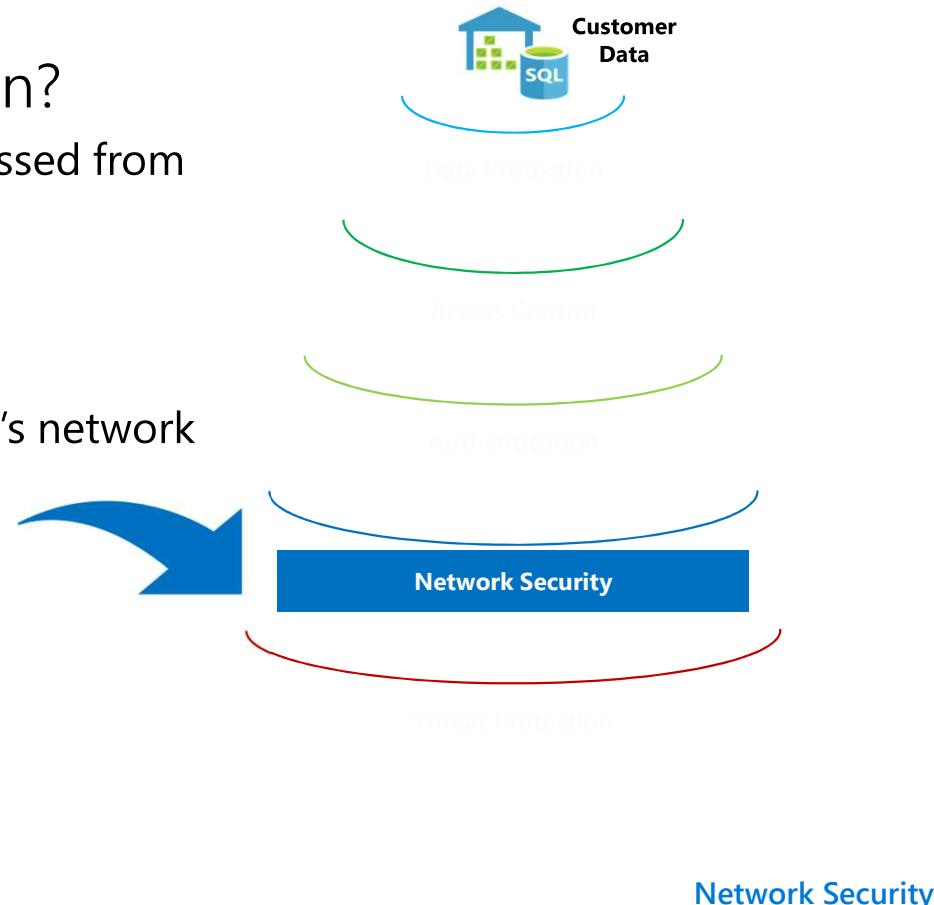
DISPLAY NAME	DESCRIPTION
Public	Business data that is specifically prepared and approved for public consumption
General	Business data that is not intended for public consumption. However, this can be shared with...
Confidential	Sensitive business data that could cause damage to the business if shared with unauthorized...
Confidential - GDPR	Sensitive data containing personal information associated with an individual, that could b...
Highly confidential	Very sensitive business data that would cause damage to the business if it was shared with...
Highly confidential - GDPR	Sensitive data containing personal information associated with an individual, that can cau...

- ✓ Automatic **discovery** of columns with sensitive data
- ✓ Add **persistent** sensitive data labels
- ✓ **Audit and detect** access to the sensitive data
- ✓ Manage labels for your entire Azure tenant using Azure Security Center

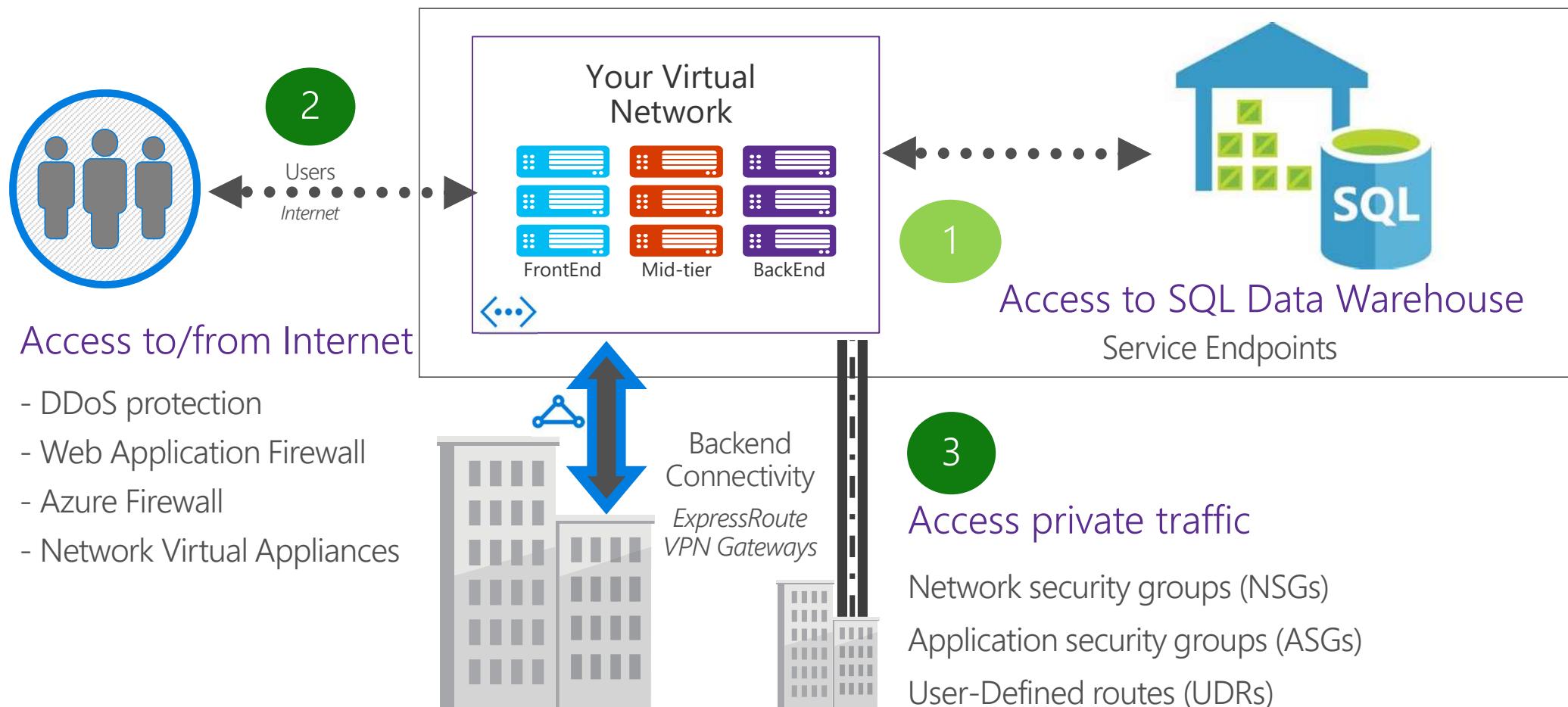
[Threat Protection](#)

Business Requirements

- How do we implement network isolation?
 - Data at different levels of security needs to be accessed from different locations.
- How do we achieve separation?
 - Disallowing Access to entities outside the company's network security boundary



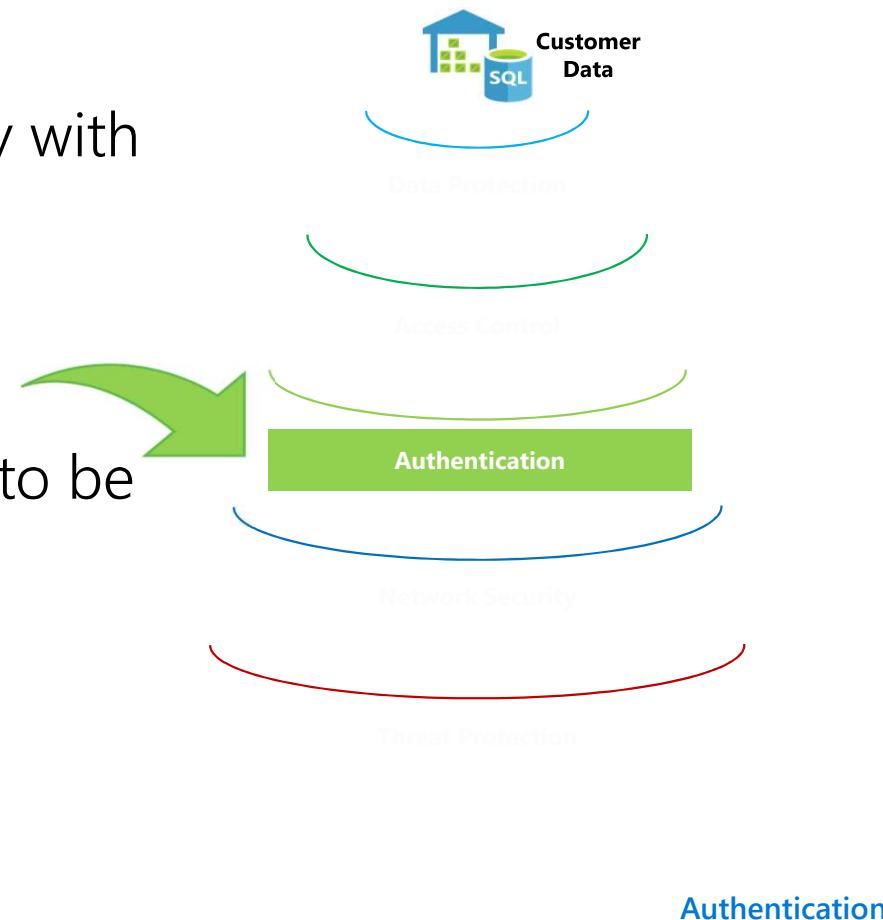
Azure Networking – Application Access Patterns



Network Security

Business Requirements

- How do I configure Azure Active Directory with Azure SQL Data Warehouse?
 - I want additional control in the form of Multi-factor authentication
- How do I allow non-Microsoft accounts to be able to authenticate?



Azure Active Directory Authentication

Overview

Manage user identities in one location

Enable access to Azure SQL Data Warehouse and other Microsoft services with Azure Active Directory user identities and groups

Benefits

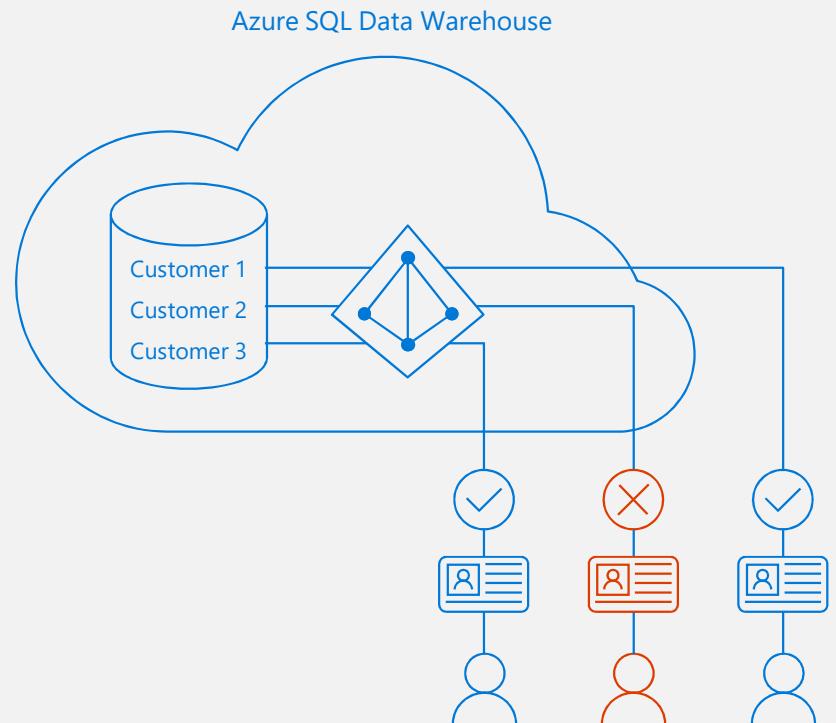
Alternative to SQL Server authentication

Limits proliferation of user identities across databases

Allows password rotation in a single place

Enables management of database permissions by using external Azure Active Directory groups

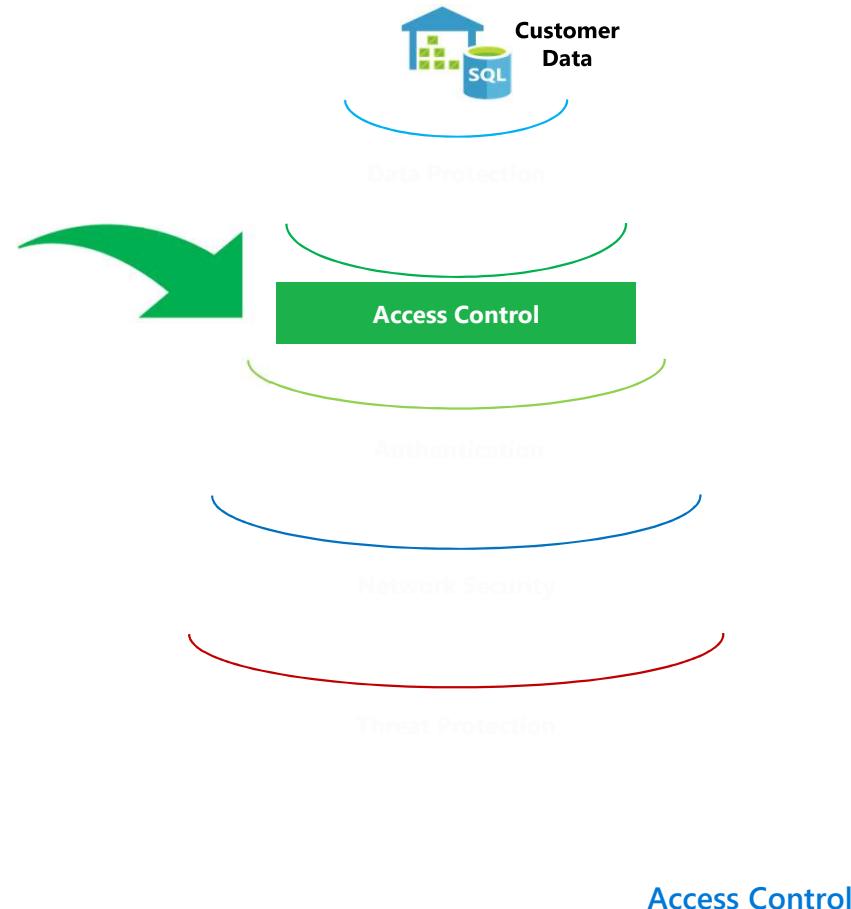
Eliminates the need to store passwords



Authentication

Business Requirements

- How do I restrict access to sensitive data to specific database users?
- How do I ensure users only have access to relevant data?
 - For example, in a hospital only medical staff should be allowed to see patient data that is relevant to them and not every patients data



Column-Level Security

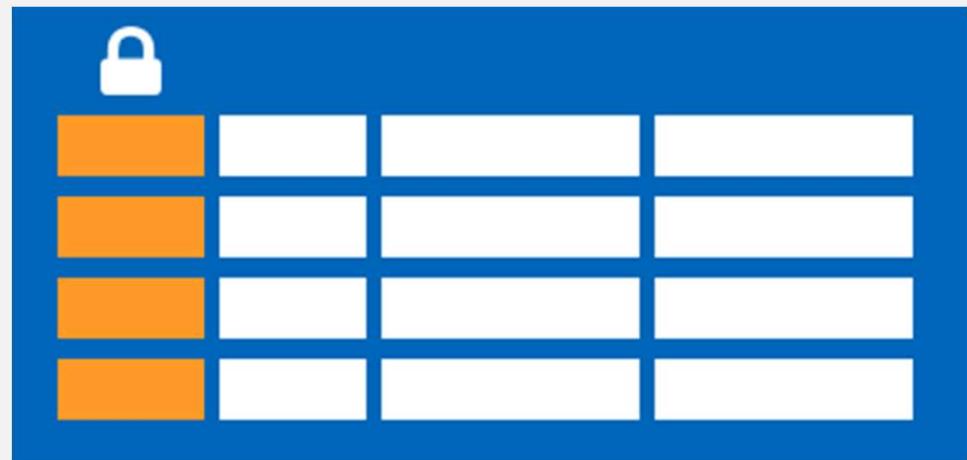
Overview

Control access of specific columns in a database table based on customer's group membership or execution context

Simplifies the design and implementation of security by putting restriction logic in database tier as opposed to application tier

Administer via GRANT T-SQL statement

Both Azure Active Directory (AAD) and SQL authentication are supported



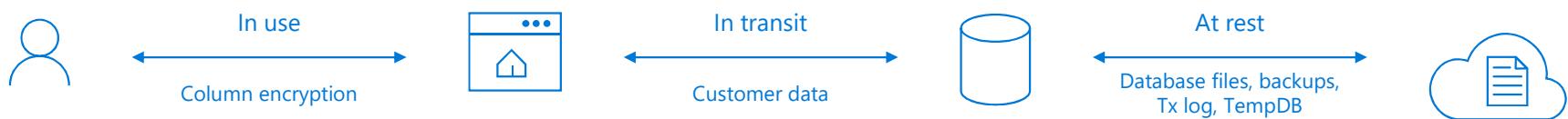
Business Requirements

- How do I protect sensitive data against unauthorized (high-privileged) users?
 - *What key management options do I have?*



Types of Data Encryption

Data encryption	Encryption technology	Customer value
In transit	Transport Layer Security (TLS) from the client to the server TLS 1.2	Protects data between client and server against snooping and man-in-the-middle attacks
At rest	Transparent Data Encryption (TDE) for Azure SQL Data Warehouse	Protects data on the disk User or Service Managed key management is handled by Azure, which makes it easier to obtain compliance

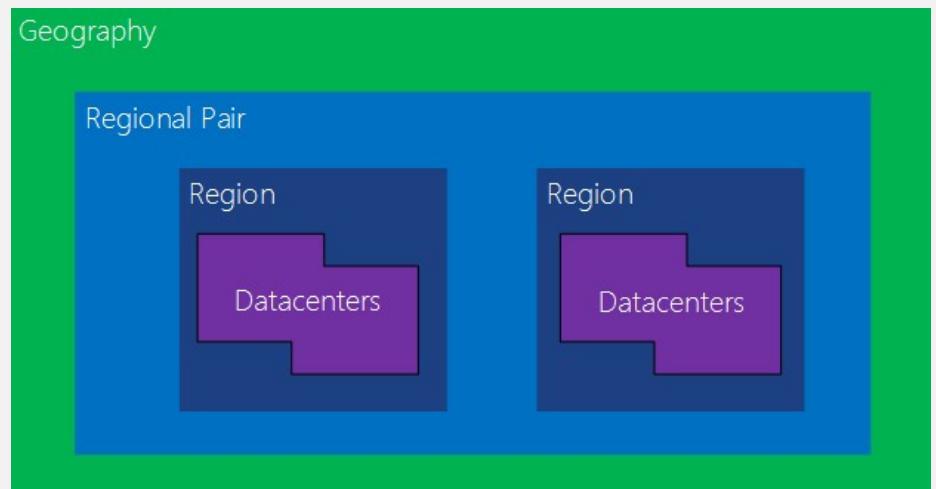


Disaster Recovery and High Availability built-in

Snapshots and Restores

Overview

Automatic copies of the data warehouse state
Taken throughout the day, or triggered manually
Available for up to 7 days, even after DW deletion
Regional restore in under 20 minutes, no matter data size
Schemas and geo-backups allow cross-region restores
Automatic snapshots and geo-backups on by default



Benefits

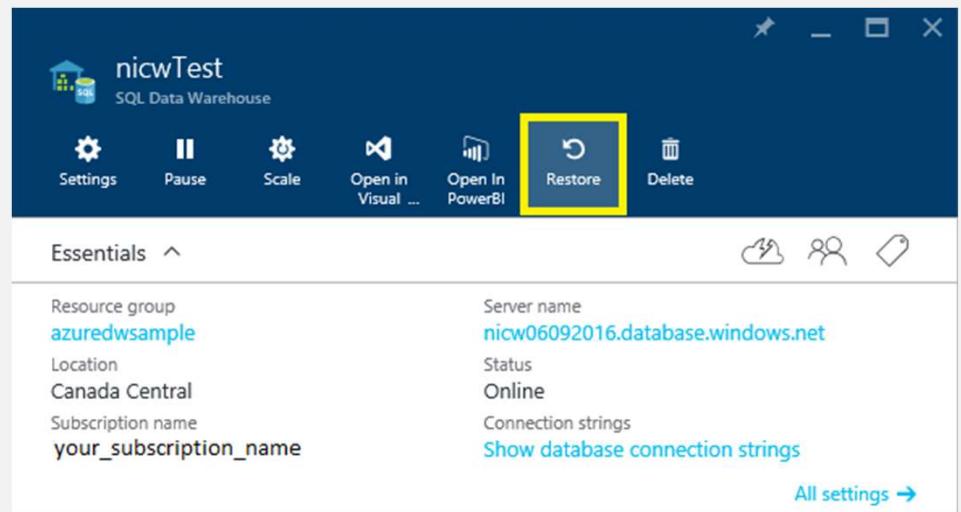
Snapshots protect against data corruption and deletion
Restore to quickly create dev/test copies of data
Manual snapshots protect large modifications
Geo-backups ensure data security in region loss

```
--View most recent snapshot time  
SELECT top 1 *  
FROM sys.pdw_loader_backup_runs  
ORDER BY run_id DESC;
```

Snapshots and Restores

Usage

Restore via PowerShell, Azure Portal, or T-SQL
Trigger manual snapshot via Powershell or Portal
Snapshot costs rolled into SQL DW Storage costs
Geo-backup costs rolled into Disaster Recovery Storage
Total snapshot costs depends on data modification



```
# Get the deleted database to restore
$DeletedDatabase = Get-AzureRmSqlDeletedDatabaseBackup -ResourceGroupName $ResourceGroupName -ServerName $ServerName -FromDeleteDate $(Get-Date).AddDays(-30)

# Restore deleted database
$RestoredDatabase = Restore-AzureRmSqlDatabase -FromDeletedDatabaseBackup -DeletionDate $DeletedDatabase.DeletionDate -ToServerName $ServerName -ToDatabaseName $DeletedDatabase.DatabaseName

# Verify the status of restored database
$RestoredDatabase.status
```

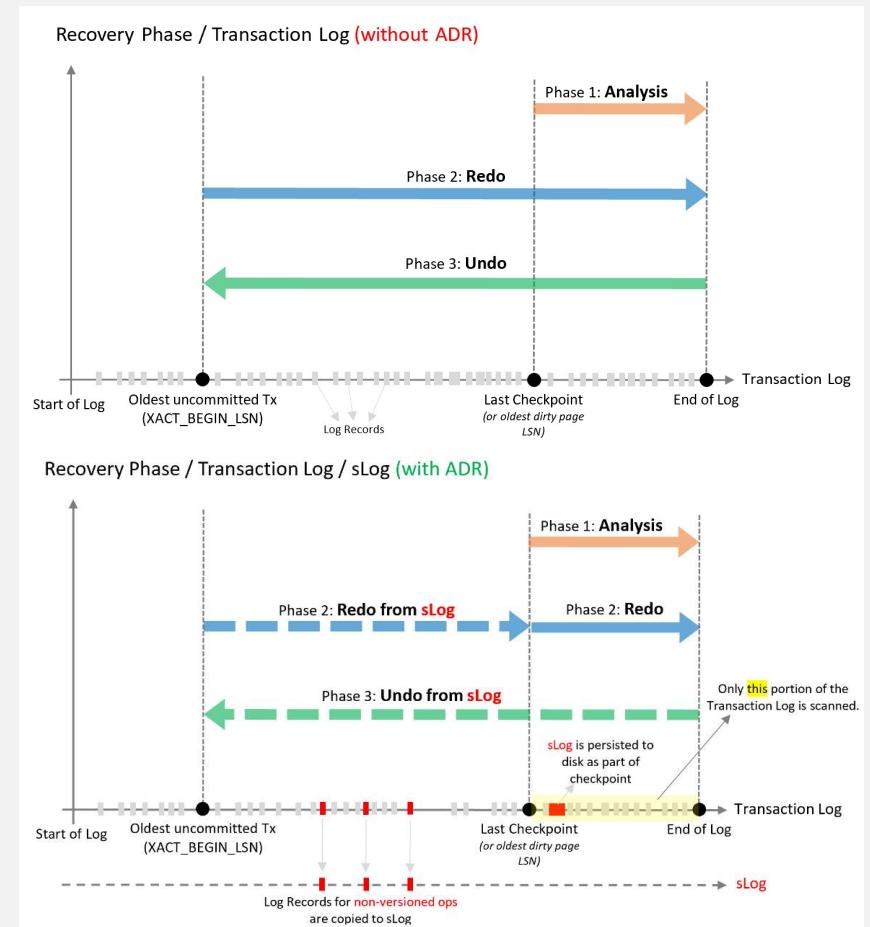
Accelerated Database Recovery

Overview

New SQL database engine feature
Redesigns the engine recovery process
Speeds up the 3 recovery phases

Benefits

Fast and consistent database recovery
Instantaneous transaction rollback
Regardless of number or age of transactions
Fast pause and resume operations



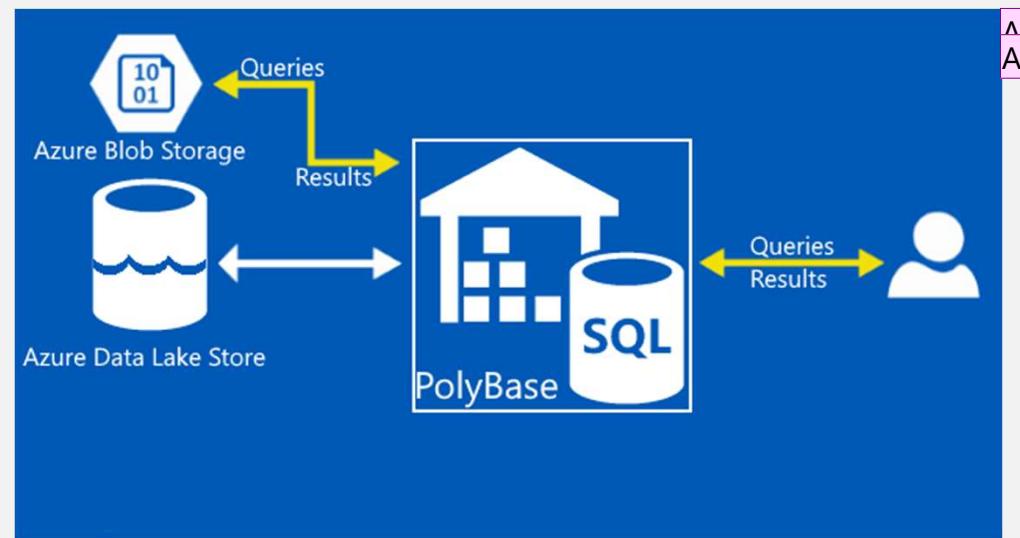
Data ingestion

Polybase

Overview

Polybase enables users to run queries and import/export data residing outside of the SQL data warehouse

Users write T-SQL to read and access data that is stored externally to the data warehouse



Slide 93

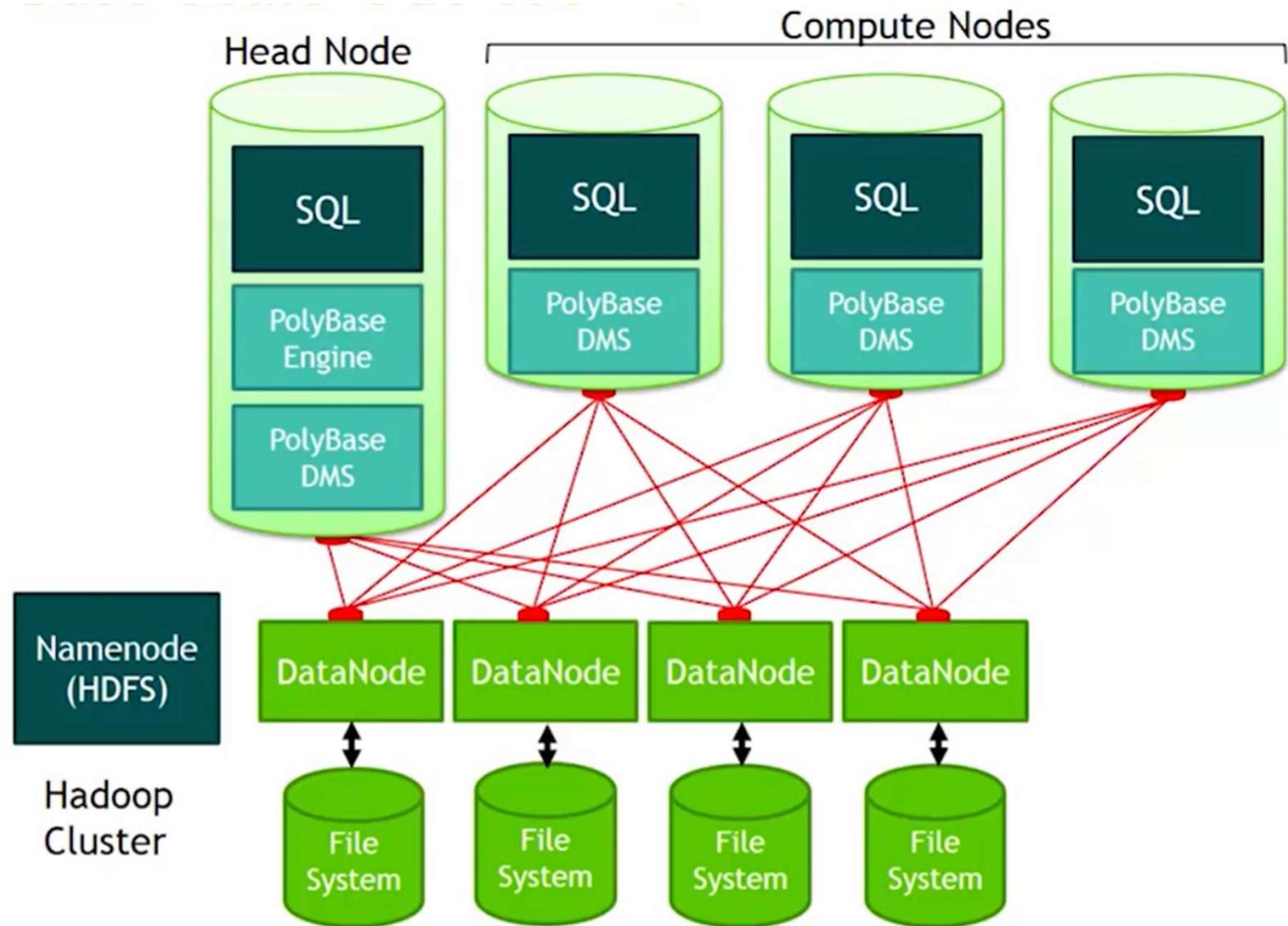
A6 SQL Data Warehouse doesn't support Hadoop

Author, 1/26/2019

A7 Removed

Author, 1/28/2019

Polybase



Polybase - Authentication

Overview

The credentials used for Polybase queries are stored in the data warehouse and are encrypted with a symmetric key entered by the user during setup.

```
-- Create master key to encrypt credential secret
CREATE MASTER KEY ENCRYPTION BY PASSWORD =
'S0me!nfo';

-- Create database scoped credential for Azure Data
Lake Store Gen2 (required if not using managed
service identity)
CREATE DATABASE SCOPED CREDENTIAL
AzureStorageCred^A9ntial
WITH IDENTITY = A9user', Secret =
'<storage_account_key>;
```

Slide 95

A8 We need something about Data Lake Store Gen 2 also
Author, 1/28/2019

A9 done
Author, 1/28/2019

Polybase – External File Access

Overview

Polybase supports querying files stored in a Hadoop File System (HDFS), Azure Blob storage, or Azure Data Lake Store

To query files, users create three objects:

External data source, external file format, external table

```
-- Create Azure DataLake Gen2 Storage reference
CREATE EXTERNAL DATA SOURCE AzureStorage with
(
    TYPE = HADOOP,
    LOCATION='ab^10://<containername>@<storageaccount>.blob.core
    .windows.netA11
    CREDENTIAL = AzureStorageCredential
);
-- Type of format in Hadoop (CSV, RCFILE , ORC, PARQUET).
CREATE EXTERNAL FILE FORMAT TextFileFormat WITH
(
    FORMAT_TYPE = DELIMITEDTEXT,
    FORMAT_OPTIONS (FIELD_TERMINATOR = '|', USE_TYPE_DEFAULT =
    TRUE)
)
-- LOCATION: path to file or directory that contains data
CREATE EXTERNAL TABLE [dbo].[CarSensor_Data]
(
    [SensorKey] int NOT NULL,
    [Speed] float NOT NULL,
    [YearMeasured] int NOT NULL
)
WITH (LOCATION='/Demo/', DATA_SOURCE = AzureStorage,
FILE_FORMAT = TextFileFormat
);
```

Slide 96

A10 Same as previous slide, we should primarily lead with Data Lake Storeg Gen 2 examples
Author, 1/28/2019

A11 done
Author, 1/28/2019

Create Table As Select (CTAS)

Overview

The CTAS statement is a parallel operation that creates a new table in based the output of a SELECT statement.

It is the simplest and fastest way to create a copy of a table. Additionally, it allows for ingesting data stored in an external source into managed data warehouse tables.

```
-- Ingest external table data into data
warehouse
CREATE TABLE [dbo].[FactInternetSales]
WITH
(
    DISTRIBUTION = ROUND_ROBIN
    CLUSTERED COLUMNSTORE INDEX
)
AS
SELECT *
FROM    [staging].[FactInternetSales]
;
```

Copy Command

Overview

- Simplifies loading data into data warehouse
- Accesses directly from external sources

Data Lake Store Gen 2

Blob Storage

- Highly parallelized, scales with cluster compute
- No dependency on managed objects such as External Tables

```
--Create destination table in SQL DW
CREATE TABLE [dbo].[weatherTable]
(
    [ObservationTypeCode] [nvarchar](5) NOT NULL,
    [ObservationTypeName] [nvarchar](100) NOT NULL,
    [ObservationUnits] [nvarchar](5) NULL
)
WITH (
    DISTRIBUTION = ROUND_ROBIN, HEAP);

--Copy files in parallel directly into datawarehouse table
COPY INTO [dbo].[weatherTable]
FROM 'abfss://<storageaccount>.blob.core.windows.net/<filepath>'
WITH (
    FILE_FORMAT = 'DELIMITEDTEXT',
    SECRET = CredentialObject);
```

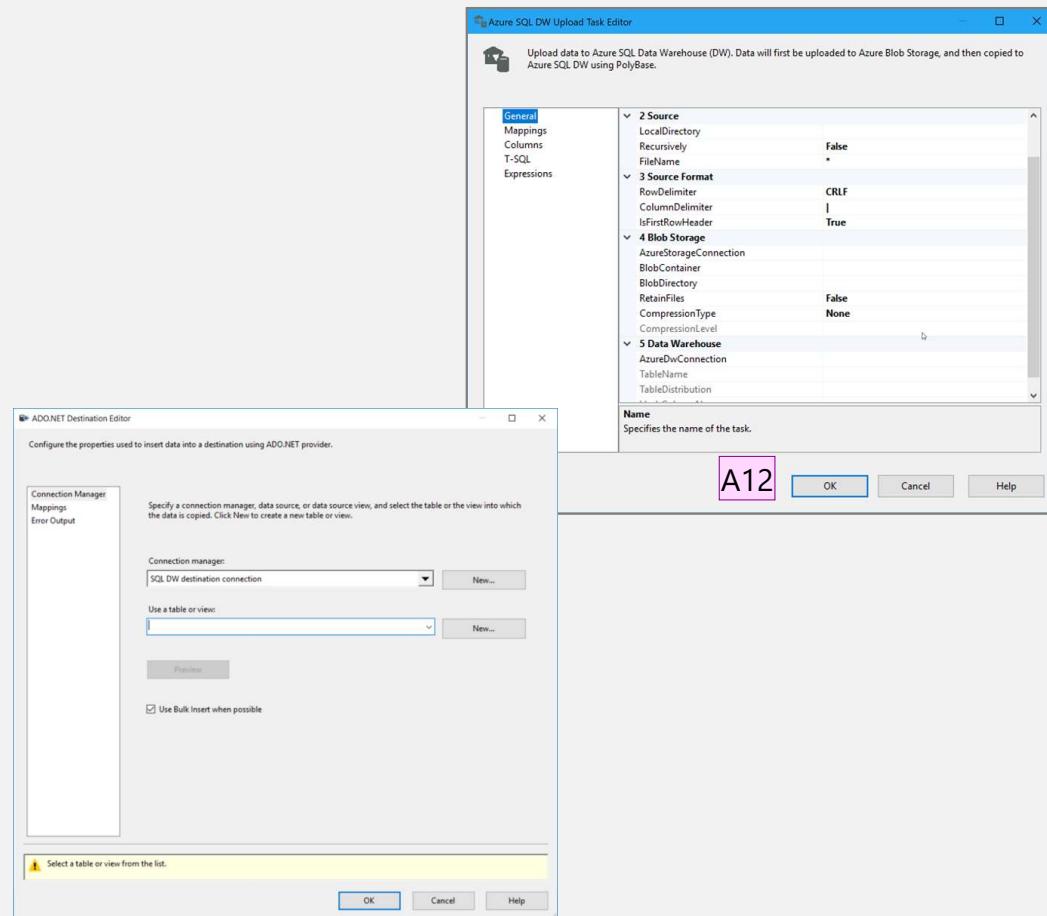
SQL Server Integration Services (SSIS)

Overview

SQL Server Integration Services is used to extract, transform data and load data from a variety of sources into Azure SQL Data Warehouse.

There are 2 options for loading data into SQL Data Warehouse with SSIS:

- **Azure SQL DW Upload Task:** provides best performance but assumes source data is in delimited text file format.
- **Data Flow Task:** slower than SQL DW upload task but supports a wider range of data sources.



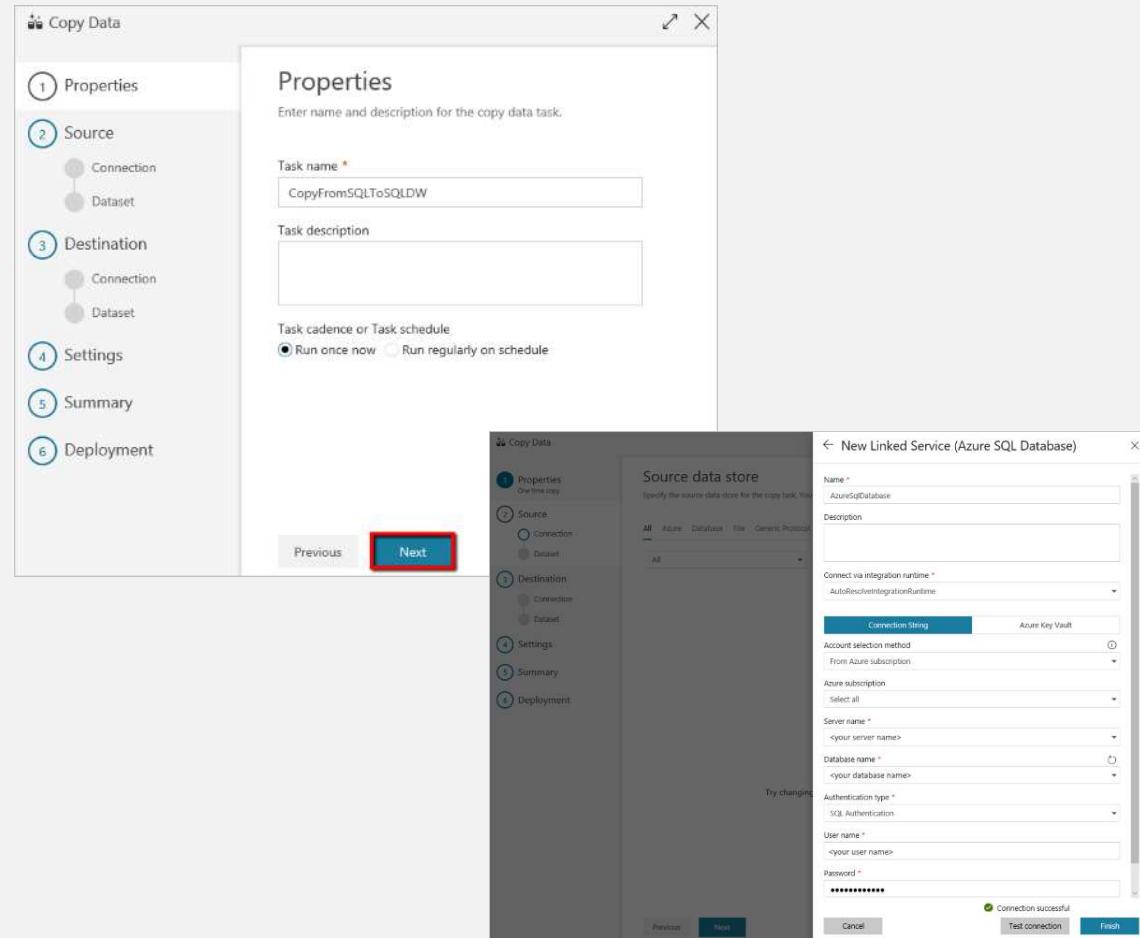
A12 I think wd could have more impactful images here. Could we get a screenshot of the SQL DW component specifically, instead of the entire Visual Studio window?

Author, 1/28/2019

Azure Data Factory Copy Data Tool

Overview

The Azure Data Factory Copy tool in the provides an intuitive wizard that allows you to copy data from a variety of data sources into Azure SQL Data Warehouse



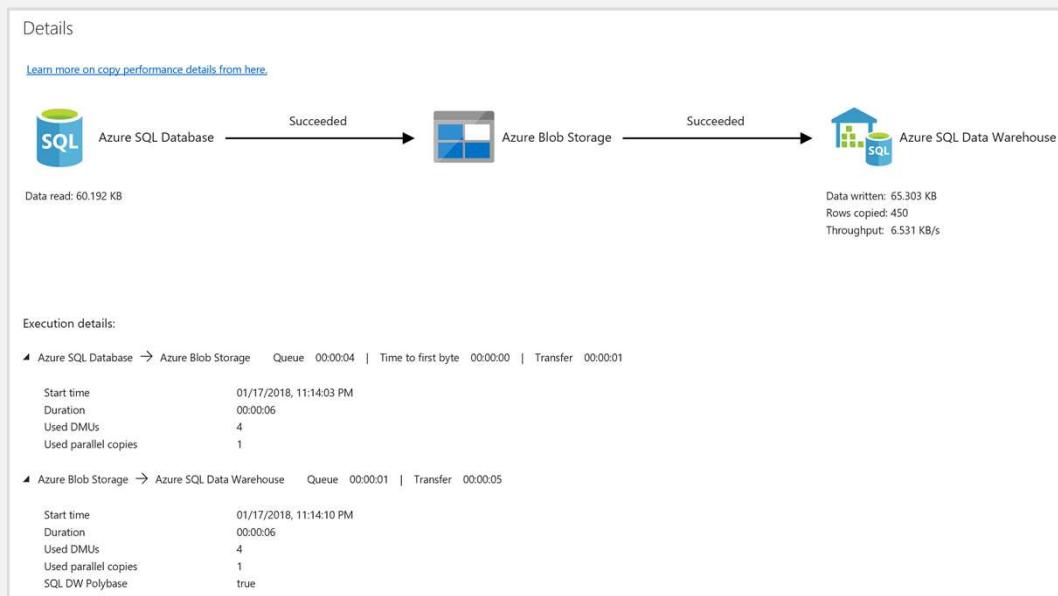
Azure Data Factory Copy Activity

Overview

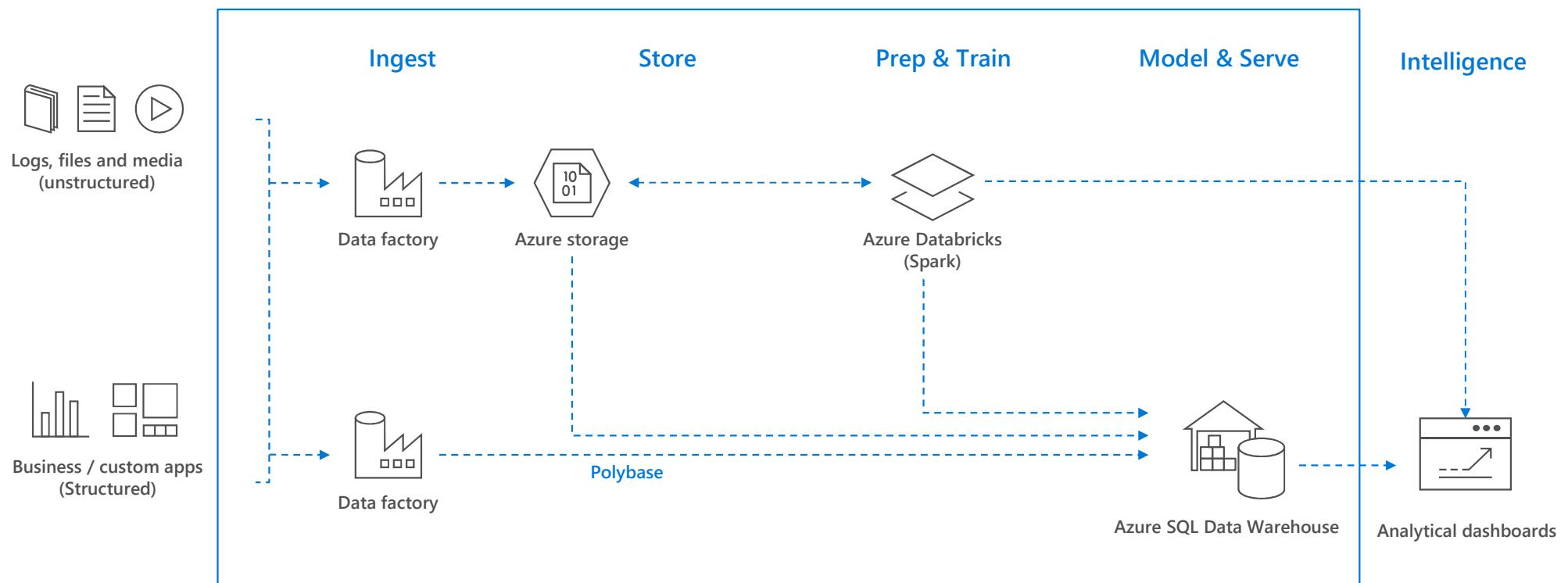
The Azure Data Factory Copy activity allows copy to and from Azure SQL Data Warehouse from any supported data store.

The copy activity also supports retrieving data from a SQL source by using a SQL query or stored procedure. Authentication can be via:

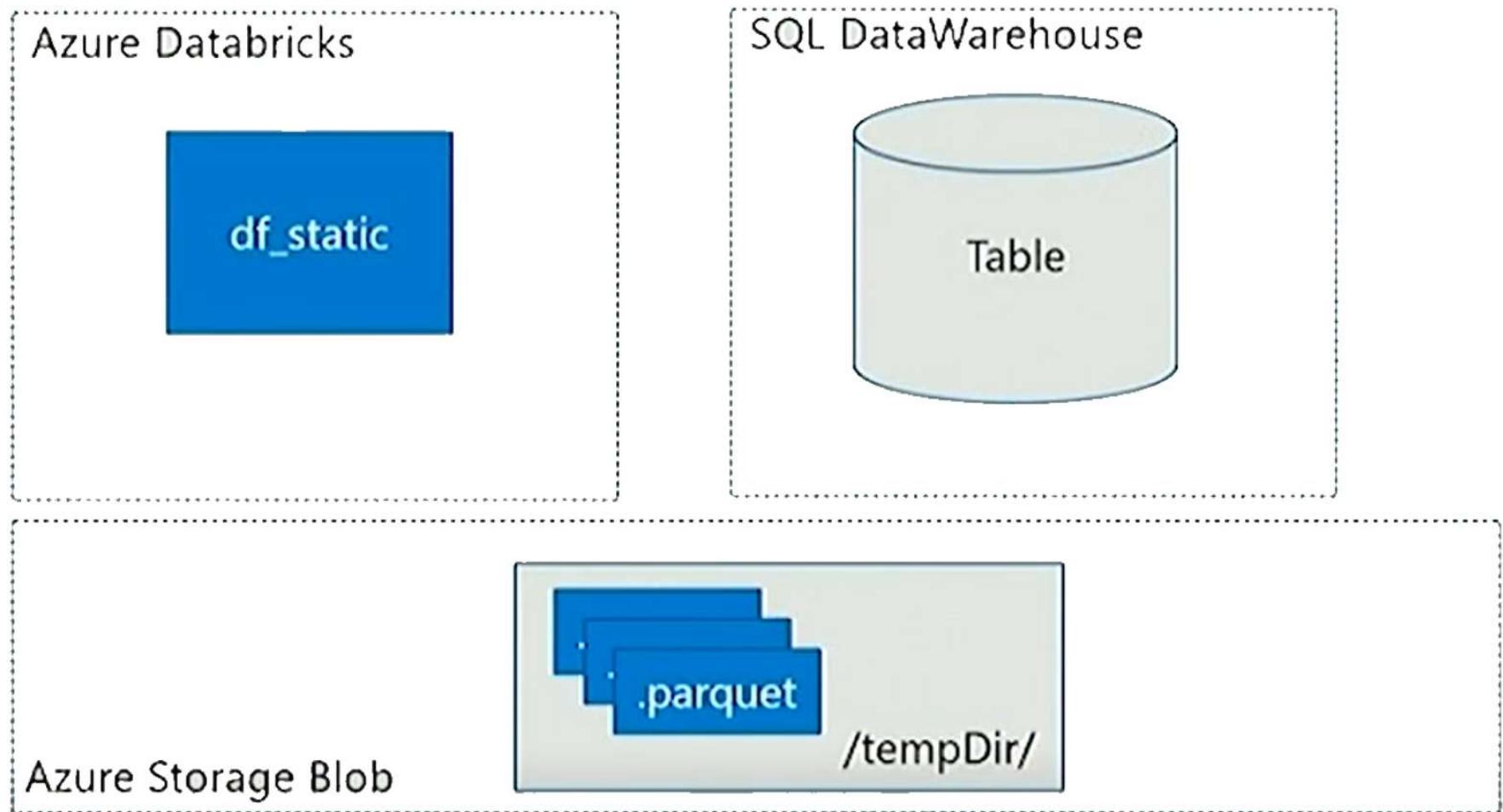
- SQL Authentication
- Service principal token authentication
- Managed identity token authentication



Modern Big Data Warehouse



Batch Data into Datawarehouse



Python for Batch Data Load

```
df.write \  
    .format("com.databricks.spark.sqldw") \  
    .option("url", "jdbc-url") \  
    .option("tempDir", tempdir) \  
    .option("forwardSparkAzureStorageCredentials", "true") \  
    .option("dbTable", "my_table_in_dw") \  
    .save()
```

JDBC Connection String

Azure Storage Blob Directory

Introduction to Structure Streaming

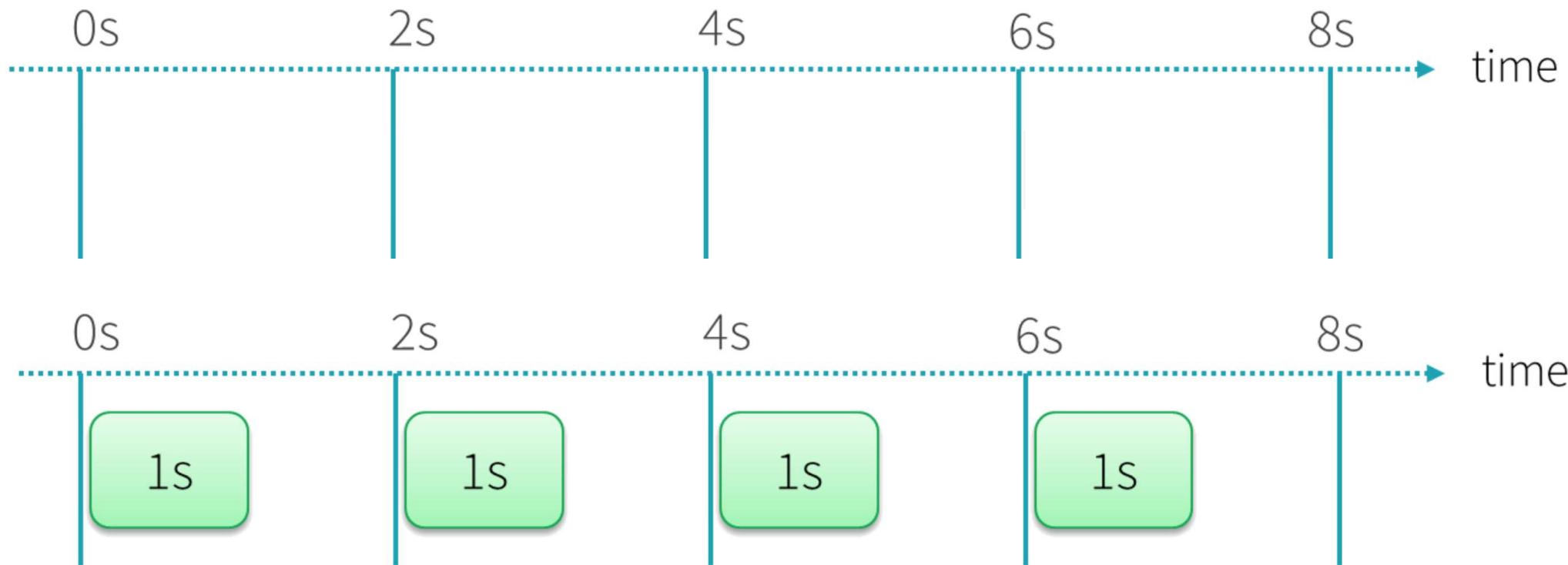
The Problem ????



Streaming ETL w/ Structured Streaming



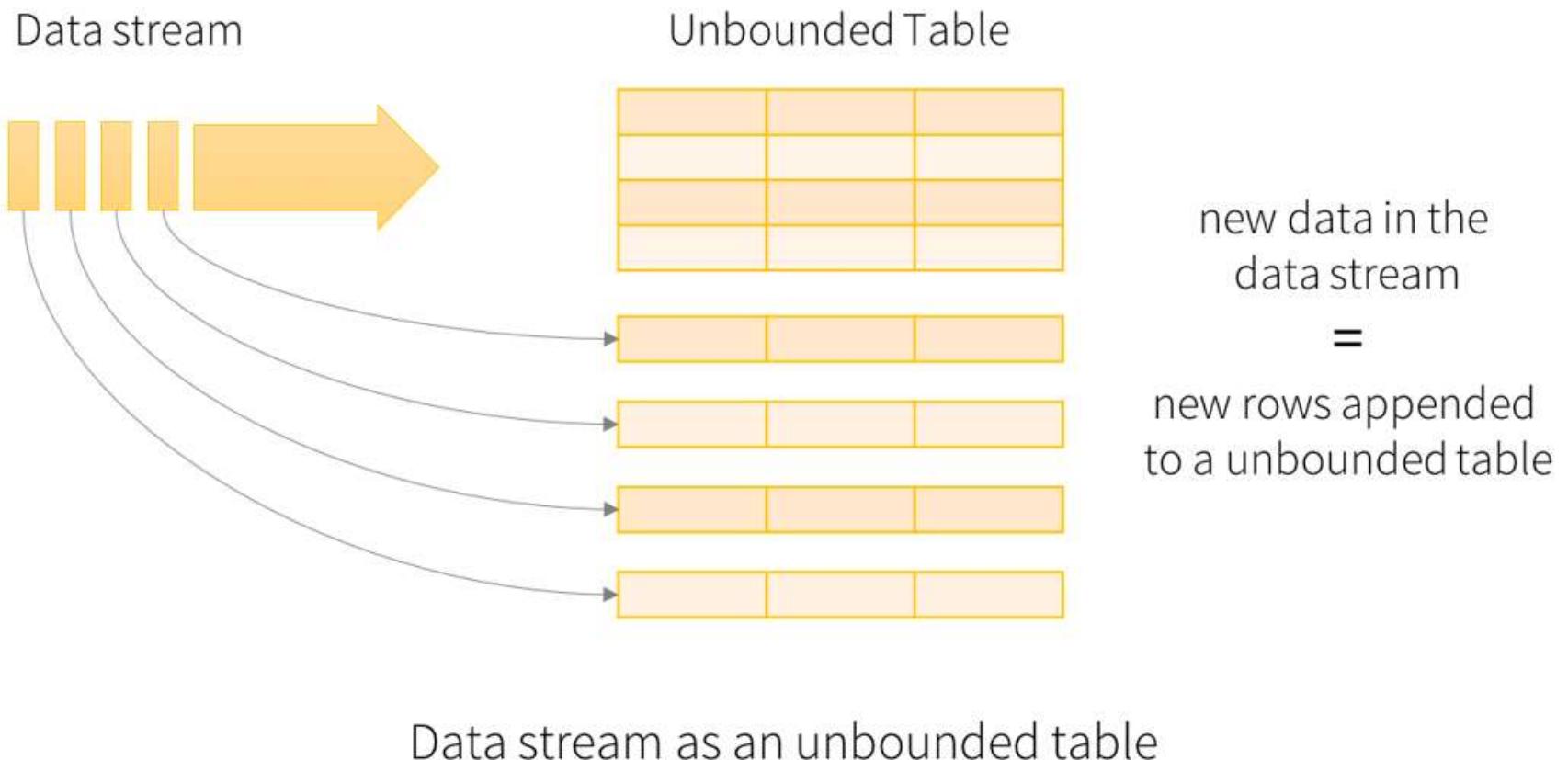
Micro Batch Model



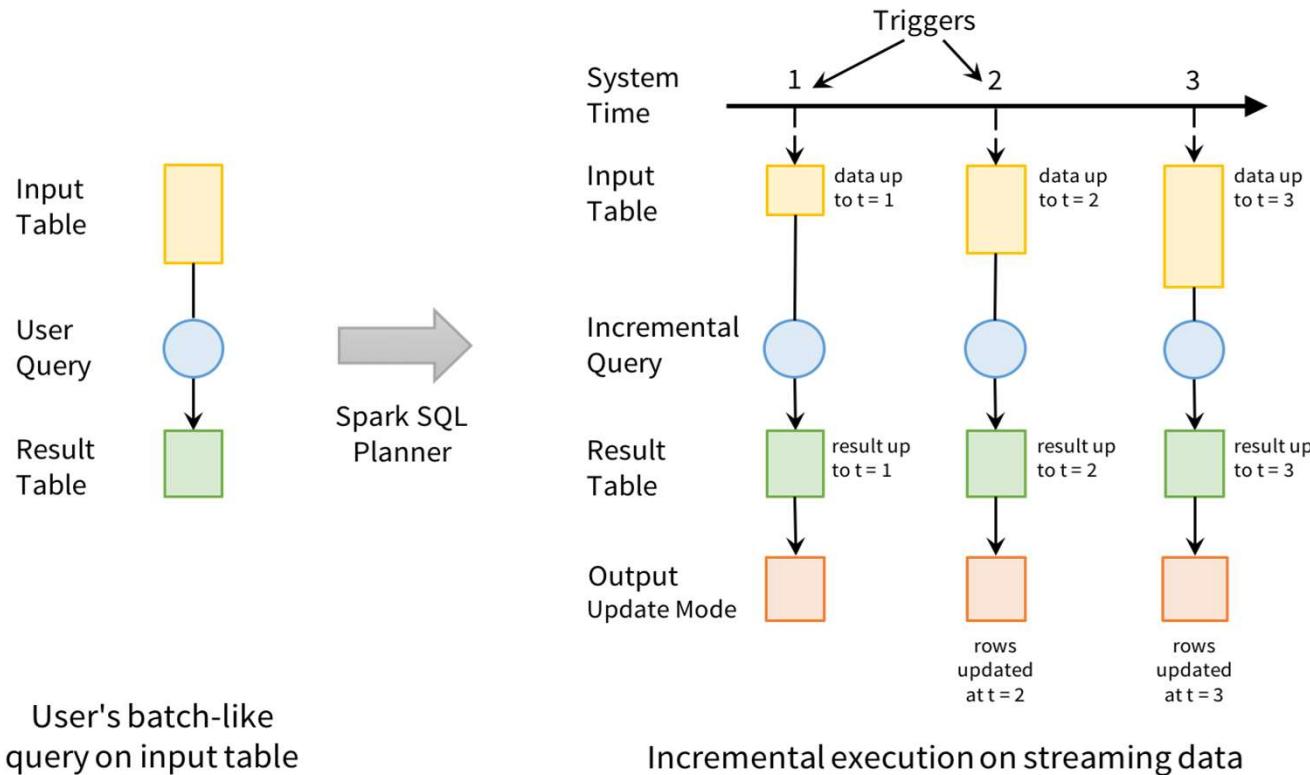
Questions?

- What happens if we don't process the data fast enough when reading from a TCP/IP Stream?
- What happens if we don't process the data fast enough when reading from a pubsub system like Kafka?

From Micro Batch Model to Table



What is structured streaming?



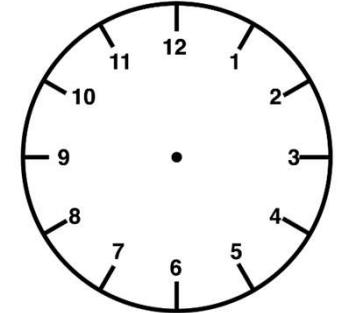
Structured Streaming Processing Model

Users express queries using a batch API; Spark incrementalizes them to run on streams

Question?

- **What problems might you encounter if you aggregate over a stream's entire dataset?**

Solution



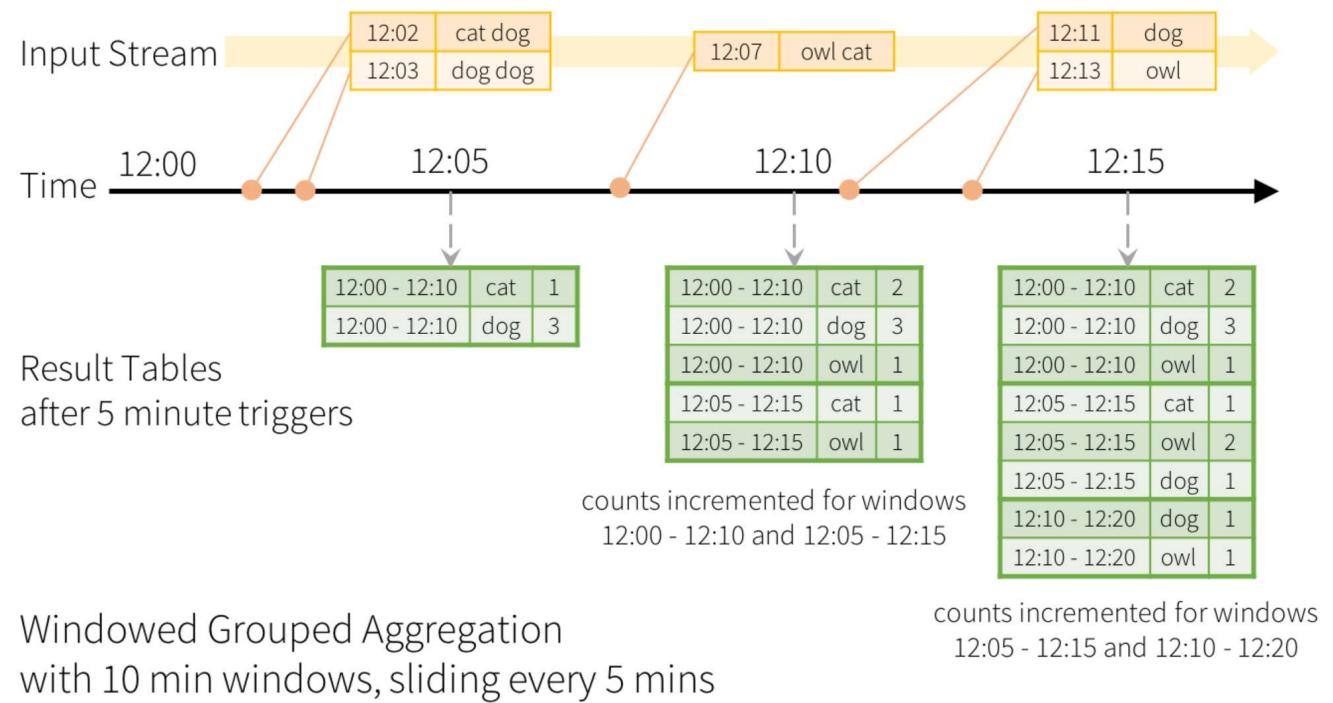
Working with time

Windowing Concepts

Output at the end of each window

Windows are fixed length

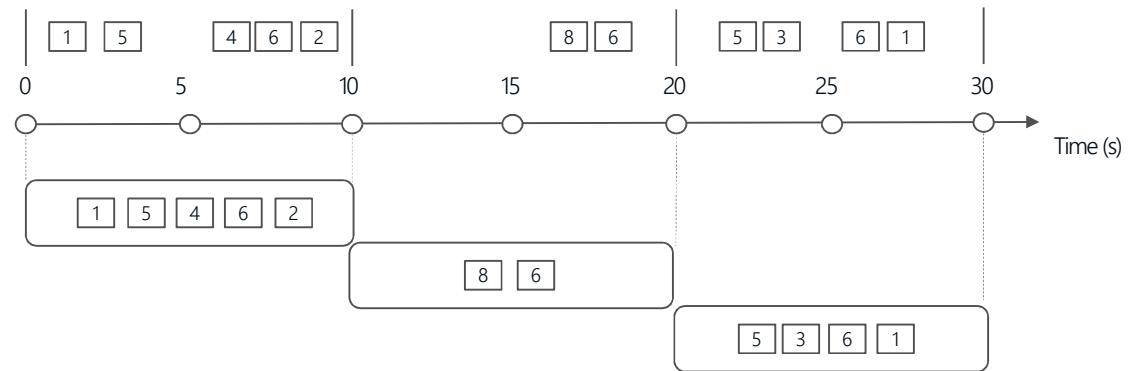
Used in a GROUP BY clause



Tumbling Windows

Every 10 seconds give me the count of vehicles entering each toll booth over the last 10 seconds

A 10-second Tumbling Window

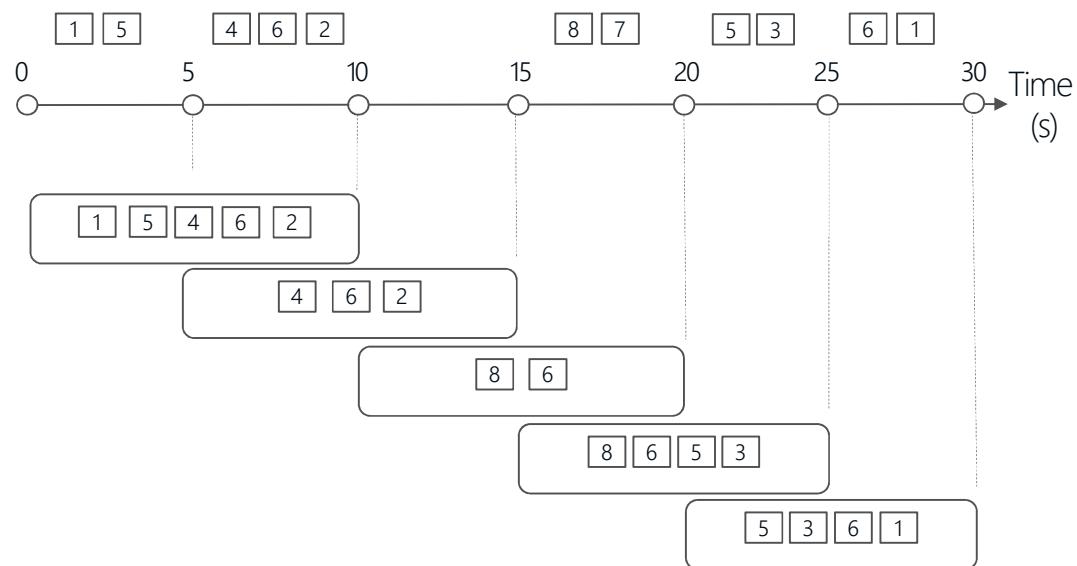


```
SELECT TollId, Count(*)  
FROM EntryStream TIMESTAMP BY EntryTime  
GROUP BY TollId, TumblingWindow(second, 10)
```

Hopping Windows

Every 5 seconds give me the count of vehicles entering each toll booth over the last 10 seconds

A 10 second Hopping Window with a 5 second hop

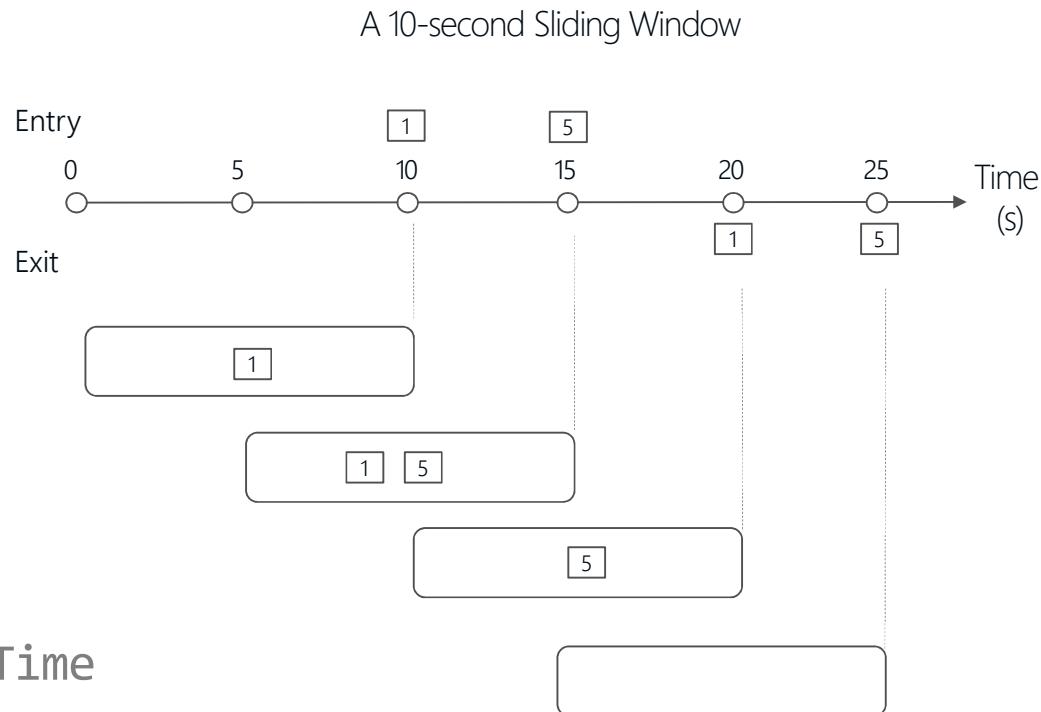


```
SELECT TollId, Count(*)  
FROM EntryStream TIMESTAMP BY EntryTime  
GROUP BY TollId, HoppingWindow(second, 10, 5)
```

Sliding Windows

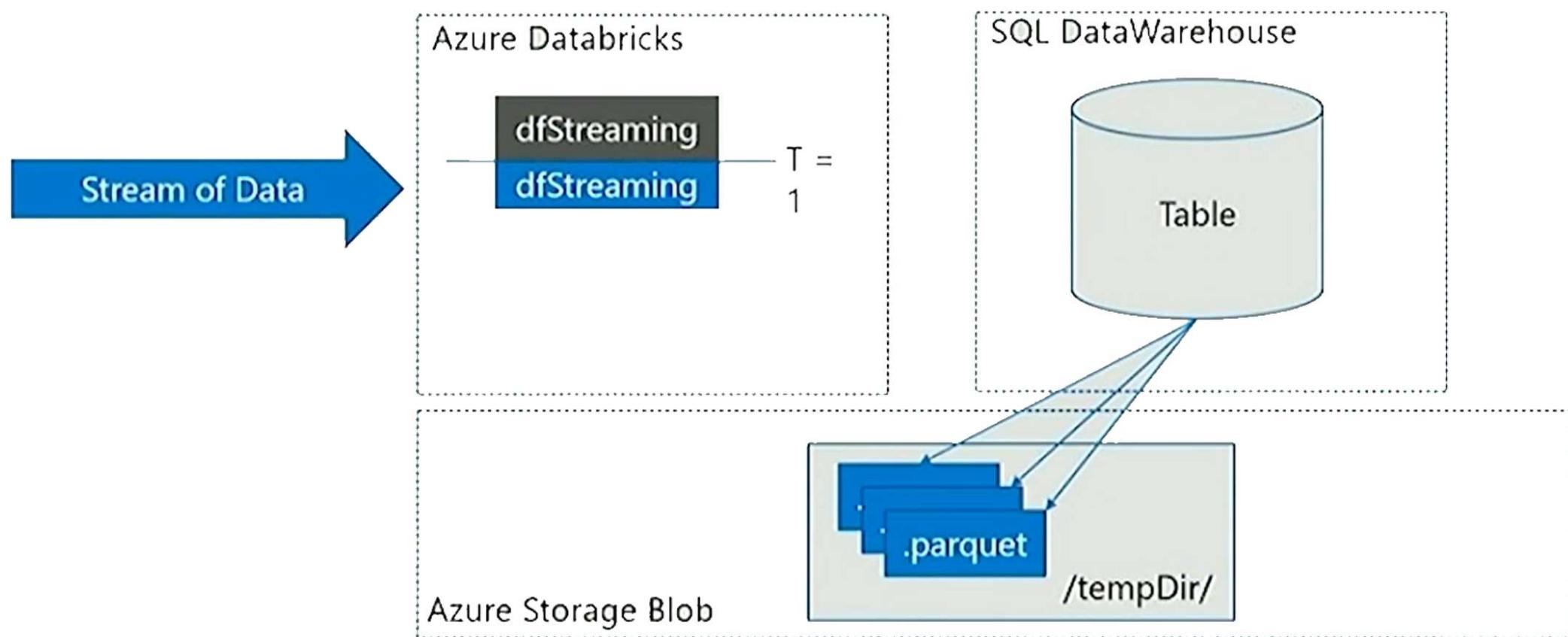
Find all toll booths that have served more than 10 vehicles in the last 20 seconds

```
SELECT TollId, Count(*)  
FROM EntryStream TIMESTAMP BY EntryTime  
GROUP BY TollId, SlidingWindow(second, 20)  
HAVING Count(*) > 10
```



An output is generated whenever an event either enters/leaves the system

Structured streaming into Data Warehouse



Python for structured streaming load

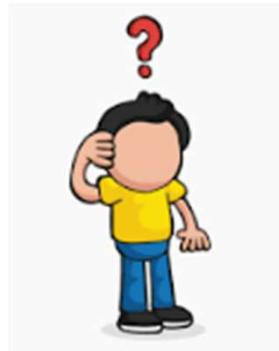
```
df.writeStream \
    .format("com.databricks.spark.sqldw") \
    .option("url", "jdbc-url") \
    .option("tempDir", tempdir) \
    .option("forwardSparkAzureStorageCredentials", "true") \
    .option("dbTable", "my_table_in_dw") \
    .option("chkpointLoc", "/tmp_loc") \
    .save()
```

JDBC Connection String

Azure Storage Blob Directory

Introduction to Databricks Deltas

Services in Azure



Errr....
What are all these?
Why so many?
When do I use these?
Wait, now you have this new thing called *Delta*?
I am dizzy and ready to pass out!

MPP database



Azure SQL
Datawarehouse

Object store



Azure
Data Lake
Store



Azure
Blob Storage

Processing Engine



Azure Databricks



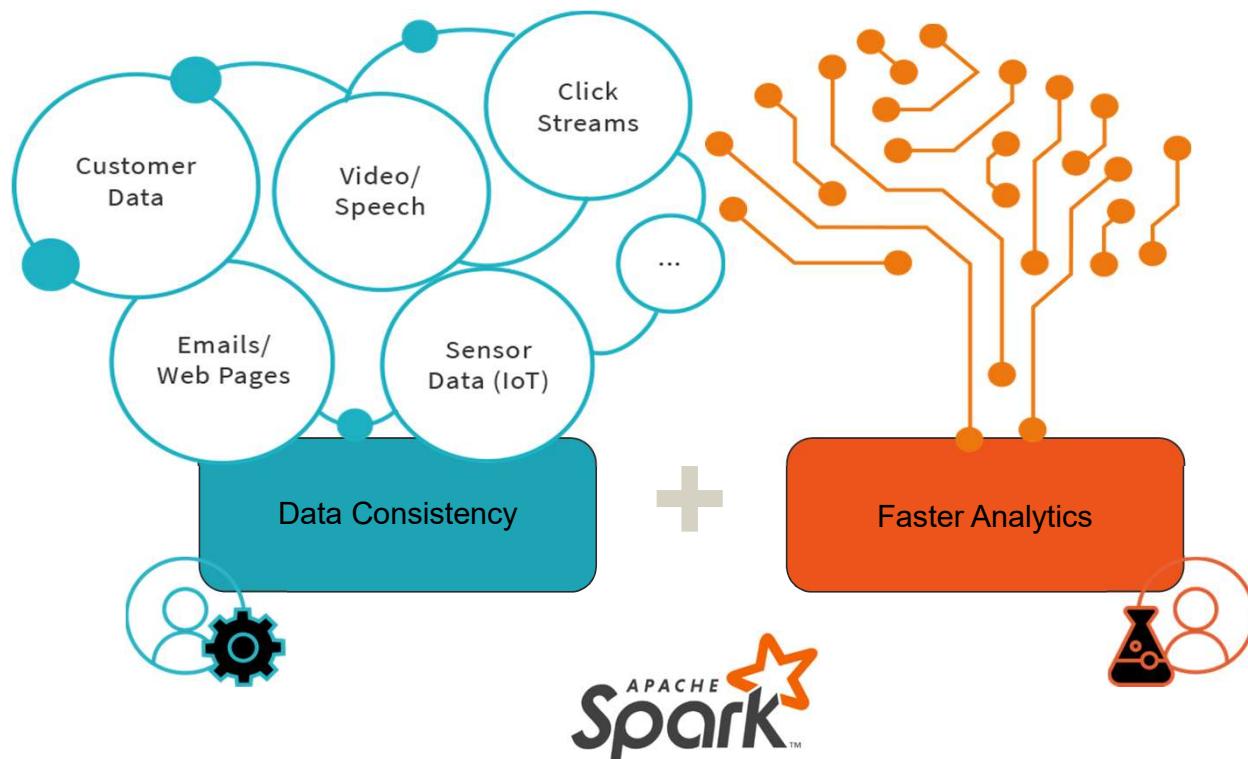
HDInsight



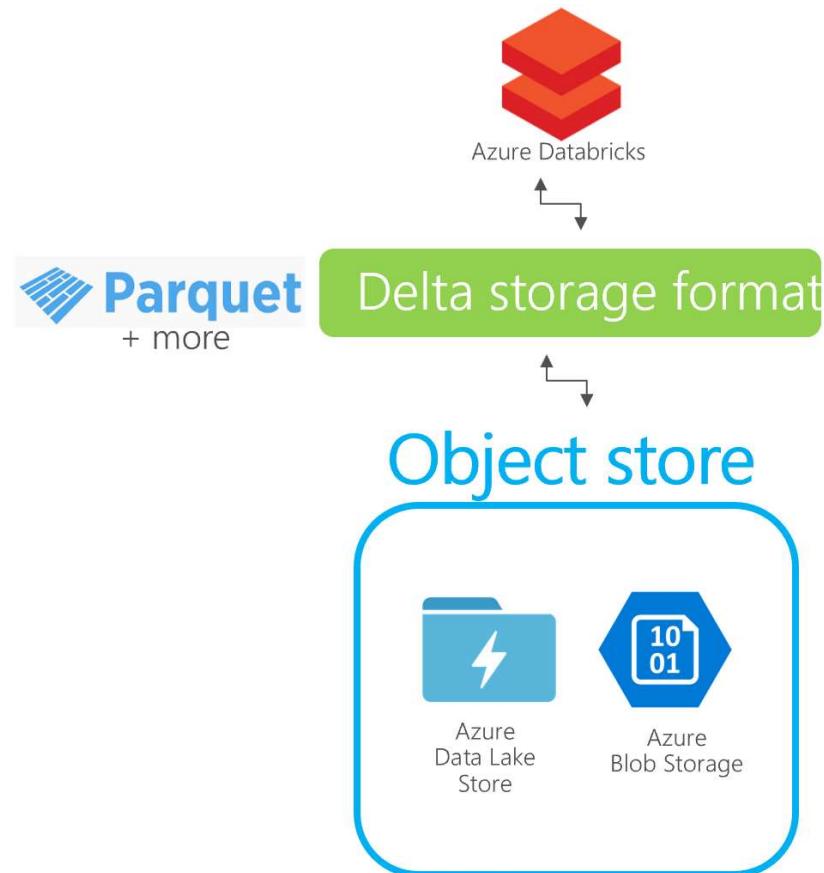
Azure Data Lake Analytics

Databricks Delta

Extends Apache Spark to simplify data reliability and boost performance



Databricks Delta fundamentally?



ONLY ON Databricks – not on OSS Spark

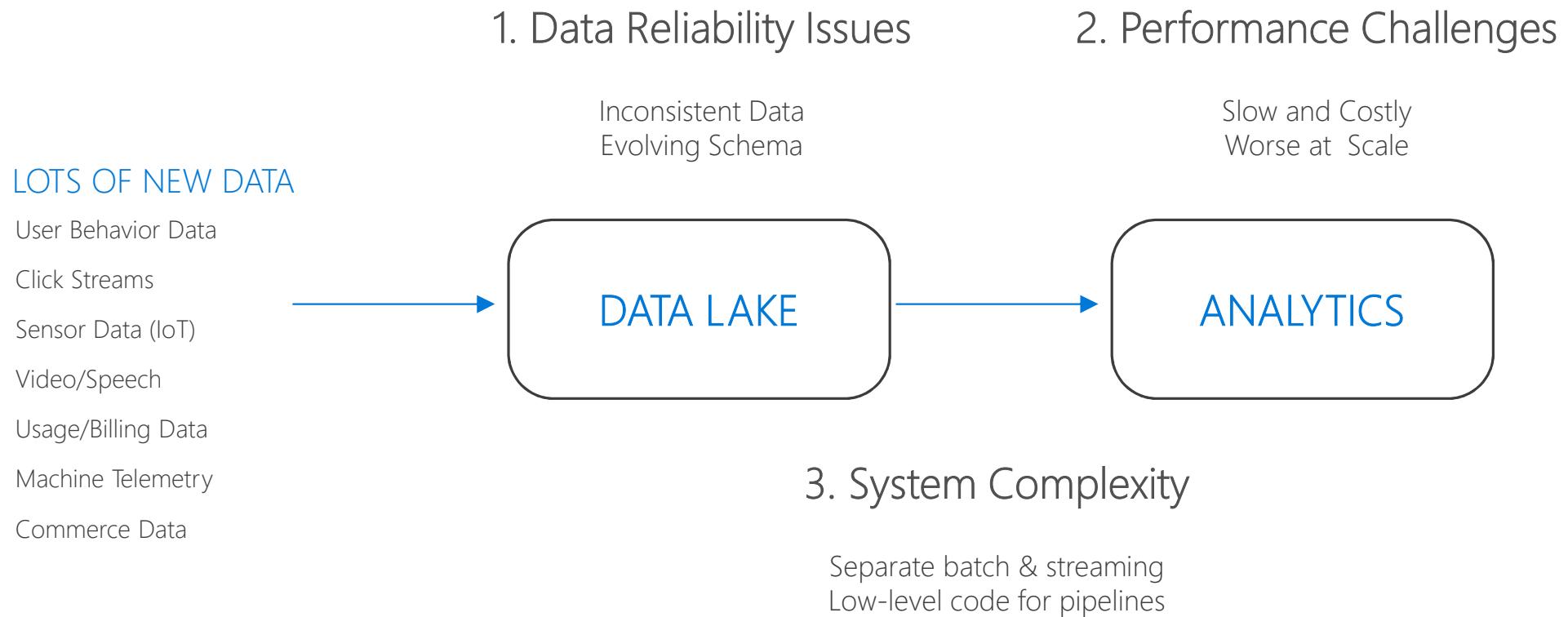
Databricks Delta – Unified data management system

The
SCALE
Of data lake

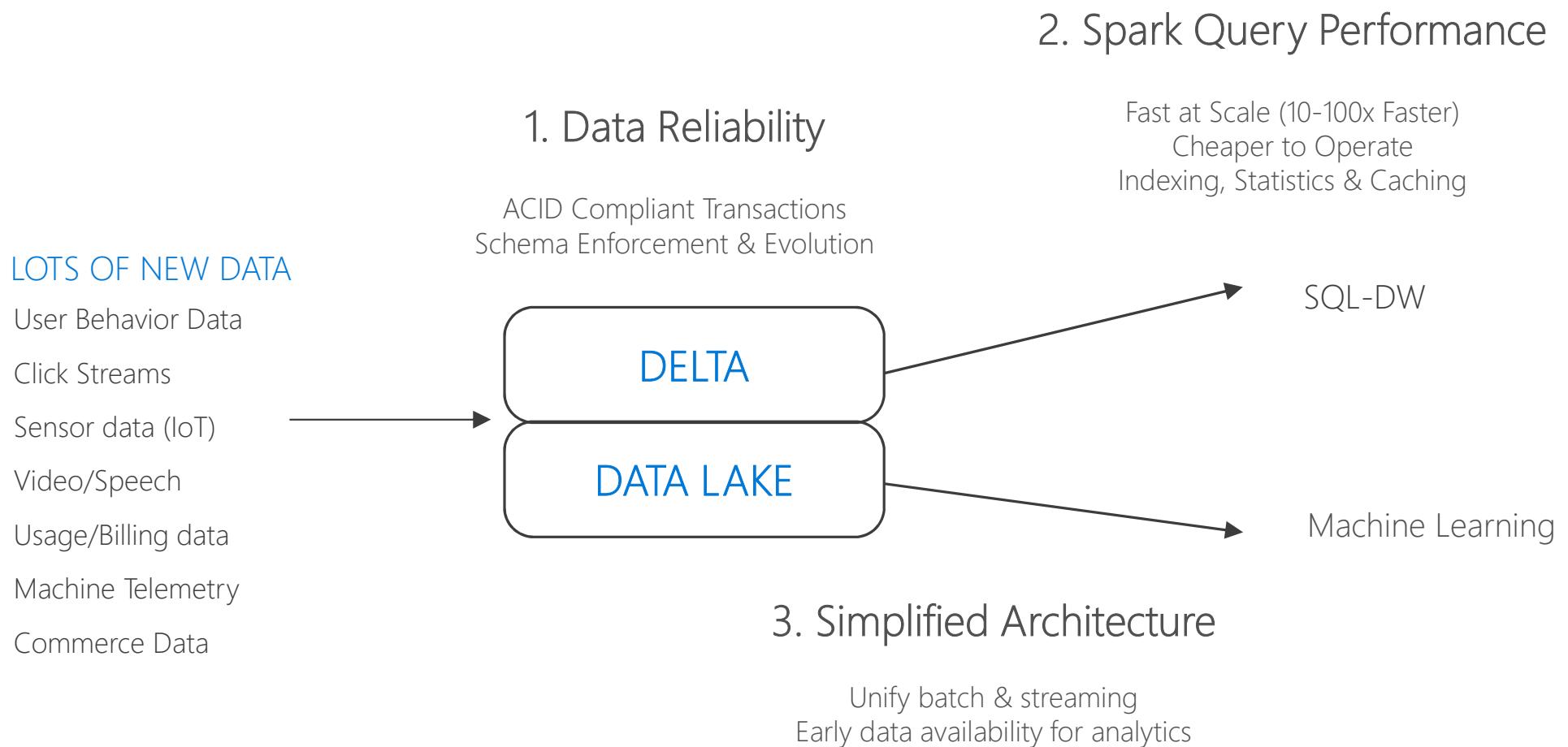
The
**RELIABILITY &
PERFORMANCE**
Of data lake

The
LOW LATENCY
Of streaming

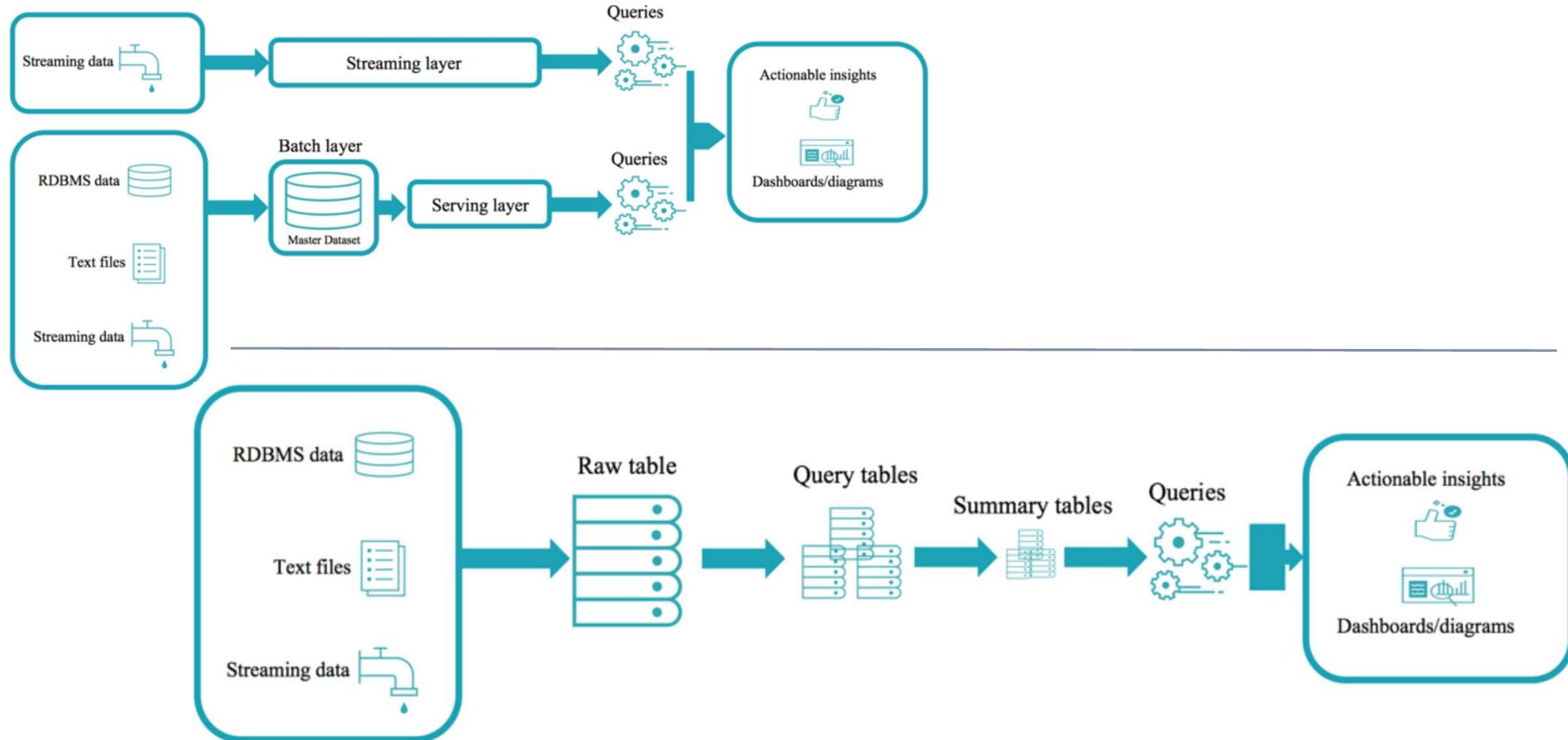
Why Databricks Delta?



Problems Solved



Lambda architecture vs Databricks Delta



Multi-Hop Data Pipelines

LOTS OF NEW DATA

User Behavior
Data

Click Streams

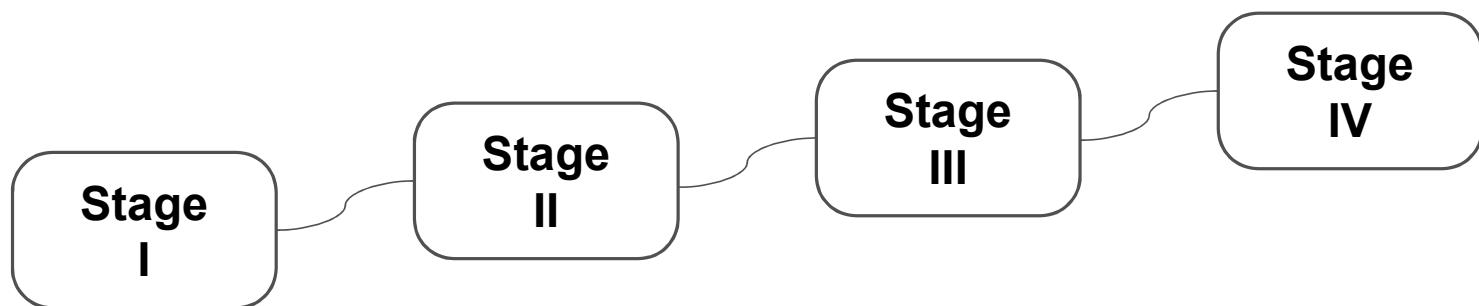
Sensor Data (IoT)

Video/Speech

Usage/Billing Data

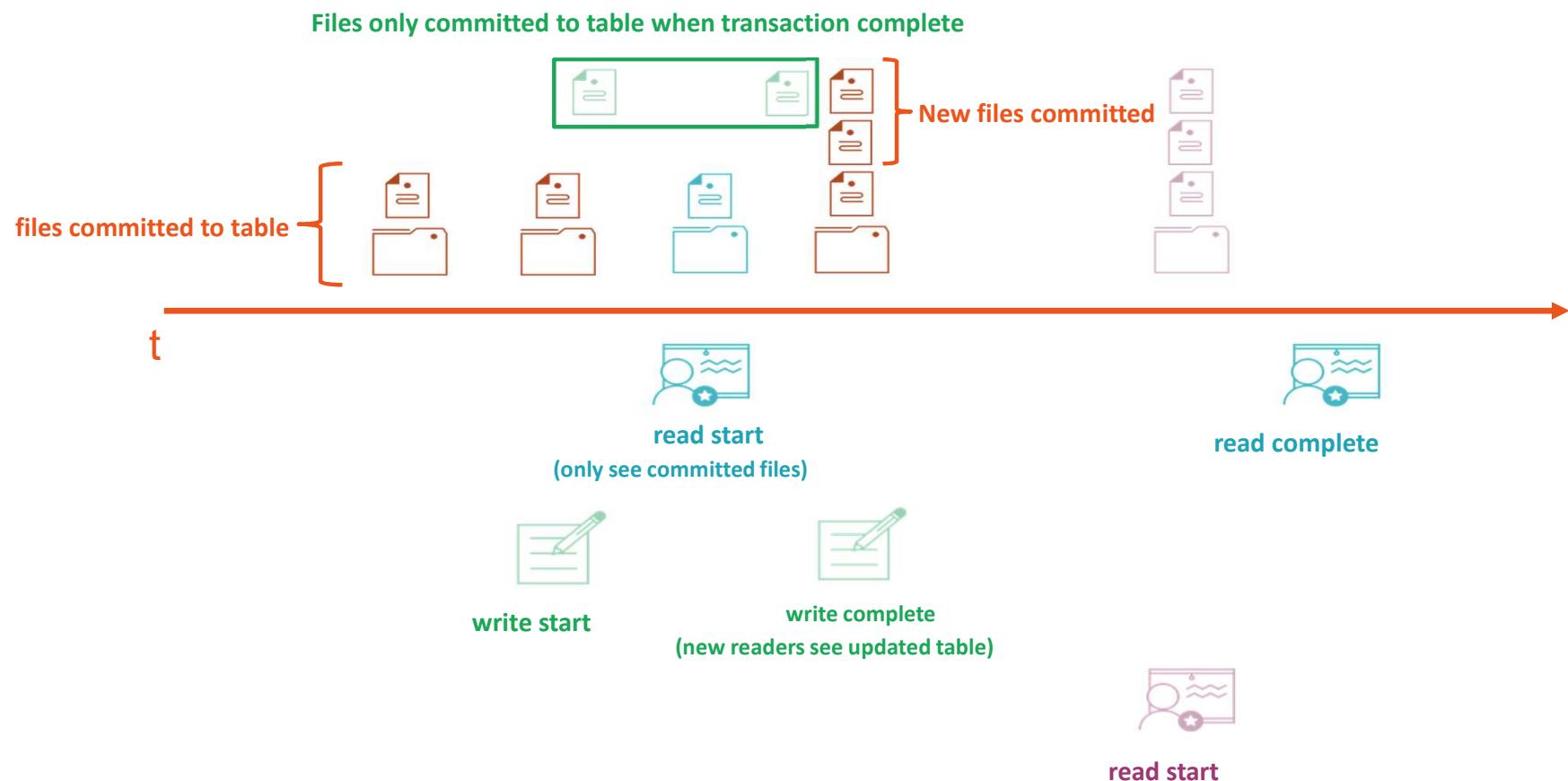
Machine
Telemetry

Commerce Data



- Stage I - Raw events from many different parts of the organization
- Stage II - Normalized and enriched with dimension information
- Stage III - Filtered down and aggregated for particular business objective.
- Stage IV - High-level summaries of key business metrics.

Data Reliability



Questions?

