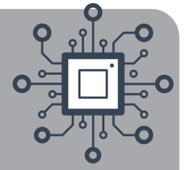


An Introduction to Delta Lakes

& Delta Lake-Houses

Paul Andrew | Technical Architect in Azure CoE

 @MrPaulAndrew

 In/MrPaulAndrew

 MrPaulAndrew.com

An Introduction to Delta* Lakes

& Delta* Lake-Houses

* We are not talking about the delta of changed records since our data processing last ran.

Uppercase Δ
Lowercase δ or δ

Paul Andrew | Technical Architect in Azure CoE

Microsoft® Most Valuable Professional

avanade

@MrPaulAndrew

In/MrPaulAndrew

MrPaulAndrew.com

https://github.com/mrpaulandrew

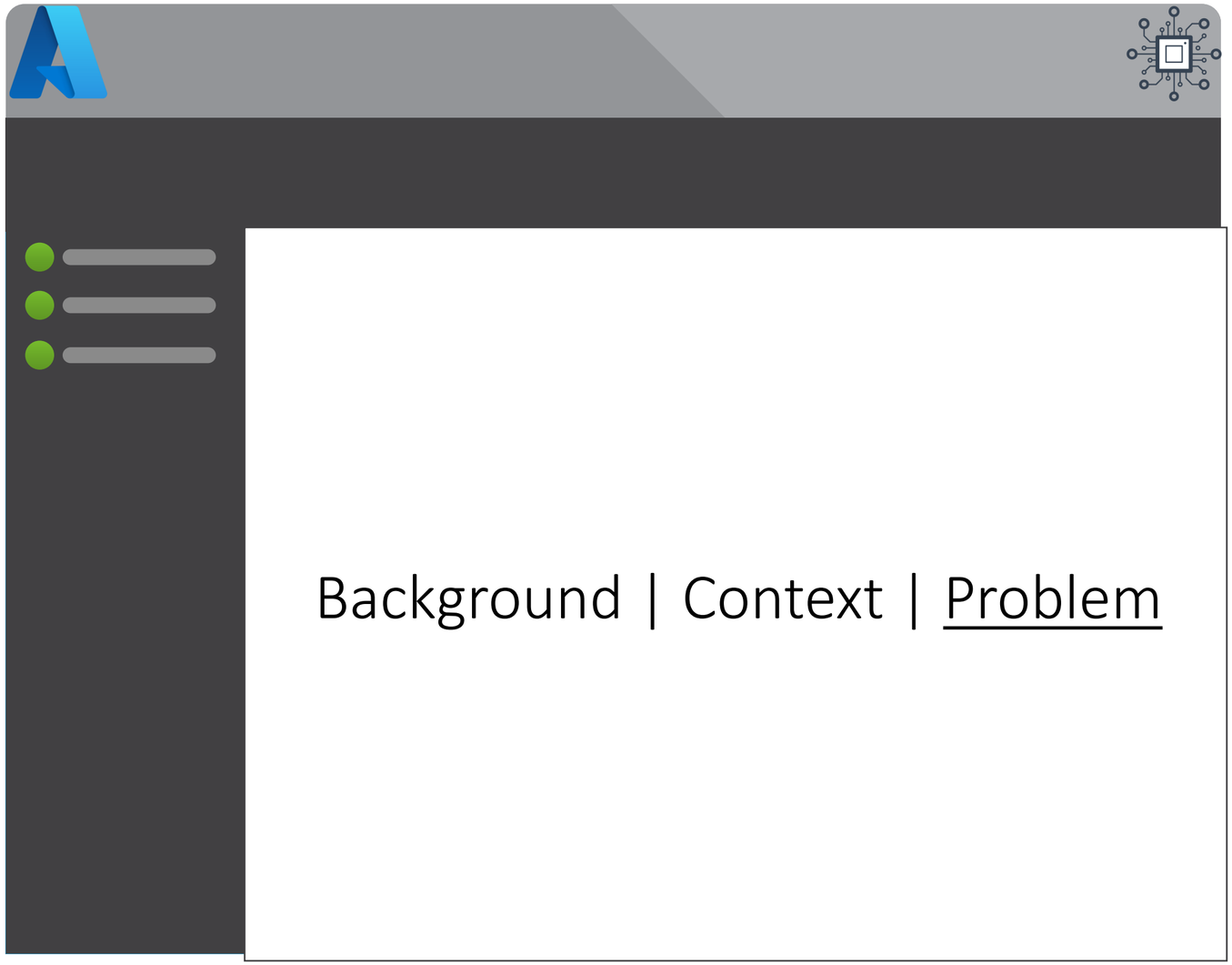
CommunityEvents

Demo code, content and slides from various community events.

C++

{Event/Location}-{Month}-{Year}

Part 1.0 – Theory



Background | Context | Problem

ACID!

Human Traffic (1999)

ACID – In Computer Science

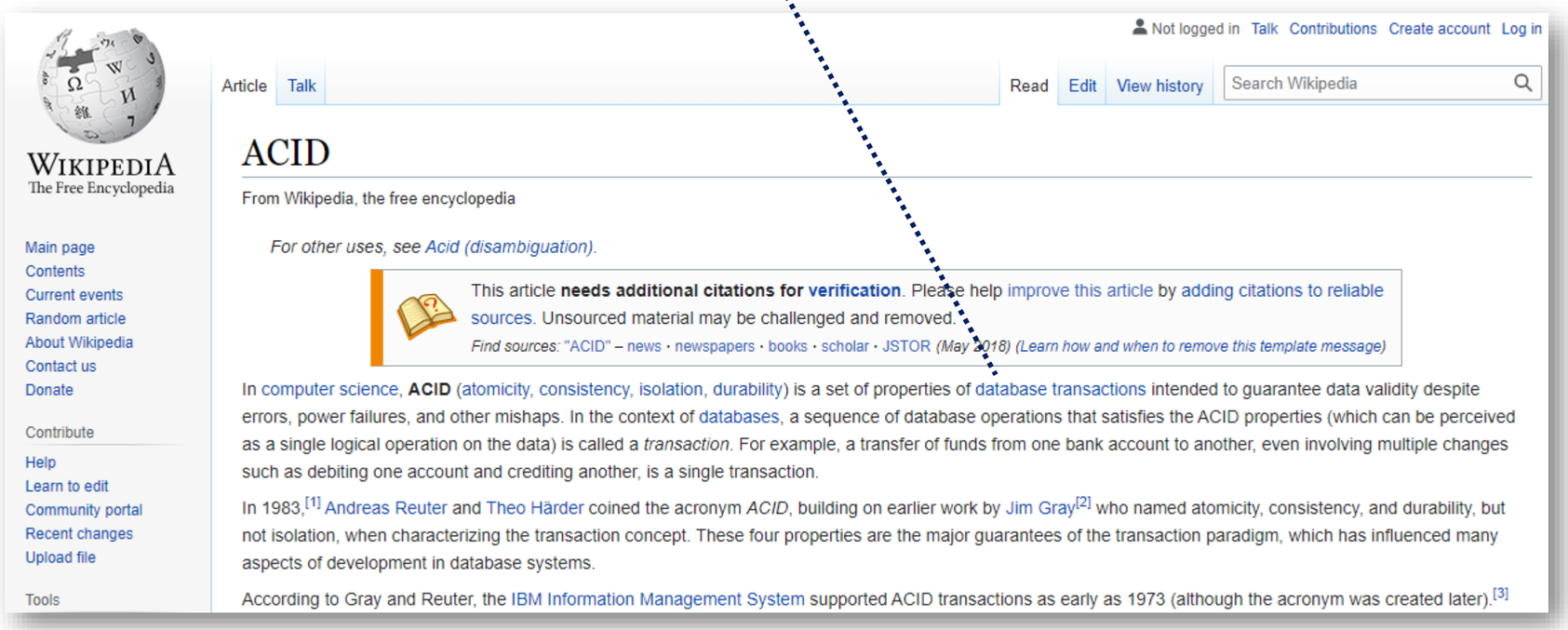
Atomicity

Consistency

Isolation

Durability

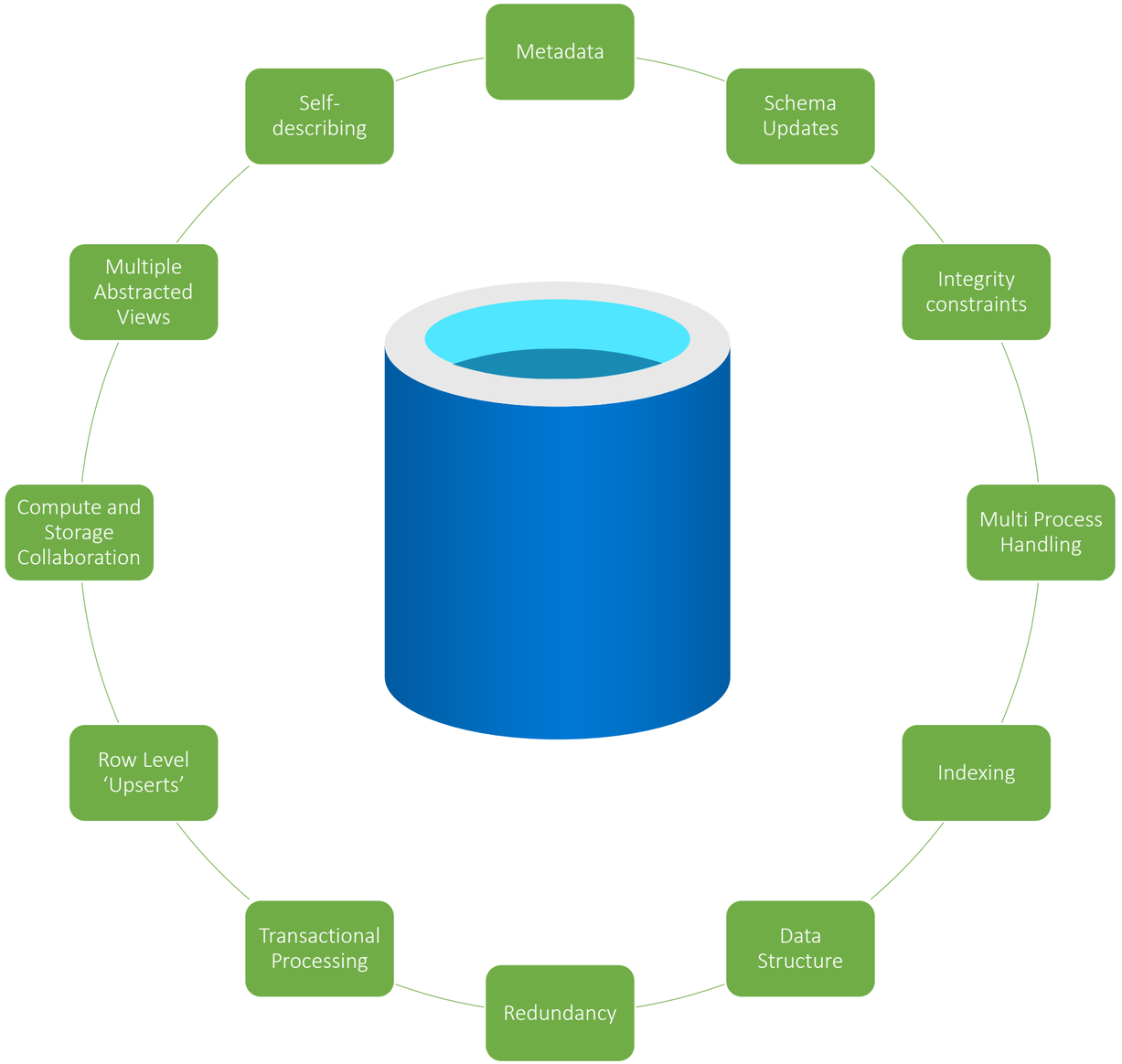
"is a set of properties of database transactions intended to guarantee data validity"

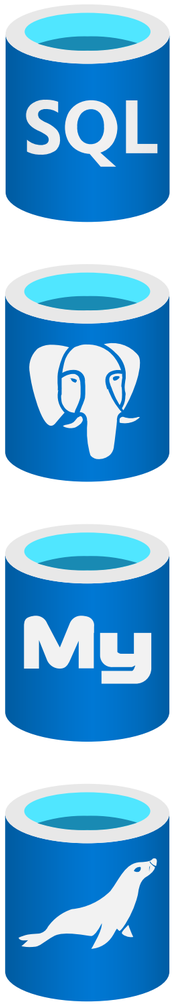


https://en.wikipedia.org/wiki/ACID

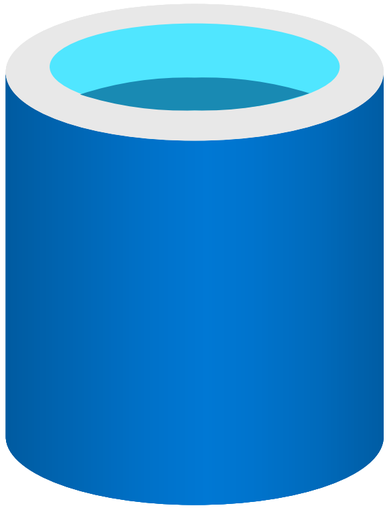
Databases

Data**B**ase
Management
System





Databases



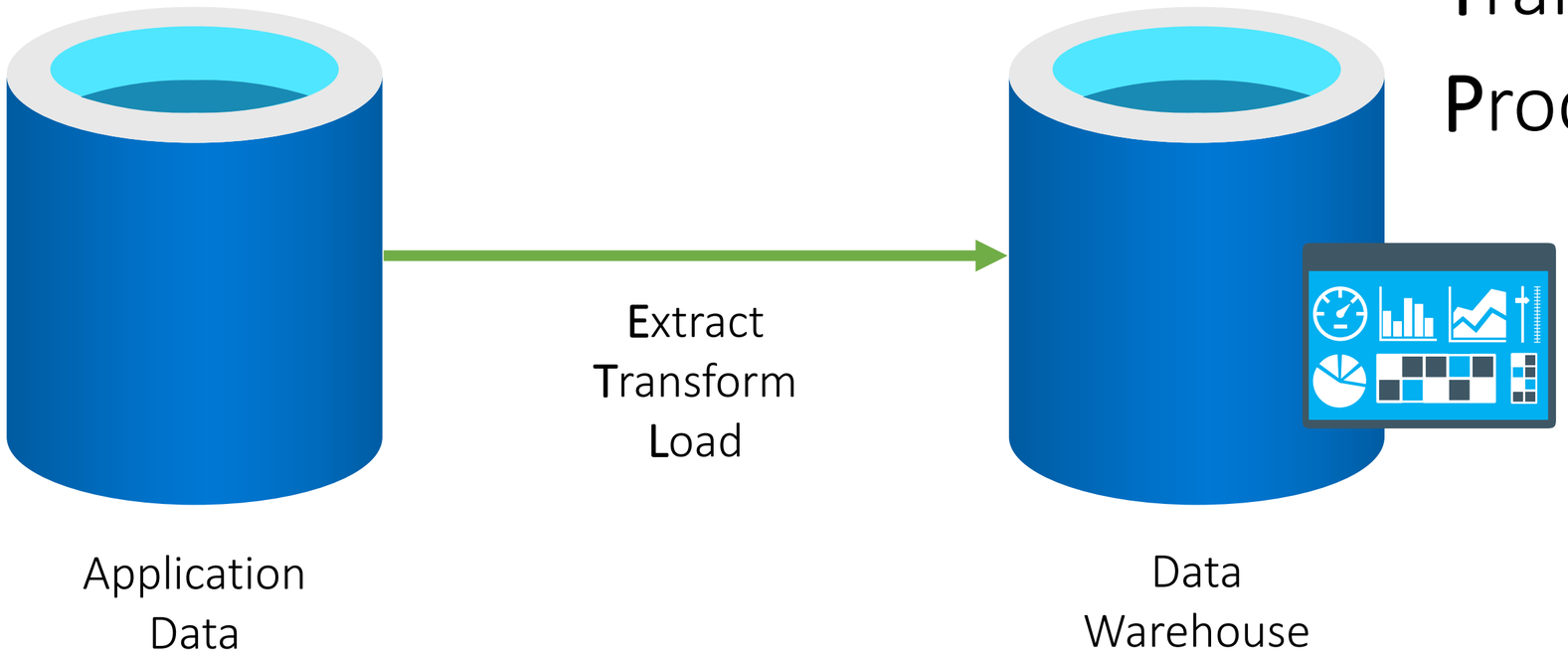
Creating a Data Warehouse

Online

Line

Transactional

Processing



Offline

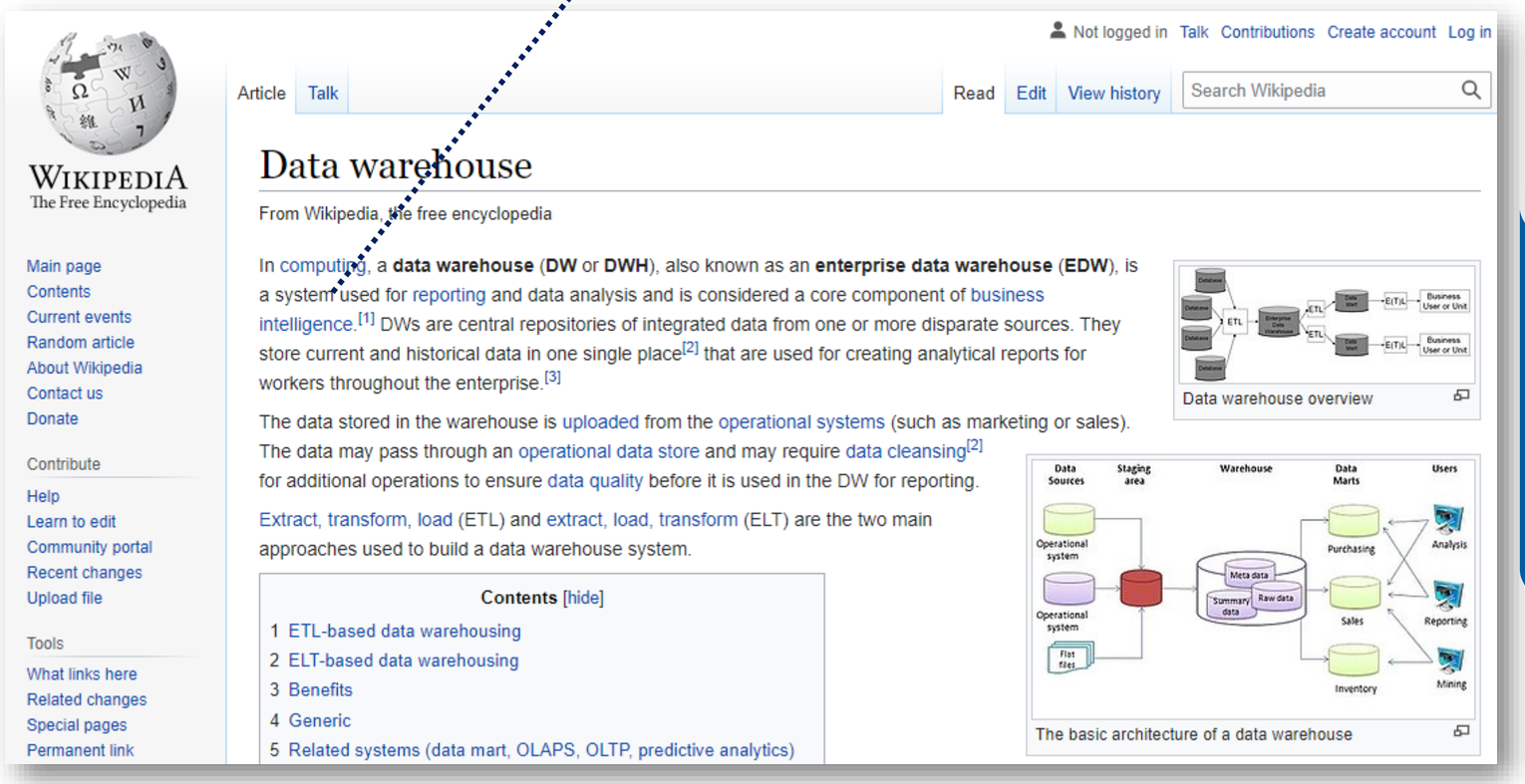
Analytical

Transactional

Processing

Creating a Data Warehouse

"a system for reporting and data analysis"



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Data warehouse

From Wikipedia, the free encyclopedia

In computing, a **data warehouse** (**DW** or **DWH**), also known as an **enterprise data warehouse** (**EDW**), is a system used for reporting and data analysis and is considered a core component of business intelligence.[1] DWs are central repositories of integrated data from one or more disparate sources. They store current and historical data in one single place[2] that are used for creating analytical reports for workers throughout the enterprise.[3]

The data stored in the warehouse is uploaded from the operational systems (such as marketing or sales). The data may pass through an operational data store and may require data cleansing[2] for additional operations to ensure data quality before it is used in the DW for reporting.

Extract, transform, load (ETL) and extract, load, transform (ELT) are the two main approaches used to build a data warehouse system.

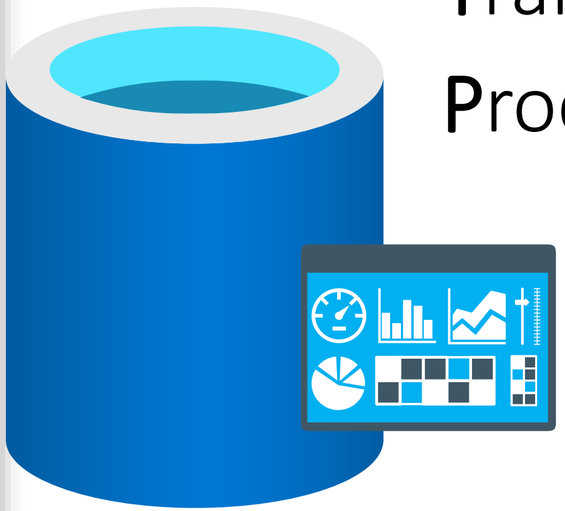
Contents [hide]
1 ETL-based data warehousing
2 ELT-based data warehousing
3 Benefits
4 Generic
5 Related systems (data mart, OLAPS, OLTP, predictive analytics)

Data warehouse overview

The basic architecture of a data warehouse

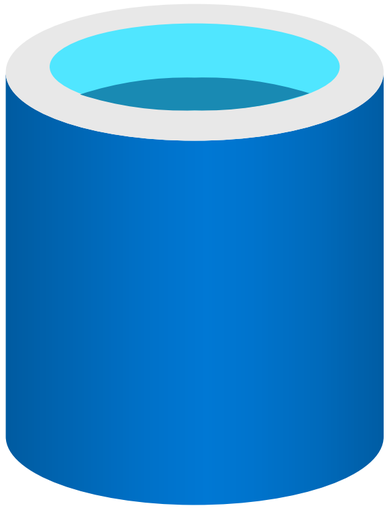
https://en.wikipedia.org/wiki/Data_warehouse

Offline
Analytical
Transactional
Processing

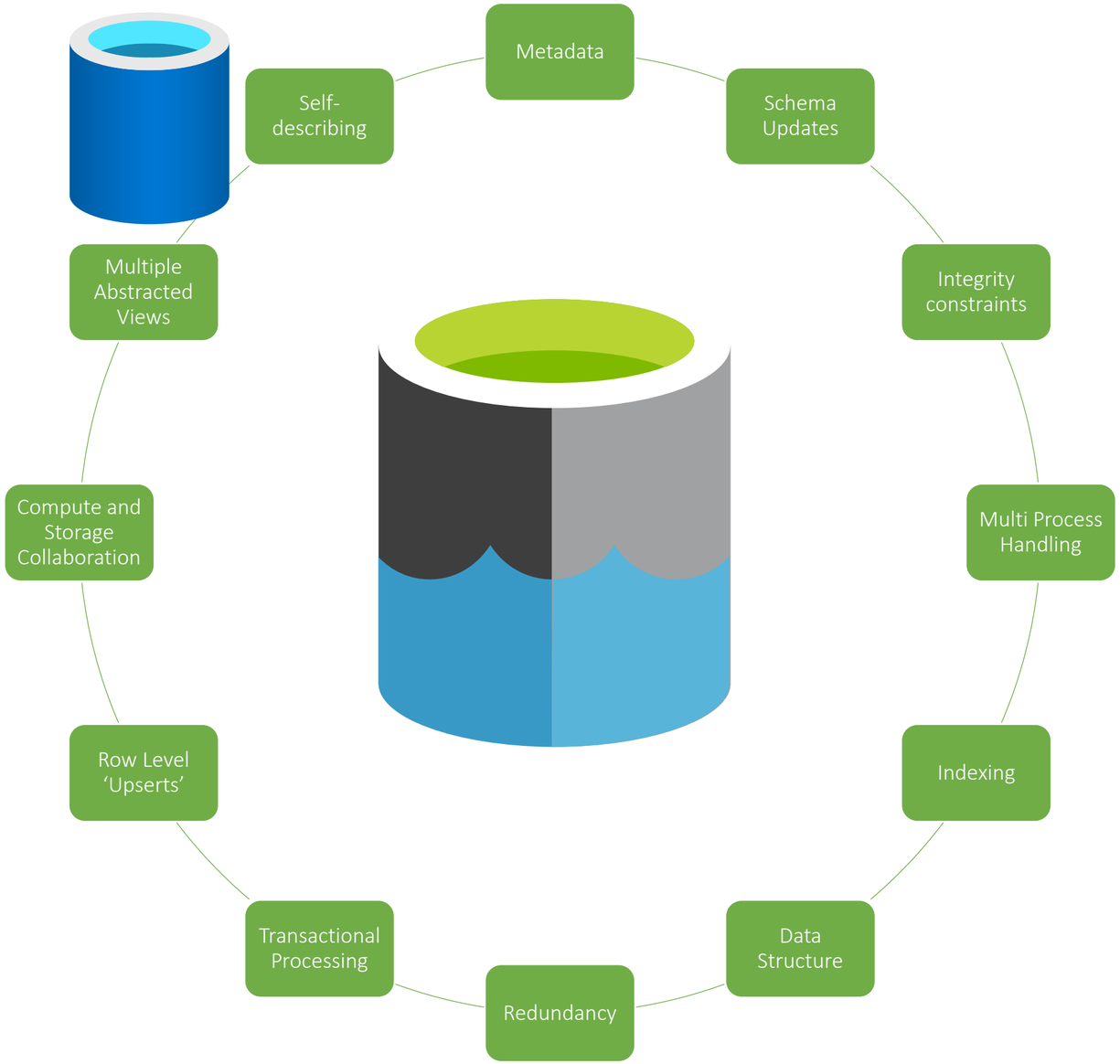


Data Warehouse

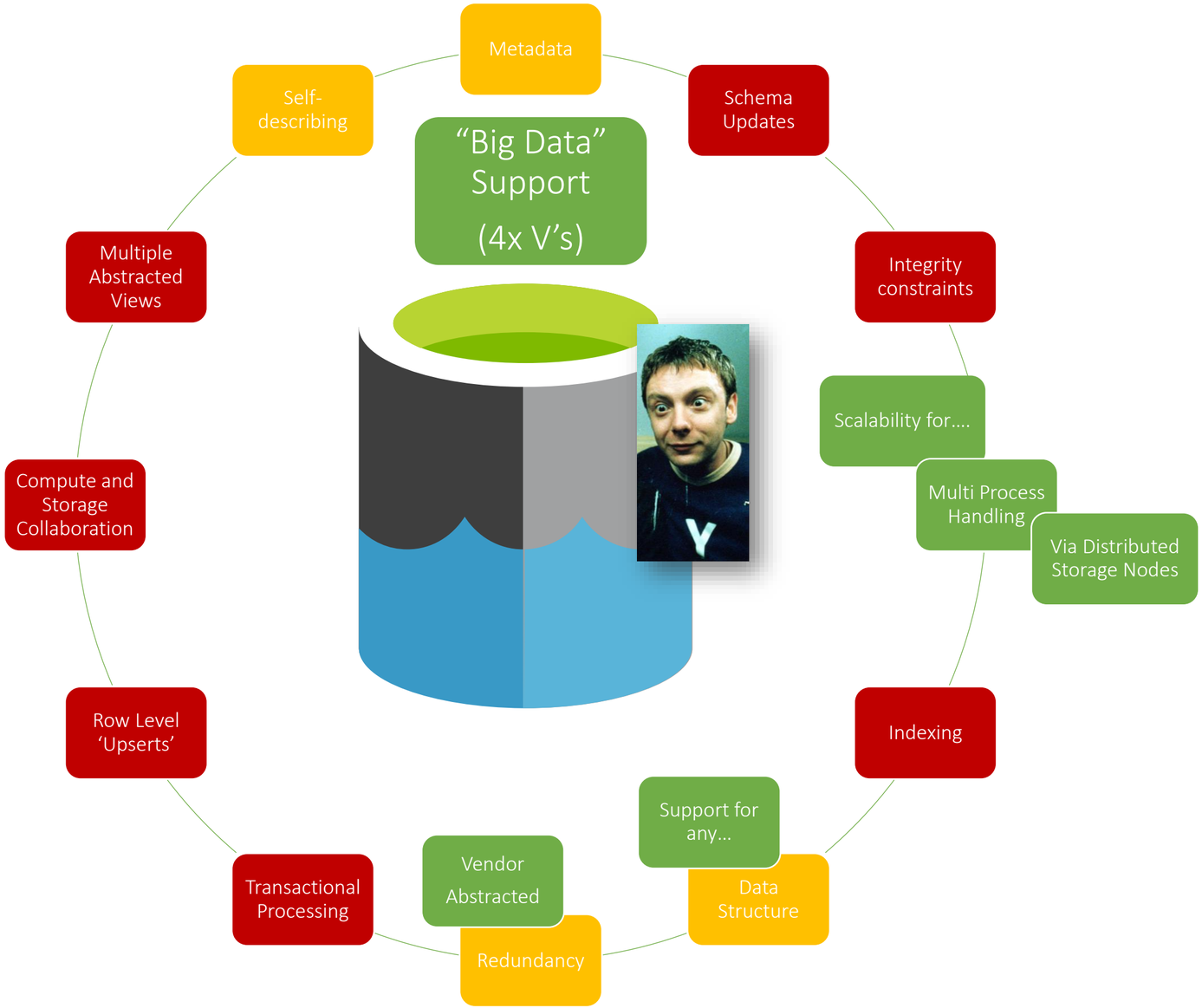
Databases



Data Lakes


Metadata
Schema Updates
Integrity constraints
Multi Process Handling
Indexing
Data Structure
Redundancy
Transactional Processing
Row Level ‘Upserts’
Compute and Storage Collaboration
Multiple Abstracted Views
Self-describing

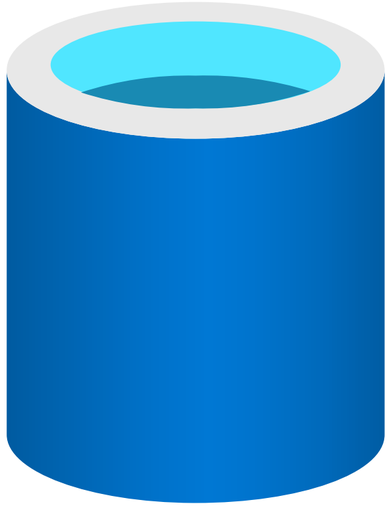
Data Lakes


Metadata
Schema Updates
Integrity constraints
Scalability for….
Multi Process Handling
Via Distributed Storage Nodes
Indexing
Support for any…
Data Structure
Redundancy
Vendor Abstracted
Transactional Processing
Row Level ‘Upserts’
Compute and Storage Collaboration
Multiple Abstracted Views
Self-describing
“Big Data” Support
(4x V’s)

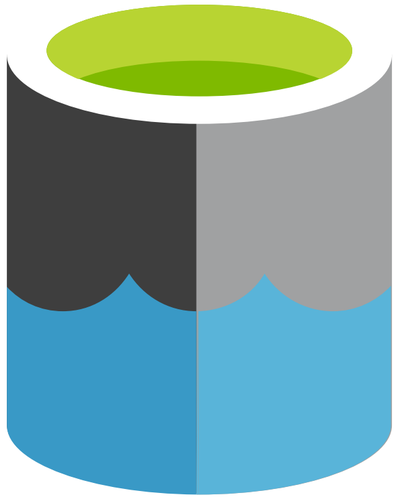
Problem Summary

Data Lakes are good, but they still lack some of the basic ACID functionality needed for data processing.

We are/were trying to use Data Lakes for everything (to replace Databases).



VS



Scales Up	Scales Out
Natural Home for Structured Data	Any Data Structure
Storage Limits	No Storage Limits
Transactional Resilience	No Transactional Handling
Storage & Compute Coupled	Storage & Compute Decoupled

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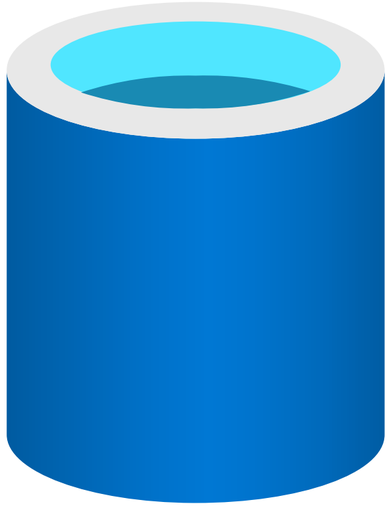
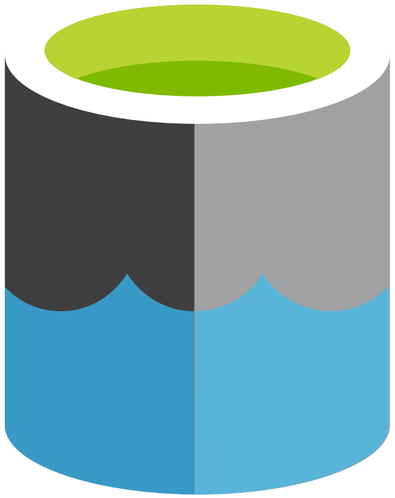


VS



Scales Up	Scales Out
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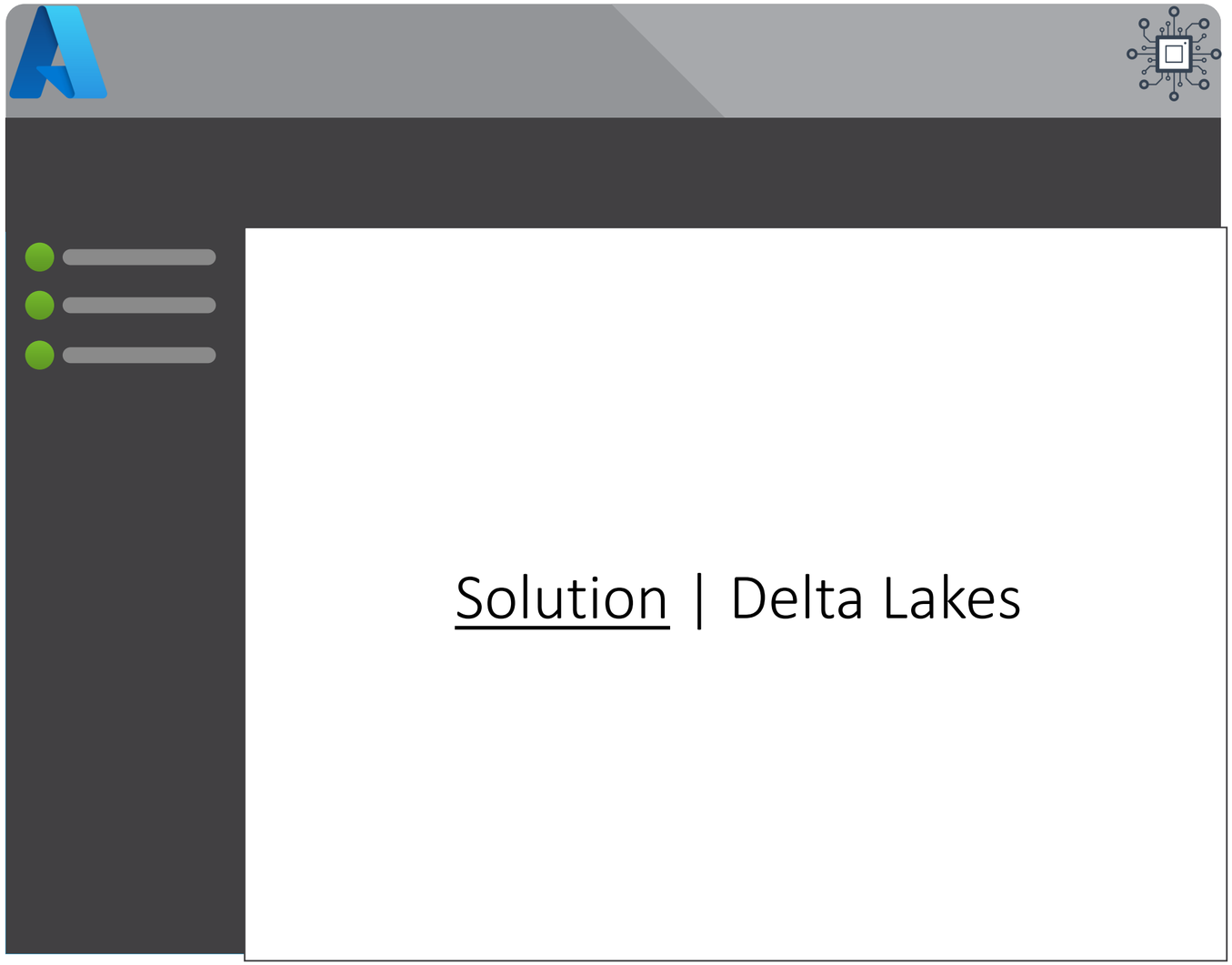
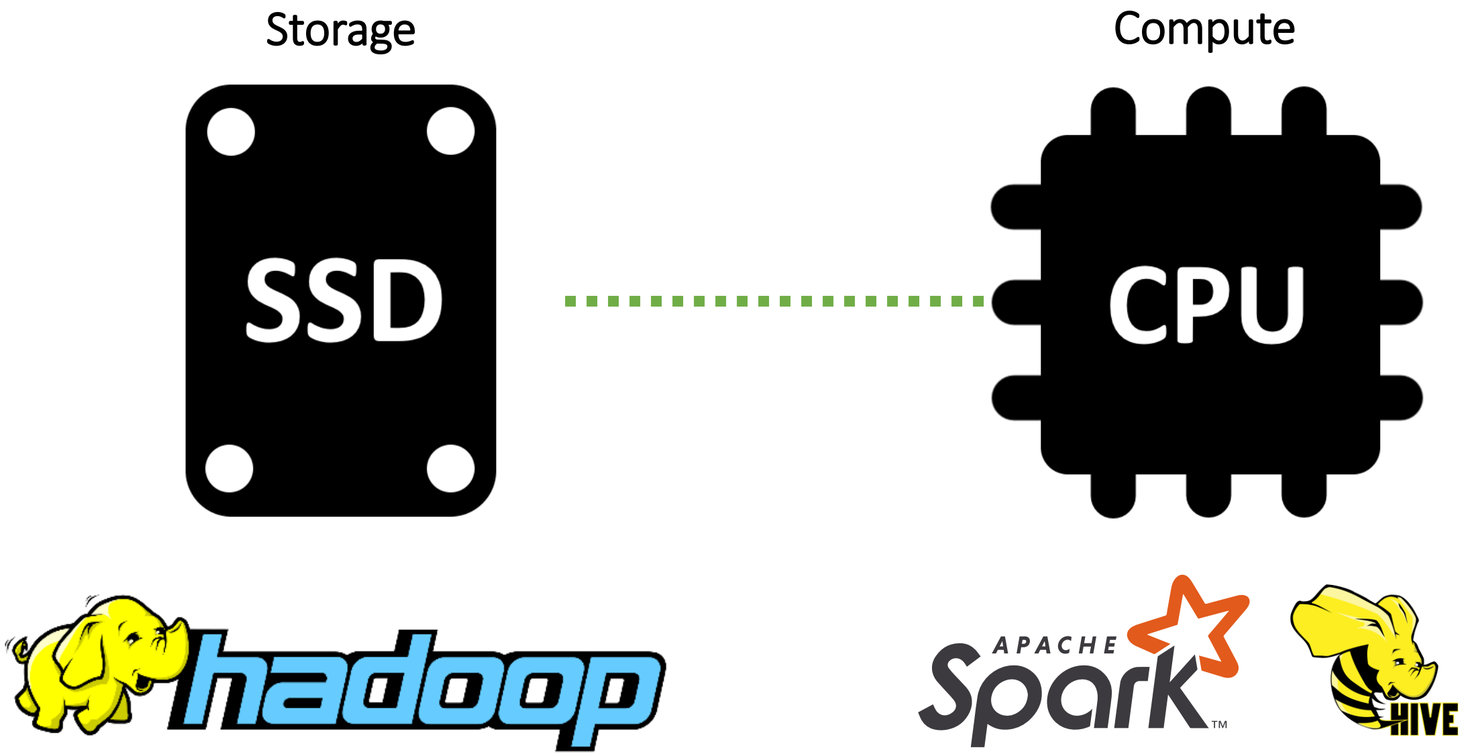
Part 1.1 – Theory



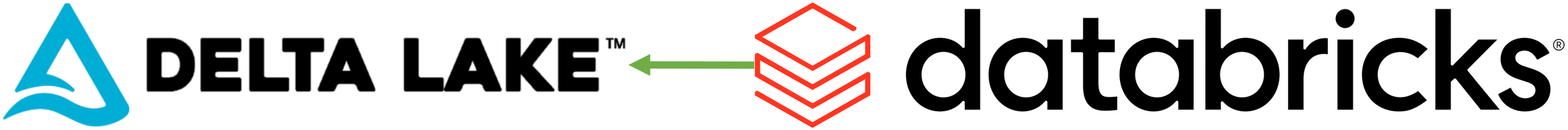
Solution

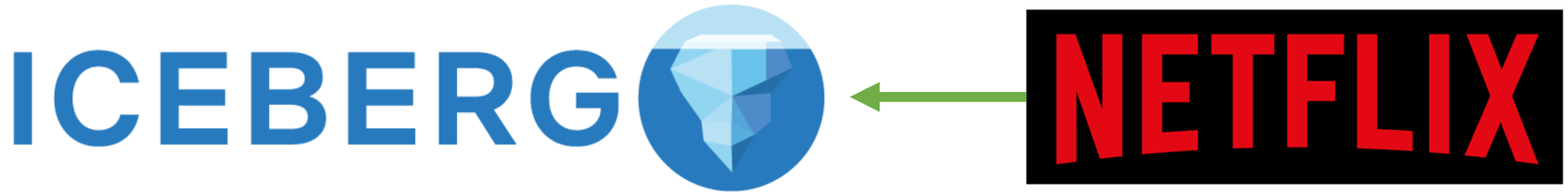
Enable ACID transactional support for Data Lakes...



Storage & Compute ~~Decoupled~~ Working Together Again As Friends!

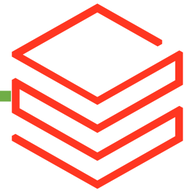
ACID Data Frameworks for Data Lakes



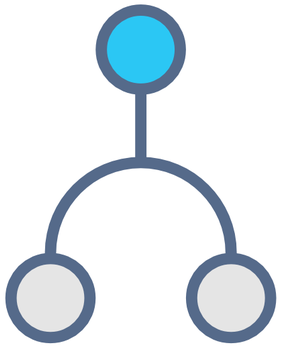


What is Delta Lake?

DELTA LAKE™



databricks®



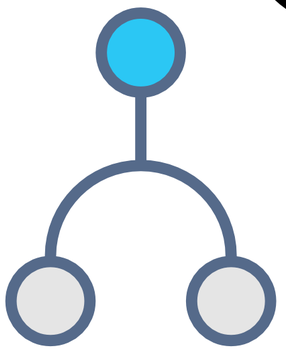
February 2019

What is Delta Lake?

https://delta.io

https://github.com/delta-io/delta

April 2019



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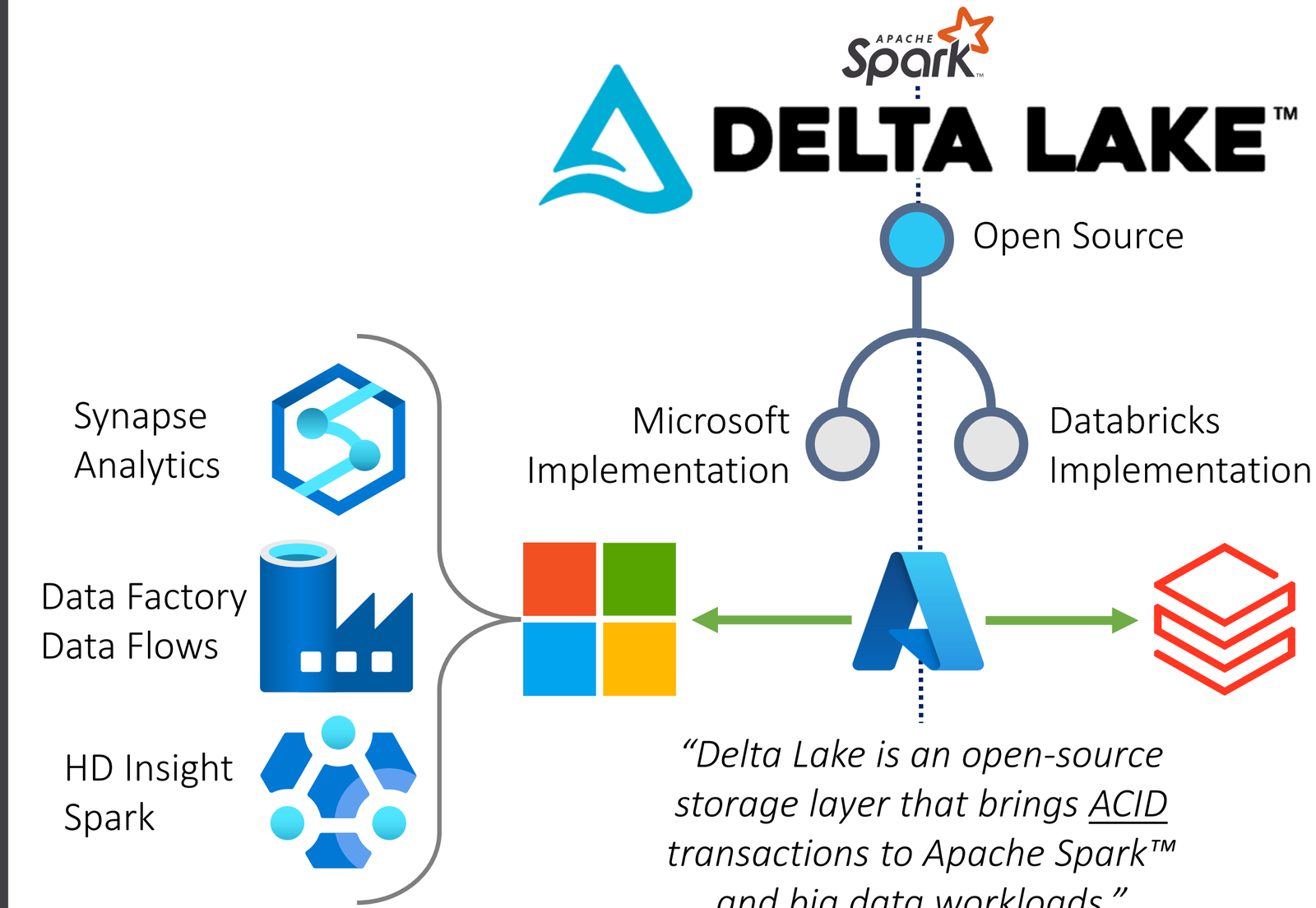
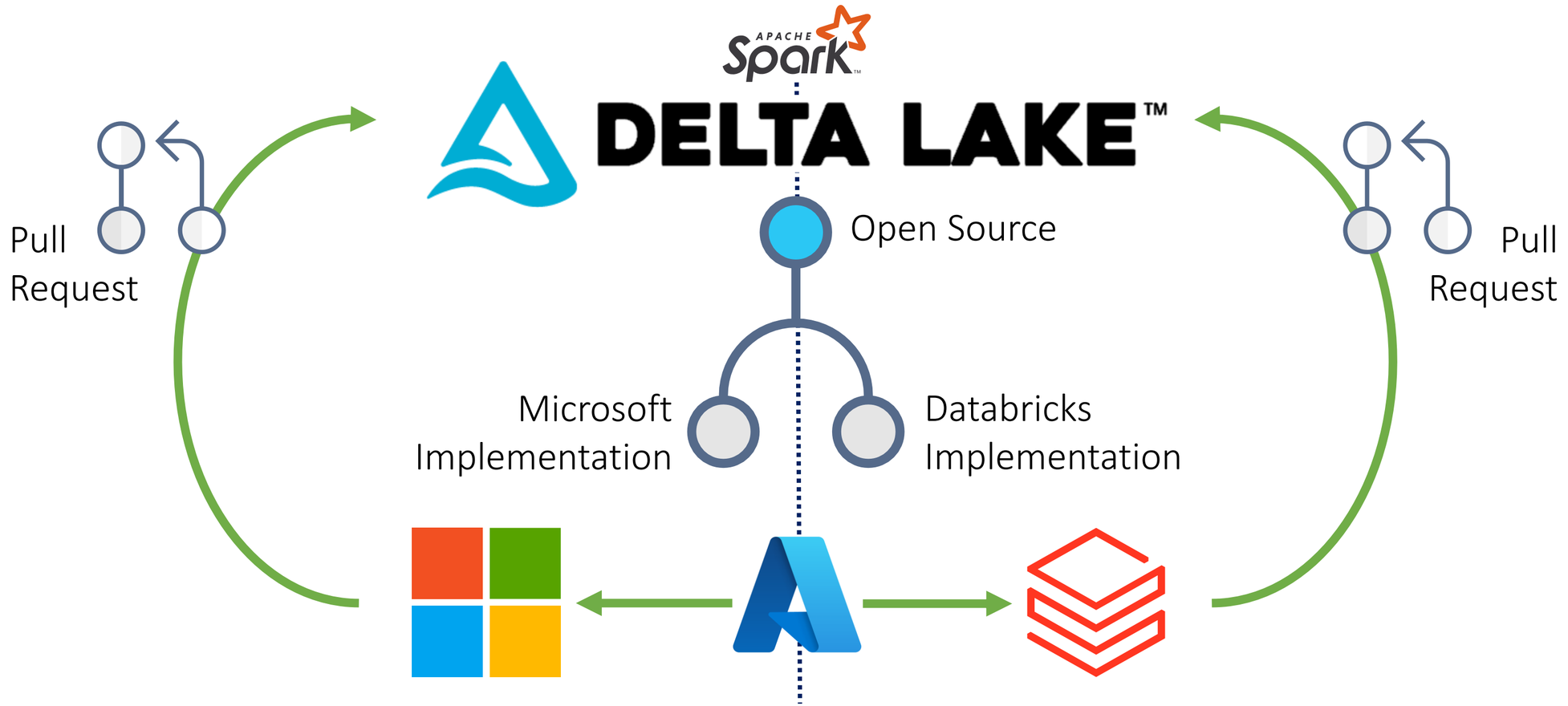
What is Delta Lake?



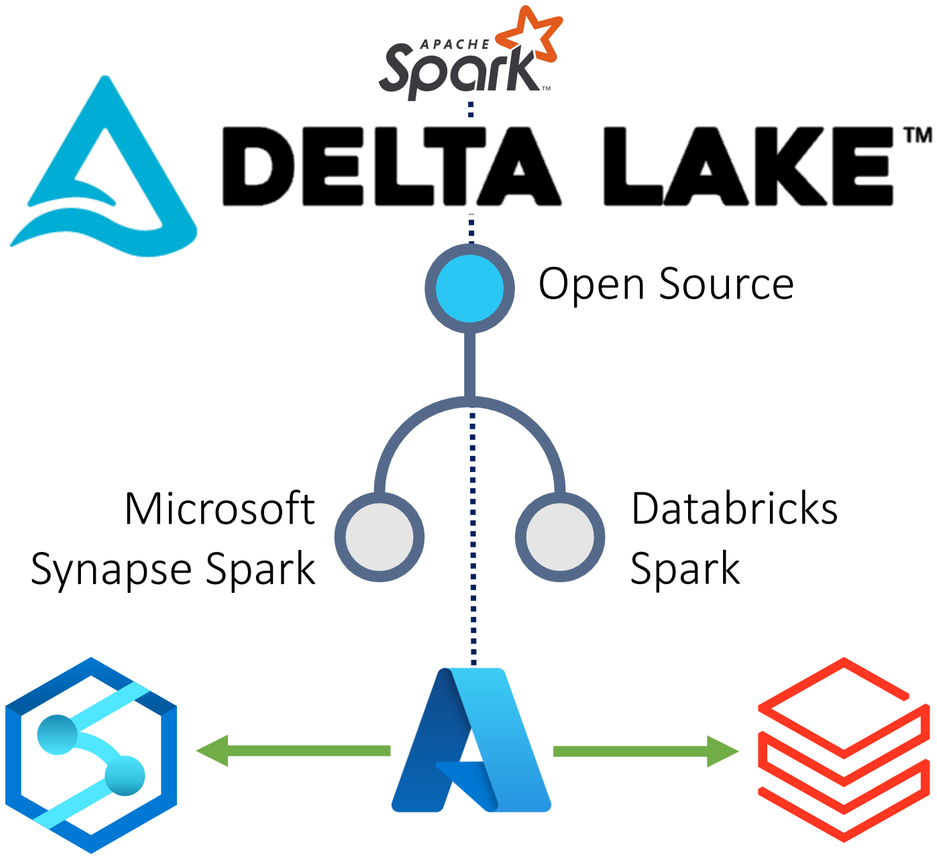
"Delta Lake is an open-source storage layer that brings ACID transactions to Apache Spark™ and big data workloads."

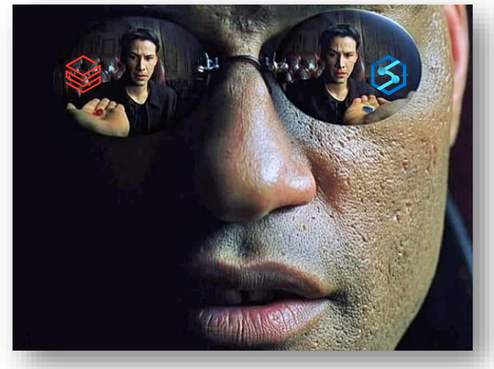
What is Delta Lake?



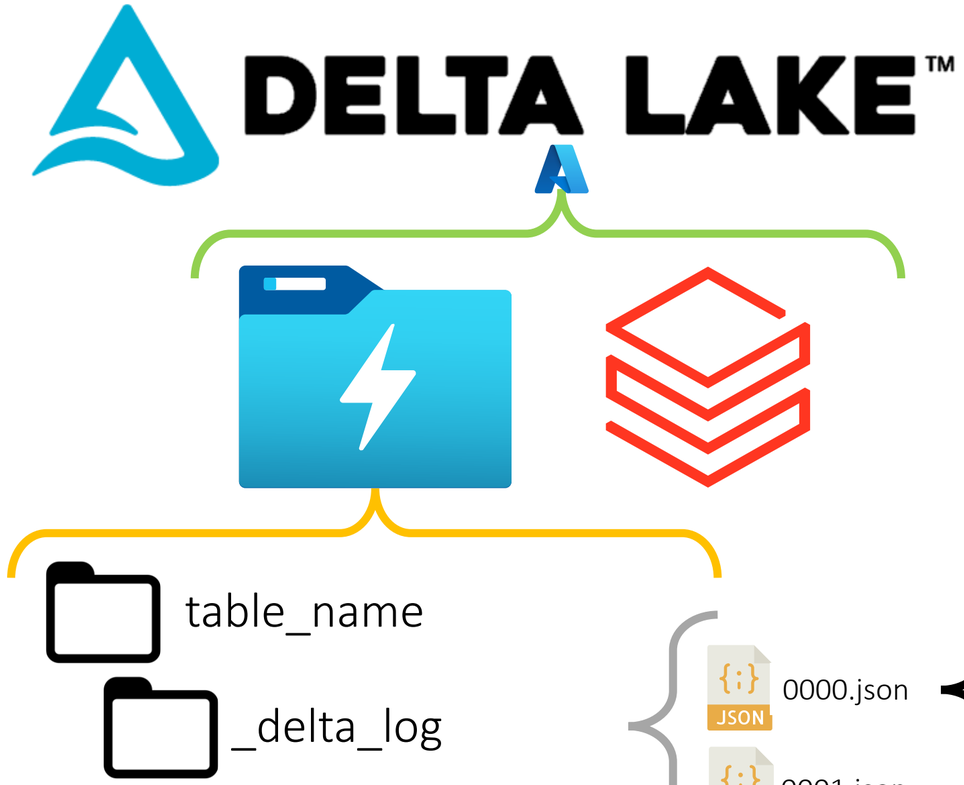
"Delta Lake is an open-source storage layer that brings ACID transactions to Apache Spark™ and big data workloads."

Which Spark Implementation is Better?



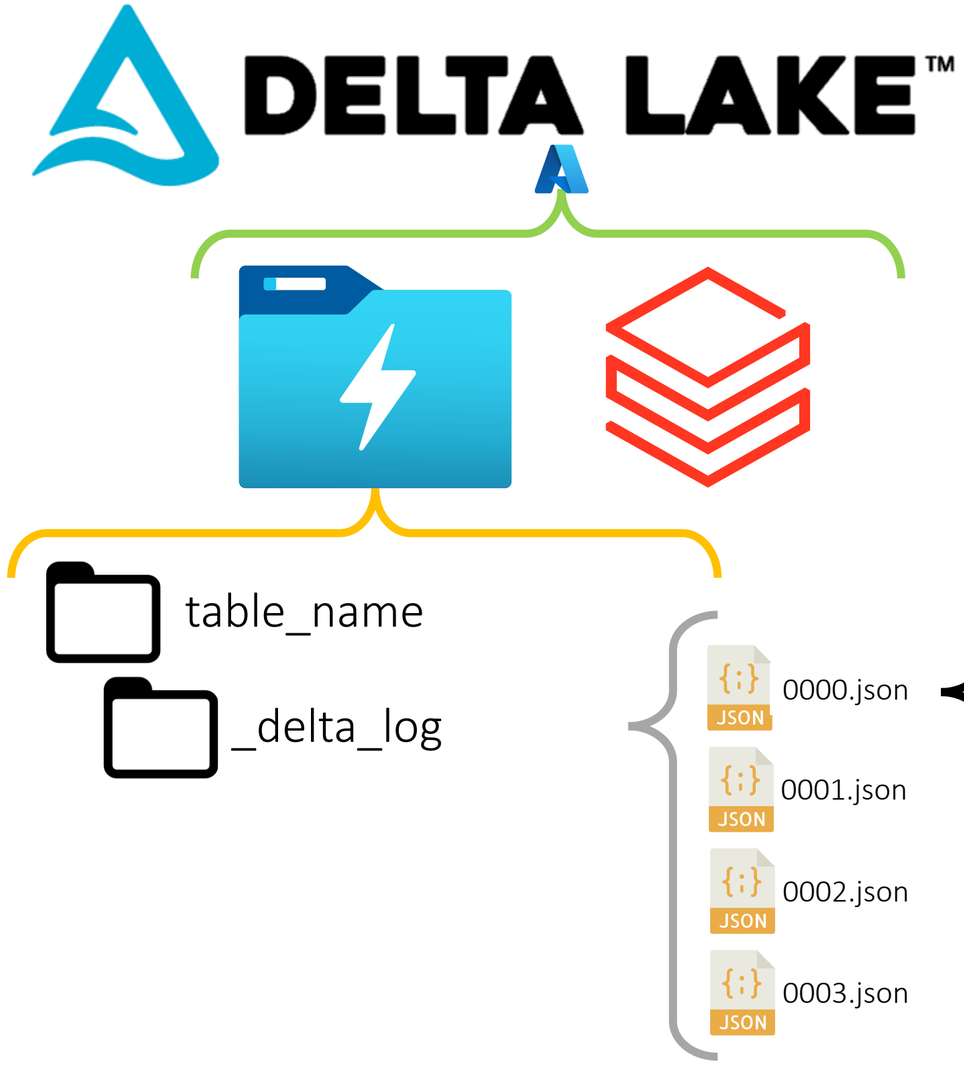


Delta Table - Transaction Log




```
{
    "commitInfo":
    {
        "timestamp":1628596034417,
        "operation":"WRITE",
        "operationParameters":
        {
            "mode":"ErrorIfExists",
            "partitionBy":"[]"
        },
        "isBlindAppend":true,
        "operationMetrics":
            {
                "numFiles":"6",
                "numOutputBytes":"2407",
                "numOutputRows":"5"
            }
    }
}
{"protocol":{"minReaderVersion":1,"minWriterVersion":2}}
{
    "metaData":
    {
    "id":"58e5de01-de72-4d5b-a208-d0b4ae919efe",
    "format":
    {
        "provider":"parquet",
        "options":{}
    },
    "schemaString":
                "{\"type\":\"struct\",\"fields\":[{\"name\":\"id\",\"type\":\"long\",
                  \"nullable\":true,\"metadata\":{}}]}",
    "partitionColumns":[],
    "configuration":{},
    "createdTime":1628596029470
    }
}
{"add":{"path":"part-00000.snappy.parquet","size":262,"modificationTime":1628596034000}}
{"add":{"path":"part-00001.snappy.parquet","size":429,"modificationTime":1628596034000}}
{"txn":{"appId":"731b2c96-bf64-445c-8ca8-cd6cad6735e2","lastUpdated":1628596094191}}
{"add":{"path":"part-00000.snappy.parquet","size":429,"modificationTime":1628596094000}}
{"add":{"path":"part-00001.snappy.parquet","size":429,"modificationTime":1628596094000}}
{"remove":{"path":"part-00150.snappy.parquet","deletionTimestamp":1628596098597}}
{"remove":{"path":"part-00128.snappy.parquet","deletionTimestamp":1628596098597}}
```

Delta Table - Transaction Log



Breaking Down Transactions Into Atomic Commits

Whenever a user performs an operation to modify a table (such as an INSERT, UPDATE or DELETE), Delta Lake breaks that operation down into a series of discrete steps composed of one or more of the actions below.

Add file – adds a data file.

Remove file – removes a data file.

Update metadata – Updates the table's metadata (e.g., changing the table's name, schema or partitioning).

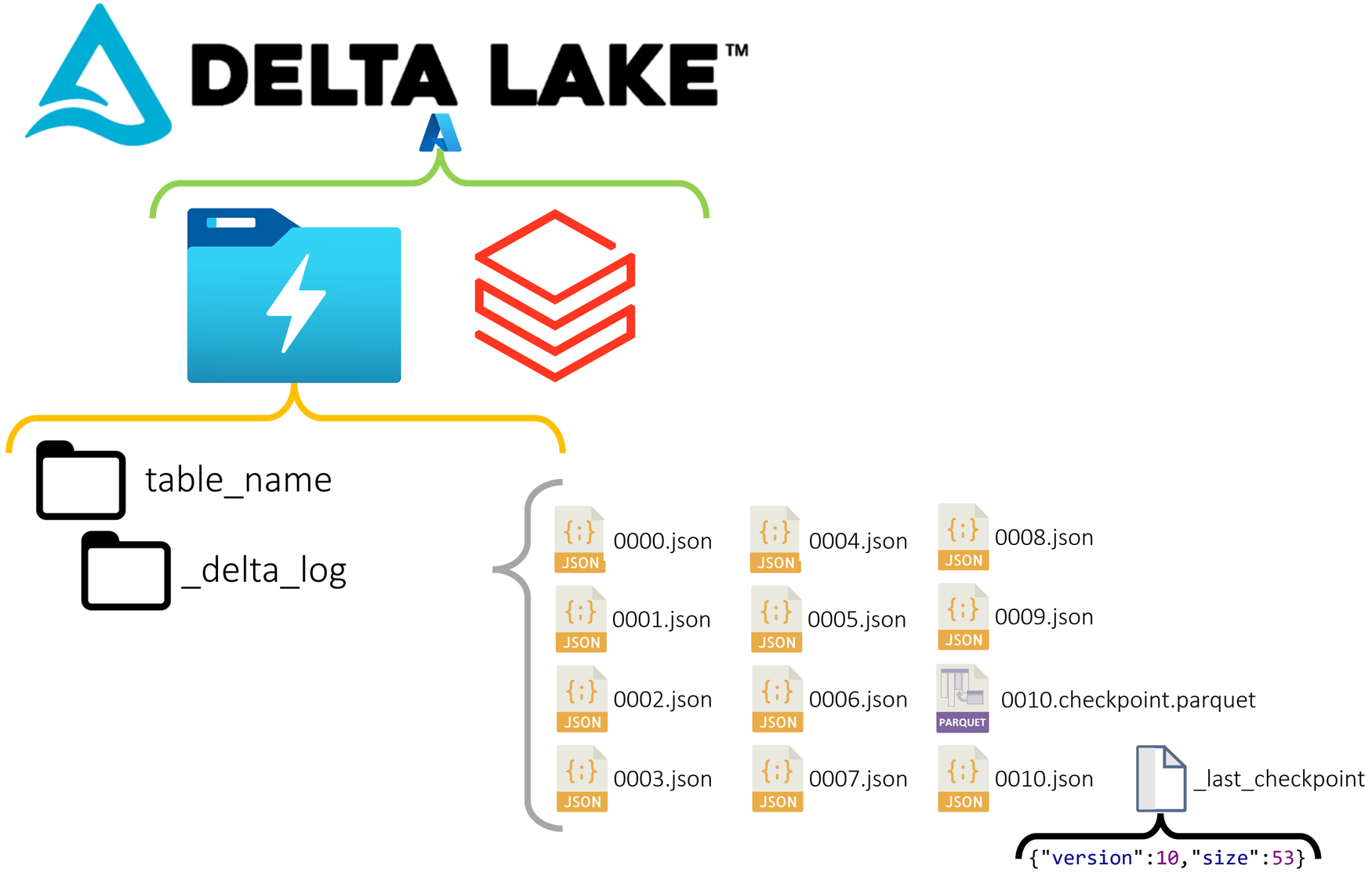
Set transaction – Records that a structured streaming job has committed a micro-batch with the given ID.

Change protocol – enables new features by switching the Delta Lake transaction log to the newest software protocol.

Commit info – Contains information around the commit, which operation was made, from where and at what time.

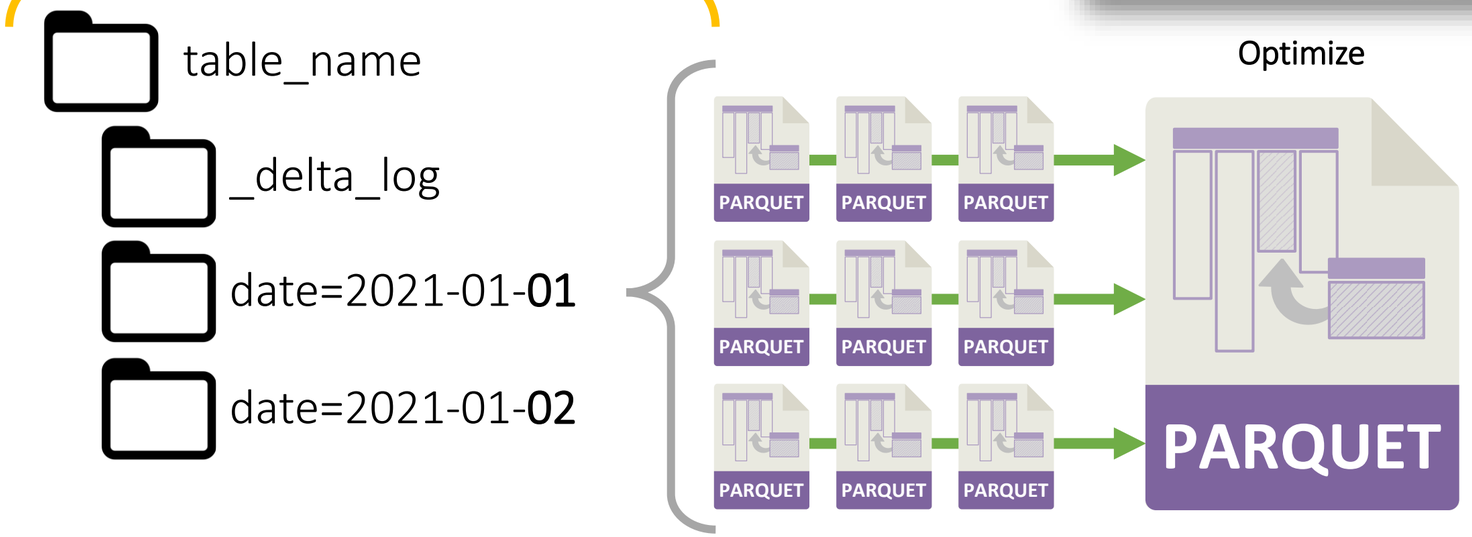
Source: https://databricks.com/blog

Delta Table - Transaction Log

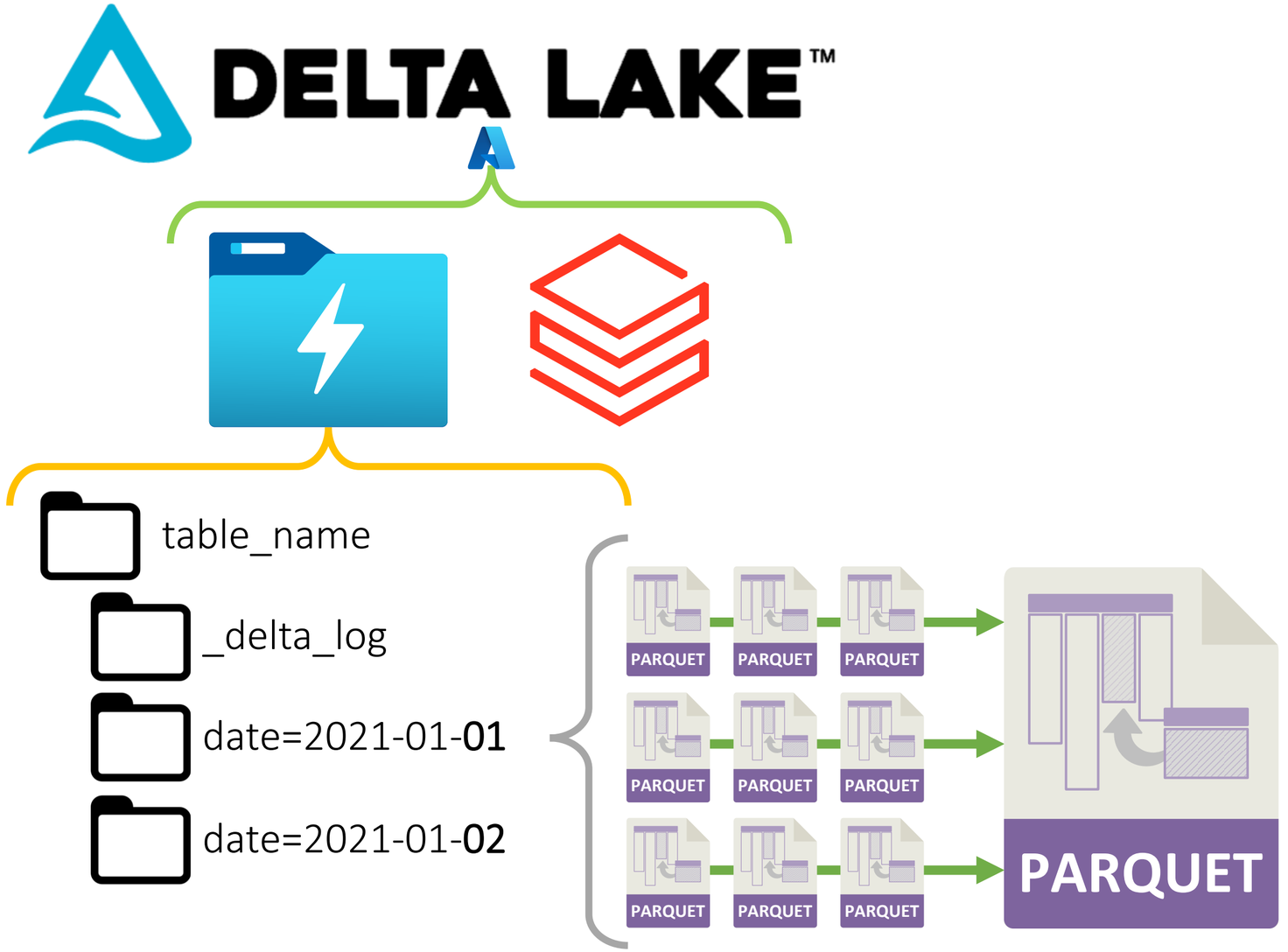


Delta Table - Transaction Log

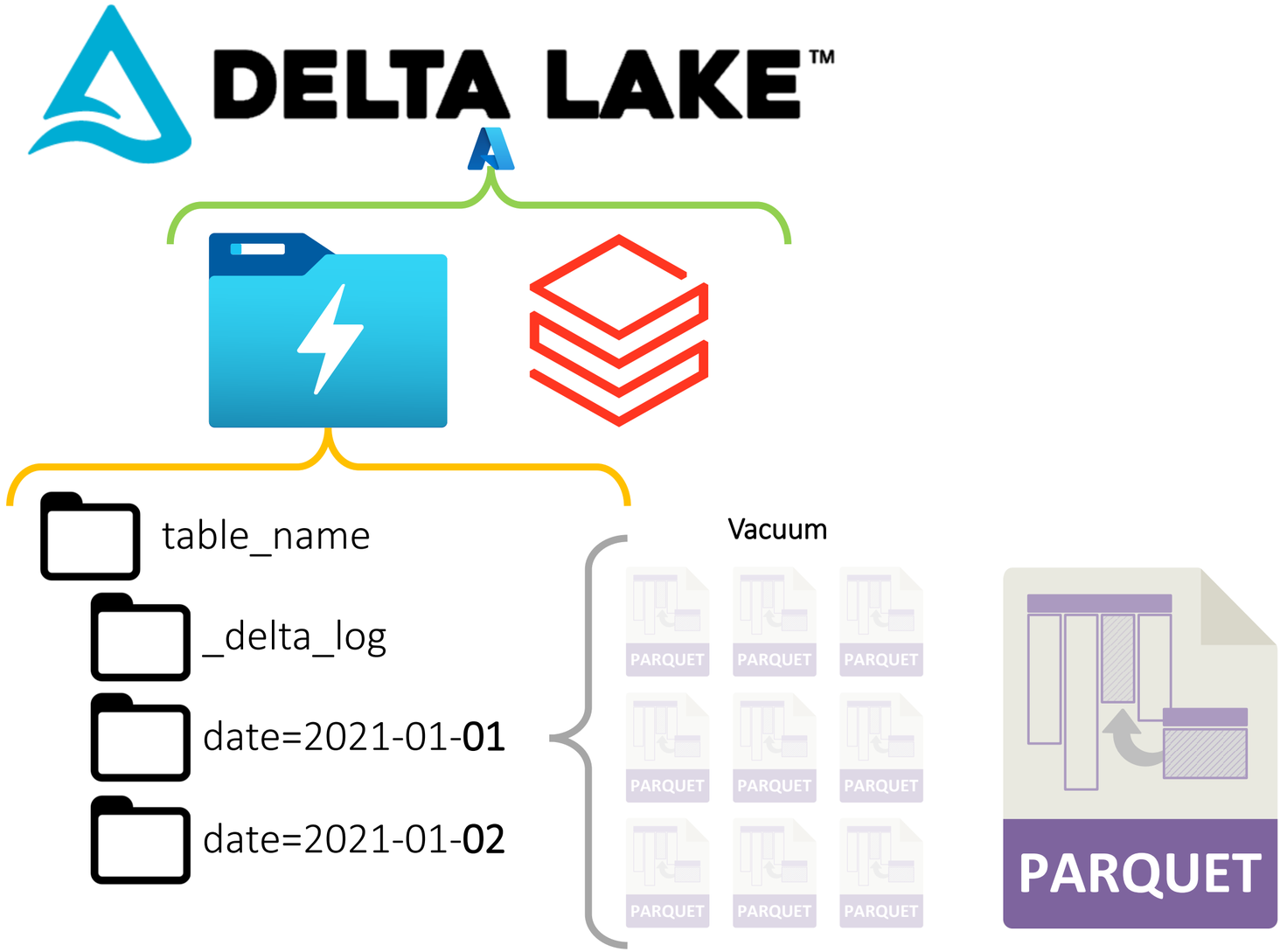
Optimize



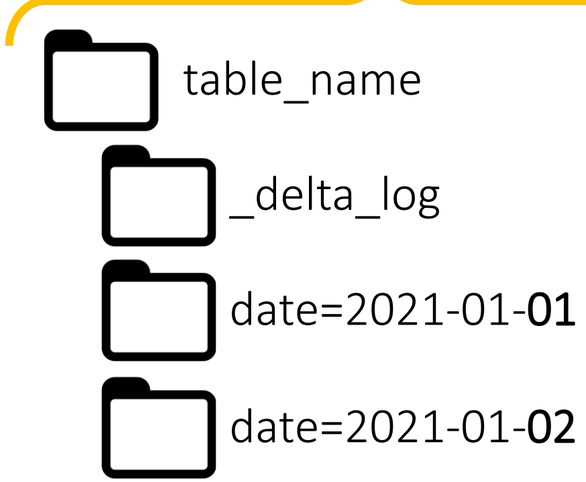
Delta Table - Transaction Log

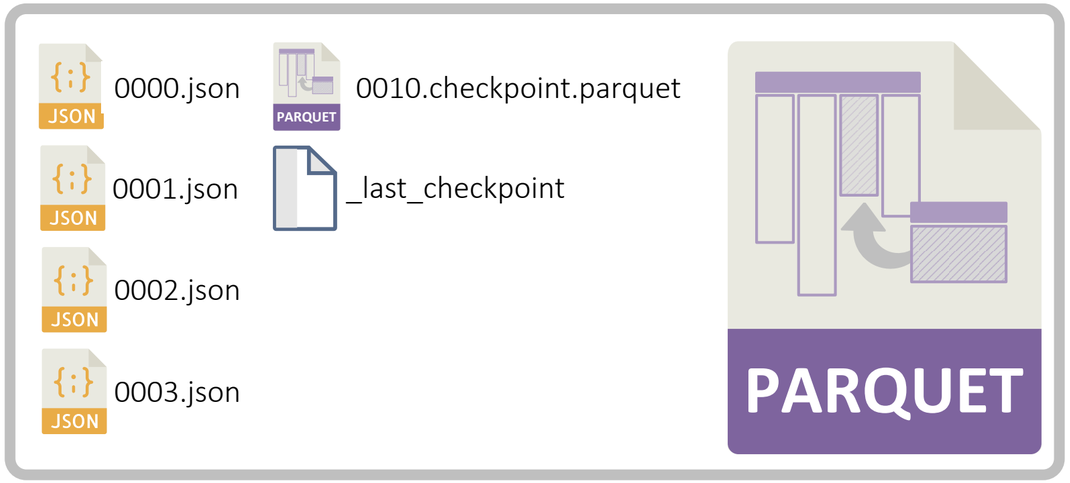


Delta Table - Transaction Log



Delta Table – On Disk





Delta Table - Querying

DELTA LAKE WITH SPARK SQL

Delta Lake is an open source storage layer that brings ACID transactions to Apache Spark™ and big data workloads.

delta.io | Documentation | GitHub | Delta Lake on Databricks

CREATE AND QUERY DELTA TABLES

Create and use managed database

```
-- Managed database is saved in the Hive metastore.
Default database is named "default".
DROP DATABASE IF EXISTS dbName;
CREATE DATABASE dbName;
USE dbName  -- This command avoids having to specify
dbName.tableName every time instead of just tableName.
```

Query Delta Lake table by table name (preferred)

```
/* You can refer to Delta Tables by table name, or by
path. Table name is the preferred way, since named tables
are managed in the Hive Metastore (i.e., when you DROP a
named table, the data is dropped also — not the case for
path-based tables.) */
SELECT * FROM [dbName.] tableName
```

Query Delta Lake table by path

```
SELECT * FROM delta.`path/to/delta_table` -- note backticks
```

Convert Parquet table to Delta Lake format in place

```
-- by table name
CONVERT TO DELTA [dbName.]tableName
[PARTITIONED BY (col_name1 col_type1, col_name2
col_type2)]

-- path-based tables
CONVERT TO DELTA parquet.`/path/to/table` -- note backticks
[PARTITIONED BY (col_name1 col_type1, col_name2 col_type2)]
```

Create Delta Lake table as SELECT * with no upfront schema definition

```
CREATE TABLE [dbName.] tableName
USING DELTA
AS SELECT * FROM tableName | parquet.`path/to/data`
[LOCATION `/path/to/table`]
-- using location = unmanaged table
```

Create table, define schema explicitly with SQL DDL

```
CREATE TABLE [dbName.] tableName (
    id INT [NOT NULL],
    name STRING,
    date DATE,
    int_rate FLOAT)
USING DELTA
[PARTITIONED BY (time, date)] -- optional
```

Copy new data into Delta Lake table (with idempotent retries)

```
COPY INTO [dbName.] targetTable
  FROM (SELECT * FROM "/path/to/table")
  FILEFORMAT = DELTA  -- or CSV, Parquet, ORC, JSON, etc.
```

Provided to the open source community by Databricks

DELTA LAKE DDL/DML: UPDATE, DELETE, MERGE, ALTER TABLE

Update rows that match a predicate condition

```
UPDATE tableName SET event = 'click' WHERE event = 'clk'
```

Delete rows that match a predicate condition

```
DELETE FROM tableName WHERE "date < '2017-01-01"
```

Insert values directly into table

```
INSERT INTO TABLE tableName VALUES (
    (8003, "Kim Jones", "2020-12-18", 3.875),
    (8004, "Tim Jones", "2020-12-20", 3.750)
);
-- Insert using SELECT statement
INSERT INTO tableName SELECT * FROM sourceTable
-- Atomically replace all data in table with new values
INSERT OVERWRITE loan_by_state_delta VALUES (...)
```

Upsert (update + insert) using MERGE

```
MERGE INTO target
USING updates
ON target.Id = updates.Id
WHEN MATCHED AND target.delete_flag = "true" THEN
  DELETE
WHEN MATCHED THEN
  UPDATE SET *  -- star notation means all columns
WHEN NOT MATCHED THEN
  INSERT (date, Id, data) -- or, use INSERT *
  VALUES (date, Id, data)
```

Insert with Deduplication using MERGE

```
MERGE INTO logs
USING newDedupedLogs
ON logs.uniqueId = newDedupedLogs.uniqueId
WHEN NOT MATCHED
  THEN INSERT *
```

Alter table schema — add columns

```
ALTER TABLE tableName ADD COLUMNS (
    col_name data_type
    [FIRST|AFTER colA_name])
```

Alter table — add constraint

```
-- Add "Not null" constraint:
ALTER TABLE tableName CHANGE COLUMN col_name SET NOT NULL
-- Add "Check" constraint:
ALTER TABLE tableName
ADD CONSTRAINT dateWithinRange CHECK date > "1900-01-01"
-- Drop constraint:
ALTER TABLE tableName DROP CONSTRAINT dateWithinRange
```

TIME TRAVEL

View transaction log (aka Delta Log)

```
DESCRIBE HISTORY tableName
```

Query historical versions of Delta Lake tables

```
SELECT * FROM tableName VERSION AS OF 0
SELECT * FROM tableName@v0  -- equivalent to VERSION AS OF 0
SELECT * FROM tableName TIMESTAMP AS OF "2020-12-18"
```

Find changes between 2 versions of table

```
SELECT * FROM tableName VERSION AS OF 12
EXCEPT ALL SELECT * FROM tableName VERSION AS OF 11
```

TIME TRAVEL (CONTINUED)

Rollback a table to an earlier version

```
-- RESTORE requires Delta Lake version 0.7.0+ & DBR 7.4+.
RESTORE tableName VERSION AS OF 0
RESTORE tableName TIMESTAMP AS OF "2020-12-18"
```

UTILITY METHODS

View table details

```
DESCRIBE DETAIL tableName
DESCRIBE FORMATTED tableName
```

Delete old files with Vacuum

```
VACUUM tableName [RETAIN num HOURS] [DRY RUN]
```

Clone a Delta Lake table

```
-- Deep clones copy data from source, shallow clones don't.
CREATE TABLE [dbName.] targetName
[SHALLOW | DEEP] CLONE sourceName [VERSION AS OF 0]
[LOCATION "path/to/table"]
-- specify location only for path-based tables
```

Interoperability with Python / DataFrames

```
-- Read name-based table from Hive metastore into DataFrame
df = spark.table("tableName")
-- Read path-based table into DataFrame
df = spark.read.format("delta").load("/path/to/delta_table")
```

Run SQL queries from Python

```
spark.sql("SELECT * FROM tableName")
spark.sql("SELECT * FROM delta.`/path/to/delta_table`")
```

Modify data retention settings for Delta Lake table

```
-- logRetentionDuration -> how long transaction log history
is kept, deletedFileRetentionDuration -> how long ago a file
must have been deleted before being a candidate for VACCUM.
ALTER TABLE tableName
SET TBLPROPERTIES(
    delta.logRetentionDuration = "interval 30 days",
    delta.deletedFileRetentionDuration = "interval 7 days"
);
SHOW TBLPROPERTIES tableName;
```

PERFORMANCE OPTIMIZATIONS

Compact data files with Optimize and Z-Order

```
*Databricks Delta Lake feature
OPTIMIZE tableName
[ZORDER BY (colNameA, colNameB)]
```

Auto-optimize tables

```
*Databricks Delta Lake feature
ALTER TABLE [table_name | delta.`path/to/delta_table`]
SET TBLPROPERTIES (delta.autoOptimize.optimizeWrite = true)
```

Cache frequently queried data in Delta Cache

```
*Databricks Delta Lake feature
CACHE SELECT * FROM tableName
-- or:
CACHE SELECT colA, colB FROM tableName WHERE colNameA > 0
```

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DELTA LAKE WITH PYTHON

Delta Lake is an open source storage layer that brings ACID transactions to Apache Spark™ and big data workloads.

delta.io | Documentation | GitHub | API reference | Databricks

READS AND WRITES WITH DELTA LAKE

Read data from pandas DataFrame

```
df = spark.createDataFrame(pdf)
# where pdf is a pandas DF
# then save DataFrame in Delta Lake format as shown below
```

Read data using Apache Spark™

```
# read by path
df = (spark.read.format("parquet"|"csv"|"json"|etc.)
        .load("/path/to/delta_table"))
# read by table name
df = spark.table("events")
```

Save DataFrame in Delta Lake format

```
(df.write.format("delta")
  .mode("append"|"overwrite")
  .partitionBy("date")  # optional
  .option("mergeSchema", "true")  # option - evolve schema
  .saveAsTable("events") | .save("/path/to/delta_table")
)
```

Streaming reads (Delta table as streaming source)

```
# by path or by table name
df = (spark.readStream
  .format("delta")
  .schema(schema)
  .table("events") | .load("/delta/events")
)
```

Streaming writes (Delta table as a sink)

```
streamingQuery = (
df.writeStream.format("delta")
  .outputMode("append"|"update"|"complete")
  .option("checkpointLocation", "/path/to/checkpoints")
  .trigger(once=True|processingTime="10 seconds")
  .table("events") | .start("/delta/events")
)
```

CONVERT PARQUET TO DELTA LAKE

Convert Parquet table to Delta Lake format in place

```
deltaTable = DeltaTable.convertToDelta(spark,
"parquet.`/path/to/parquet_table`")

partitionedDeltaTable = DeltaTable.convertToDelta(spark,
"parquet.`/path/to/parquet_table`", "part int")
```

Provided to the open source community by Databricks

WORKING WITH DELTA TABLES

```
# A DeltaTable is the entry point for interacting with
tables programmatically in Python — for example, to
perform updates or deletes.
from delta.tables import *

deltaTable = DeltaTable.forName(spark, tableName)
deltaTable = DeltaTable.forPath(spark,
delta.`path/to/table`)
```

DELTA LAKE DDL/DML: UPDATES, DELETES, INSERTS, MERGES

Delete rows that match a predicate condition

```
# predicate using SQL formatted string
deltaTable.delete("date < '2017-01-01'")
# predicate using Spark SQL functions
deltaTable.delete(col("date") < "2017-01-01")
```

Update rows that match a predicate condition

```
# predicate using SQL formatted string
deltaTable.update(condition = "eventType = 'clk'",
          set = { "eventType": "'click'" } )
# predicate using Spark SQL functions
deltaTable.update(condition = col("eventType") == "clk",
          set = { "eventType": lit("click") } )
```

Upsert (update + insert) using MERGE

```
# Available options for merges [see documentation for
details]:
.whenMatchedUpdate(...)    | .whenMatchedUpdateAll(...)  |
.whenNotMatchedInsert(...) | .whenMatchedDelete(...)
(deltaTable.alias("target").merge(
        source = updatesDF.alias("updates"),
        condition = "target.eventId = updates.eventId")
  .whenMatchedUpdateAll()
  .whenNotMatchedInsert(
     values = {
        "date": "updates.date",
        "eventId": "updates.eventId",
        "data": "updates.data",
        "count": 1
        }
  ).execute()
)
```

Insert with Deduplication using MERGE

```
(deltaTable.alias("logs").merge(
    newDedupedLogs.alias("newDedupedLogs"),
    "logs.uniqueId = newDedupedLogs.uniqueId")
  .whenNotMatchedInsertAll()
.execute()
)
```

TIME TRAVEL

View transaction log (aka Delta Log)

```
fullHistoryDF = deltaTable.history()
```

Query historical versions of Delta Lake tables

```
# choose only one option: versionAsOf, or timestampAsOf
df = (spark.read.format("delta")
                .option("versionAsOf", 0)
                .option("timestampAsOf", "2020-12-18")
                .load("/path/to/delta_table"))
```

TIME TRAVEL (CONTINUED)

Find changes between 2 versions of a table

```
df1 = spark.read.format("delta").load(pathToTable)
df2 = spark.read.format("delta").option("versionAsOf",
2).load("/path/to/delta_table")
df1.exceptAll(df2).show()
```

Rollback a table by version or timestamp

```
deltaTable.restoreToVersion(0)
deltaTable.restoreToTimestamp('2020-12-01')
```

UTILITY METHODS

Run Spark SQL queries in Python

```
spark.sql("SELECT * FROM tableName")
spark.sql("SELECT * FROM delta.`/path/to/delta_table`")
spark.sql("DESCRIBE HISTORY tableName")
```

Compact old files with Vacuum

```
deltaTable.vacuum() # vacuum files older than default
retention period (7 days)
deltaTable.vacuum(100) # vacuum files not required by
versions more than 100 hours old
```

Clone a Delta Lake table

```
deltaTable.clone(target="/path/to/delta_table/",
isShallow=True, replace=True)
```

Get DataFrame representation of a Delta Lake table

```
df = deltaTable.toDF()
```

Run SQL queries on Delta Lake tables

```
spark.sql("SELECT * FROM tableName")
spark.sql("SELECT * FROM delta.`/path/to/delta_table`")
```

PERFORMANCE OPTIMIZATIONS

Compact data files with Optimize and Z-Order

```
*Databricks Delta Lake feature
spark.sql("OPTIMIZE tableName [ZORDER BY (colA, colB)]")
```

Auto-optimize tables

```
*Databricks Delta Lake feature. For existing tables:
spark.sql("ALTER TABLE [table_name |
delta.`path/to/delta_table`]
SET TBLPROPERTIES (delta.autoOptimize.optimizeWrite = true)
To enable auto-optimize for all new Delta Lake tables:
spark.sql("SET spark.databricks.delta.properties.
defaults.autoOptimize.optimizeWrite = true")
```

Cache frequently queried data in Delta Cache

```
*Databricks Delta Lake feature
spark.sql("CACHE SELECT * FROM tableName")
-- or:
spark.sql("CACHE SELECT colA, colB FROM tableName
          WHERE colNameA > 0")
```

databricks

DELTA LAKE WITH SPARK SQL

Delta Lake is an open source storage layer that brings ACID transactions to Apache Spark™ and big data workloads.

delta.io | Documentation | GitHub | Delta Lake on Databricks

CREATE AND QUERY DELTA TABLES

Create and use managed database

```
-- Managed database is saved in the Hive metastore.
Default database is named "default".
DROP DATABASE IF EXISTS dbName;
CREATE DATABASE dbName;
USE dbName  -- This command avoids having to specify
dbName.tableName every time instead of just tableName.
```

Query Delta Lake table by table name (preferred)

```
/* You can refer to Delta Tables by table name, or by
path. Table name is the preferred way, since named tables
are managed in the Hive Metastore (i.e., when you DROP a
named table, the data is dropped also — not the case for
path-based tables.) */
SELECT * FROM [dbName.] tableName
```

Query Delta Lake table by path

```
SELECT * FROM delta.`path/to/delta_table` -- note backticks
```

Convert Parquet table to Delta Lake format in place

```
-- by table name
CONVERT TO DELTA [dbName.]tableName
[PARTITIONED BY (col_name1 col_type1, col_name2
col_type2)]

-- path-based tables
CONVERT TO DELTA parquet.`/path/to/table` -- note backticks
[PARTITIONED BY (col_name1 col_type1, col_name2 col_type2)]
```

Create Delta Lake table as SELECT * with no upfront schema definition

```
CREATE TABLE [dbName.] tableName
USING DELTA
AS SELECT * FROM tableName | parquet.`path/to/data`
[LOCATION `/path/to/table`]
-- using location = unmanaged table
```

Create table, define schema explicitly with SQL DDL

```
CREATE TABLE [dbName.] tableName (
    id INT [NOT NULL],
    name STRING,
    date DATE,
    int_rate FLOAT)
USING DELTA
[PARTITIONED BY (time, date)] -- optional
```

Copy new data into Delta Lake table (with idempotent retries)

```
COPY INTO [dbName.] targetTable
  FROM (SELECT * FROM "/path/to/table")
  FILEFORMAT = DELTA  -- or CSV, Parquet, ORC, JSON, etc.
```


DELTA LAKE DDL/DML: UPDATE, DELETE, MERGE, ALTER TABLE

Update rows that match a predicate condition

```
UPDATE tableName SET event = 'click' WHERE event = 'clk'
```

Delete rows that match a predicate condition

```
DELETE FROM tableName WHERE "date < '2017-01-01"
```

Insert values directly into table

```
INSERT INTO TABLE tableName VALUES (
    (8003, "Kim Jones", "2020-12-18", 3.875),
    (8004, "Tim Jones", "2020-12-20", 3.750)
);
-- Insert using SELECT statement
INSERT INTO tableName SELECT * FROM sourceTable
-- Atomically replace all data in table with new values
INSERT OVERWRITE loan_by_state_delta VALUES (...
```

Upsert (update + insert) using MERGE

```
MERGE INTO target
USING updates
ON target.Id = updates.Id
WHEN MATCHED AND target.delete_flag = "true" THEN
  DELETE
WHEN MATCHED THEN
  UPDATE SET *  -- star notation means all columns
WHEN NOT MATCHED THEN
  INSERT (date, Id, data) -- or, use INSERT *
  VALUES (date, Id, data)
```

Insert with Deduplication using MERGE

```
MERGE INTO logs
USING newDedupedLogs
ON logs.uniqueId = newDedupedLogs.uniqueId
WHEN NOT MATCHED
  THEN INSERT *
```

Alter table schema — add columns

```
ALTER TABLE tableName ADD COLUMNS (
    col_name data_type
    [FIRST|AFTER colA_name])
```

Alter table — add constraint

```
-- Add "Not null" constraint:
ALTER TABLE tableName CHANGE COLUMN col_name SET NOT NULL
-- Add "Check" constraint:
ALTER TABLE tableName
ADD CONSTRAINT dateWithinRange CHECK date > "1900-01-01"
-- Drop constraint:
ALTER TABLE tableName DROP CONSTRAINT dateWithinRange
```

TIME TRAVEL

View transaction log (aka Delta Log)

```
DESCRIBE HISTORY tableName
```

Query historical versions of Delta Lake tables

```
SELECT * FROM tableName VERSION AS OF 0
SELECT * FROM tableName@v0 -- equivalent to VERSION AS OF 0
SELECT * FROM tableName TIMESTAMP AS OF "2020-12-18"
```

Find changes between 2 versions of table

```
SELECT * FROM tableName VERSION AS OF 12
EXCEPT ALL SELECT * FROM tableName VERSION AS OF 11
```

TIME TRAVEL (CONTINUED)

Rollback a table to an earlier version

```
-- RESTORE requires Delta Lake version 0.7.0+ & DBR 7.4+.
RESTORE tableName VERSION AS OF 0
RESTORE tableName TIMESTAMP AS OF "2020-12-18"
```

UTILITY METHODS

View table details

```
DESCRIBE DETAIL tableName
DESCRIBE FORMATTED tableName
```

Delete old files with Vacuum

```
VACUUM tableName [RETAIN num HOURS] [DRY RUN]
```

Clone a Delta Lake table

```
-- Deep clones copy data from source, shallow clones don't.
CREATE TABLE [dbName.] targetName
[SHALLOW | DEEP] CLONE sourceName [VERSION AS OF 0]
[LOCATION "path/to/table"]
-- specify location only for path-based tables
```

Interoperability with Python / DataFrames

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-- Read name-based table from Hive metastore into DataFrame
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```

Run SQL queries from Python

```
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```

Modify data retention settings for Delta Lake table

```
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must have been deleted before being a candidate for VACCUM.
ALTER TABLE tableName
SET TBLPROPERTIES(
    delta.logRetentionDuration = "interval 30 days",
    delta.deletedFileRetentionDuration = "interval 7 days"
);
SHOW TBLPROPERTIES tableName;
```

PERFORMANCE OPTIMIZATIONS

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OPTIMIZE tableName
[ZORDER BY (colNameA, colNameB)]
```

Auto-optimize tables

```
*Databricks Delta Lake feature
ALTER TABLE [table_name | delta.`path/to/delta_table`]
SET TBLPROPERTIES (delta.autoOptimize.optimizeWrite = true)
```

Cache frequently queried data in Delta Cache

```
*Databricks Delta Lake feature
CACHE SELECT * FROM tableName
-- or:
CACHE SELECT colA, colB FROM tableName WHERE colNameA > 0
```

databricks

Part 1.2 – Theory

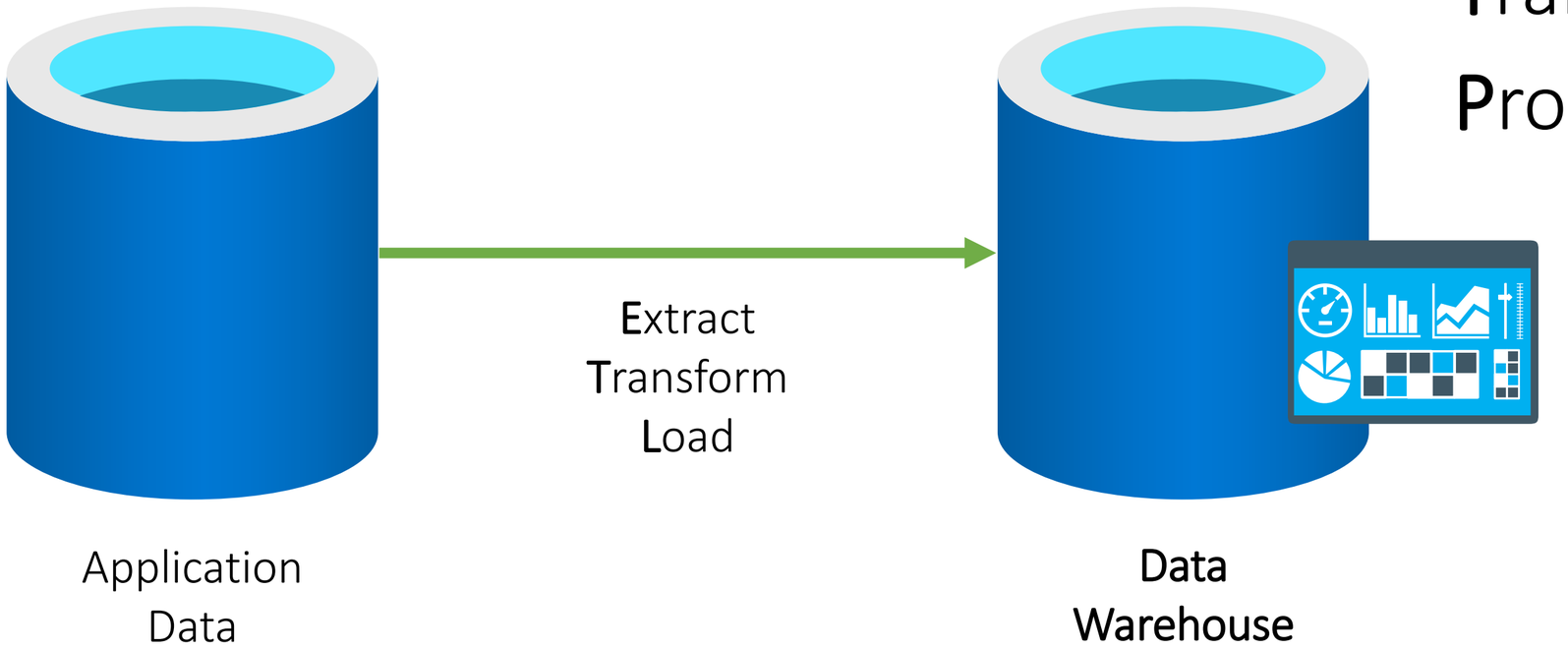
Data Warehouse

Online

Line

Transactional

Processing



Offline

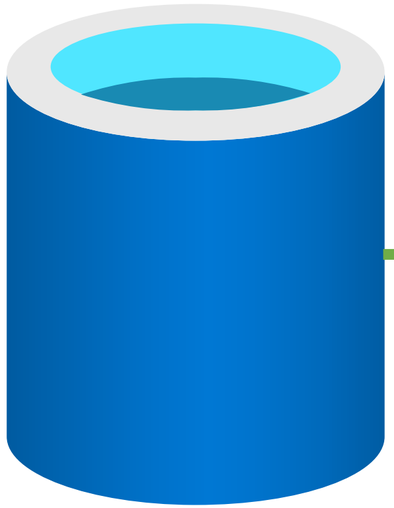
Analytical

Transactional

Processing

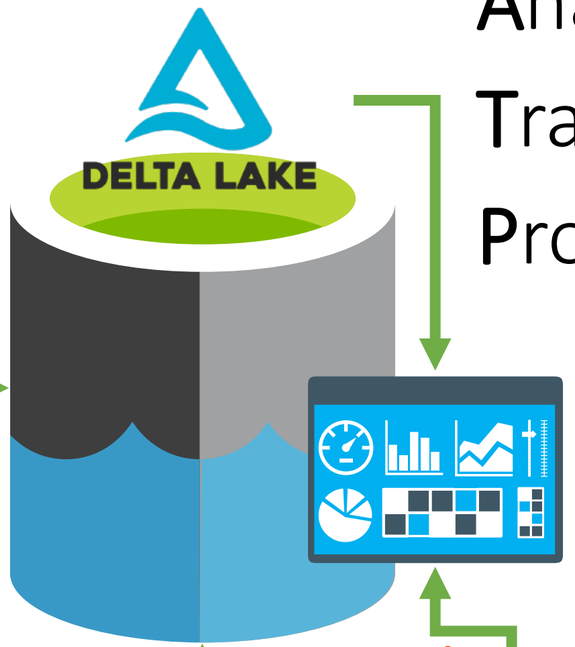
Lake House

Online
Line
Transactional
Processing

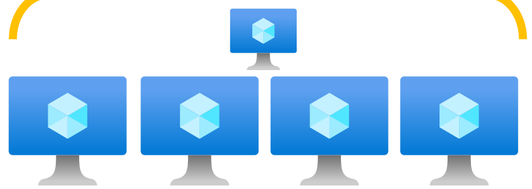


Application
Data

Extract
Transform
Load



Lake
House



Offline
Analytical
Transactional
Processing

Lake House

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The Lake House (film)

From Wikipedia, the free encyclopedia

This article includes a list of general references, but it remains largely unverified because **it lacks sufficient corresponding inline citations**. Please help to improve this article by introducing more precise citations. *(October 2017) (Learn how and when to remove this template message)*

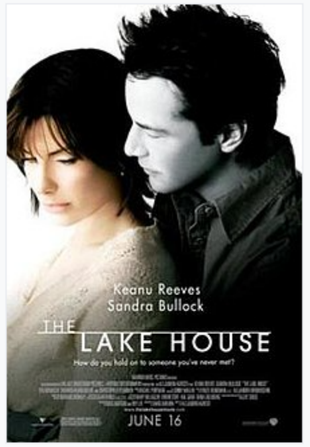
The Lake House is a 2006 American fantasy romantic drama film directed by Alejandro Agresti, starring Keanu Reeves and Sandra Bullock (who had previously appeared together in the box office hit *Speed*). It was written by David Auburn.[2] A remake of the South Korean motion picture *Il Mare* (2000), it centers on an architect living in 2004 and a doctor living in 2006 who meet via letters left in a mailbox at the lake house where they have lived at separate points in time. They carry on correspondence over two years, remaining separated by their original difference of two years.[3]

Contents [hide]
1 Plot
2 Cast
3 Production
4 Music
5 Reception
5.1 Box office
5.2 Critical response
5.3 Home media
5.4 Awards
6 References
7 External links

Plot [edit]

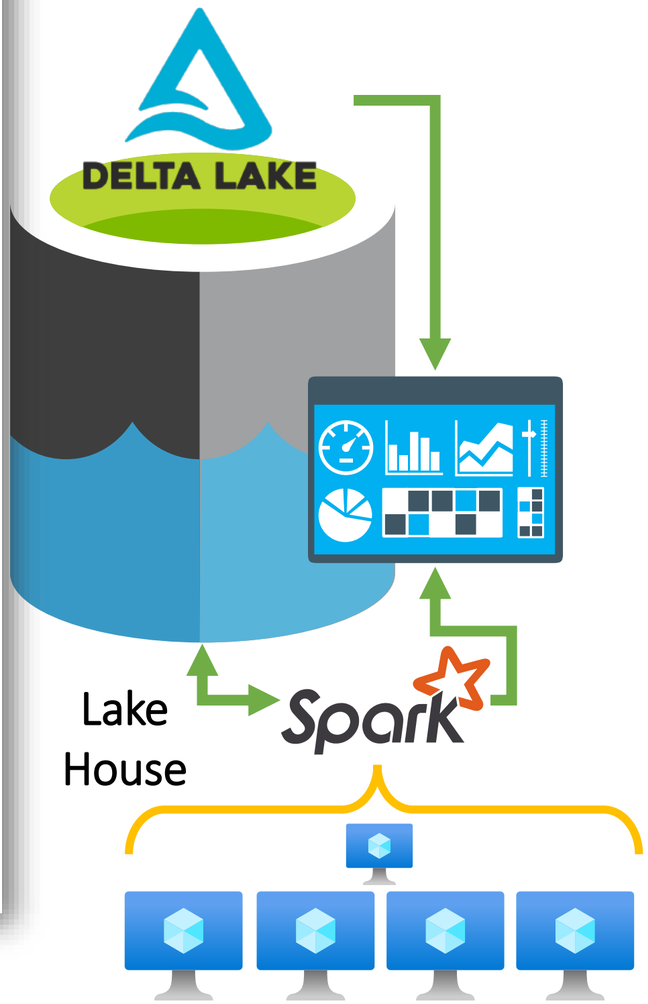
In 2006, Dr. Kate Forster (Sandra Bullock) is leaving a lake house that she has been renting in Chicago. Kate leaves a note in the mailbox for the next tenant to forward her mail, adding that the paint-embedded pawprints on the path leading to the house were already there when she arrived.

The Lake House

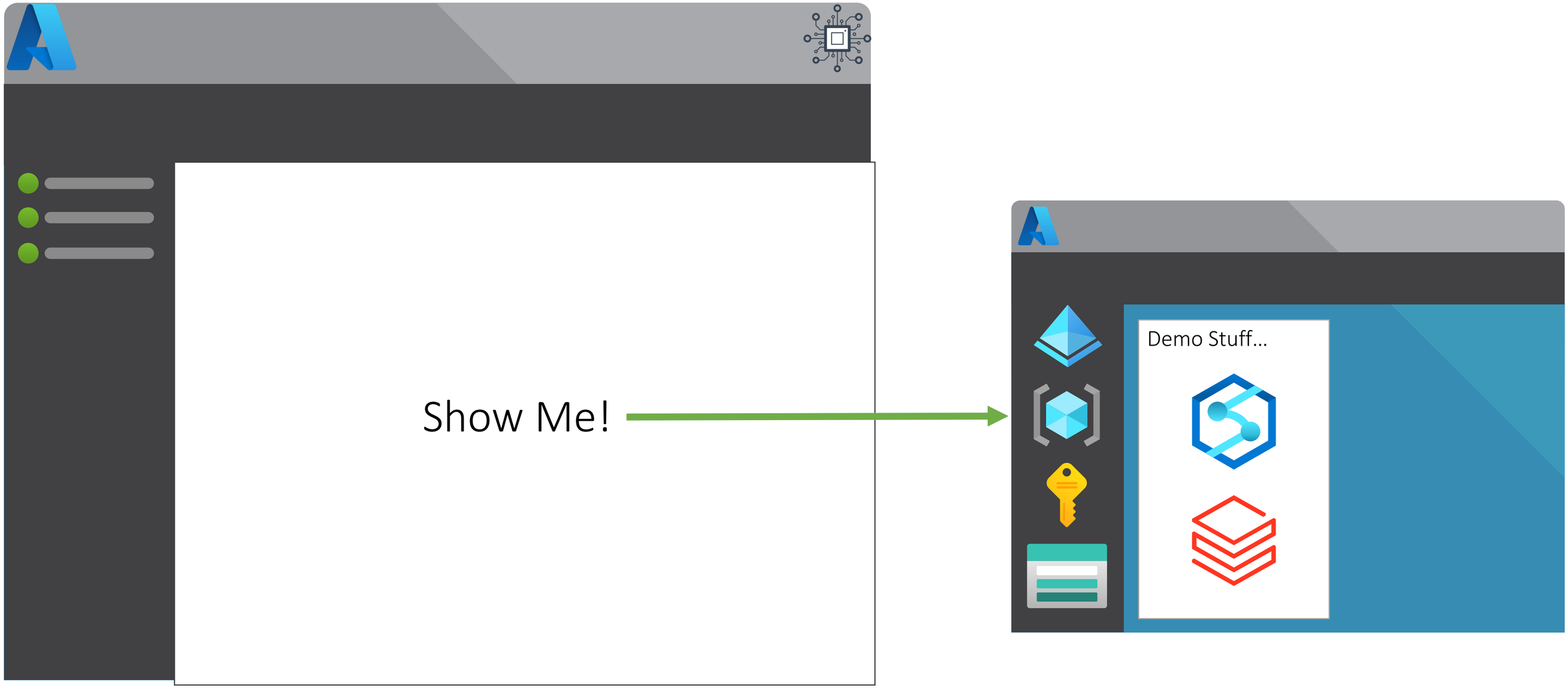


Theatrical release poster

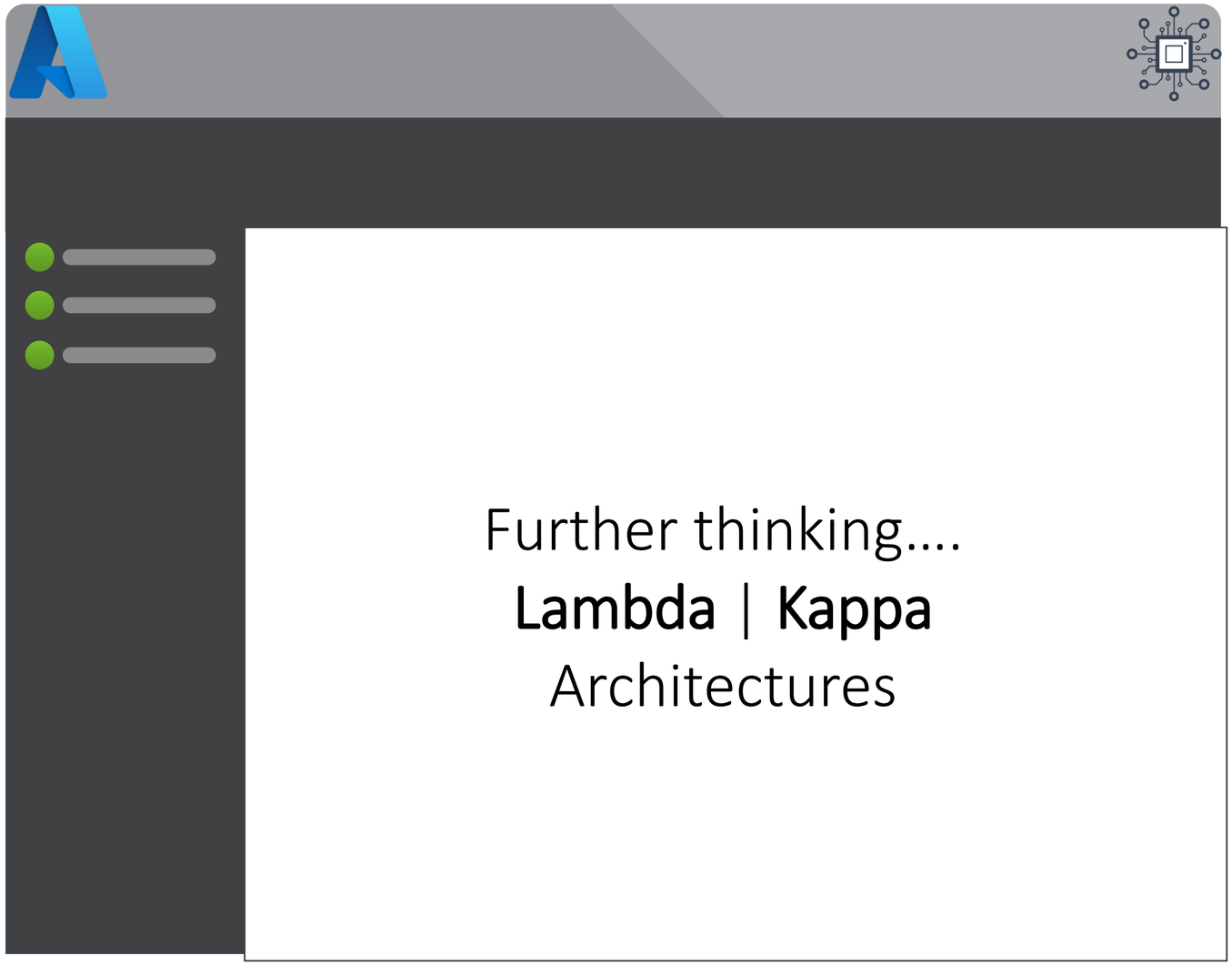
Directed by	Alejandro Agresti
Written by	David Auburn
Based on	*Il Mare* by Kim Eun-jeong Kim Mi-yeong
Produced by	Doug Davison Roy Lee
Starring	Keanu Reeves



Part 2.0 – Practice



Part 3.0 – Final Thoughts



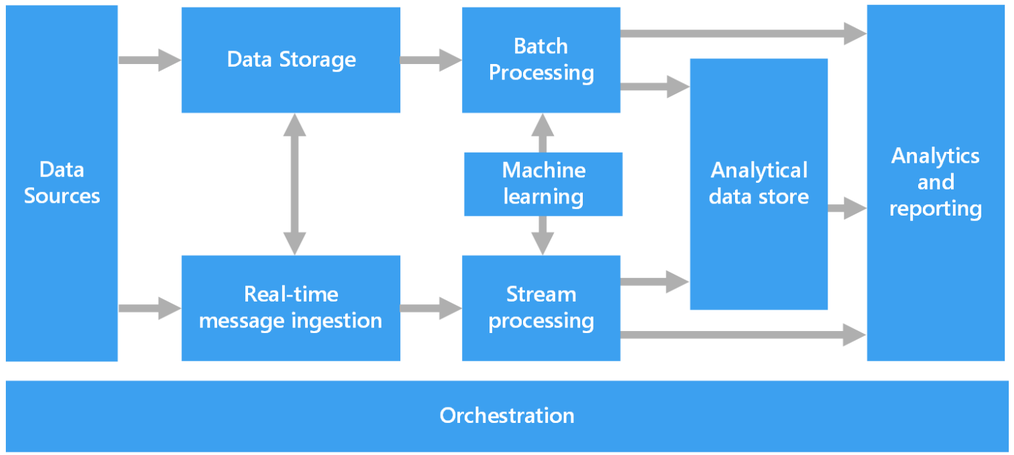
Further thinking….

Lambda | **Kappa**

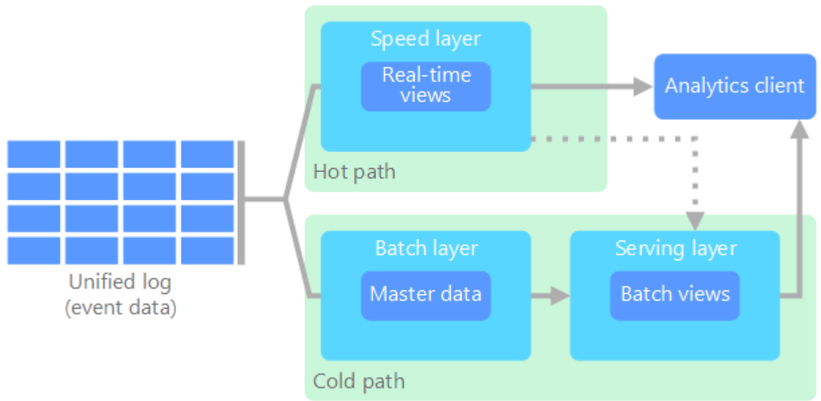
Architectures

Lambda & Kappa Architectures

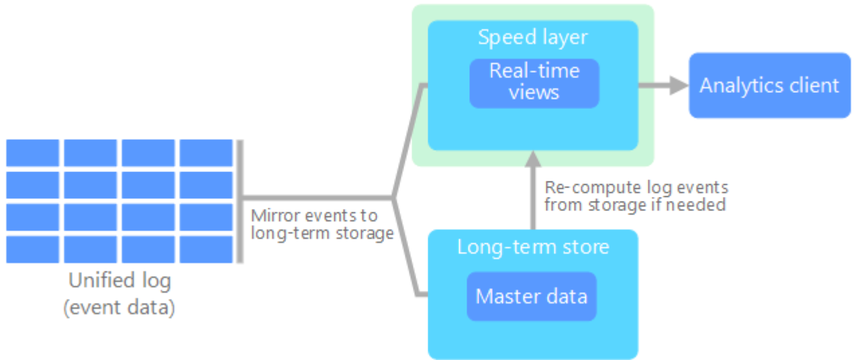
Components of a Big Data Architecture



Lambda



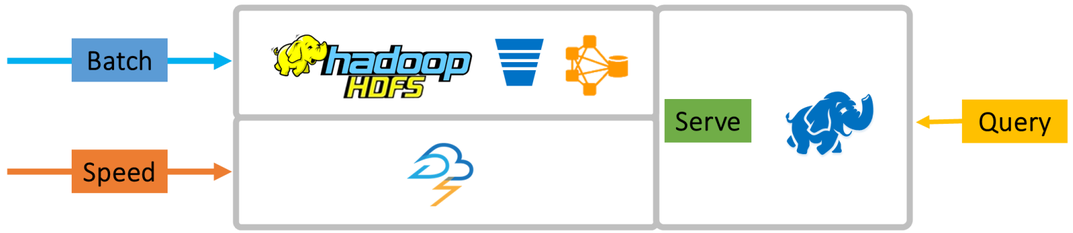
Kappa

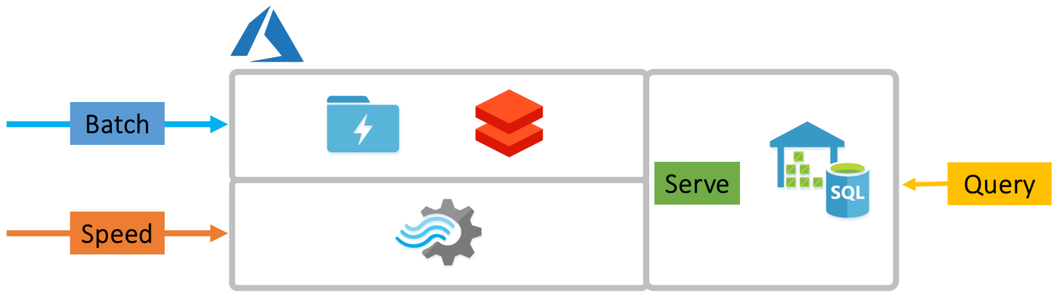


https://docs.microsoft.com/en-us/azure/architecture/data-guide/big-data/

Delta Lake in the Context of Lambda & Kappa

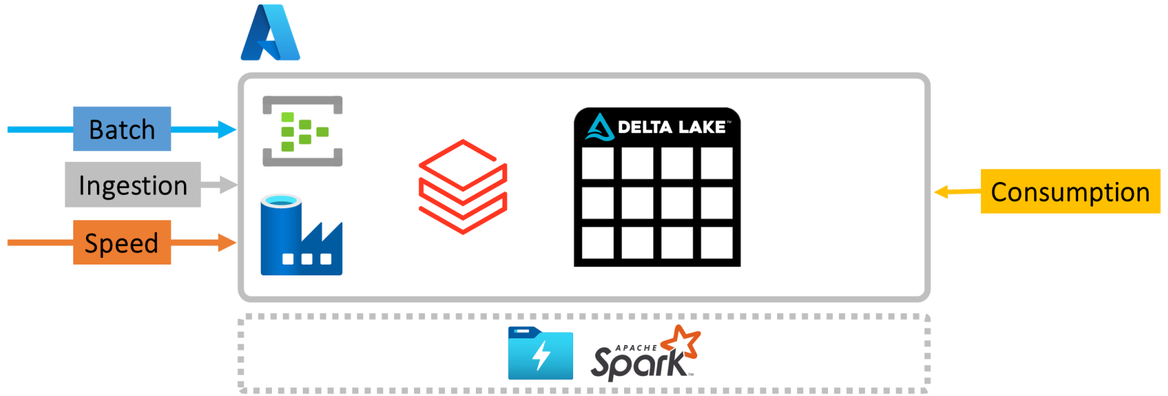
Lambda

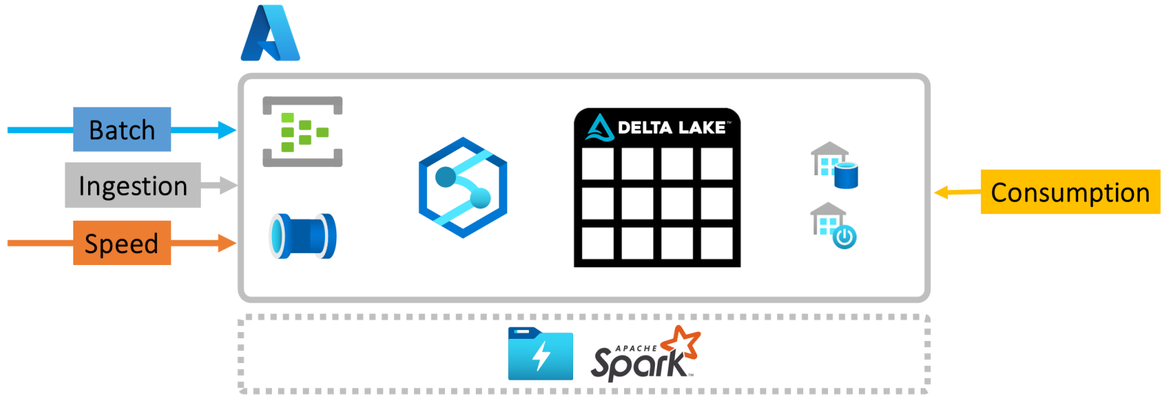




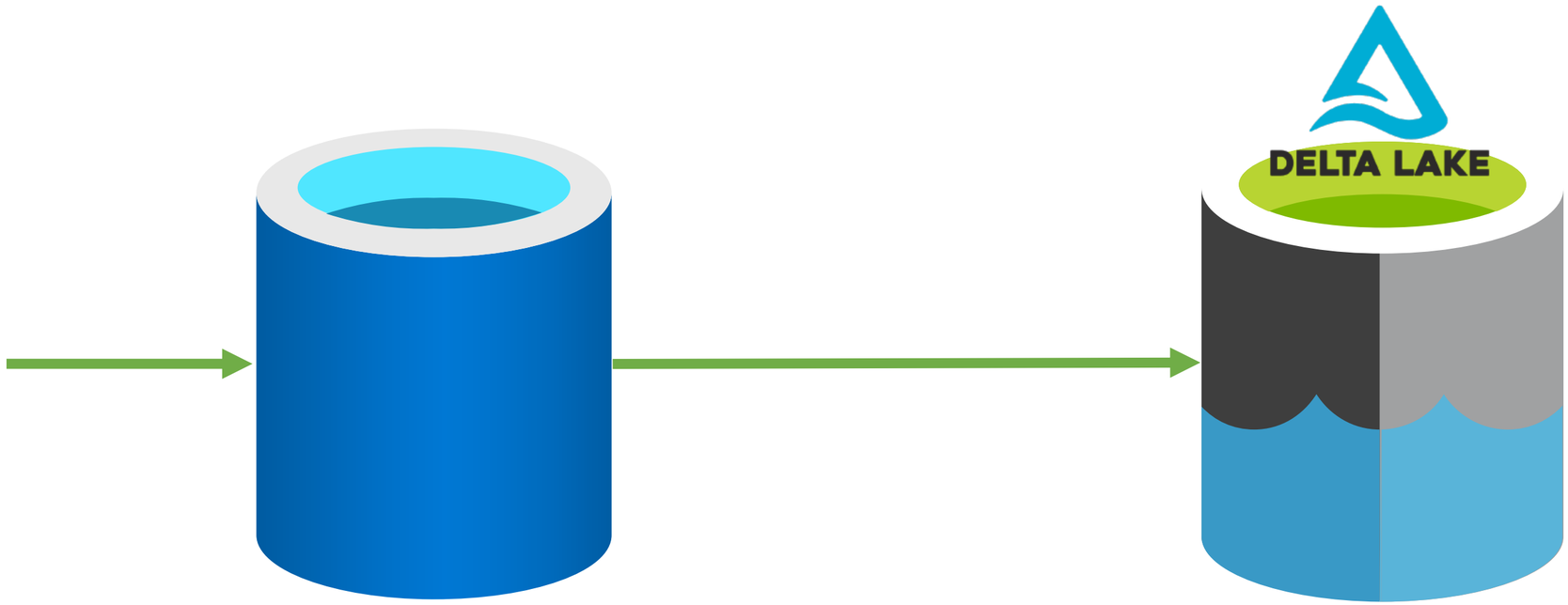
* Pre Delta-Lake

Kappa

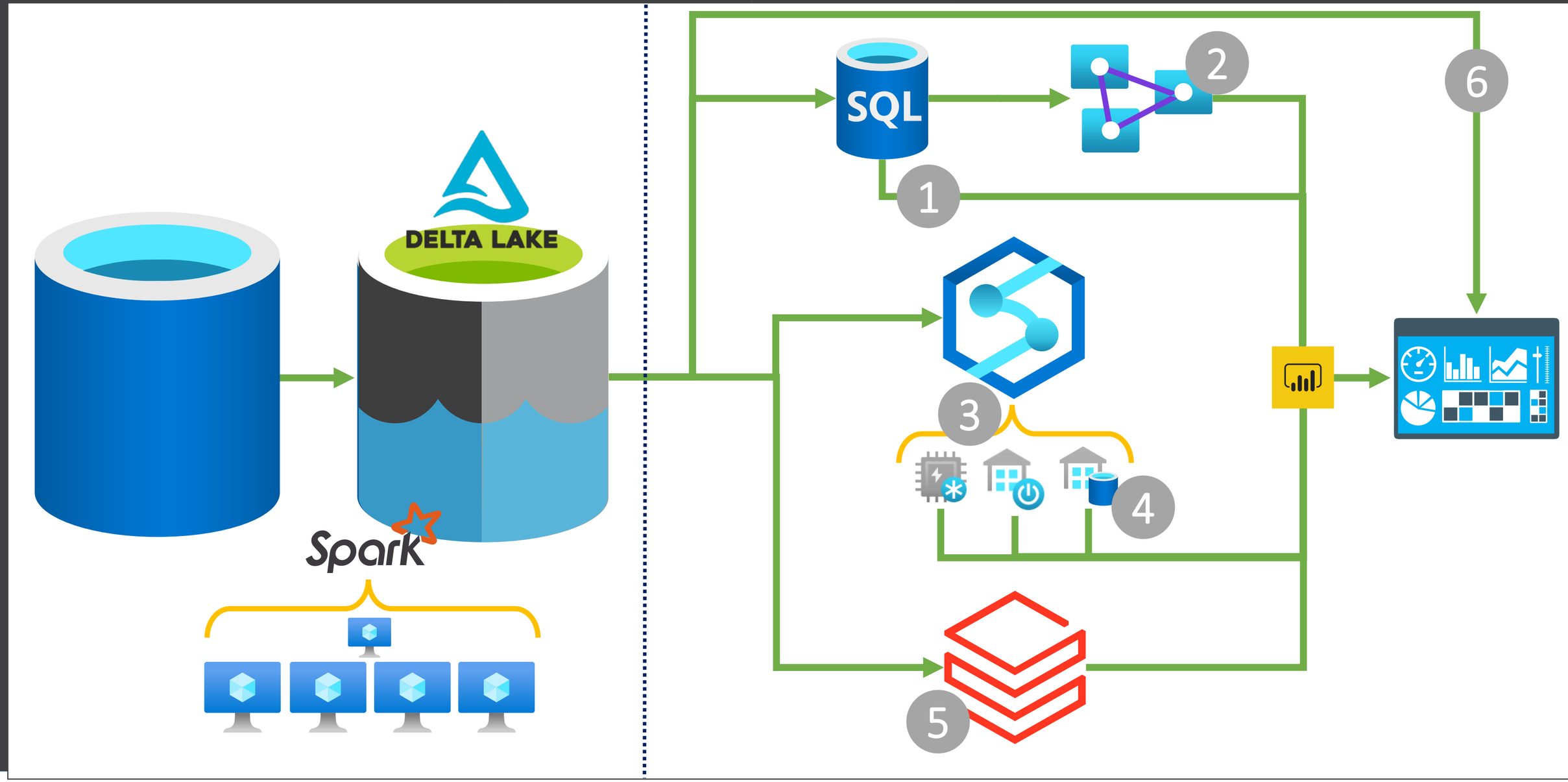




Consuming Our Lake House



Consuming Our Lake House in Azure



References and Further Reading

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https://databricks.com/blog/2019/08/21/diving-into-delta-lake-unpacking-the-transaction-log.html

Query Delta Lake files (preview) using serverless SQL pool in Azure Synapse Analytics
https://docs.microsoft.com/en-us/azure/synapse-analytics/sql/query-delta-lake-format

Delta Lake Cheat Sheet
https://github.com/delta-io/delta/blob/master/examples/cheat_sheet/delta_lake_cheat_sheet.pdf

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https://mrpaulandrew.com/2021/01/21/how-interchangeable-are-delta-tables-between-azure-databricks-and-azure-synapse-analytics/

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https://nileshprajapati.net/blog/2020/lambda-and-kappa-architecture-with-databricks/

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Simon Whitley on YouTube
https://www.youtube.com/channel/UCmRI-X6XoeH2dQE4BShRU9Q

Ali Ghodsi (Spark + AI Summit 2019 - Keynote)
https://www.youtube.com/watch?v=5I5pqDsvGEc

Thank you for listening…

Paul Andrew

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