Using Lakehouse data at scale with Power BI. Featuring Power BI Direct Lake mode!

Benni De Jagere

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MINOVA

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volda;
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DashData.

VisionBI
Smart Data Experts

easydash

Microsoft

Benni De Jagere

Senior Program Manager | Fabric Customer Advisory Team (FabricCAT)

Fabric CAT

dataMinds .be Member

@BenniDeJagere

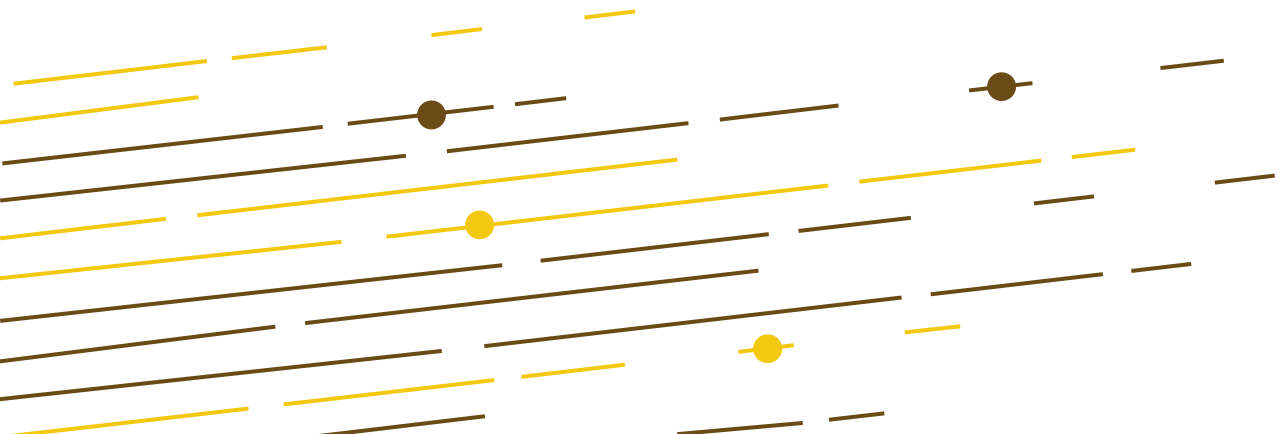
/bennidejagere

sessionize /bennidejagere

/bennidejagere

#SayNoToPieCharts

Session Objectives



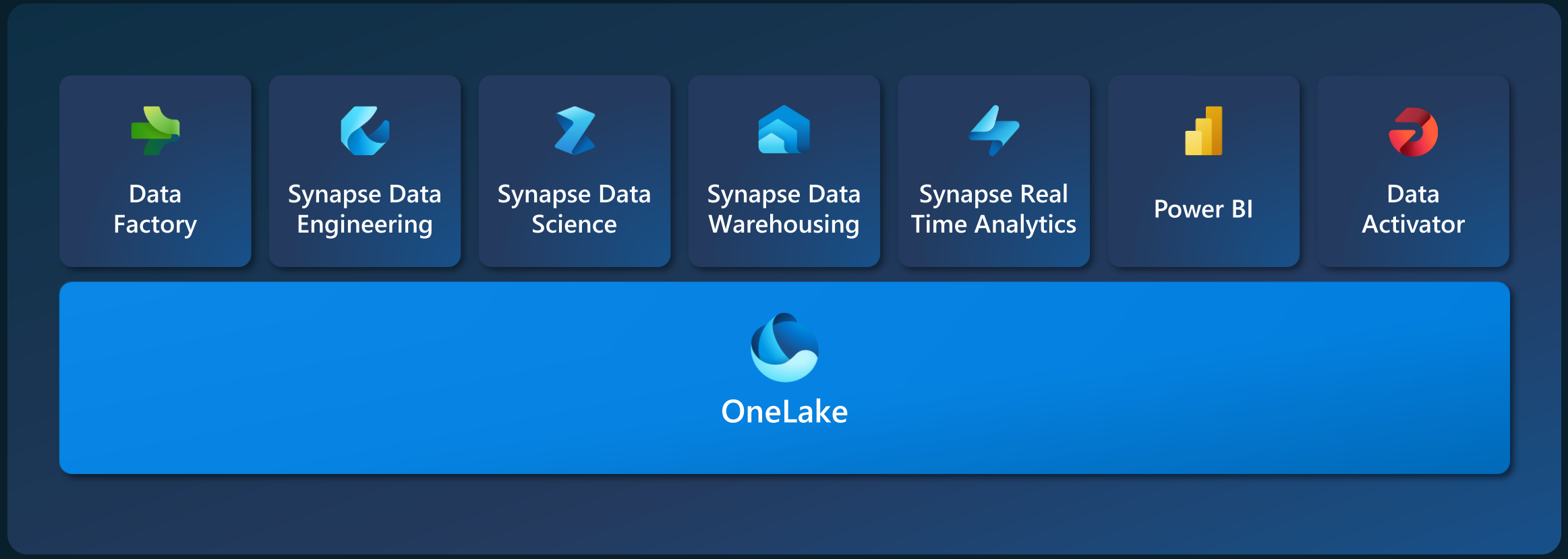
Session Objectives

- Introduce Fabric and OneLake
- Set the scene for Direct Lake
- Take it for spin.. ☺

Introducing Fabric

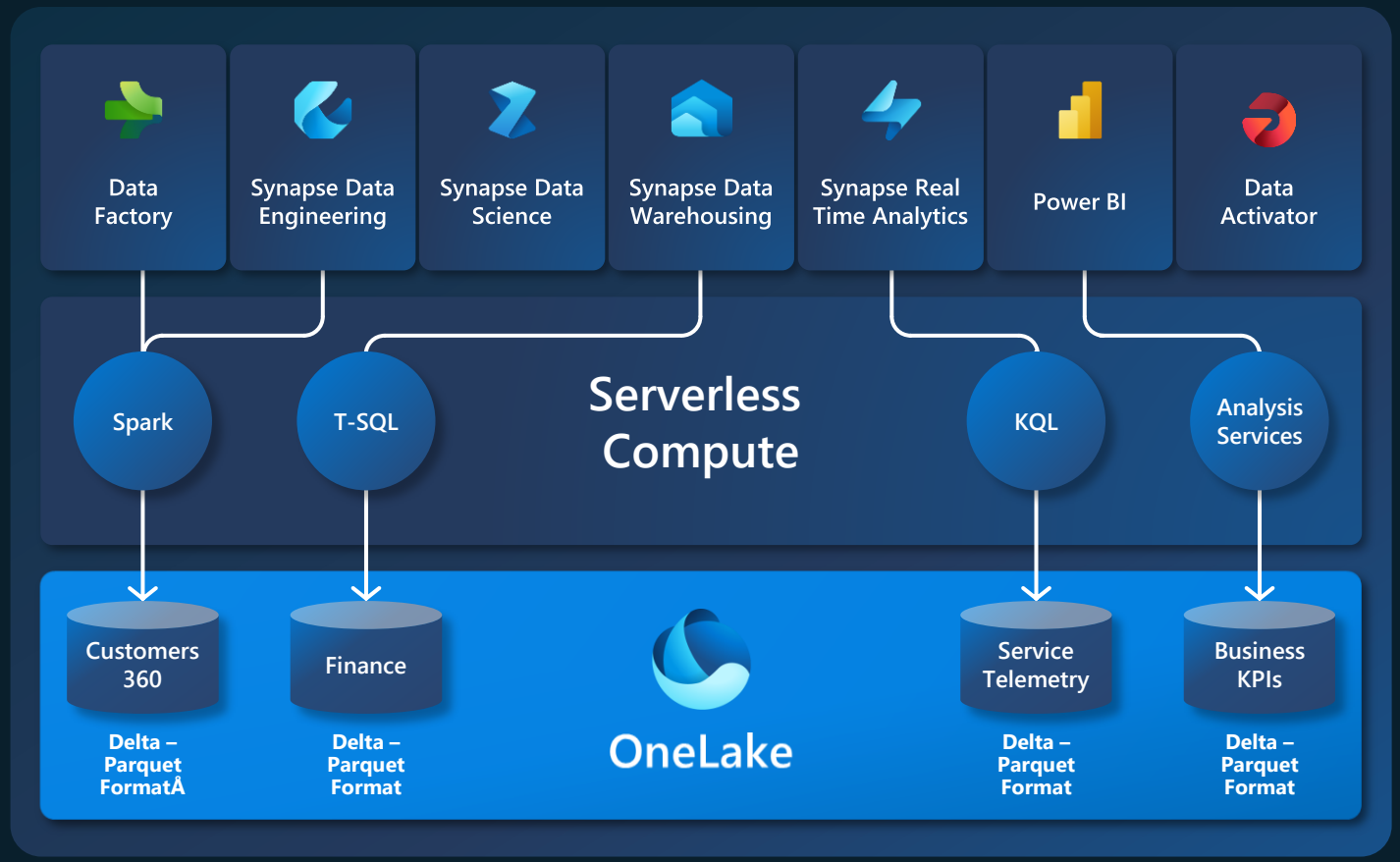
Microsoft Fabric

The unified data platform for the era of AI



One Copy for all computes

Real separation of compute and storage



All the compute engines store their data automatically in OneLake

The data is stored in a single common format

Delta – Parquet, an open standards format, is the storage format for all tabular data in Fabric

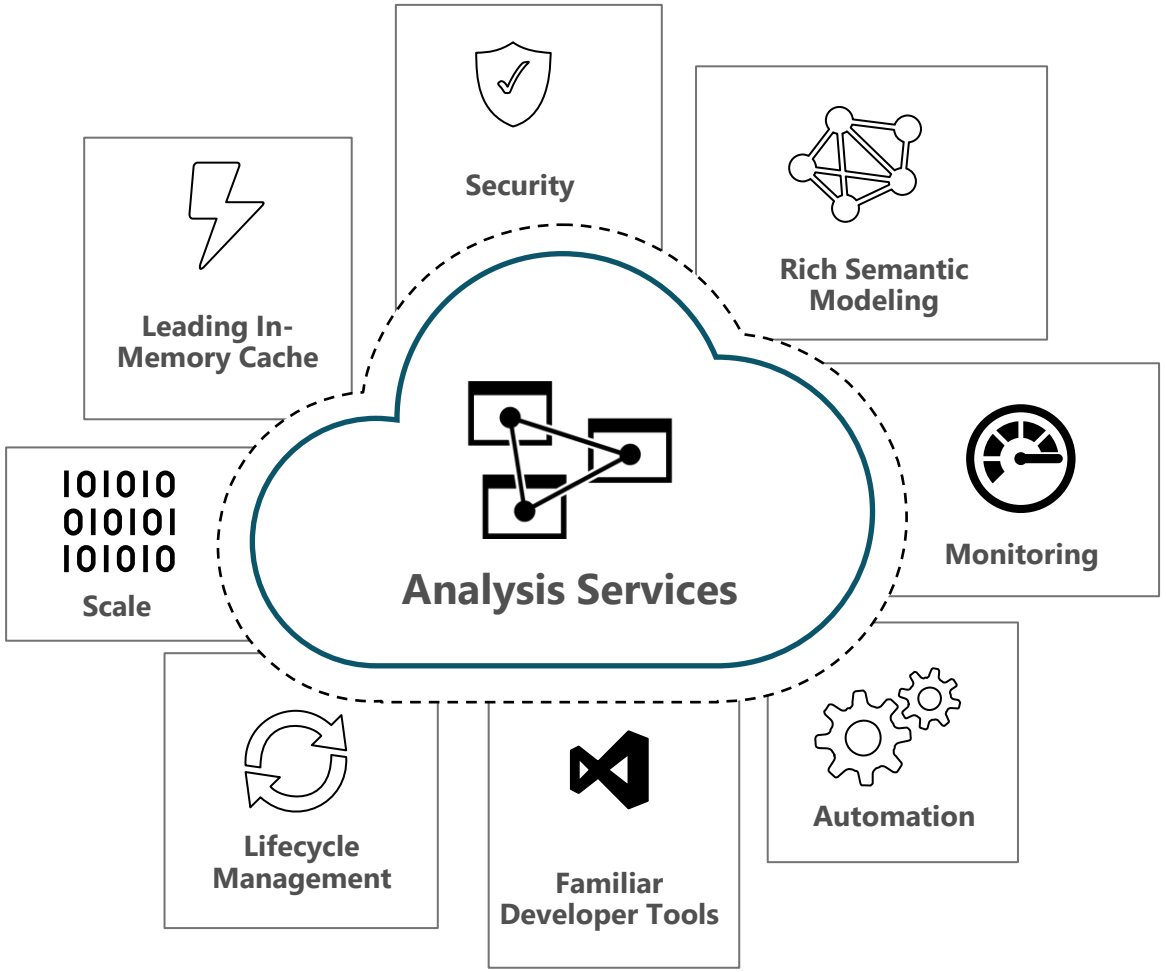
Once data is stored in the lake, it is directly accessible by all the engines without needing any import/export

All the compute engines have been fully optimized to work with Delta Parquet as their native format

Analysis Services Engine

Battle tested Analytics Engine Technology

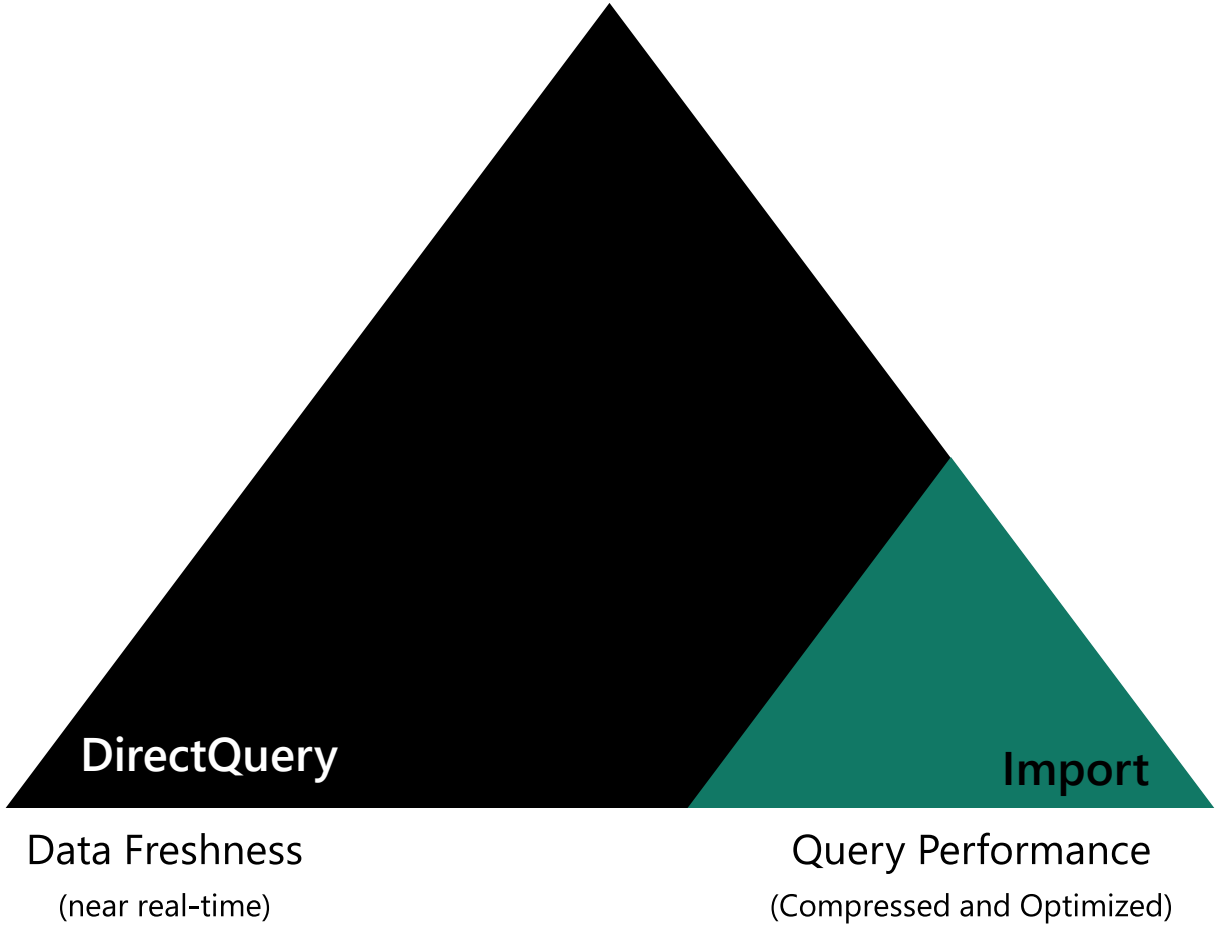
- Enterprise grade analytics **engine** as a service
- Excellent query performance over massive data volumes
- Rich semantic modeling
- Interactive Exploration over even **TRILLIONS** of rows of data, by intelligent proactive caching of aggregates



Storage Modes

Import: Caches data into memory to deliver extremely fast performance using the **analysis services** database engine. The default mode when creating a new Power BI Desktop solution along with providing Data Modelers the most design flexibility.

DirectQuery: Does not import the data into memory, consists only of the metadata defining the structure. When the model is queried, native queries are used to retrieve data from the underlying data source.



Changing the **Storage mode** of a table to **Import** is an irreversible operation. Once set, this property can't later be changed using Power BI Desktop.

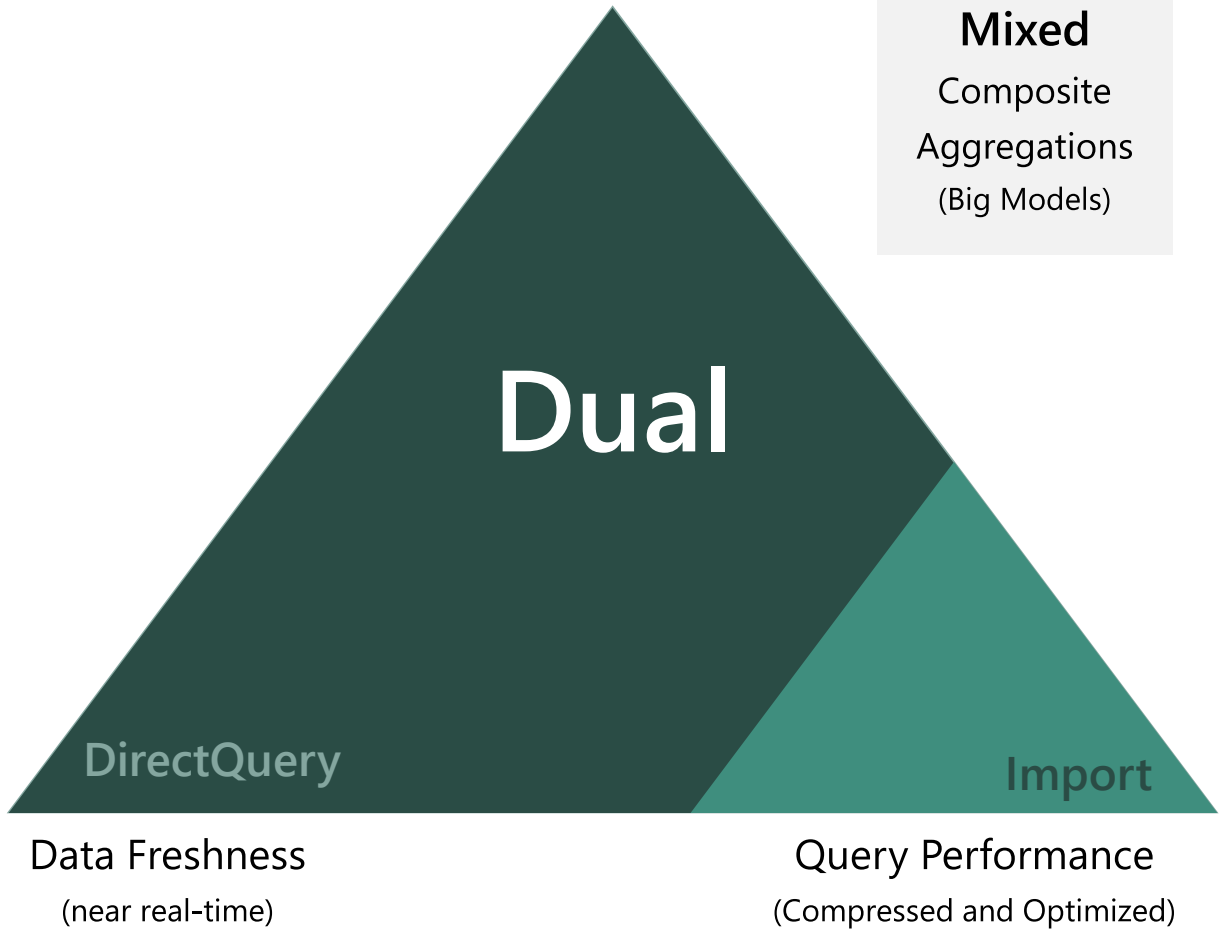
Storage Modes

Import: Caches data into memory to deliver extremely fast performance using the **analysis services** database engine. The default mode when creating a new Power BI Desktop solution along with providing Data Modelers the most design flexibility.

DirectQuery: Does not import the data into memory, consists only of the metadata defining the structure. When the model is queried, native queries are used to retrieve data from the underlying data source.

Dual: Can act as either cached or not cached, depending on the context of the query that's submitted to the Power BI dataset. In some cases, you fulfill queries from cached data. In other cases, you fulfill queries by executing an on-demand query to the underlying data source.

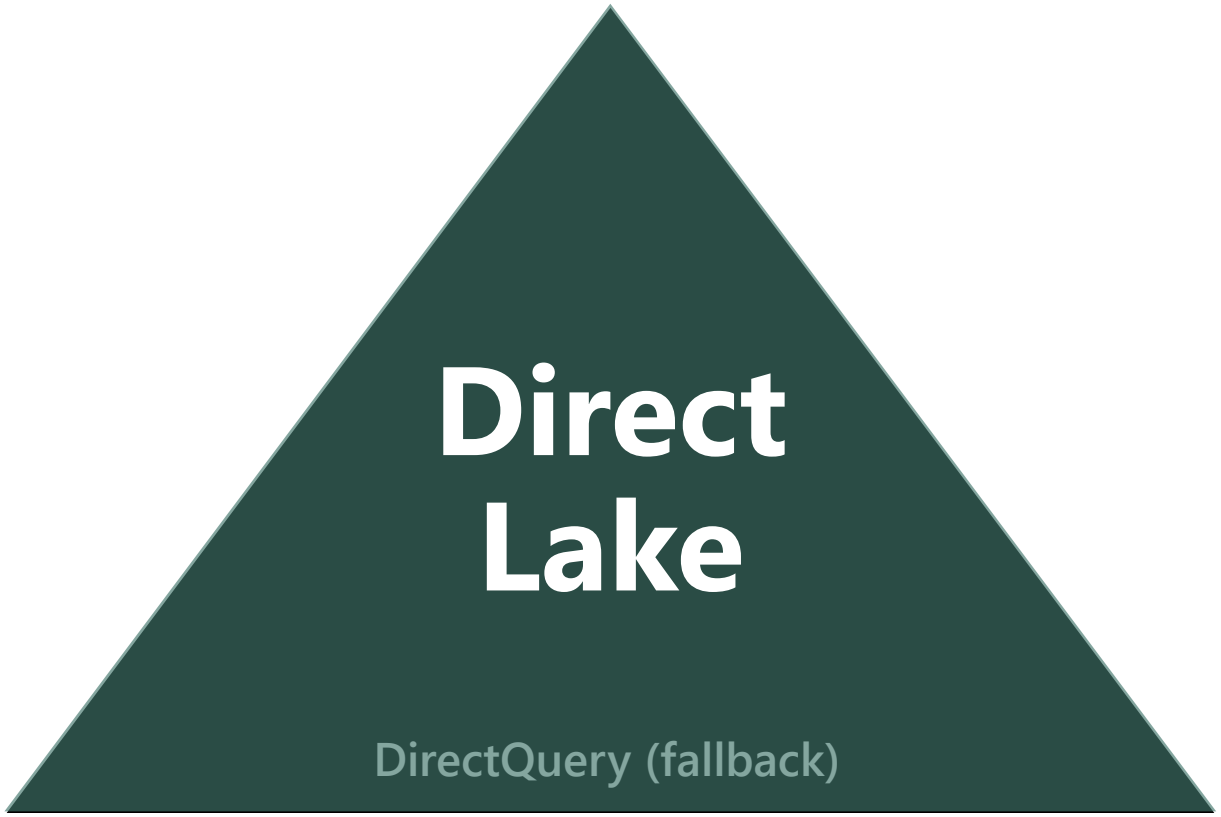
Changing the **Storage mode** of a table to **Import** is an irreversible operation. Once set, this property can't later be changed to either **DirectQuery** or **Dual** using Power BI Desktop.



Storage Modes

Direct Lake: A groundbreaking new dataset capability for analyzing very large data volumes. Based on loading parquet-formatted files directly from a data lake **without having to query a Lakehouse endpoint**, and **without having to import or duplicate data** into a Power BI dataset. Direct Lake is a fast-path to load the data from the lake straight into the Power BI engine, ready for analysis and yielding performance similar to import mode.

DirectQuery (fallback): Automatically switches modes- either due to current limitations or based on factors such as available memory in the capacity.



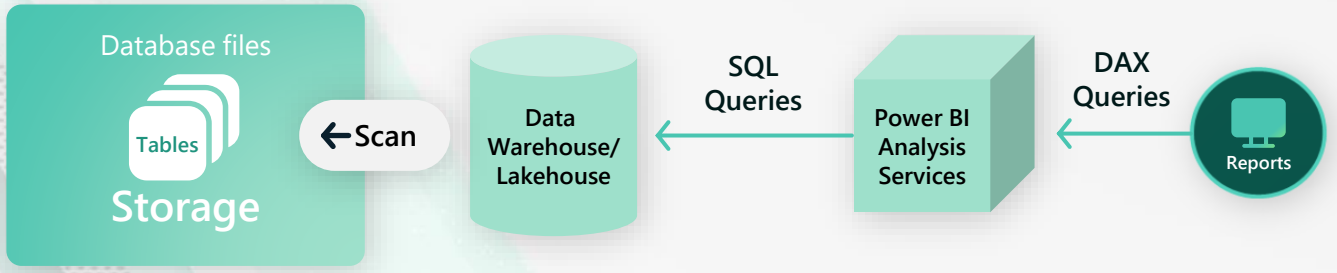
Data Freshness & Query Performance

Power BI | Direct Lake Mode

Direct Lake is a fast-path to load the data from the lake straight into the Power BI engine, ready for analysis

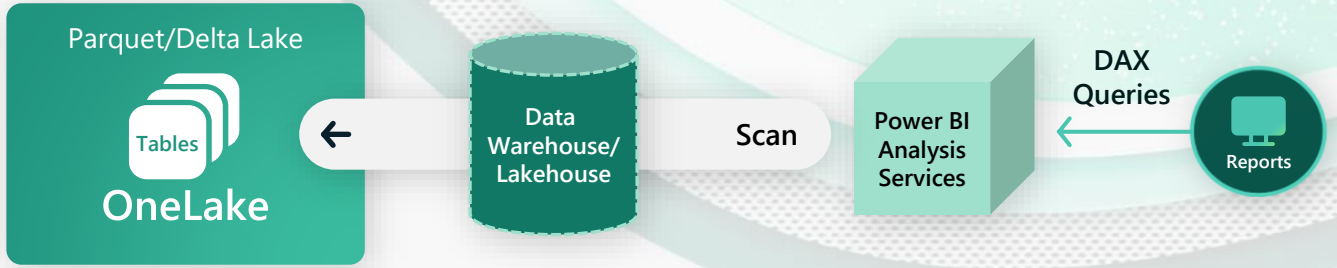
Direct Lake is based on loading parquet-formatted files directly from a data lake without having to query a Lakehouse endpoint, and without having to import or duplicate data into a Power BI dataset

DirectQuery Mode. Slow, but real time



Import Mode. Fast, but latent and duplicative

Direct Lake Mode. **Fast and real time**

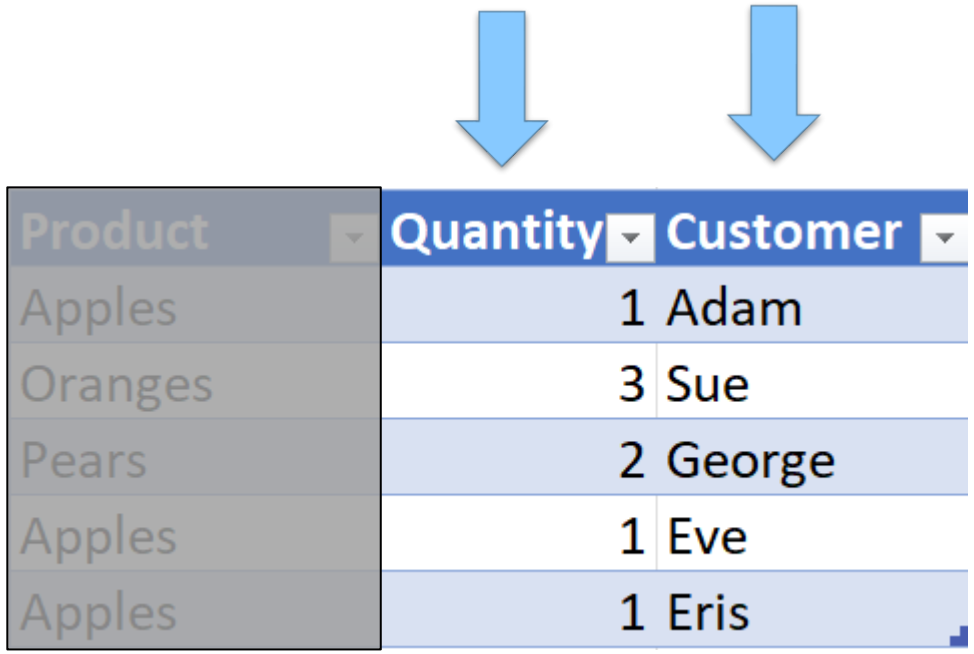


Why Delta?

Why Delta (Parquet)?

- Open Standard for file format
- Column oriented, efficient data storage and retrieval
- Efficient Data Compression and Encoding
- Becoming the Industry Standard
- Well suited for pruning (Column, rowgroup)
- Thrives on bulk operations

What is Parquet



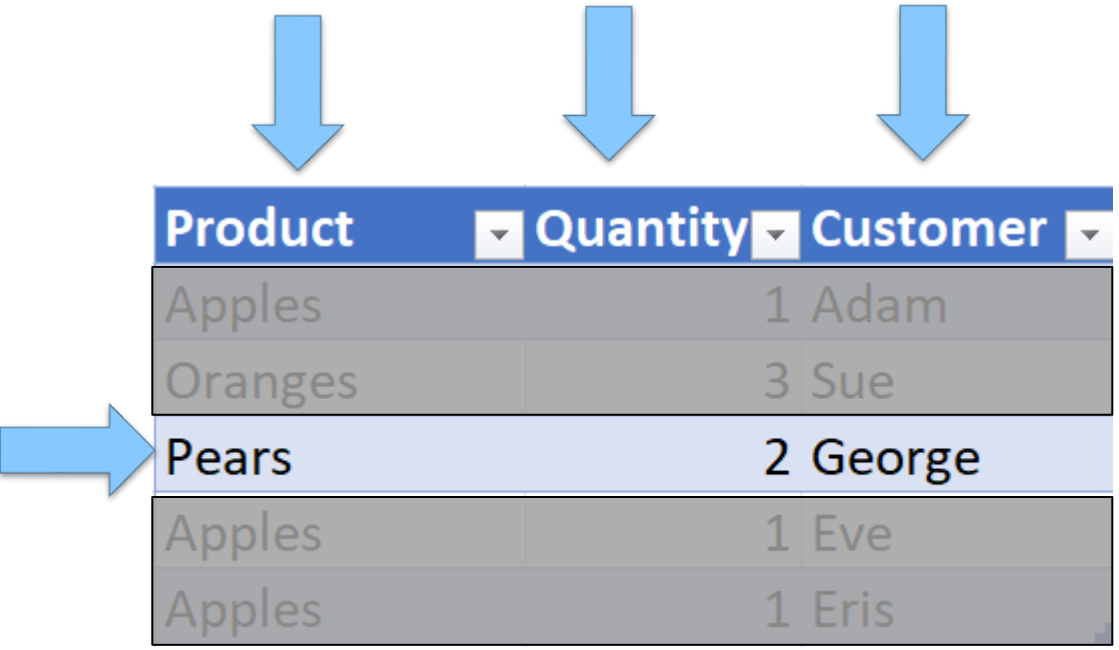
Product	Quantity	Customer
Apples	1	Adam
Oranges	3	Sue
Pears	2	George
Apples	1	Eve
Apples	1	Eris

A columnar format…

Great for this

```
SELECT SUM(Quantity)
GROUP BY Customer
```

What is Parquet



Product	Quantity	Customer
Apples	1	Adam
Oranges	3	Sue
Pears	2	George
Apples	1	Eve
Apples	1	Eris

A columnar format…

Not so great for this:

```
UPDATE (Product, Quantity)
WHERE Customer='George'
```

What is Parquet

Product	Quantity	Customer
Apples (6)	1	Adam
Oranges (7)	3	Sue
Pears (5)	2	George
Apples (6)	1	Eve
Apples (6)	1	Eris

Product Size = 30 characters (bytes)

…, dictionary encoded, …

Let

Apples = 1

Oranges = 2

Pears = 3

What is Parquet

Product	Quantity	Customer
1	1	Adam
2	3	Sue
3	2	George
1	1	Eve
1	1	Eris

Product Size = 5x4 bytes = 20 bytes

…, dictionary encoded, …

Let

Apples = 1

Oranges = 2

Pears = 3

What is Parquet

Product	Quantity	Customer
0b01	1	Adam
0b10	3	Sue
0b11	2	George
0b01	1	Eve
0b01	1	Eris

Product Size = 5x2 bits = 10 bits ~ 2 bytes

That's 15x smaller!

…, dictionary encoded, …

2 bits are enough for 3 values!!! -- BITPACKING

Let

Apples = 1 = 0b01

Oranges = 2 = 0b10

Pears = 3 = 0b11

What is Parquet

Product	Quantity	Customer
Apples	1	Adam
Oranges	3	Sue
Pears	2	George
Apples	1	Eve
Apples	1	Eris

…, with RLE compression

RLE - Run-length encoding

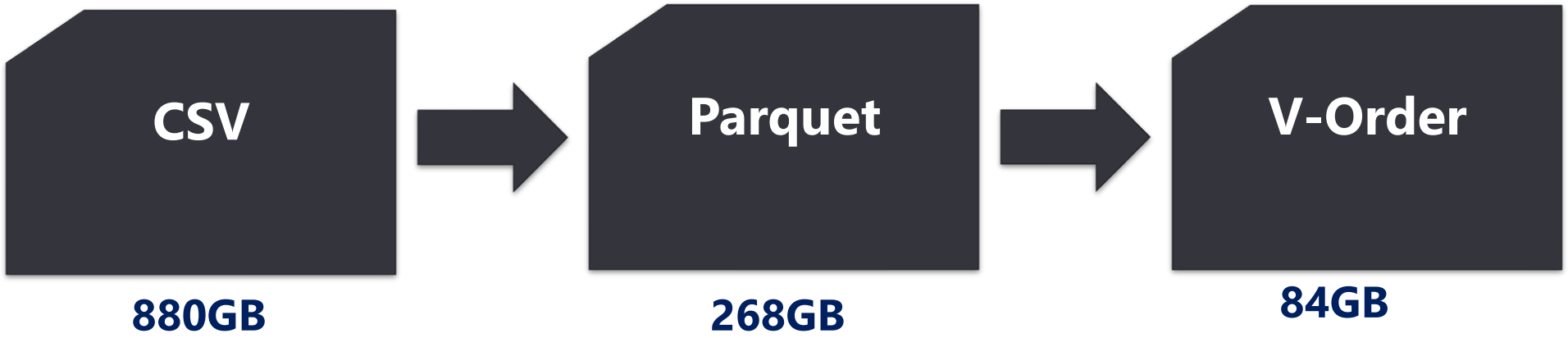
(replace repeated occurrences with the count)

Introducing V-Ordering

- Write time optimization to parquet files
- Sorting, row group distribution, dictionary encoding, and compression (Shuffling)
- Complies to the open standard
- Z-Order, compaction, vacuum, time travel, etc. are compatible with V-Order

V-ordering in action

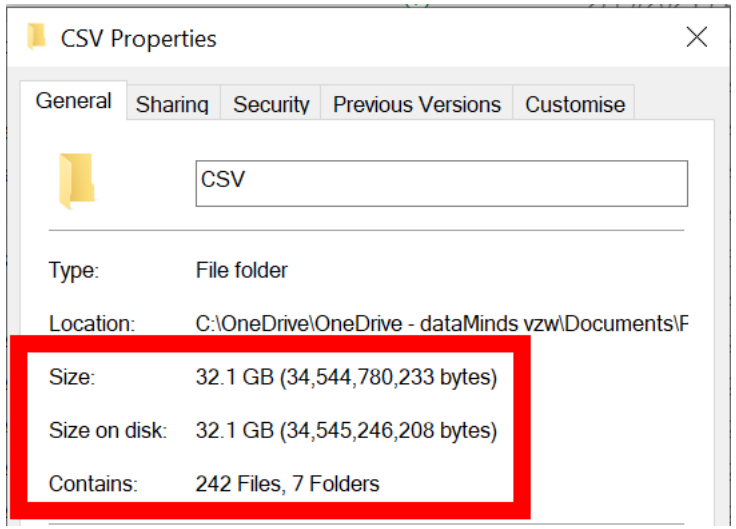
Microsoft Internal DB (162 tables)



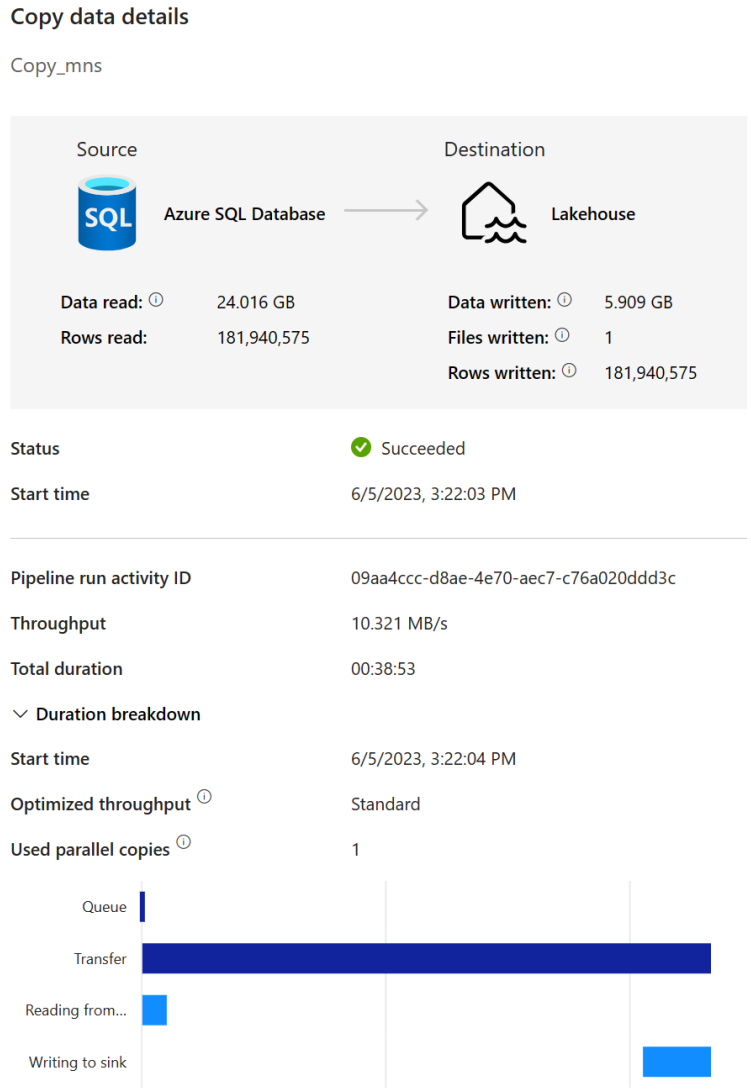
x3.2

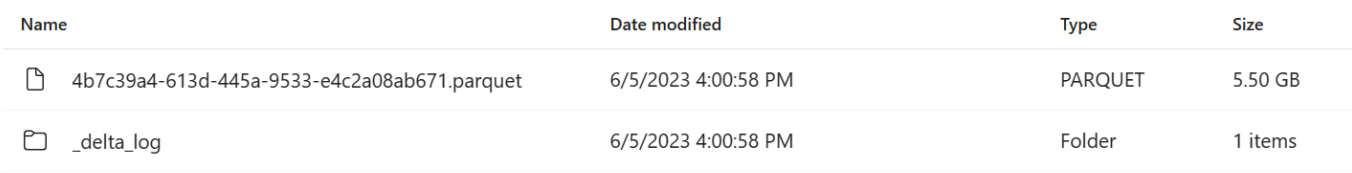
Reduced IO for workloads

V-ordering in our demo case



	TABLE_NAME	SCHEMA_NAME	Rows	TotalReservedSpaceMB	UsedDataSpaceMB	FreeUnusedSpaceMB
1	Trips_FA	Analytical	181940575	6413	6412	0
2	Time_DI	Analytical	86400	15	15	15
3	Bike_DI	Analytical	35553	1	1	1
4	Date_DI	Analytical	7304	19	19	19
5	Date_DI	Analytical	7304	0	0	0
6	Station_DI	Analytical	3430	0	0	0
7	Gender_DI	Analytical	59	0	0	0
8	Region_DI	Analytical	8	0	0	0
9	RideType_DI	Analytical	4	0	0	0
10	UserType_DI	Analytical	3	0	0	0
11	TripType_DI	Analytical	3	0	0	0
12	MemberType_DI	Analytical	3	0	0	0
13	FileType_DI	Analytical	3	0	0	0





What is Direct Lake Mode?

DirectLake Mode

- On start, no data is loaded in-memory
- Column data is *transcoded* from Parquet files when queried
- Tables can have mix of *transcoded* (resident) and non-resident
- Column data can get evicted over time
- DirectLake fallback as an alternative
- “Framing” of dataset determines what gets loaded from DeltaLake

STOP! Demo time!

Using Direct Lake mode over a Lakehouse

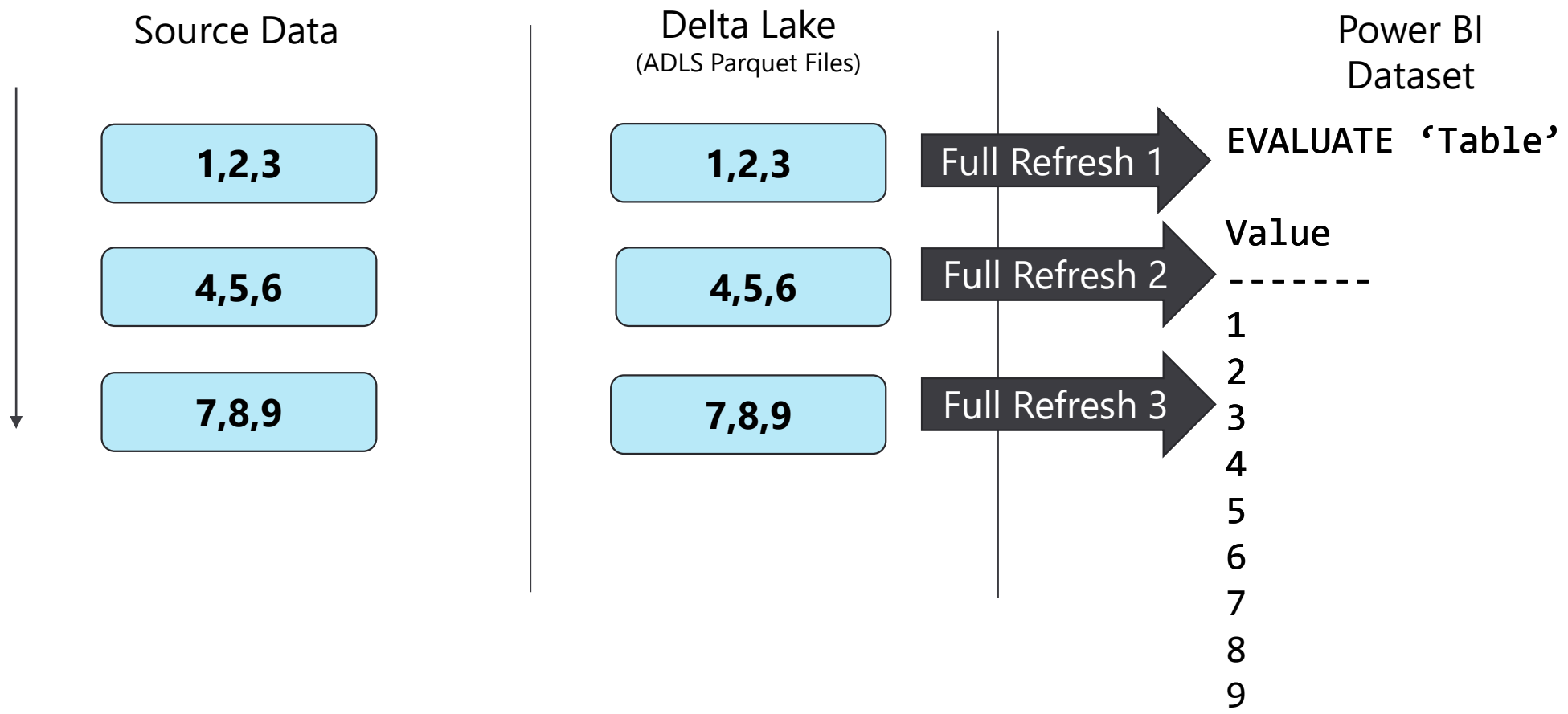
STOP! Demo time!

Let’s look at Framing

Framing

- What is framing
  - "point in time" way of tracking what data can be queried by DirectLake
- Framing is near instant and acts like a cursor
  - Determines the set of .parquet files to use/ignore for *transcoding* operations
- Why is this important
  - Delta-lake data is transient for many reasons
- Typical ETL Process
  - Ingest data to delta lake tables
  - Transform as needed using preferred tool
  - When ready, perform *Framing* operation on dataset

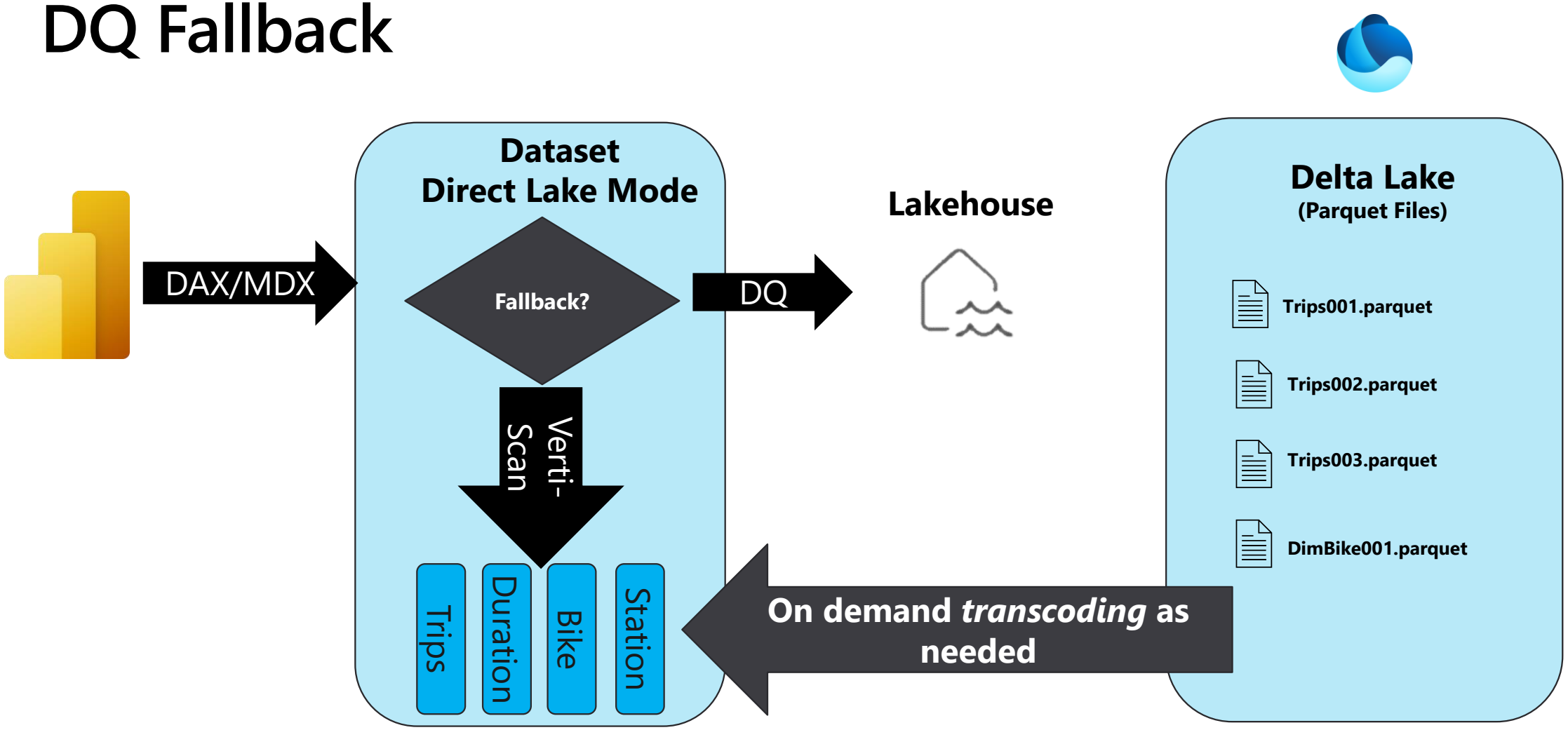
Framing


Source Data
1,2,3
4,5,6
7,8,9
Delta Lake
(ADLS Parquet Files)
1,2,3
4,5,6
7,8,9
Full Refresh 1
Full Refresh 2
Full Refresh 3
Power BI
Dataset
EVALUATE 'Table'
Value

1
2
3
4
5
6
7
8
9

Fallback to DirectQuery

DQ Fallback


DAX/MDX
Dataset
Direct Lake Mode
Fallback?
DQ
Lakehouse
Delta Lake
(Parquet Files)
Trips001.parquet
Trips002.parquet
Trips003.parquet
DimBike001.parquet
Verti-Scan
Trips
Duration
Bike
Station
On demand *transcoding* as needed

Guardrails

Fabric/Power BI SKUs	Parquet files per table	Row groups per table	Rows per table (millions)	Max model size on disk/OneLake1 (GB)	Max memory (GB)
F2	1000	1000	300	10	3
F4	1000	1000	300	10	3
F8	1000	1000	300	10	3
F16	1000	1000	300	20	5
F32	1000	1000	300	40	10
F64/FT1/P1	5000	5000	1500	Unlimited	25
F128/P2	5000	5000	3000	Unlimited	50
F256/P3	5000	5000	6000	Unlimited	100
F512/P4	10000	10000	12000	Unlimited	200
F1024/P5	10000	10000	24000	Unlimited	400
F2048	10000	10000	24000	Unlimited	400

https://learn.microsoft.com/en-us/power-bi/enterprise/directlake-overview#fallback

Limitations

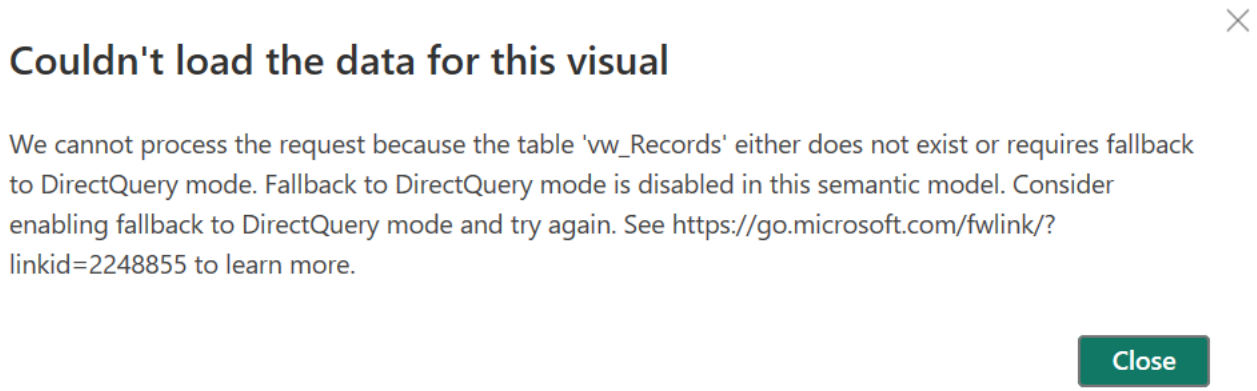
- DateTime relationships
- Calculated Columns and Calculated Tables
- Complex delta table column types (i.e. Binary and GUID)
  - Some other
- T-SQL Based views will always fallback to DQ mode
- Composite models are not yet supported

Identifying Fallback

- You can tell when Fallback happens if ..
  - It’s slower than usual ☺
  - Using the Performance Analyzer, you see a “DirectQuery” category
  - Performing a trace, you see DirectQueryBegin and DirectQueryEnd events
  - Depending on the behaviour, you get an error

Controlling Fallback Behaviour

- The FallbackBehaviour is set to ‘Automatic’ by default
- Alternative options are:
  - DirectLake only
  - DirectQuery only
- Be careful when making changes to this ..



STOP! Demo time!

Let’s look at Fallback

External Tools

External Tools

- For now, Web Based Modelling is the recommended way
- But .. You can use External Tools!
- Be sure to enable the tenant and workspace setting to allow
- https://blog.tabulareditor.com/2024/01/29/new-access-your-tabular-editor-authored-model-in-the-fabric-ui/

Data **model** settings

Users can edit data **model**s in the Power BI service (preview)

Enabled for the entire organization

Turn on this setting to allow users to edit data **model**s in the service. This setting doesn't apply to DirectLake semantic **model**s or editing a semantic **model** through an API or XMLA endpoint. Learn More

Enabled

Apply to:

- (•) The entire organization
- ( ) Specific security groups

[ ] Except specific security groups

Apply Cancel

Workspace settings

About
Premium
Azure connections
System storage
Git integration
OneLake
Workspace identity
Network security
Other

Power BI
General
Data connections
Embed codes

Data Engineering/Science

Organization apps

Secure update

Allow contributors to update the app for this workspace

☐ Allow contributors to update the app

Template apps

Template apps

Template apps are developed for sharing outside your organization. A template app workspace will be created for developing and releasing the app. Learn more about template apps

☐ Develop template apps

Data model settings

Data model settings

Allow workspace members to edit data models in the service. Edits are permanent and automatically saved in this feature preview, and version history isn't saved. This setting doesn't apply to Direct Lake datasets or editing a dataset through an API or XMLA endpoint. Learn more

☑ Users can edit data models in the Power BI service (preview)

Optimizing Delta for Direct Lake mode

Optimizing Delta for Direct Lake mode

- V-Order makes a big difference, as it's tailored for Verti-Scan
- Direct Lake will work over Shortcuts to external data
  - Expect a performance impact, because reasons ..
- Direct Lake thrives on fewer, larger .parquet files
  - Physical structure will always be crucial
  - OPTIMIZE (bin-compaction) and VACUUM in the Data Engineering process will be key
  - Especially with streaming/small batch architectures, keep this in mind
- Principle of lean models will still apply
  - Only include what's needed for the reports and datasets

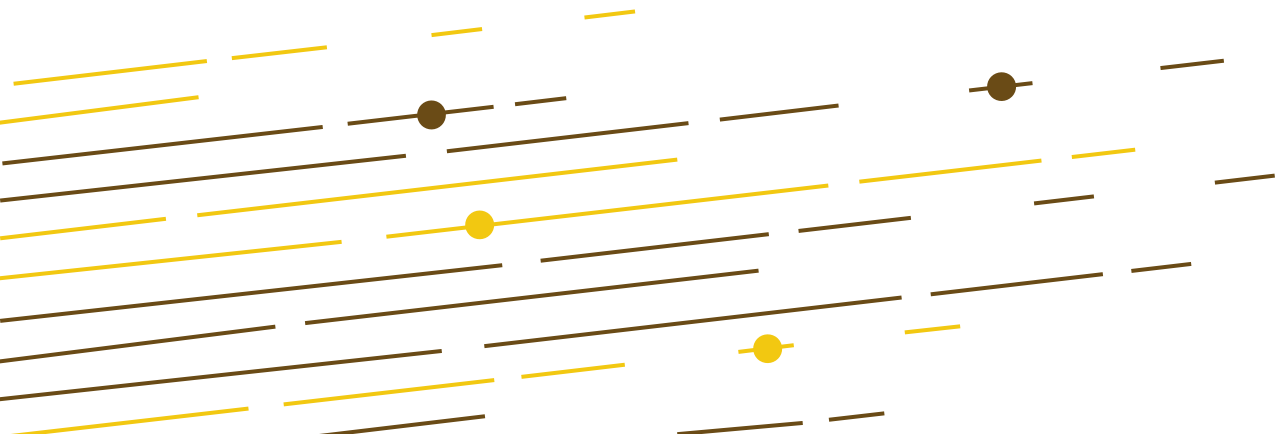
Warming the cache

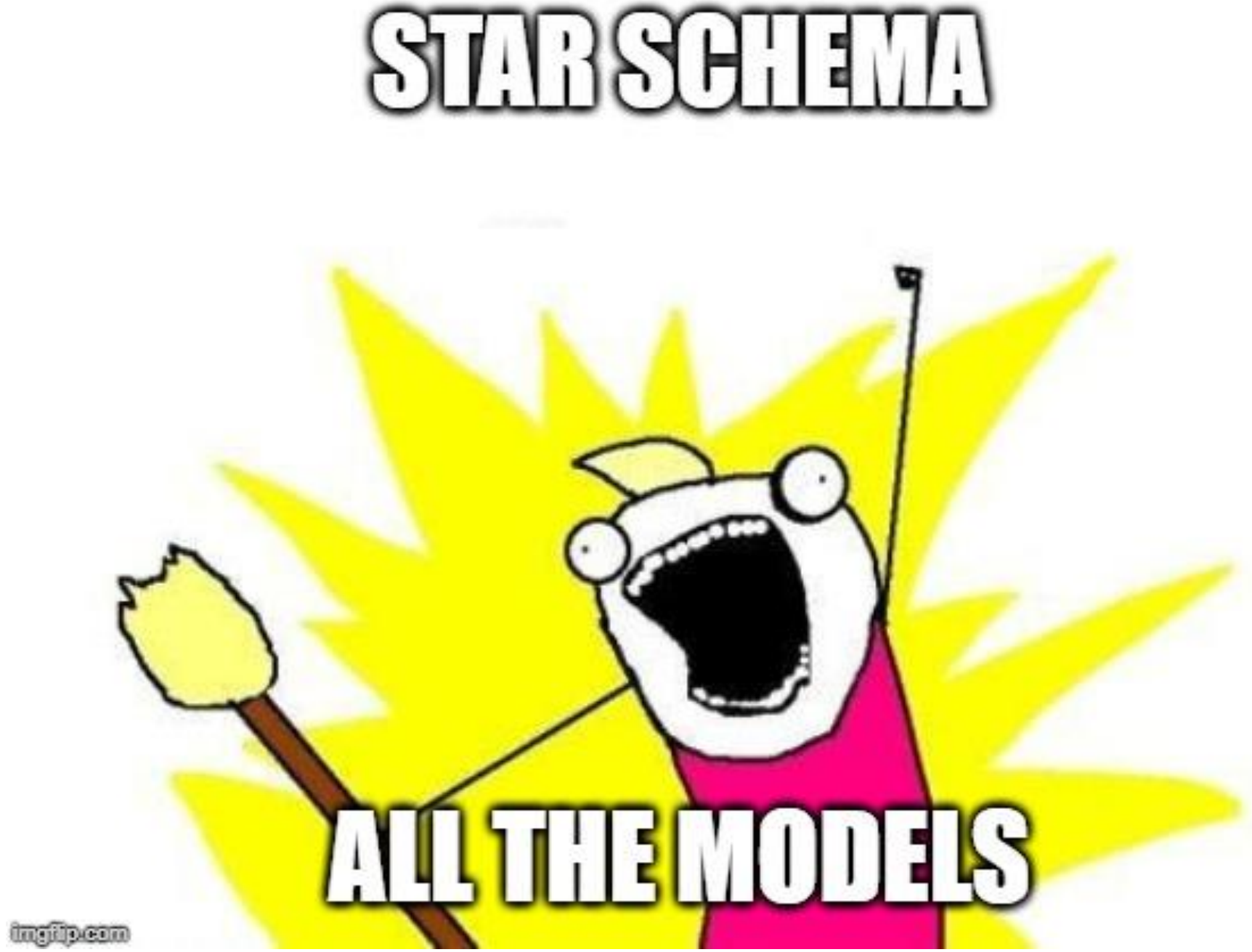
Common Answers to Common Questions

“Greatest Hits”

- Delta doesn’t like spaces in object names ☺
- Delta Tables are a hard requirement for Direct Lake mode
  - Dataflows Gen2, Pipelines, Notebooks can create them for you in the lakehouse
- Web modelling is the recommended way to create DirectLake datasets
- XMLA Read/Write is supported, but disables web modelling (default)
- Direct Lake doesn’t have unique DAX limitations
  - DQ does ..
- No confirmed plans right now to support Apache Iceberg, HUDI, ..
- YES, you can have Copilot! (Now stop asking me)

What does this mean for my data modelling?





Thanks, @KoVer!

Data should be transformed as far upstream as possible, and as far downstream as necessary.

Matthew Roche, 2021
(The purple haired sword afficionado)
https://ssbipolar.com/2021/05/31/roches-maxim

Resources

- https://learn.microsoft.com/en-us/power-bi/enterprise/directlake-overview
- https://learn.microsoft.com/en-us/power-bi/enterprise/directlake-analyze-qp
- https://learn.microsoft.com/en-us/fabric/data-engineering/lakehouse-pbi-reporting
- https://learn.microsoft.com/en-us/fabric/data-engineering/delta-optimization-and-v-order?tabs=sparksql
- https://fabric.guru/power-bi-direct-lake-mode-frequently-asked-questions
- https://www.fourmoo.com/2023/05/24/using-power-bi-directlake-in-microsoft-fabric/
- https://fabric.guru/controlling-direct-lake-fallback-behavior
- https://milescole.dev/optimization/2023/10/08/Delta-Table-Maintenance-101.html
- https://aka.ms/delta

Slides

https://github.com/BenniDeJagere/Presentations/{Year}/{YYYYMMDD}_{Event}

Thank you