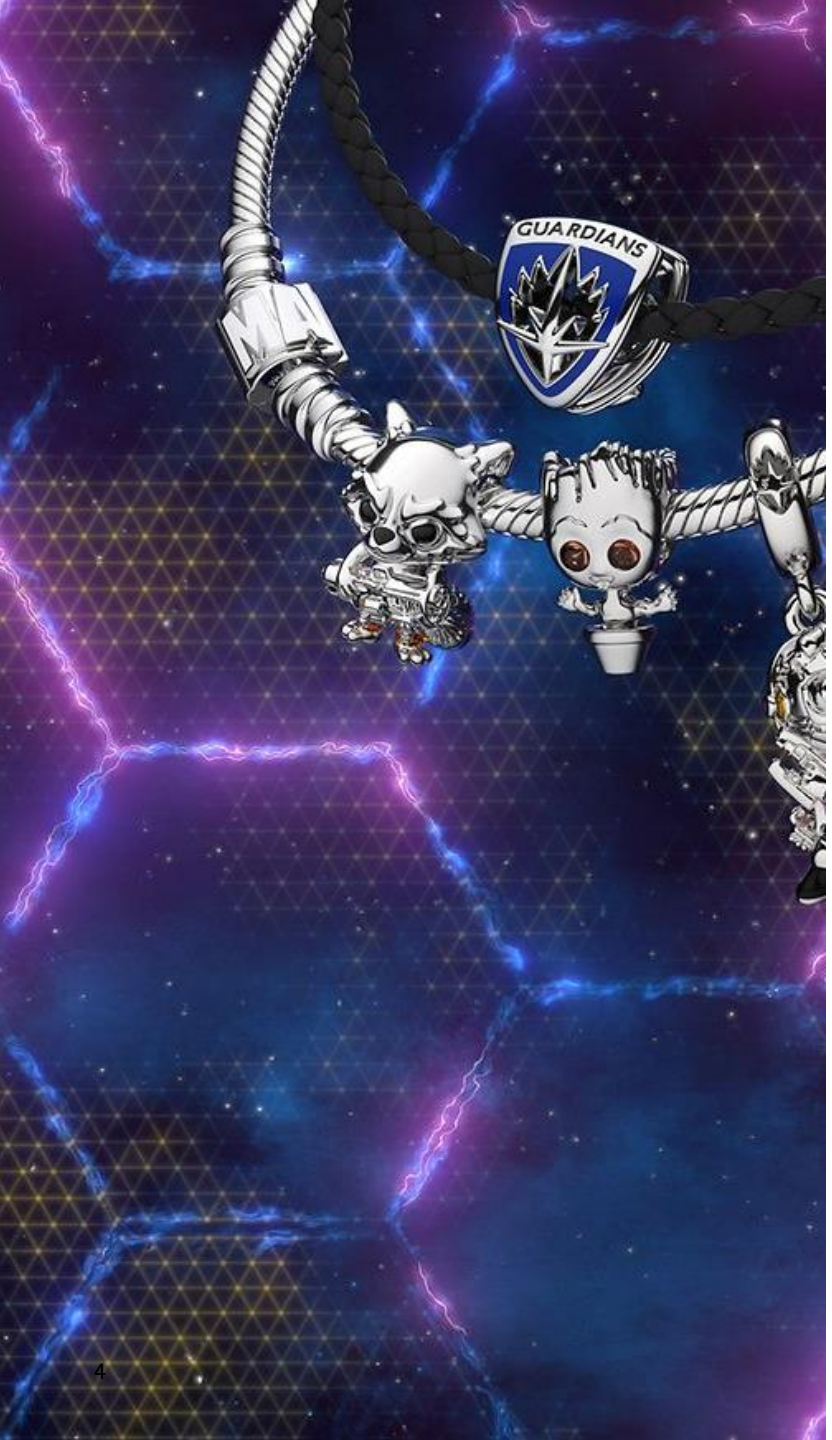
2023-04-25: foss-north 2023 (Gothenburg, Sweden)

HOW TO TRANSFORM AVRO (IDL) DATA TO MULTIPLE PARQUET FILES

AGENDA

- About Pandora and me (very shortly)
- Matching of expectations
- Background
- Proposed solution, FOSS and demo
- Summary
- Q&A

ABOUT PANDORA AND ME (VERY SHORTLY)



ABOUT **PANDORA** AND ME (VERY SHORTLY)

Pandora, world's biggest jewellery brand, 40-year anniversary last year summary:

- **1982 founded as small goldsmithing shop in CPH**
- 1989 crafting jewellry in Thailand
- **2000 signature charm bracelet concept is launched**
- 2005 fully-owned crafting facility opens in Bangkok
- 2014 strategic 10-year alliance with Disney (Star Wars, Marvel, …)
- 2019 UNICEF partnership, donating USD 10 million, helping more than 1.2 million children
- **2020 crafting facilities running 100% renewable energy (CO2 neutral by 2025)**
- **2021 introduce jewellry with lab-created diamonds**
- 2022 employee number 32.000

- Our values:
  - WE DREAM
  - WE DARE
  - WE CARE
  - WE DELIVER

PANDORA

ABOUT PANDORA AND **ME** (VERY SHORTLY)

- Lead Tech/Architect at Pandora's Digital Hub in CPH
- Previous talks at foss-north:
  - 2020 - DDD with Algebraic Data Types (ADT)
  - 2019 - Limiting side-effects of app at compile-time
- **Datology/datologist** are terms coined to **Peter Naur** (*) and heavily inspired by (his friend) Edsger Dijkstra's quote: «***Computer Science is no more about computers than astronomy is about telescopes***», for when he founded the first Computer Science Department in Denmark (CPH University)

(*) - Only Dane with an ACM Turing Award

MATCHING OF EXPECTATIONS

MATCHING OF EXPECTATIONS

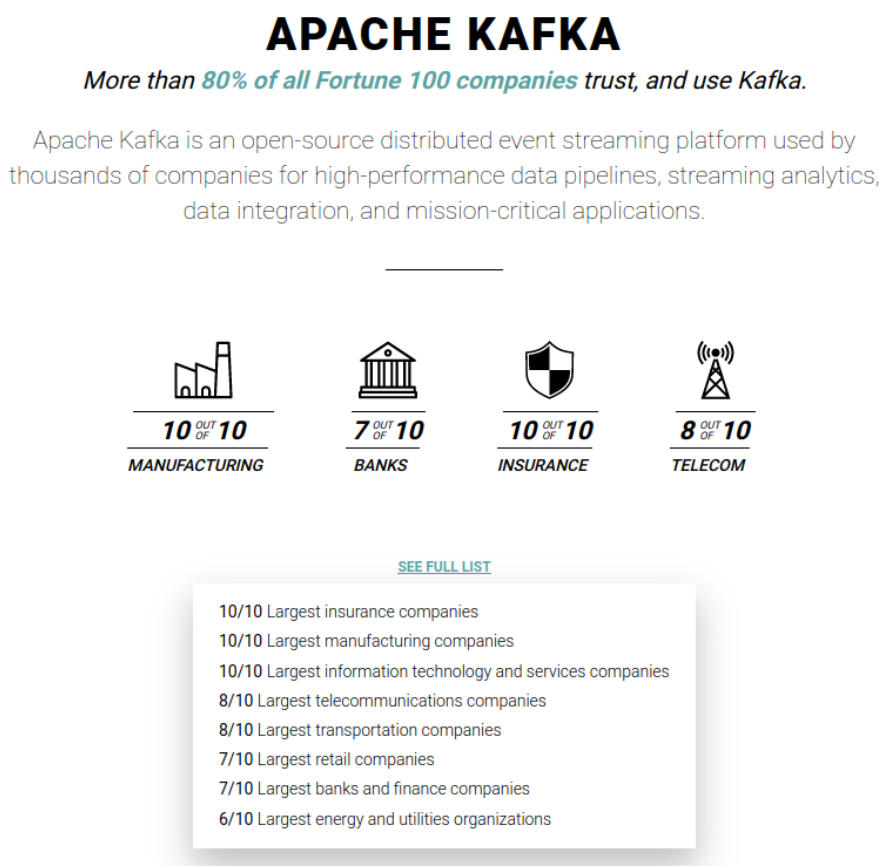
- Showcase a **tool** that **automates the transformation** of Apache Avro (**AVRO**), with **nested data**, into **multiple** Apache Parquet (**PARQUET**) **files**, **merging raw and structured/validated/deduplicated data** together
- Our **assumption** is that this allows for a **reduction** in the amount of **data storage and costs**, **by merging**, if we think in medallion lake-house architecture, the **bronze and silver layers**
- Furthermore, thanks to the **reduction in data storage**, it could also **help reduce CO2 emissions by roughly 33%**, using **fewer servers and less computing power**. The exact calculation and emissions reduction is **to be confirmed by** the **Pandora's Climate Team** and **Microsoft**, who are our cloud provider
- The **tool** is a free and open-source software (**FOSS**) library that is **available on NuGet**, and the source code is available at **Pandora's GitHub profile**

Remark: I would ♥ questions, but please save them to the end of the talk. Lots to say and time is mana, I mean limited

BACKGROUND

BACKGROUND
KAFKA & DDD DATA MESH

- We are **onboarding** Apache **Kafka** (KAFKA), a distributed event store and stream-processing platform that is an open-source system developed by the **Apache Software Foundation**. One of its most important capabilities is to provide scalable real-time integrations. It's **widely used** by the **biggest companies**
- Due to this and based on our **data mesh strategy**, our **domain-driven design (DDD) "ubiquitous"/common language** has become **AVRO IDL (subset of AVRO)**, as the format allows our: subject-matter experts (SME) & domain-experts; development & products teams; code and other stakeholders to have a **shared mental and common model** of the **representation of our data**
  - Visit Confluent's blog post: Saxo Bank's Best Practices for a Distributed Domain-Driven Architecture Founded on the Data Mesh for info on DDD + Data Mesh



Source: https://kafka.apache.org/

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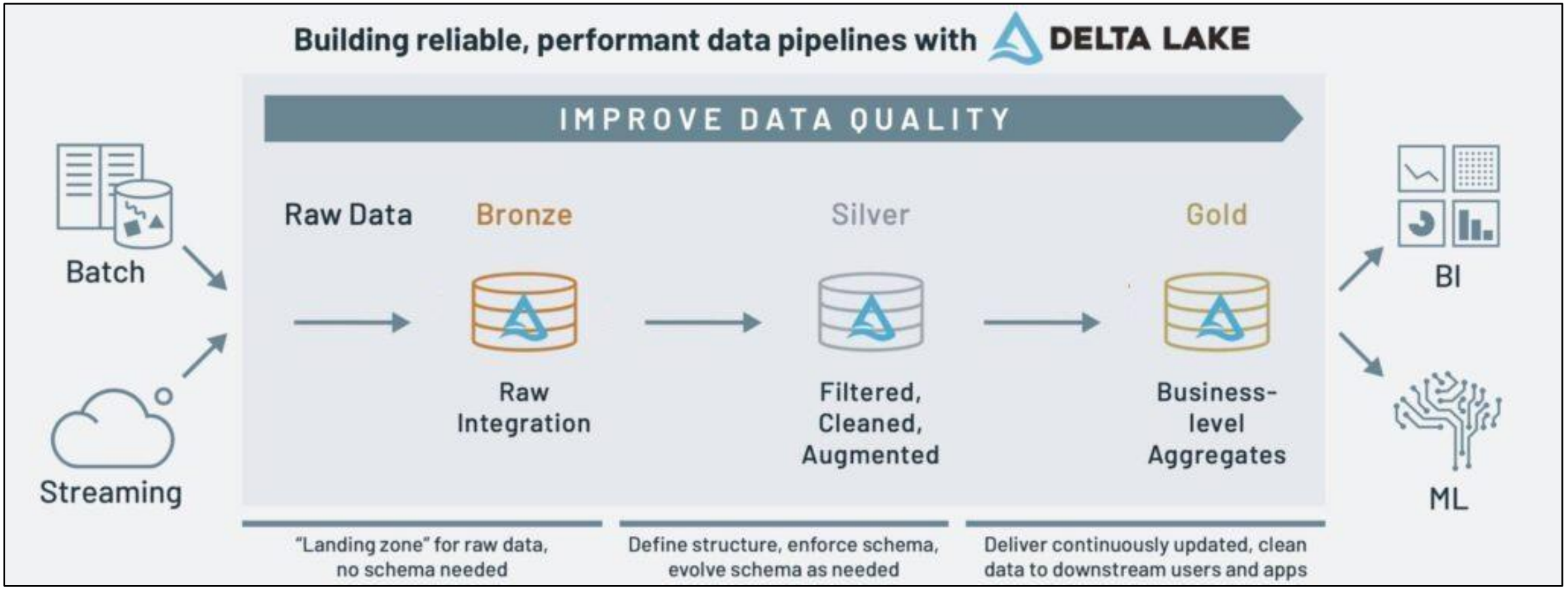
BACKGROUND
KAFKA (EDA) & DATA MESH DATA-LAKES (AVRO VS PARQUET)

- By using **KAFKA**, we will **rely on integrations** from **system-to-KAFKA** and **KAFKA-to-system** and hereby **reduce** to an **absolute minimum the system-to-system** integrations. This will ensure that **we do NOT expand our current systems** with **technical debt** just because we are going to **consume a new data stream**
- Since **KAFKA** is based on an **event-driven architecture (EDA)**, this would result in that **not ALL the data**, that is stored as an event in the EDA, **will be utilized by a given system**. And based on **the nature of EDA**, where the **important part** is the **communication strategy**, the **data will only be available** for a **short period of time**
- Therefore, it's **mandatory to introduce Event Sourcing (ES) as well**, where the **important part** is the **persistence strategy**, as that will allows us to **store ALL the data from the EDA** into our **data mesh data-lakes**
- To **make the data usable** in the **data mesh data-lakes**, the **AVRO data format might not be ideal** and therefore we would need to **transform it** to a format, that is optimized **to be consumed by the tools that normally are used by our data teams**
- The **PARQUET file format seems to be the de-facto standard** when it comes to persistence of data in data-lakes (Hadoop, Spark, Databricks, Synapse, ...). It is a column-oriented data storage format, which seems to differ from some of the other normally used formats (CSV, TSV, ...) and it **provides efficient data compression and encoding schemes** with **enhanced performance to handle complex data** in bulk

BACKGROUND
MEDALLION LAKE-HOUSE ARCHITECTURE (AVRO AS PARQUET)



Built-in Spark/Databricks (medallion lake-house architecture) will persist AVRO as single PARQUET file in bronze

Source: https://www.databricks.com/glossary/medallion-architecture

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BACKGROUND
USING BUILT-IN TOOLING IS TEDIOUS AND COSTLY

- Spark/Databricks **built-in** AVRO to PARQUET (**persistence capabilities**):
  - https://docs.databricks.com/external-data/avro.html
  - **Main issues** by having AVRO nested data **stored in a single PARQUET file** is that it's **tedious and costly to work with** afterwards as you must **manually unwrap to reach specific data**
- Spark/Databricks **built-in** read and write to streamed AVRO (**real-time capabilities**):
  - https://docs.databricks.com/structured-streaming/avro-dataframe.html
  - **Main issues** with this approach is that a **cluster must be running 24/7** and the **same constraints (working with nested data)** as mentioned in previous bullet-point, apply as well
    - **Azure Databricks cluster**: **400 USD/month** (Standard light) - **925 USD/month** (Premium)
      - Source: https://cprosenjit.medium.com/azure-databricks-cost-optimizations-5e1e17b39125
    - **Azure K8S container**: **15 EUR/month** and **Azure Container App**: **17 EUR/month**
      - Source: https://jussiroine.com/2021/12/running-a-single-docker-container-in-azure-cost-effectively

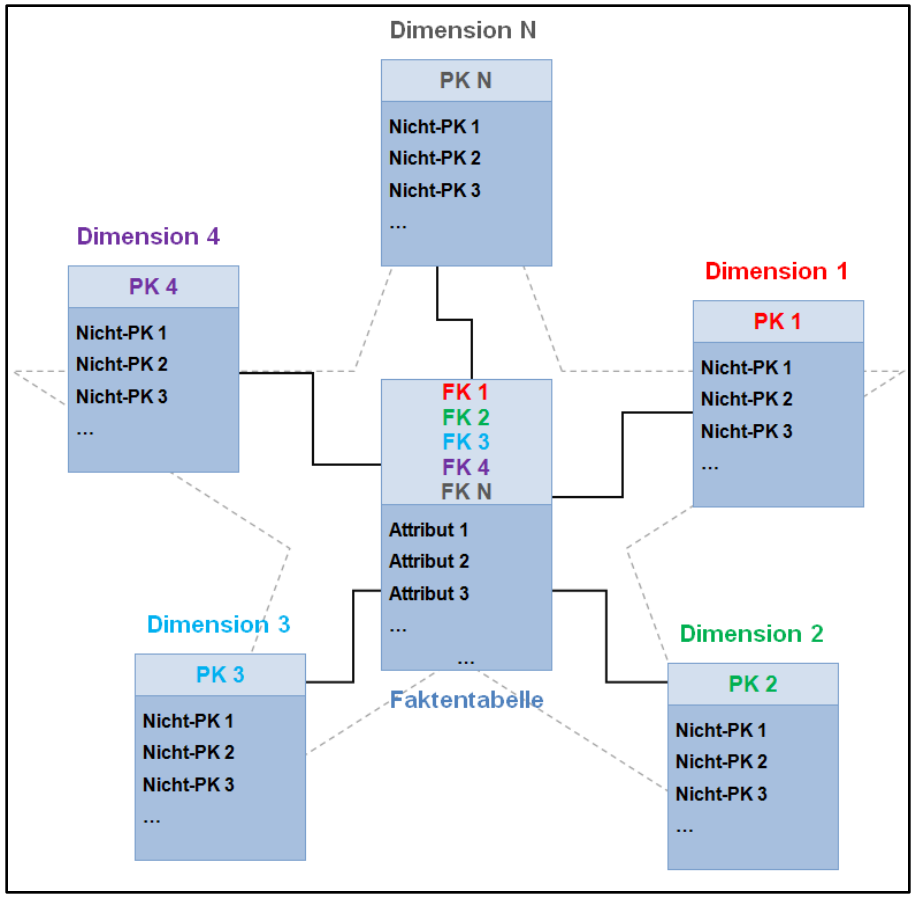
PROPOSED SOLUTION, FOSS AND DEMO

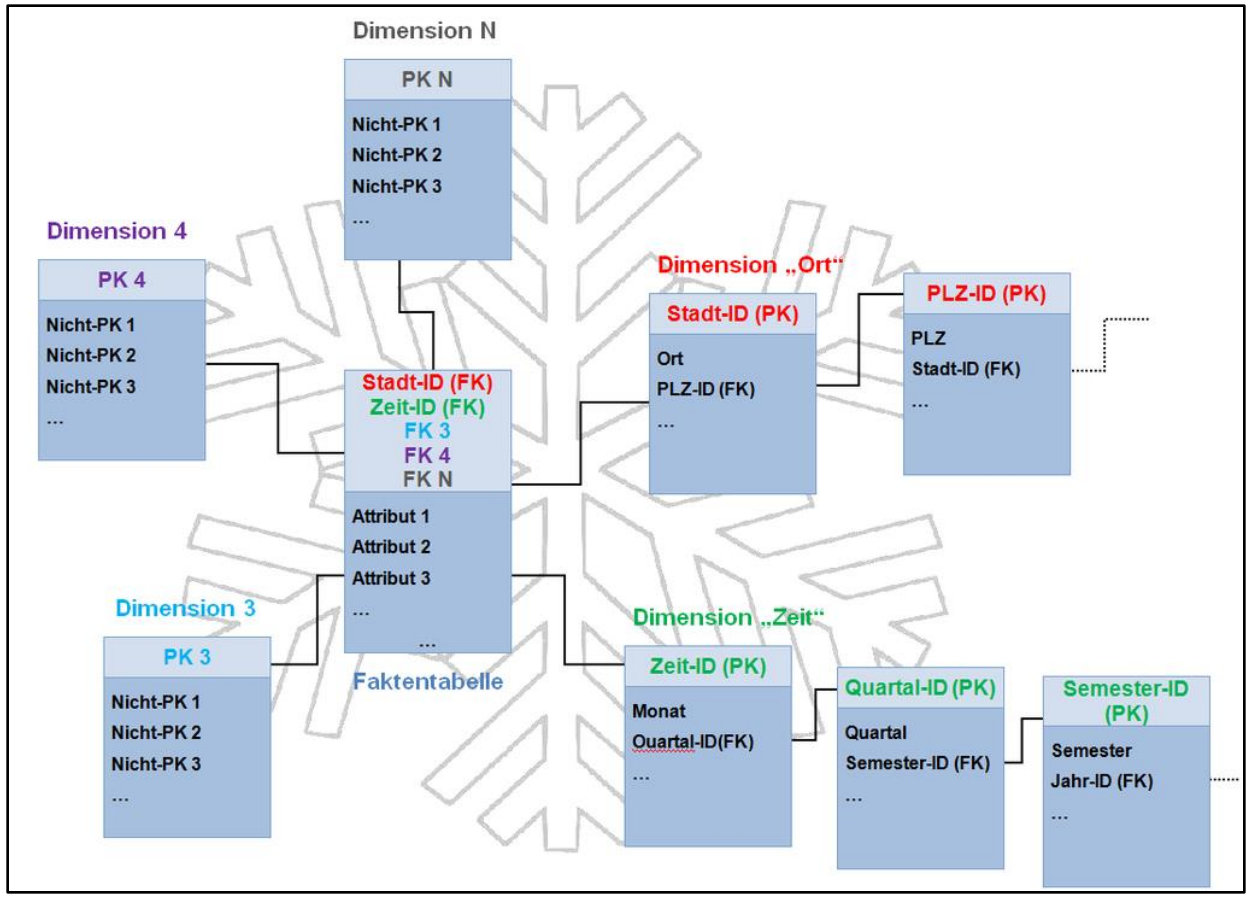
PROPOSED SOLUTION, FOSS AND DEMO
PROPOSED SOLUTION > TOOL

- The tool presents a **novel and state-of-the-art solution** and **transforms** our Apache Avro® data (**AVRO IDL**) into multiple Apache Parquet® (**PARQUET**) files in a fully automated way
- **AVRO** and **PARQUET** are formats to **handle data in a very-optimized and cost-effective manner** and are **widely accepted and used**
- This means **nested data elements** are **shown as an extension table** (a separate file) and **allows us to merge raw and validated/deduplicated** data together, **making it easier** for data engineers/scientists and business analysts **to utilize data**

PROPOSED SOLUTION, FOSS AND DEMO

PROPOSED SOLUTION > TOOL > EXTENSION TABLES





Fact and dimension tables (star schema) and recursively (snowflake schema)

Source: https://en.wikipedia.org/wiki/Star_schema and https://en.wikipedia.org/wiki/Snowflake_schema

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PROPOSED SOLUTION, FOSS AND DEMO
PROPOSED SOLUTION > TOOL > STAR/SNOWFLAKE SCHEMAS

- **Benefits** of Star/Snowflake schemas:
  - **Simpler queries**
  - **Simplified** business **reporting logic**
  - **Query performance gains**, when read-only (*)
  - **Fast aggregations**
  - **Efficient** and **compact storage** of normalised data
  - Sample Querying One Trillion Rows of Data with PowerBI and Azure Databricks:
    - Tables: 1 fact, 2 dimension and 1 aggregate
    - **Queries** only take a **few seconds**
    - **Delta Lake**

(*) - Suits us well as **we are only atomically appending** the **immutable data stream of events** for **historical purposes**

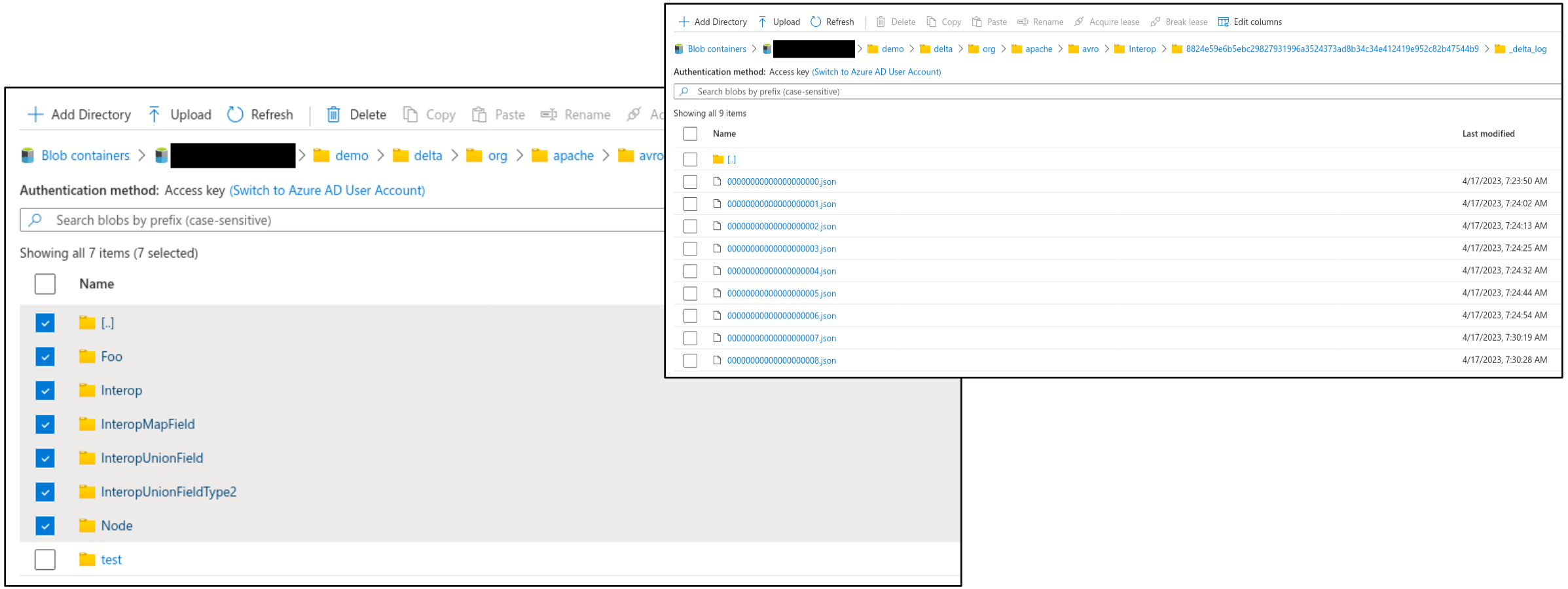
PROPOSED SOLUTION, FOSS AND DEMO
PROPOSED SOLUTION > TOOL > TRANSFORM NESTED TYPES & SHA256

- Before we can automatically generate our Star/Snowflake schemas, we will **need to translate the nested** (and complex) **AVRO IDL types** to **a single and uniform type** that can handle them all. We can achieve this by doing the following transformations:
  - `array of 't      => record {                 item  : 't                          }`
  - `map   of 't      => record { key : string, value : 't                          }`
  - `union of 't seq => record {                 type0 : 't_0, …, typeN : 't_n }`
- By doing this, we can now utilize the Avro.Generic.GenericRecord class to **transform any given AVRO IDL record** type **to our defined PARQUET schema AST**
- Furthermore, due to the **nature of AVRO IDL** and Application Lifecycle Management (**ALM**) where it is **supported to do changes to the schemas**, it's **important to ensure** that we **do NOT get invalid data in the data-lakes**. Therefore, we are performing a **SHA-256 hash** on the **Avro.Generic.GenericRecord Schema (string) property**, to ensure that ALL the **related data to that given schema version**, will go to the **right data-lake folder**. The generation of the SHA-256 **hash is always deterministic** in the sense **if v.1.0 and v.42.0 are equal**, then data will **share the same folder** (surjective mapping)

Source: https://www.nuget.org/packages/Apache.Avro

PROPOSED SOLUTION, FOSS AND DEMO

PROPOSED SOLUTION > TOOL > DATA-LAKE VS DELTA LAKE (JSONL)



Delta Lake JSONL control files provides fast & efficient queries and ignore/prune of irrelevant partitions capabilities

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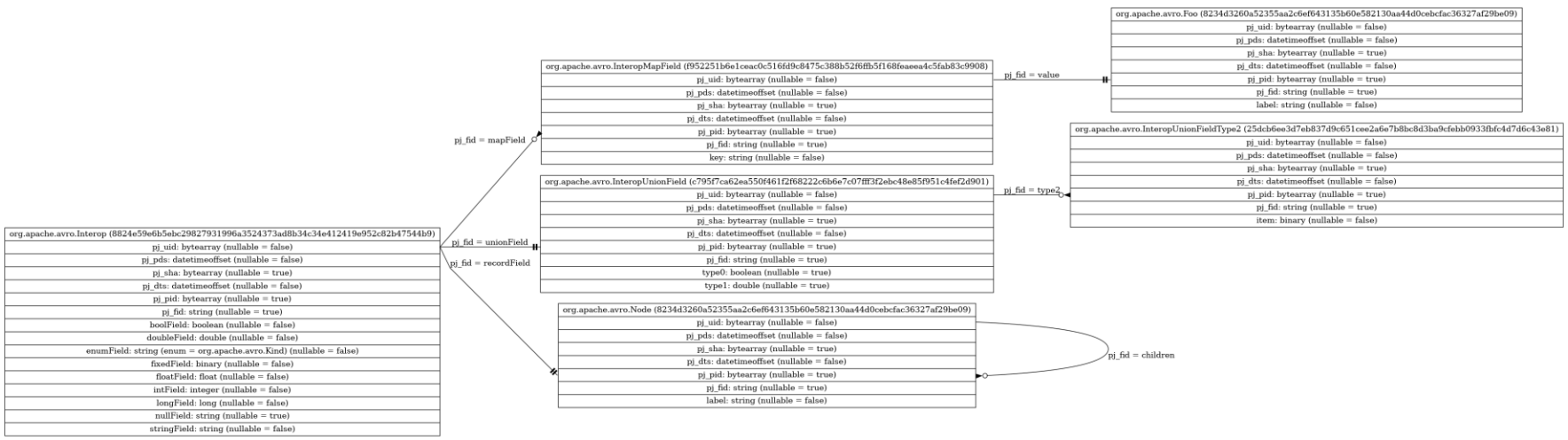
PROPOSED SOLUTION, FOSS AND DEMO
PROPOSED SOLUTION > TOOL > GOALS

- **Ripple effect**: Fully automated propagation of schemas to data storages, based on well-defined data-contracts
- **Onboarding**: Ease onboarding to KAFKA by providing 2-for-1 development (create producer, get consumer for free)
- **Delta Lake support**: This means we can search in massive datasets, very quickly. By delivering to a lake-house architecture that has support for data partitions, it will allow for fast and efficient queries of large datasets by using parallelization as well as quickly ignore/prune of irrelevant partitions. Furthermore, the Delta Lake is cloud agnostic
- **User friendliness (UI/UX)**: Data engineers/scientists and business analysts will be able to keep using the tools they used too. It will be a fully transparent experience for them
- **Automation and cost & time reduction**: Adding our solution to a data pipeline will only require a few lines of configuration (no code needed). From that point, the consumed data, will be delivered and persisted to the chosen data storage reducing engineering tasks as well as cloud storage/processing
- **Our sustainability journey**: We believe high-quality (jewellery), strong business performance and high ethical standards go hand in hand, and we craft (our jewellery) with respect for resources, environment and people.

PROPOSED SOLUTION, FOSS AND DEMO

PROPOSED SOLUTION > TOOL > GOALS > RIPPLE-EFFECT

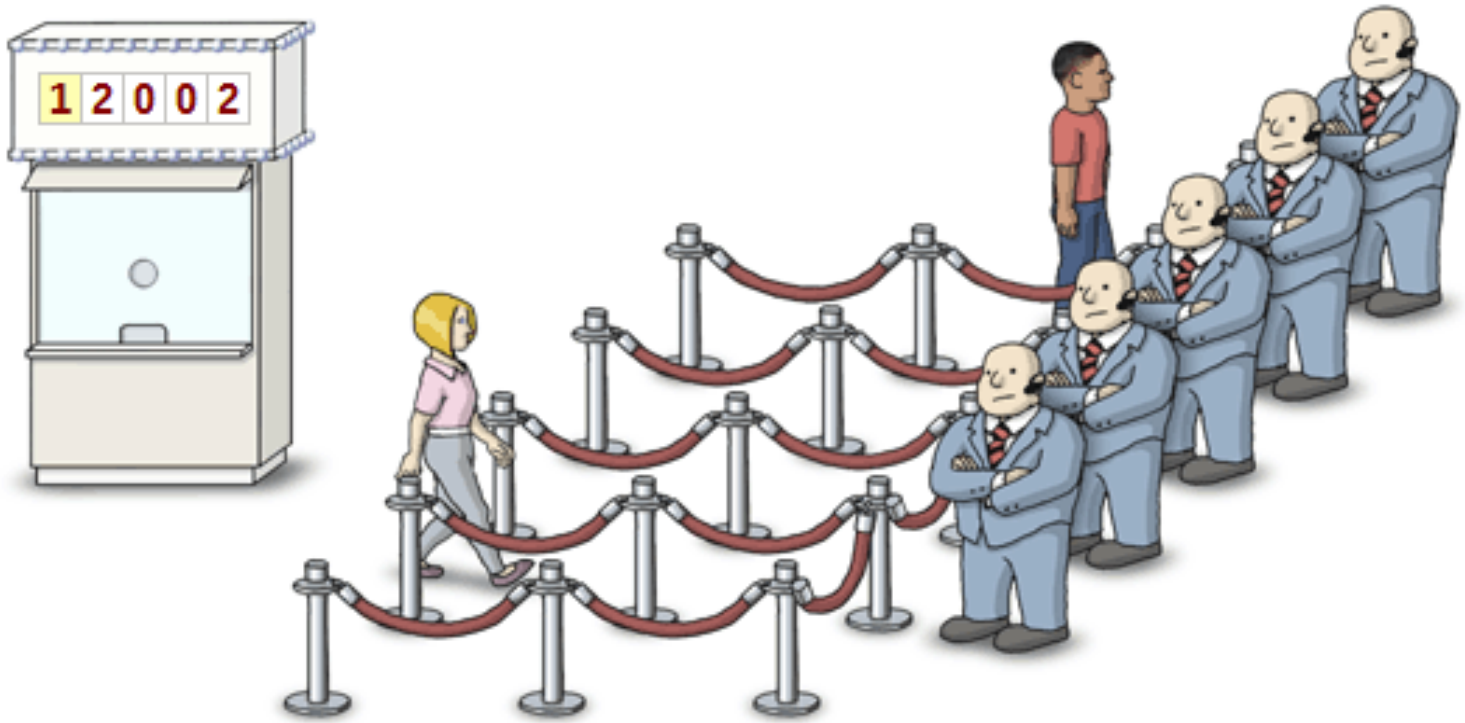



```
/**
 Currently genavro only does Protocols.
 */
@namespace("org.apache.avro")
protocol InteropProtocol {

  record Foo {

    string label;

  }

  enum Kind {

    A,
    B,
    C

  }

  fixed MD5 (16);

  record Node {

    string label;

    array<org.apache.avro.Node> children = [];

  }

  record Interop {

    int intField = 1;

    long longField = -1;

    string stringField;

    boolean boolField = false;

    float floatField = 0.000000;

    double doubleField = -1000000000000.000000;

    null nullField;

    map<org.apache.avro.Foo> mapField;

    union{boolean,double,array<bytes>} unionField;

    org.apache.avro.Kind enumField;

    org.apache.avro.MD5 fixedField;

    org.apache.avro.Node recordField;

  }
```

Source: https://github.com/apache/avro/blob/master/lang/java/compiler/src/test/idl/input/interop.avdl

PROPOSED SOLUTION, FOSS AND DEMO

PROPOSED SOLUTION > TOOL > GOALS > ONBOARDING



- **Invest** in creating **a data producer** that **ingests data to KAFKA**
- **Use generic sink/archiver consumer**, built with the **FOSS library**, to **deliver data to a specific data mesh data-lake in a buffered manner** (combination of streaming/batch) relying on both **time interval** and **buffer upper-bound semaphores**

Source: https://preshing.com/20150316/semaphores-are-surprisingly-versatile/

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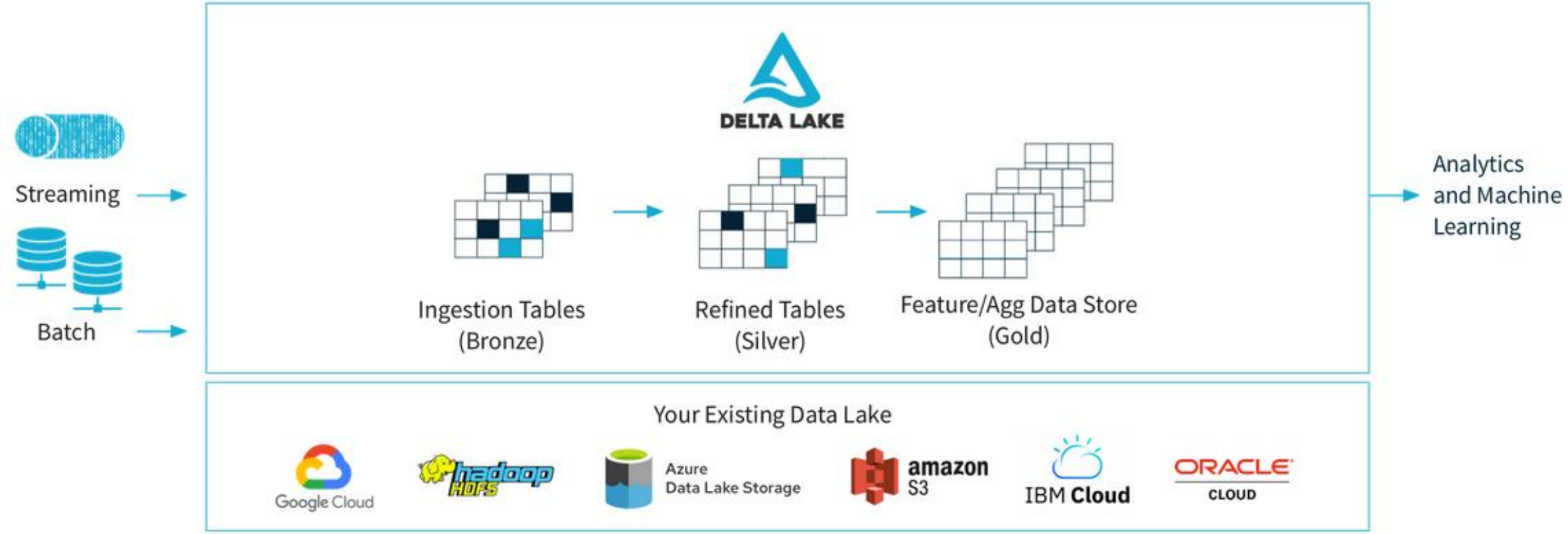
PROPOSED SOLUTION, FOSS AND DEMO

PROPOSED SOLUTION > TOOL > GOALS > DELTA LAKE SUPPORT



Delta Lake is OSS (The Linux Foundation) and is cloud agnostic

Source: https://delta.io/

PROPOSED SOLUTION, FOSS AND DEMO

PROPOSED SOLUTION > TOOL > GOALS > WELL-KNOWN UI/UX

```sql
%sql

-- Azure Databricks Delta Lake:
--
-- https://[redacted]blob.core.windows.net/[redacted]/demo/delta/org/apache/avro/Interop/8824e59e6b5ebc29827931996a3524373ad8b34c34e412419e952c82b47544b9/

-- AVRO IDL Schema v.1.0
( select distinct
    * except
        ( pj_uid
        , pj_pds
        -- , pj_dts
        , pj_pid
        , pj_fid
        )
  from
    delta.`/mnt/adl2/[redacted]/demo/delta/org/apache/avro/Interop/8824e59e6b5ebc29827931996a3524373ad8b34c34e412419e952c82b47544b9/`
  where
    pj_pds >= pj_timestamp() -- '2023-04-17'
  order by pj_dts desc
  limit 10
)
-- AVRO IDL Schema v.x.0
union
( select distinct
    * except
        ( pj_uid
        , pj_pds
        -- , pj_dts
        , pj_pid
        , pj_fid
        )
  from
    delta.`/mnt/adl2/[redacted]/demo/delta/org/apache/avro/Interop/8824e59e6b5ebc29827931996a3524373ad8b34c34e412419e952c82b47544b9/`
  where
    pj_pds >= pj_timestamp() -- '2023-04-17'
  order by pj_dts desc
  limit 10
)
```

▸ (3) Spark Jobs

▸ _sqldf: pyspark.sql.dataframe.DataFrame = [pj_sha: binary, pj_dts: timestamp ... 9 more fields]

Data scientists and business analysts are used to Databricks python notebook & SQL cells as well as Azure Synapse SQL

PROPOSED SOLUTION, FOSS AND DEMO
PROPOSED SOLUTION > TOOL > GOALS > AUTOMATION + COST & TIME

- **Less storage and CPU-cycles** at cloud providers by **merging bronze and silver** layers
  - **Bronze + silver**: full, raw and history of each dataset combined with defined structure, enforced schemas as well validated and deduplicated data
  - **Gold**: data as knowledge
- **Fewer engineering resources** that otherwise **would manually** (*) **define pipelines to transform data** between layers

(*) - Sample of data-flow that most of us will recognize right?

1. Move data from source (landing) to raw
2. Move from raw to enriched
3. Move from enriched to curated
4. Move from curated to development & archive
5. Create views
6. Visualize created views with reporting tool

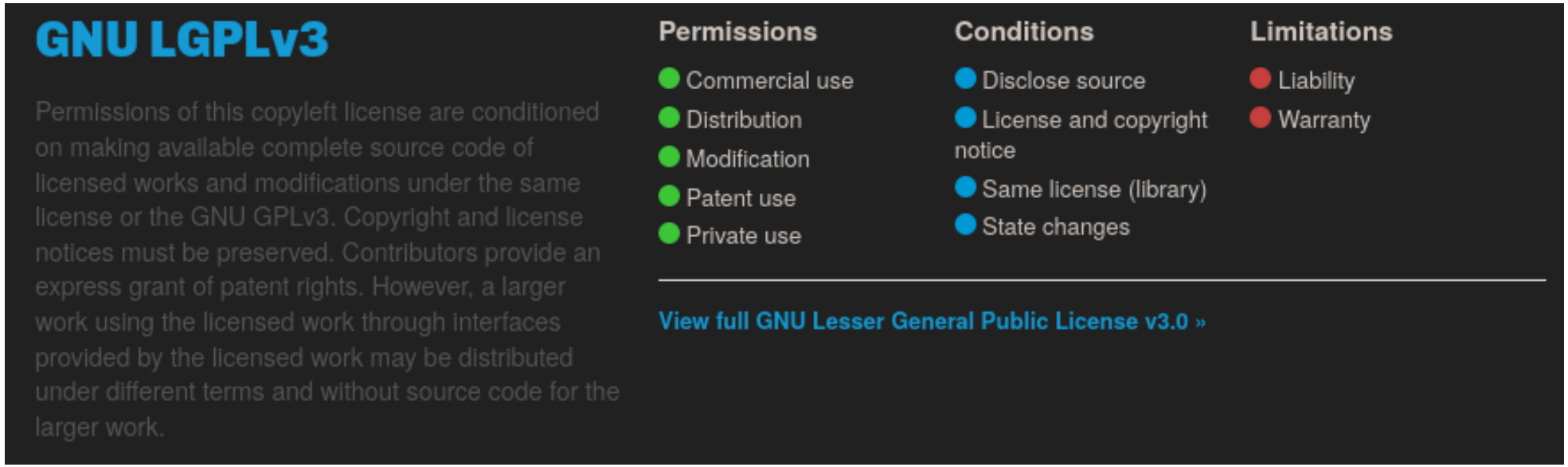
PROPOSED SOLUTION, FOSS AND DEMO
PROPOSED SOLUTION > TOOL > GOALS > SUSTAINABILITY

- Pandora wants to be a **sustainability leader**:
  - **100% renewable energy** (CO2 neutral by 2025)
  - **Recycled gold and silver**
  - **Lab-grown diamonds** (and ditching mined diamonds):
    - CNN Business: The world's largest jewelry brand is ditching mined diamonds
  - More **info** at **yearly sustainability reports**:
    - https://pandoragroup.com/sustainability/resources/sustainability-reports
- By **merging two medallion layers** into a single, **could lead** to the **possible savings of a ⅓ in disk usage**
- We are **NOT relying on a naive approach**, when flattening and storing data, therefore, it **could lead to greater savings**
- **Providing the tool for others** to follow in our steps, **could have an impact on a global scale**

Remark: The exact **calculation and emissions reduction** is **to be confirmed by the Pandora's Climate Team** and **Microsoft**, who are our cloud provider

PROPOSED SOLUTION, FOSS AND DEMO

FOSS > LGPL

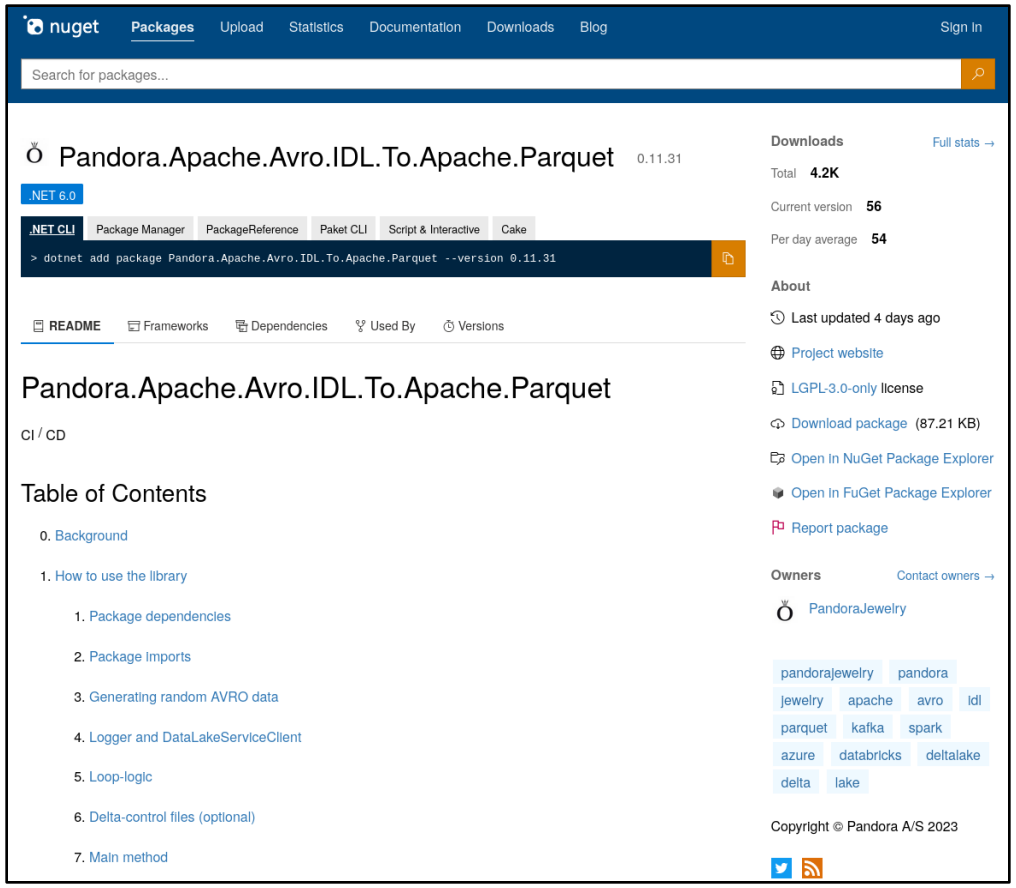


tl;dr: Permissive FOSS that allows you to use the library (at your own risk). You aren't forced to open-source your related work. However, if you make any changes to the library itself, please share it with the rest of the community.

Source: https://choosealicense.com/licenses/

PROPOSED SOLUTION, FOSS AND DEMO

FOSS > NUGET



Library available at NuGet: https://www.nuget.org/packages/Pandora.Apache.Avro.IDL.To.Apache.Parquet

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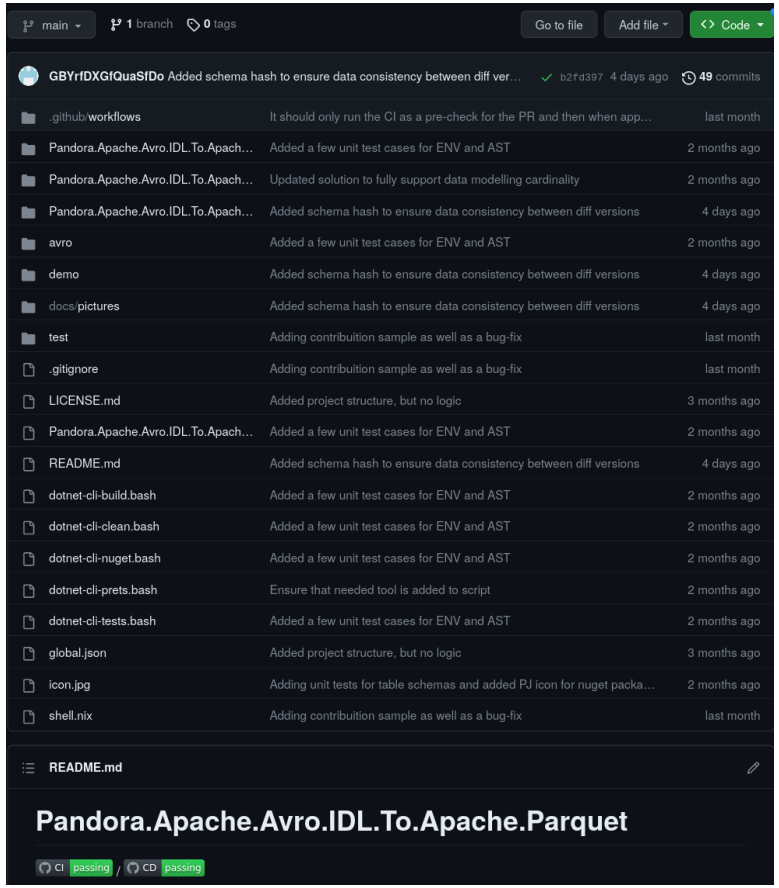
PROPOSED SOLUTION, FOSS AND DEMO

FOSS > GITHUB



Source code available on GitHub: https://github.com/PandoraJewelry/Pandora.Apache.Avro.IDL.To.Apache.Parquet

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PROPOSED SOLUTION, FOSS AND DEMO
DEMO > ER-DIAGRAMS, WITH THE CARDINALITY, BETWEEN TABLES

- Demo steps (based on **avroidl2dot** script):
  1. Emphasis on consuming the public NuGet package: **Pandora.Apache.Avro.IDL.To.Apache.Parquet**
  2. Run **avroidl2dot**, show console log and content of the **./dots/** folder
  3. Show both the generated **PNG** and **SVG** files for the Interop **AVRO IDL** file:

Source: https://github.com/apache/avro/blob/master/lang/java/compiler/src/test/idl/input/interop.avdl

SUMMARY

SUMMARY

- Matching of expectations
- Background
- Proposed solution, FOSS and demo
- Q&A

Our values: We dream, dare, care and deliver

Q&A