Beam at Talend: the long road together

Alexey Romanenko
Qlik/Talend
Open Source Engineer
Beam PMC

BEAM SUMMIT
NYC 2023

A bit of history...

2006	● Founded in **2006**, Talend was the first company to market open-source data integration software;
2006	● Released in **October 2006**, Talend Open Studio is the company's first product;
2007	● **July 2007**, Talend launched its first commercial version, Talend Data Integration;
2015	● **March 2015**, the company launched Talend Integration Cloud to enable developers to simplify and accelerate cloud and hybrid integration projects;
2016	● **January 2016**, Talend joins Cloudera, Data Artisans, Google, Cask and Paypal on the Apache Foundation's Google's Cloud Dataflow project - Apache Beam;
2018	● **May 2018**, Talend launched Talend Data Streams for AWS - a new free offering for self-service integration;
2019	● **April 2019**, the company launched Talend Pipeline Designer (formerly Talend Data Streams), a next generation data integration design environment included in Talend Cloud.
2023	● **May 2023, Qlik** acquires **Talend**

Talend and Open Source

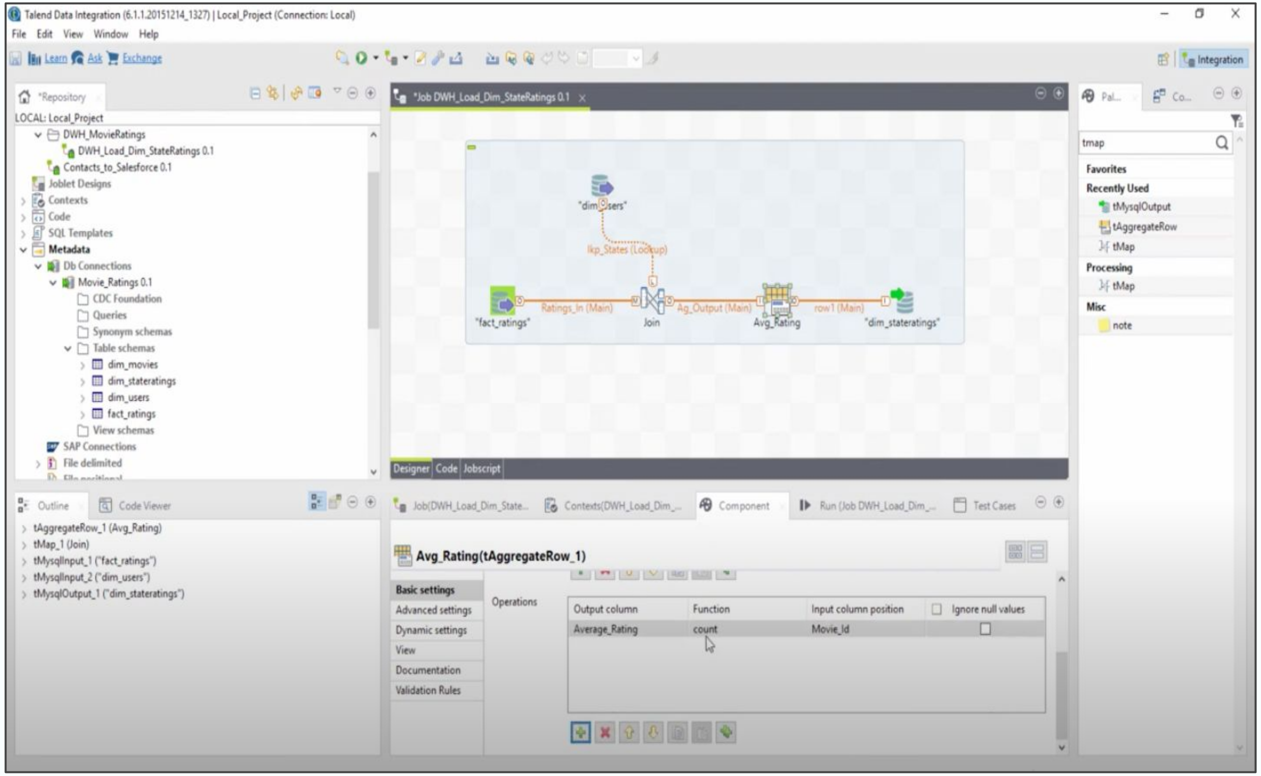
- Talend has a rich Open Source culture from the very beginning ;
- Talend is a long-time partner of the **ASF** ;
- Open Source team at Talend is **ASF** contributor for many projects:
    - notably in the *Apache CXF, Camel, Karaf, ActiveMQ, Beam, Spark, Flink, Avro* and other projects;
- Help to mentor numerous projects through the **ASF Incubator** ;
    - Beam is a good example
- The company is also a member of other open source foundations:
    - *Java Community Process (JCP), Eclipse Foundation, OW226* and *the Open Source School.*

Beam at Talend

The long and winding road...

Talend Open Studio / Data Integration

- Talend Open Studio is a free open source ETL tool for Data Integration and Big Data;
- Eclipse based developer tool and job designer;
- Drag&drop components and connect them to create and run ETL/ELT jobs;
- No need to write a single line of code.



Talend Data Integration (6.1.1.20151214_1327) | Local_Project (Connection: Local)

LOCAL: Local_Project
- DWH_MovieRatings
  - DWH_Load_Dim_StateRatings 0.1
- Contacts_to_Salesforce 0.1
- Joblet Designs
- Contexts
- Code
- SQL Templates
- Metadata
  - Db Connections
    - Movie_Ratings 0.1
      - CDC Foundation
      - Queries
      - Synonym schemas
      - Table schemas
        - dim_movies
        - dim_stateratings
        - dim_users
        - fact_ratings
      - View schemas
  - SAP Connections
  - File delimited

Outline:
- tAggregateRow_1 (Avg_Rating)
- tMap_1 (Join)
- tMysqlInput_1 ("fact_ratings")
- tMysqlInput_2 ("dim_users")
- tMysqlOutput_1 ("dim_stateratings")

Avg_Rating(tAggregateRow_1)

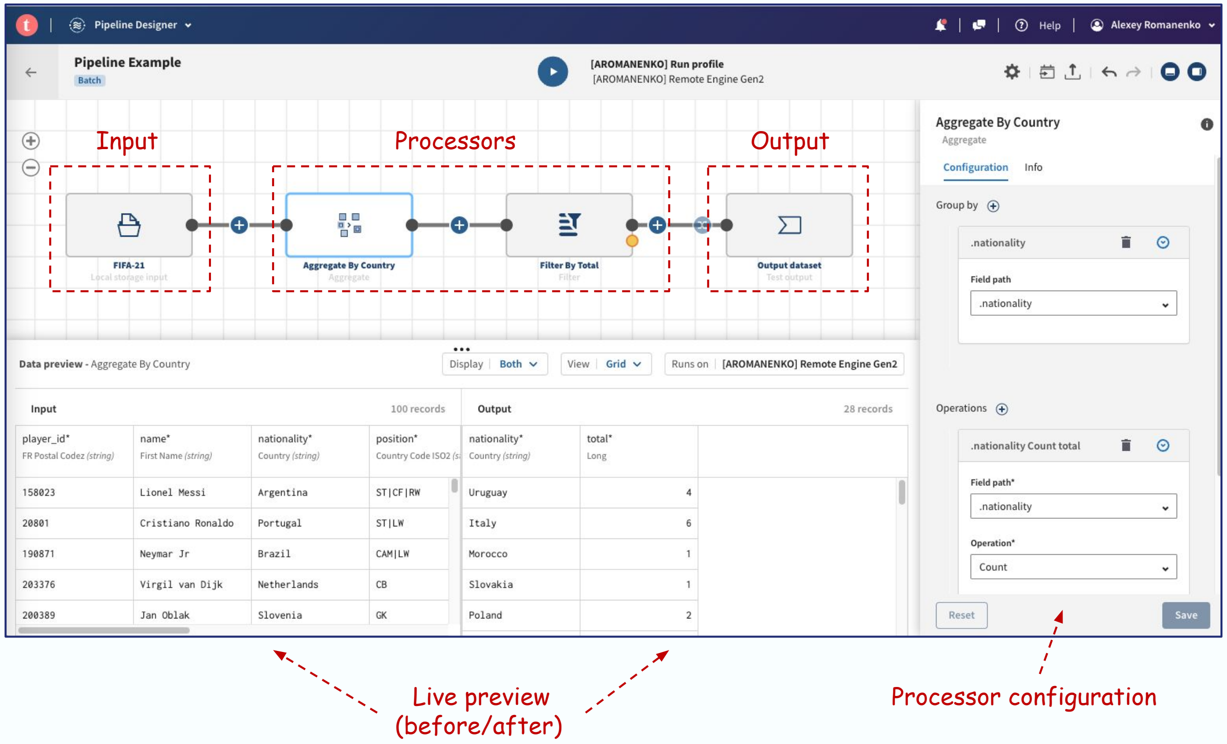
Basic settings
Advanced settings
Dynamic settings
View
Documentation
Validation Rules

Operations

Output column	Function	Input column position	Ignore null values
Average_Rating	count	Movie_Id	☐

Talend Pipeline Designer (TPD)

- Modern flexible integration tool to process data in easy and powerful manner;
- Provides a graphical interactive Web UI to create complex pipelines;
- Live preview of data changes;
- Schema-based data collections;
- Batch & Streaming;
- Portable & Scalable;
- Uses Beam under the hood!



Data preview - Aggregate By Country

Display: Both | View: Grid | Runs on: [AROMANENKO] Remote Engine Gen2

Input — 100 records

player_id* FR Postal Codez (string)	name* First Name (string)	nationality* Country (string)	position* Country Code ISO2 (s
158023	Lionel Messi	Argentina	ST|CF|RW
20801	Cristiano Ronaldo	Portugal	ST|LW
190871	Neymar Jr	Brazil	CAM|LW
203376	Virgil van Dijk	Netherlands	CB
200389	Jan Oblak	Slovenia	GK

Output — 28 records

nationality* Country (string)	total* Long
Uruguay	4
Italy	6
Morocco	1
Slovakia	1
Poland	2

Aggregate By Country
Aggregate

Configuration | Info

Group by
.nationality
Field path: .nationality

Operations
.nationality Count total
Field path*: .nationality
Operation*: Count

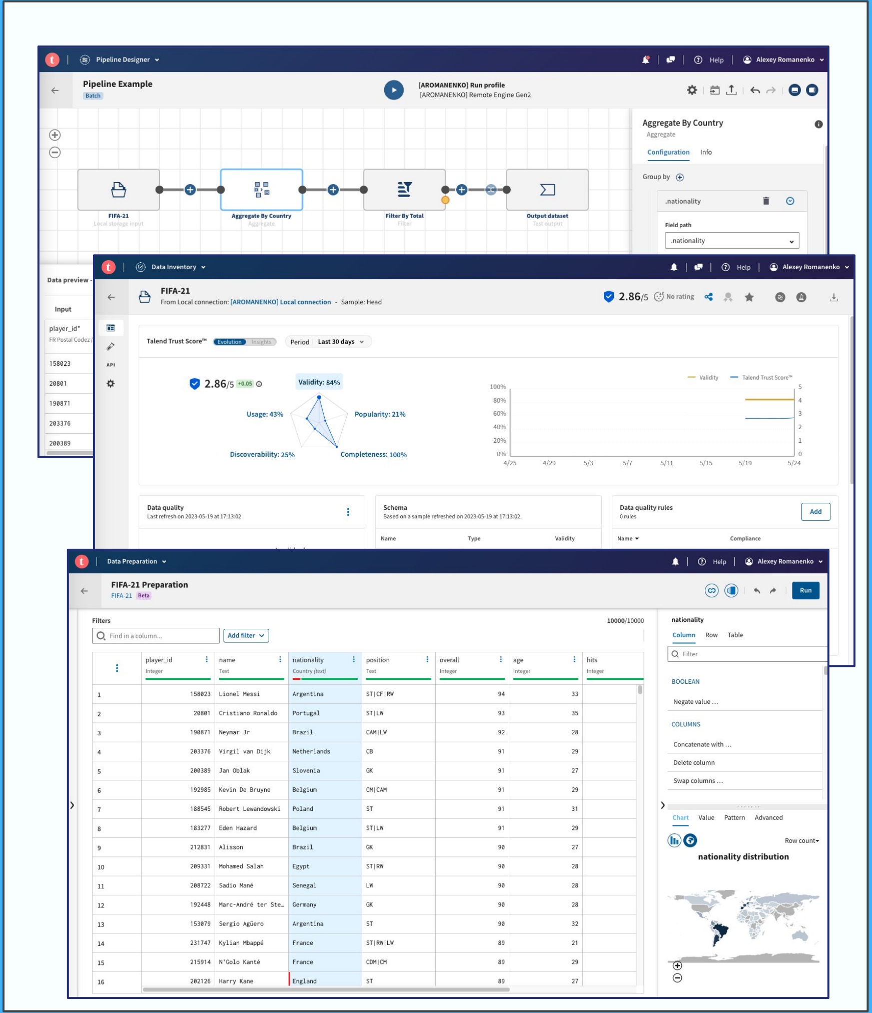
Reset | Save

Using Beam at Talend

- Started to use Beam in 2016 as ASF Incubator project for **Talend DataStreams,** then **Talend Pipeline Designer** ;

- Talend Open Source team helped Beam to become a **top-level ASF project** ;

- Beam is used in the **Data Processing Platform** for several Talend products :
    - **Pipeline Designer** : Batch & Streaming pipelines
    - **Data Inventory** : Sampling sources
    - **Data Preparation** : Running data pre-processing jobs



Filters

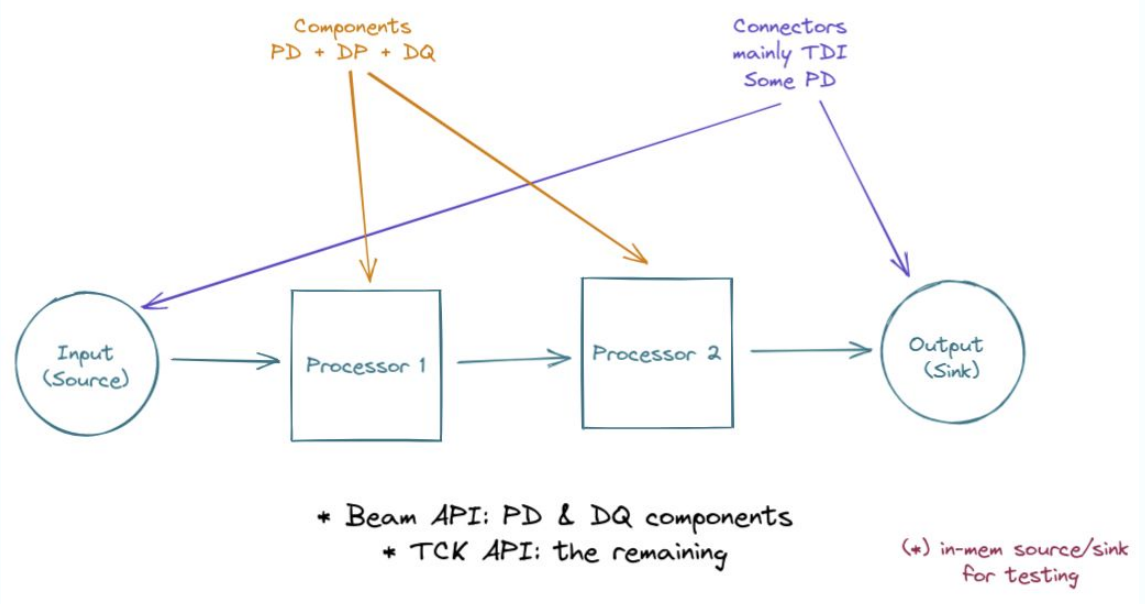
10000/10000

	player_id Integer	name Text	nationality Country (text)	position Text	overall Integer	age Integer	hits Integer
1	158023	Lionel Messi	Argentina	ST|CF|RW	94	33	
2	20801	Cristiano Ronaldo	Portugal	ST|LW	93	35	
3	190871	Neymar Jr	Brazil	CAM|LW	92	28	
4	203376	Virgil van Dijk	Netherlands	CB	91	29	
5	200389	Jan Oblak	Slovenia	GK	91	27	
6	192985	Kevin De Bruyne	Belgium	CM|CAM	91	29	
7	188545	Robert Lewandowski	Poland	ST	91	31	
8	183277	Eden Hazard	Belgium	ST|LW	91	29	
9	212831	Alisson	Brazil	GK	90	27	
10	209331	Mohamed Salah	Egypt	ST|RW	90	28	
11	208722	Sadio Mané	Senegal	LW	90	28	
12	192448	Marc-André ter Ste…	Germany	GK	90	28	
13	153079	Sergio Agüero	Argentina	ST	90	32	
14	231747	Kylian Mbappé	France	ST|RW|LW	89	21	
15	215914	N'Golo Kanté	France	CDM|CM	89	29	
16	202126	Harry Kane	England	ST	89	27	

Engine Runtime: pipeline

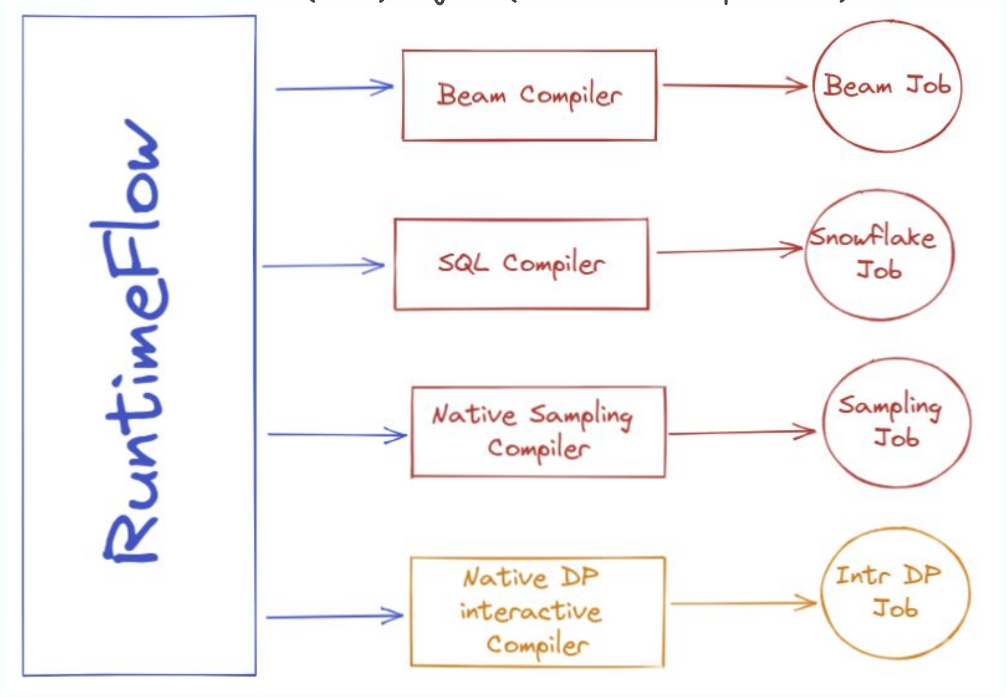
Connectors and components:

- A pipeline is essentially a **DAG** of components:
  - IO components: a.k.a. **Connectors**.
  - Intermediate components: a.k.a. **Processors**.
- To be used in a pipeline, connector or component have to be either:
  - Beam-based: implement Beam API (e.g, PTransform for processors)
  - TCK-based: internal components framework



Engine Runtime: compiler

A pipeline is represented as RuntimeFlow (RTF) object (JSON of components)

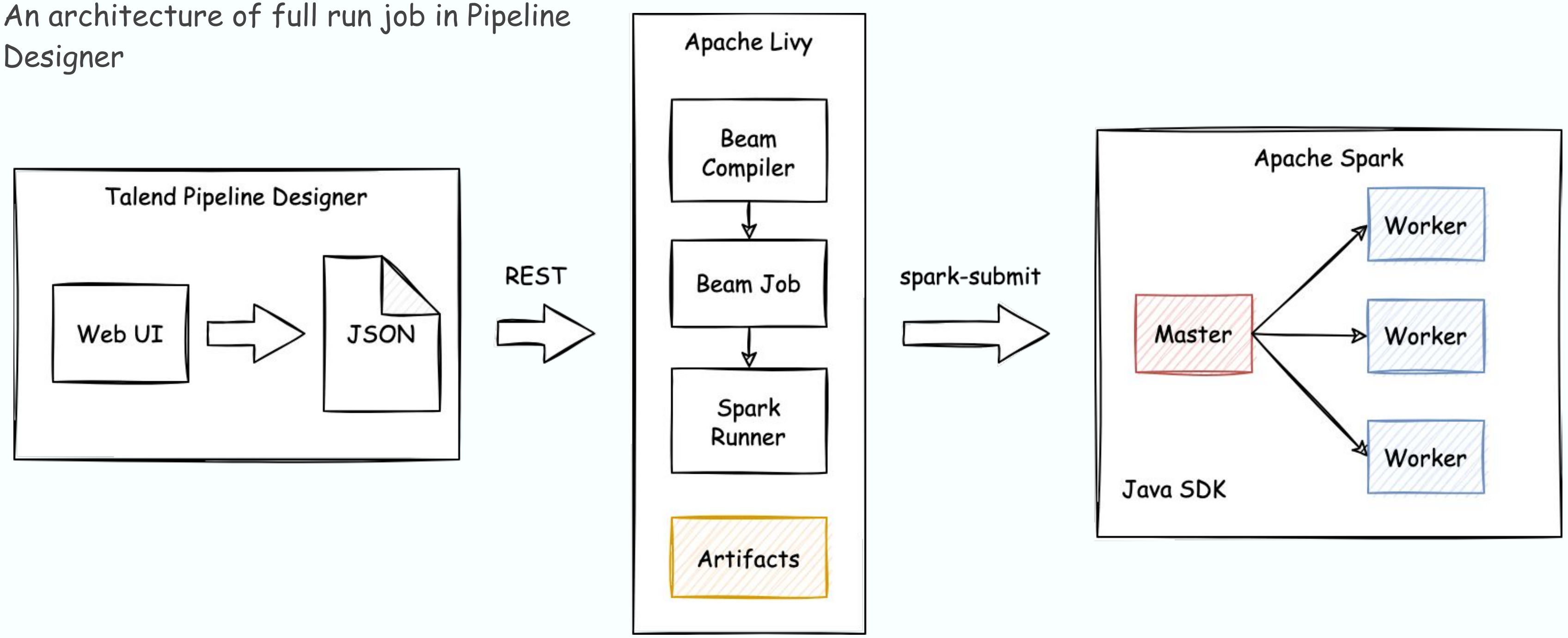


Beam Compiler (Translator):

- The first compiler that has been implemented;
- It translates an RTF to Beam pipeline;
- Then Beam pipeline is executed using either:
  - **SparkRunner** (Livy/FullRun job)
  - **FlinkRunner** (Interactive mode)
  - **DirectRunner** (Preview mode)

Full run Beam/Spark architecture

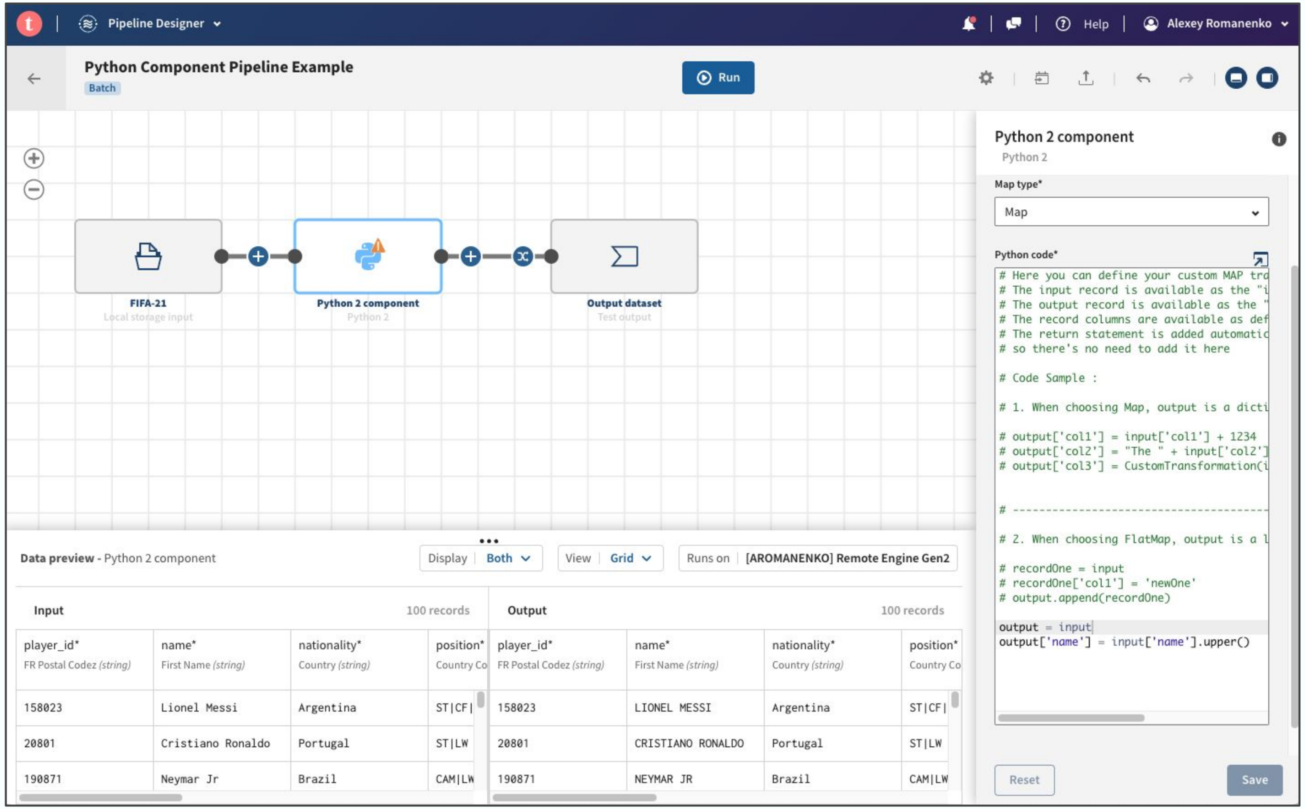
<u>Example</u>:
An architecture of full run job in Pipeline Designer



Use cases:
Python processor

Python processor

- TPD processor
- The Python processor executes user Python code to perform custom processing on user records.
- Originally, Python processor used Jython 2.7 as Python engine to process Python2 code



Python Component Pipeline Example
Batch

Python 2 component
Python 2

Map type*: Map

Python code*

```
# Here you can define your custom MAP tra
# The input record is available as the "i
# The output record is available as the "
# The record columns are available as def
# The return statement is added automatic
# so there's no need to add it here

# Code Sample :

# 1. When choosing Map, output is a dicti

# output['col1'] = input['col1'] + 1234
# output['col2'] = "The " + input['col2']
# output['col3'] = CustomTransformation(i


# ------------------------------------

# 2. When choosing FlatMap, output is a l

# recordOne = input
# recordOne['col1'] = 'newOne'
# output.append(recordOne)

output = input
output['name'] = input['name'].upper()
```

Reset　Save

Data preview - Python 2 component　Display: Both　View: Grid　Runs on: [AROMANENKO] Remote Engine Gen2

Input — 100 records

player_id* FR Postal Codez *(string)*	name* First Name *(string)*	nationality* Country *(string)*	position* Country Co
158023	Lionel Messi	Argentina	ST|CF|
20801	Cristiano Ronaldo	Portugal	ST|LW
190871	Neymar Jr	Brazil	CAM|LW

Output — 100 records

player_id* FR Postal Codez *(string)*	name* First Name *(string)*	nationality* Country *(string)*	position* Country Co
158023	LIONEL MESSI	Argentina	ST|CF|
20801	CRISTIANO RONALDO	Portugal	ST|LW
190871	NEYMAR JR	Brazil	CAM|LW

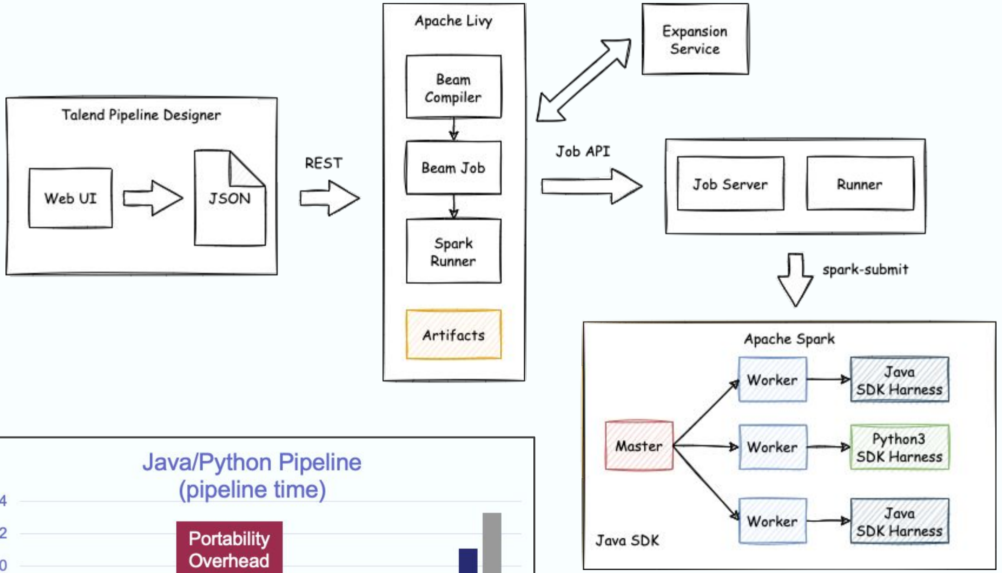
Problem:

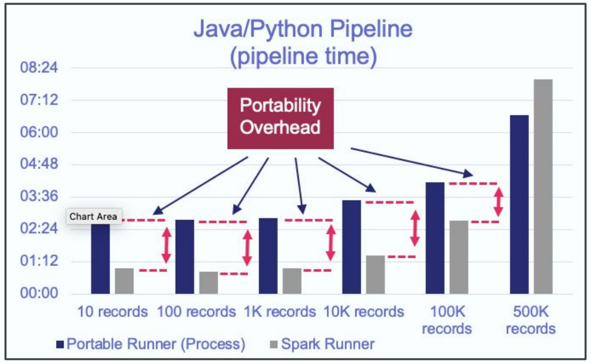
- Python 2.7 reached EOL on 12/31/2019
- Pipeline Designer Python processor used Jython 2.7 as Python engine
- Jython didn't support Python3, no plans to support it in the future
- No easy way to install 3rd-party Python libraries

Potential solutions:

- Beam portability framework:
  - Run Python 3 code as a Beam cross-language transform with Beam Portable Runner
  - See my talk *"Using Cross-Language pipeline to run Python 3 code with Java SDK"* at Beam Summit 2020
- Python-as-Service:
  - Use a custom Python server and dedicated PTransform to execute Python code
  - Thanks to **Ryan Scraba** (*@ryanskraba*) who worked on this

Cross-language Beam/Spark





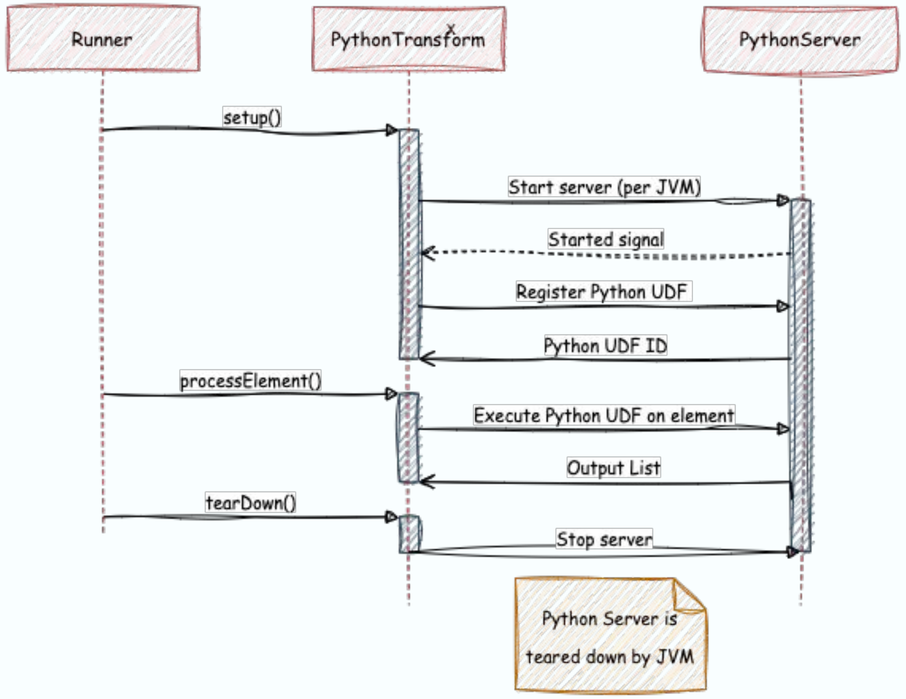
Advantages:

- Full support of Beam model and its features out-of-box;
- Tested and maintained by Beam community;
- Good performance for large data sets.

Drawbacks:

- Several times worse performance for small data;
- Required a complicated re-architecture of the TPD Runtime part
- High maintenance costs

Own Python server to execute python



Advantages:

- Simpler and configurable for our use case;
- No extra overhead/dependencies;
- Better performance for small data.

Drawbacks:

- Implementation/maintenance of the Python server;
- Only useful for specific use cases (no advanced Beam features - e.g. metrics, triggers, state, timers, etc);
- Requires a robust implementation of the Python server because of potential issues on startup/shutdown and resource leaks;
- Not tested/supported by a large community.

Use Cases:
Small Data Performance

BEAM SUMMIT
NYC 2023

Problem:

- One pipeline (DAG/schema) –> three sizes of input dataset
    - **Small dataset** (50-100 rows) for preview and interactive use;
    - **Average dataset** (~10K rows) for data sampling;
    - **Large dataset** (+10M rows) for full run pipeline.
- Fast (instant) results are critical for interactive mode
- Beam is supposed to run with large datasets and on distributed environments

Potential solutions:

- Use different runners for different use cases (current solution);
- Use native Java code compilation (PoC);
- Create Fast (In-Memory) runner for small/average datasets (PoC, WIP).

Native compilation

- Run a Beam pipeline (*MinimalWordCount*) locally as **GraalVM** native image
  - *GraalVM* is a high-performance JDK distribution designed to accelerate the execution of applications written in Java and other JVM languages along with support for a number of other popular languages.
- Use *DirectRunner* to simplify experiments
  - Other runners (*SparkRunner* & *FlinkRunner*) are in our ToDo list
- Our expectations:
  - Much lower memory usage for native images,
  - Faster startup times.

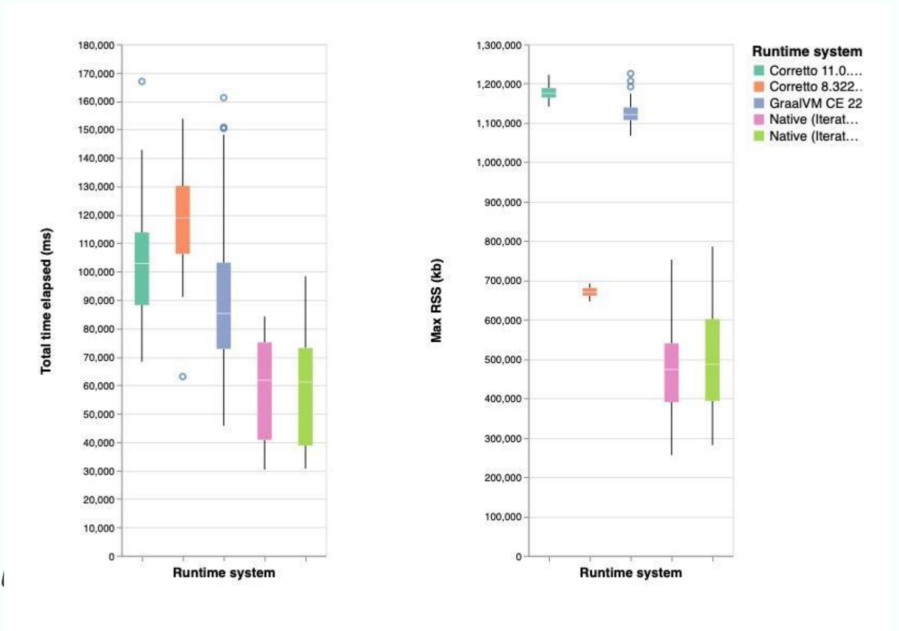
Native compilation

Benchmark results (*MinimalWordCount*):

- **Memory usage** improved ~ 29% (median) compared to the best performing JVM
- **Performance** also improved ~ 27% (median) compared to the best performing JVM.

Next steps:

- Run with more performance-oriented runners, like Spark/Flink or new *Fast Loca* runner



More details at Moritz Mack's blog post:
https://github.com/mosche/blogposts/blob/main/beamnative/README.md

Fast Local Runner

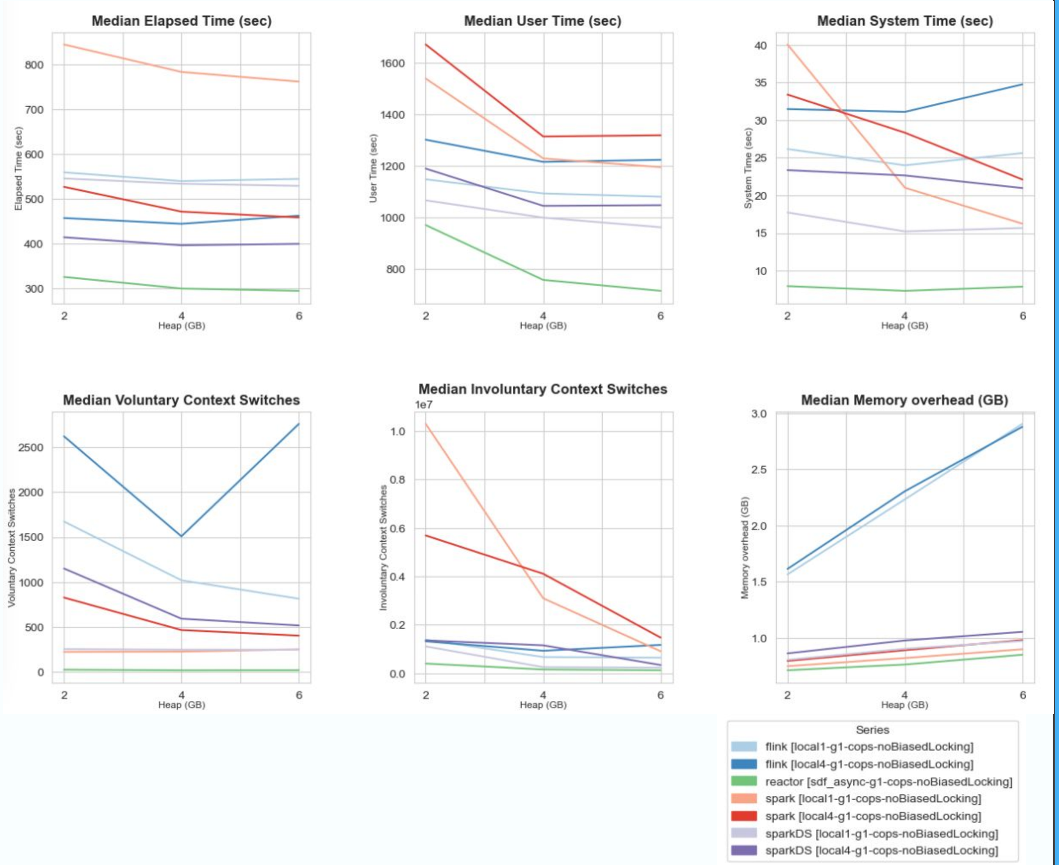
- Develop a local in-memory Beam runner from scratch;
- Replace *DirectRunner*, *FlinkRunner* and *SparkRunner* used in local mode;
- Limited Beam model implementation (at least, for PoC):
  - Batch only
  - No state / timer support
  - Global Windows only
- Use Reactive Streams (Project Reactor)
  - One JVM, keep all data in memory
  - Map Java stream operations to Beam transforms
- PoC implemented by **Moritz Mack**, early stage:
  - WIP: https://github.com/mosche/beam/tree/reactor

Reactor is a fourth-generation reactive library, based on the Reactive Streams specification, for building non-blocking applications on the JVM

PROJECT REACTOR

Intermediate results

- Used Beam TPC-DS benchmarks, 10 runs for every configuration;
- No *DirectRunner*, it constantly fails with OOM errors for the TPC-DS dataset of 1GB;
- Significant performance improvements with *ReactorRunner*;
- Next steps:
  - Add Windowing support
  - Run ValidateRunner tests
  - Add Streaming support
  - Contribute back to Beam



Talend contributions to Beam

Our Beam code contributions

- Java IO connectors
  - AWS, Hadoop, Kafka, Elasticsearch, Hbase, Jdbc, Avro, Parquet, ...
- Nexmark benchmark improvements
- TPC-DS benchmark integration
- Spark Runner
  - RDD runner improvements
  - Dataset runner from scratch
- Security fixes

Other contributions

- Releases testing
- PRs reviews
- Documentation updates
- Project mailing lists discussions
- Beam users support
- Blogging and talks at conferences
  - Beam Summit, ApacheCon, OpenSource Summit, etc

Some takeaways

- It's very important to contribute back to the OS project that is a key component of your product;
- Knowledge sharing saves time and money;
- Be part of project community;
- Sometimes it's challenging to find a balance between your specific and common users requests;
- Don't wait until someone do what you need - do it yourself!

Beam contributors at Talend

Many-many-many **thanks** to Talend all-time Beam contributors:

- JB Onofré (@jbonofre)
- Ismaël Mejía (@iemejia)
- Etienne Chauchot (@echauchot)
- Daniel Kulp (@dkulp)
- Ryan Skraba (@ryanskraba)
- Colm O'Heigeartaigh (@coheigea)
- Moritz Mack (@mosche)
- Romain Manni-Bucau (@rmannibucau)
- Alexey Romanenko (@aromanenko-dev)

Thank you!

QUESTIONS?

Twitter : @AlexRomDev
Github : @aromanenko-dev

BEAM
SUMMIT