Starburst

Optimizing data lakehouses with Starburst

Starburst Academy
v3.1.1

Optimizing data lakehouses with Starburst

This course features instructor-led discussions, demonstrations, and hands-on exercises designed to build a working knowledge of the Starburst query engine.

Upon completion, you will gain a more thorough awareness of Starburst architecture, with a specific focus applied to best practices for data lake based schemas, including table formats and partitioning, file formats and sizes, and other optimization techniques.

Course introduction

Who, what, where, when & why

Starburst

Course objectives

- Use Starburst as a single point of access for multiple data sources and federate queries across them
- Evaluate and describe how queries are executed within a Starburst cluster
- Use Hive and Iceberg table formats; construct, populate, query, and modify partitioned tables
- Employ file size/format/hierarchy strategies to improve query performance
- Understand the role of the Cost-based optimizer and read query plans to ensure optimizations are occurring as expected and to identify possible issues
- Create role-based access control policies for table operations
- Build a data engineering pipeline with Starburst Galaxy

What to expect

- Blend of conceptual and practical
- Focused learning objectives
- Instructor demonstrations
- Plenty of hands-on labs
- Interactive discussions
  - Ask questions
  - Validate assumptions
  - Discuss use cases
  - **FEEDBACK IS OXYGEN**

Course agenda

1 - Starburst features
- Overview & architecture
- Web UI
- Connectors & catalogs
- Client tools integration

2 - Data lake tables
- Separation of storage & compute
- Schema on read

3 - Data lake performance
- Limit data exchanges
- File format options
- Small files problem
- Partitioning & bucketing

4 - Table formats
- Moving beyond Hive
- Compare/contrast alternatives
- Exploring Delta Lake

5 - Apache Iceberg
- Table format architecture
- Creating tables
- Insert, delete & update

6 - Advanced Iceberg
- CDC with merge
- Schema & partition evolution
- Snapshots & compaction

7 - Parallel processing
- Divide & conquer
- Beyond single stage queries

8 - Cost-based optimizer
- Benefits of statistics
- Query plan analysis

9 - Access control
- Configuration options
- RBAC & ABAC

10 - Data pipelines
- Definition & differentiation
- Reference architecture

Introductions

Please feel free to share as much (or as little) as you feel comfortable with

- You! What's your name?
  - Where are you location? Working remote?
  - High-level role (company and/or project)
  - Any hobby/activity you want to share?
- *Identify the email address you want for your Starburst training ID*
- Prior experience with
  - Trino (Presto) and/or Starburst (Enterprise and/or Galaxy)
  - Other open-source big data solutions such as Apache Hive or Spark
- **Any expectations that appear to not be addressed in the agenda**

Starburst features

Overview

Starburst

Lesson objectives

Starburst features: Overview

1. Understand the negative consequences of data silos.
2. Describe, and understand the benefits of, the Modern Data Lake.
3. Understand the major layers of the Starburst Data Lake Analytics Platform.
4. List industries and companies where Starburst provide impact.
5. Under the two consumption models.

Is this your data strategy?

The reality and our approach

ETL is required…

when you already know what data is needed for reporting.

Data warehouses are great…

for highly structured, repeatable analytics on limited datasets.

Data centralization is fine…

for simple data environments and slower-moving data orgs.

ETL *after* you know what is needed.

Starburst enables data engineers to *explore* data at the source and *iterate* on their ETL workloads in the data lake.

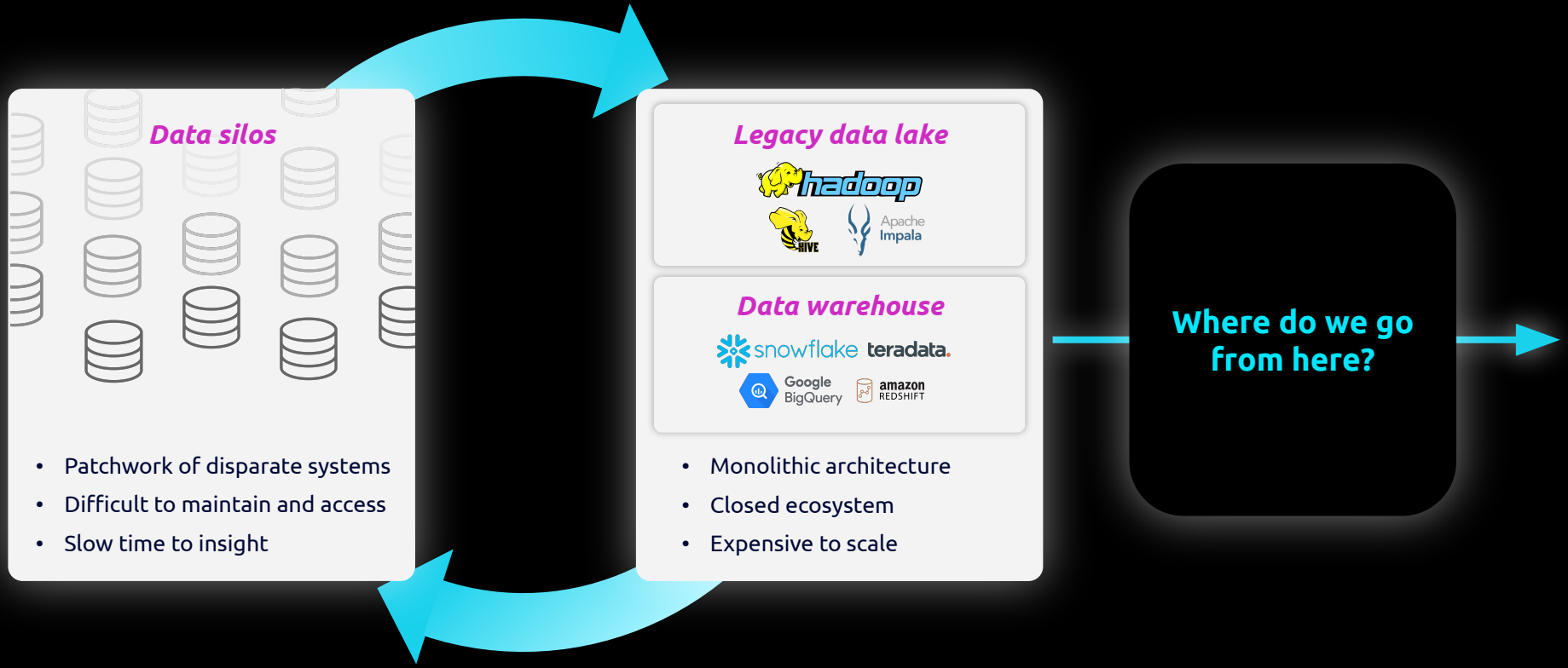
Don't rely on the data warehouse for *everything*.

Starburst *frees* data teams to choose the best data architecture for their needs, by federating across all data sources.

Decentralization is *inevitable* as you grow.

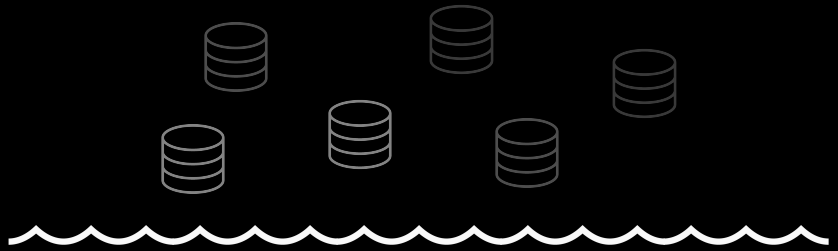
Starburst helps to *future-proof* data access and productivity for your data-driven organization.

Data silos continue to be a challenge, despite efforts to create a “single source of truth”



The Modern Data Lake

Global federated access to data sources beyond the lake



MPP query engine

trino

Open table formats

ICEBERG DELTA LAKE Apache hudi

Open file formats

AVRO Apache orc Parquet

Commodity storage & compute

Object storage

Elastic compute

Benefits

Single point of access and governance for all data

Advanced warehouse-like capabilities

Vendor agnostic

Scalable, cost effective

Starburst enhances your data lake additional flexibility, security, and ease of use for faster and broader access to all your data

	Cloud data warehouse	Traditional data lake	Modern data lake powered by Starburst
	amazon REDSHIFT, snowflake, Google BigQuery	hadoop, MAPR, Apache Impala	
Enables flexible data architecture	✖ Limited ability to access data outside of warehouse	✖ Complex data management & planning	✔ Supports open file and table formats
Cost-effective scaling	✖ Vendor lock-in leads to ballooning costs over time	✖ Expensive proprietary software and hardware	✔ Runs on commodity cloud storage and compute; 50% lower TCO
Fast time to insight	✖ New data must be ingested via ETL process	✖ Special tools & configurations needed to access external data	✔ Query data at the source when needed; 90% faster time to insight; 10x faster query speed
Global security and compliance	✖ Difficult to manage data outside of warehouse and across regions	✖ Difficult to manage data outside of lake	✔ Single governance layer for all data
Creating & sharing curated data sets	✔ Possible with external sharing	✖ Specialized skills and tools needed	✔ Data Products, Global Search

Trino is the query engine trusted by industry leaders at PB scale

25PB on S3

1 Exabyte of Data
100PB weekly data
1200 nodes
2.5M queries/week

600PB on S3
1000 nodes

10PB daily read data
250k queries per day

300PB data lake

But Trino requires extensive resources to run successfully…

Management: All manual. No autoscaling

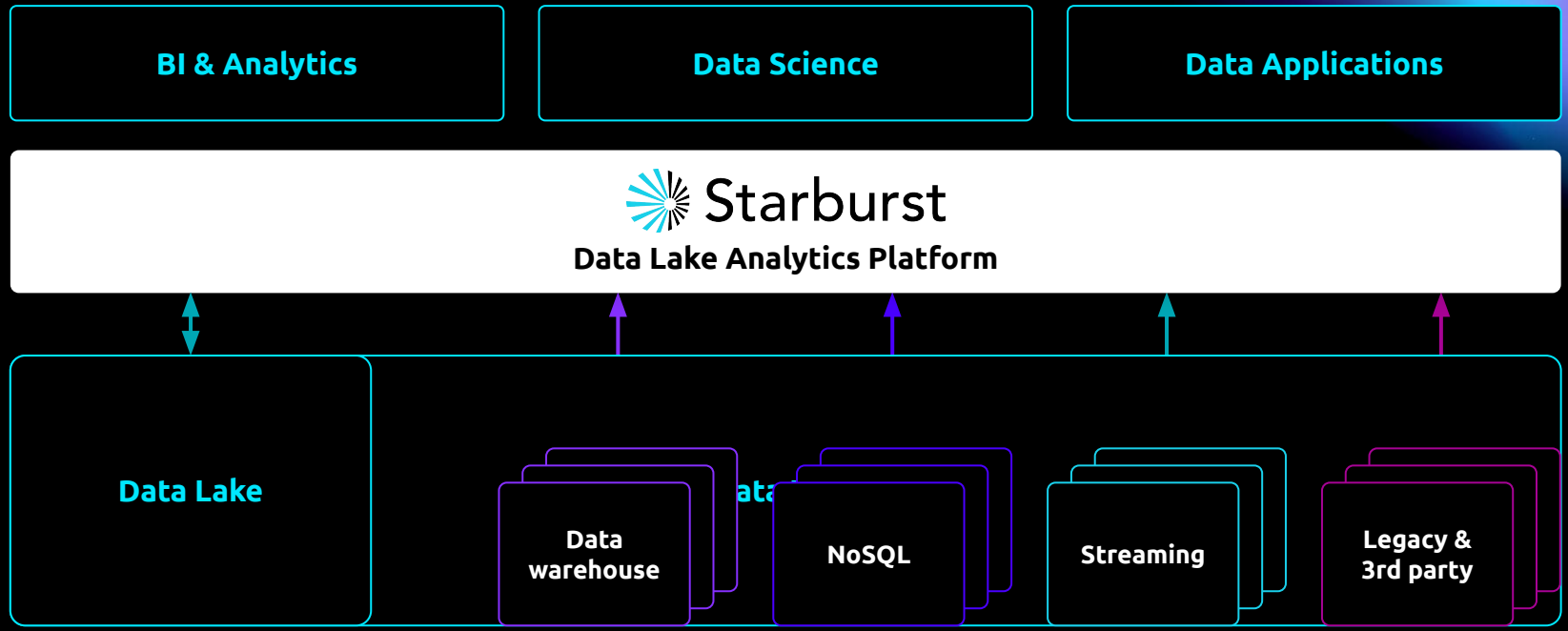
Security: No built-in security integrations

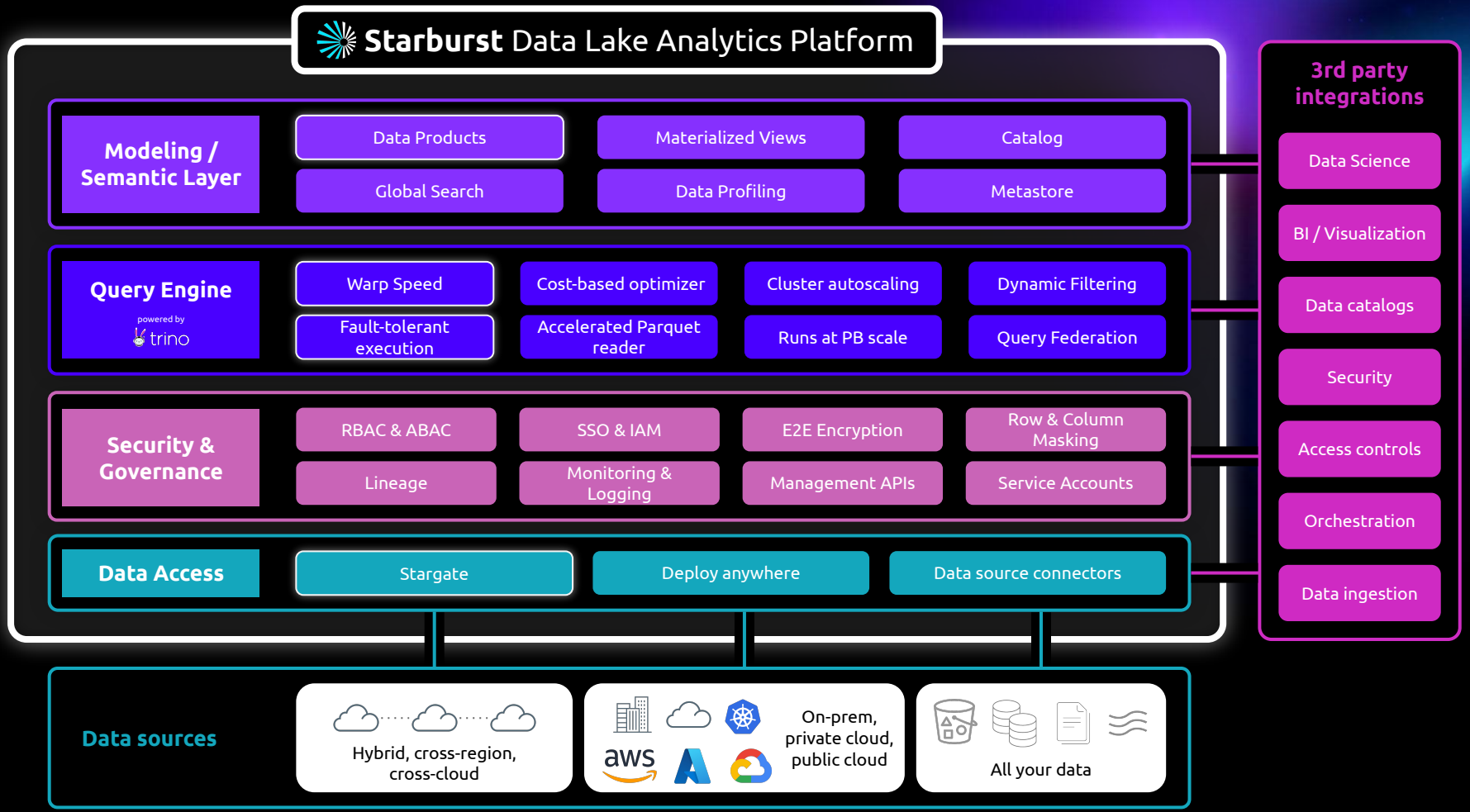
Access Control: Requires 3rd parties for RBAC

Support: No support team, reliant on community responsiveness

$$$
(and time!)

Starburst activates the data in and around your lake




Starburst Data Lake Analytics Platform
Modeling / Semantic Layer
Data Products
Materialized Views
Catalog
Global Search
Data Profiling
Metastore
Query Engine
powered by trino
Warp Speed
Cost-based optimizer
Cluster autoscaling
Dynamic Filtering
Fault-tolerant execution
Accelerated Parquet reader
Runs at PB scale
Query Federation
Security & Governance
RBAC & ABAC
SSO & IAM
E2E Encryption
Row & Column Masking
Lineage
Monitoring & Logging
Management APIs
Service Accounts
Data Access
Stargate
Deploy anywhere
Data source connectors
3rd party integrations
Data Science
BI / Visualization
Data catalogs
Security
Access controls
Orchestration
Data ingestion
Data sources
Hybrid, cross-region, cross-cloud
aws
On-prem, private cloud, public cloud
All your data

Starburst powers innovation across every industry

Financial Services

- Fraud detection
- Anti-money laundering
- Risk management

Consumer

- Customer 360
- Marketing analytics
- Supply chain analytics

Healthcare & Life Sciences

- Patient care optimization
- Regulatory compliance
- Health record analytics

Technology

- Product analytics
- In-product functionality
- Security / Log analytics

Telco

- Marketing operations
- Customer care
- Capacity planning

Trusted by industry leaders

BANK OF AMERICA · BARCLAYS · NIKE · CVS · Pfizer · Adobe · T-Mobile · COMCAST

Santander · citibank · Nestlé · MERCK · slack · vmware · orange

STATE STREET · NORDSTROM · COLGATE-PALMOLIVE · emis health · Roche · Expedia · verizon

Starburst

Data Lake Analytics Platform

$3.3B
valuation

$414M
raised

Leading investors

andreessen. horowitz

Index Ventures

COATUE

salesforce ventures

ALTIMETER

ALKEON CAPITAL MANAGEMENT

B Capital Group

Original creators of

trino

Deployed at exabyte scale at 4 out of 5 FAANG companies; adoption across thousands of companies globally.

presto

Originally created at Facebook to query **300PB Hadoop cluster**; thousands of active users today.

200+
customers

100%
YoY growth

85
NPS

Industry-recognized Leader

Gartner Market Guide for Analytics Query Accelerators
GigaOm Radar Report for Data Lakes and Lakehouses
G2 Enterprise Grid for Big Data Analytics Software

Flexible consumption models

Starburst Enterprise

Deploy anywhere

Enterprise-grade software backed by professional support and services

On prem, in the cloud, hybrid, and multi-cloud

Starburst Galaxy

Built for the cloud

Fully managed cloud data lake analytics built and supported by the creators of Trino

Available on leading public clouds

Available via marketplaces

Lesson summary

Starburst features: Overview

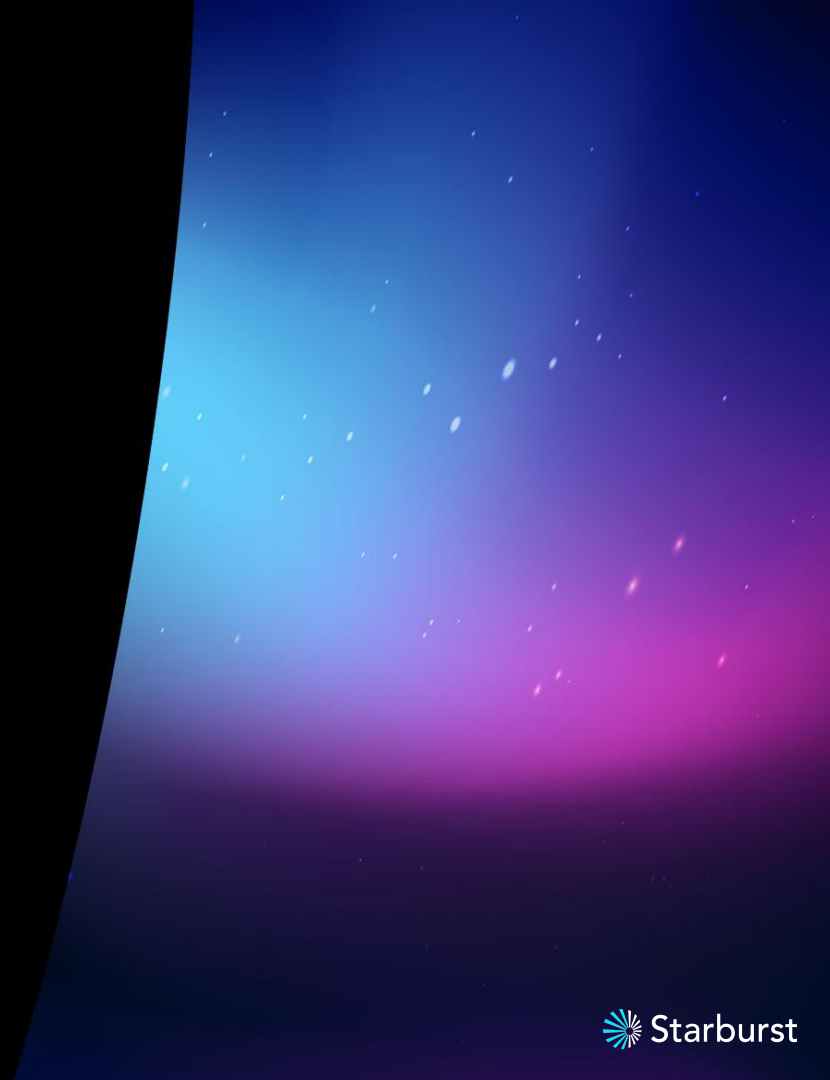
1. Data can too easily become siloed. This is both expensive and inefficient for the entire organization.

2. Benefits of the Modern Data Lake include a single point of access, governance for all data, advanced warehouse-like capabilities, vendor agnostic, scalable, and cost effective.

3. The major layers of the Starburst Data Lake Analytics Platform are Data Access, Security & Governance, Query Engine, and the Modeling / Semantic Layer.

4. Starburst powers innovation across every industry and Trino is the query engine trusted by industry leaders at PB scale.

5. Flexible consumption models offer you the options of paying for what you configure and/or paying for what you use.



Starburst features

Architecture

Starburst

Lesson objectives

Starburst features: Architecture

1. Understand the role that workers and coordinators play in Starburst clusters.
2. Explain how Starburst logical architecture functions in relation to different data sources.
3. Analyze a typical Starburst execution flow in detail.
4. Differentiate Starburst from Trino.

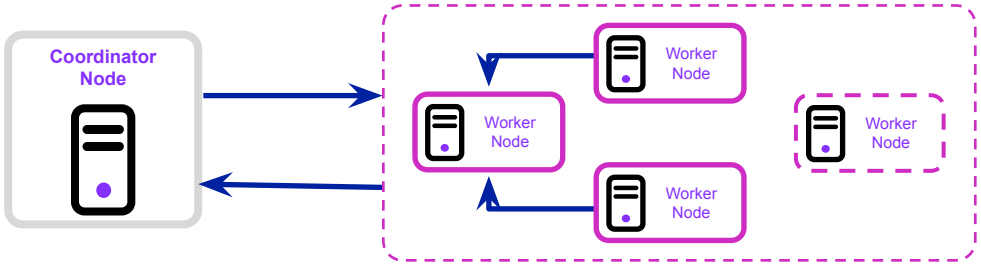
Server stereotypes

Coordinator node

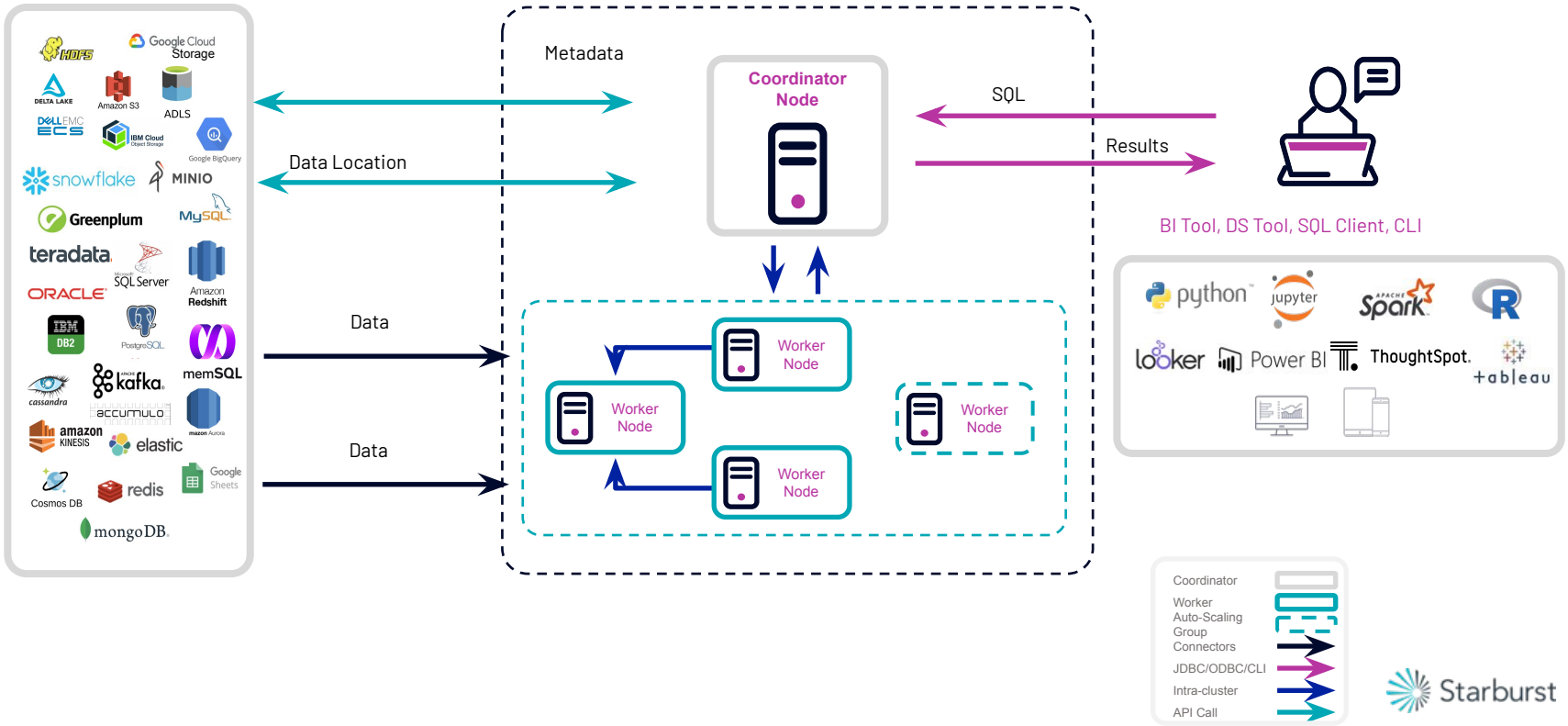
Server that is responsible for parsing statements, planning queries, and managing Trino worker nodes.

Worker nodes

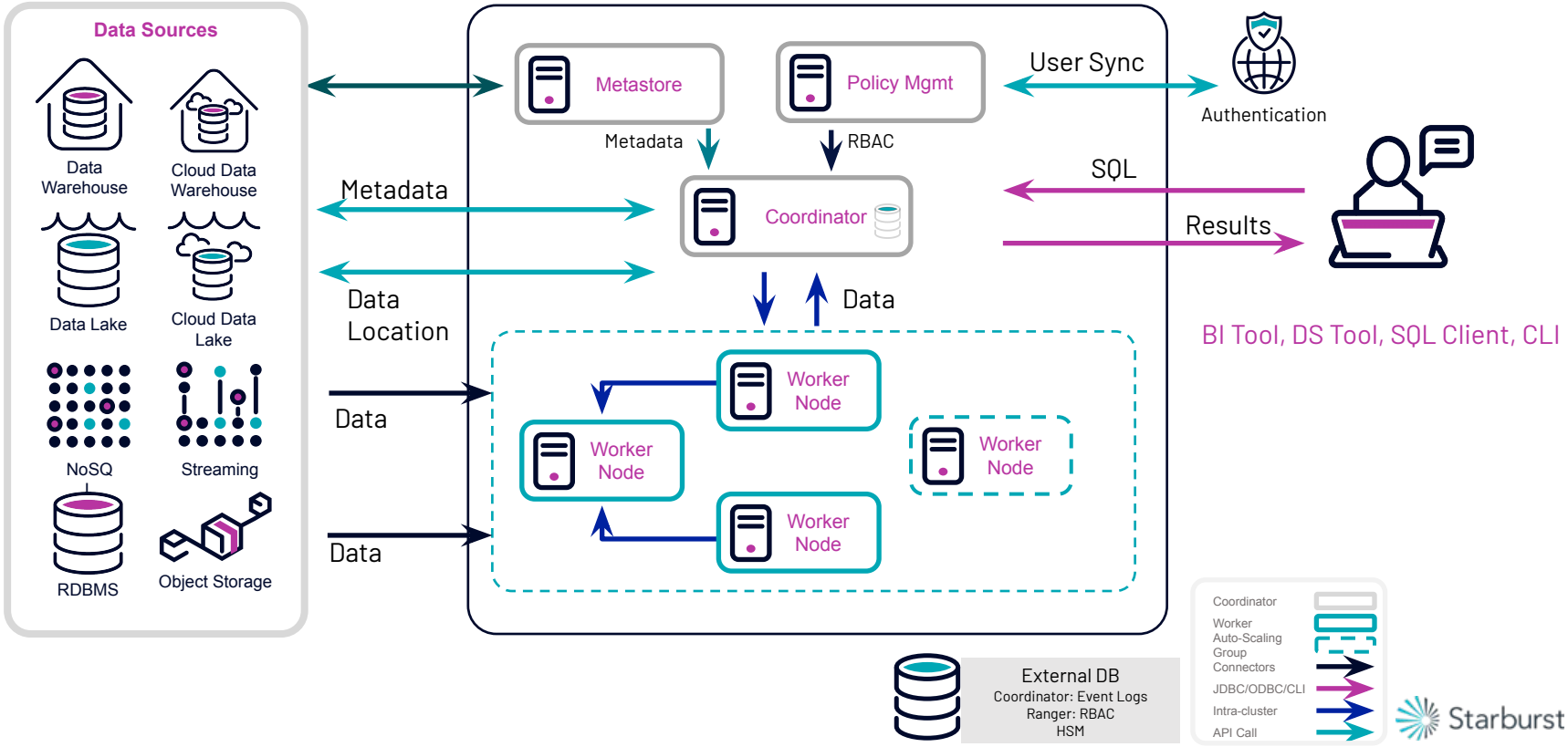
Server which is responsible for executing tasks and processing data. Worker nodes fetch data from connectors and exchange intermediate data with each other.



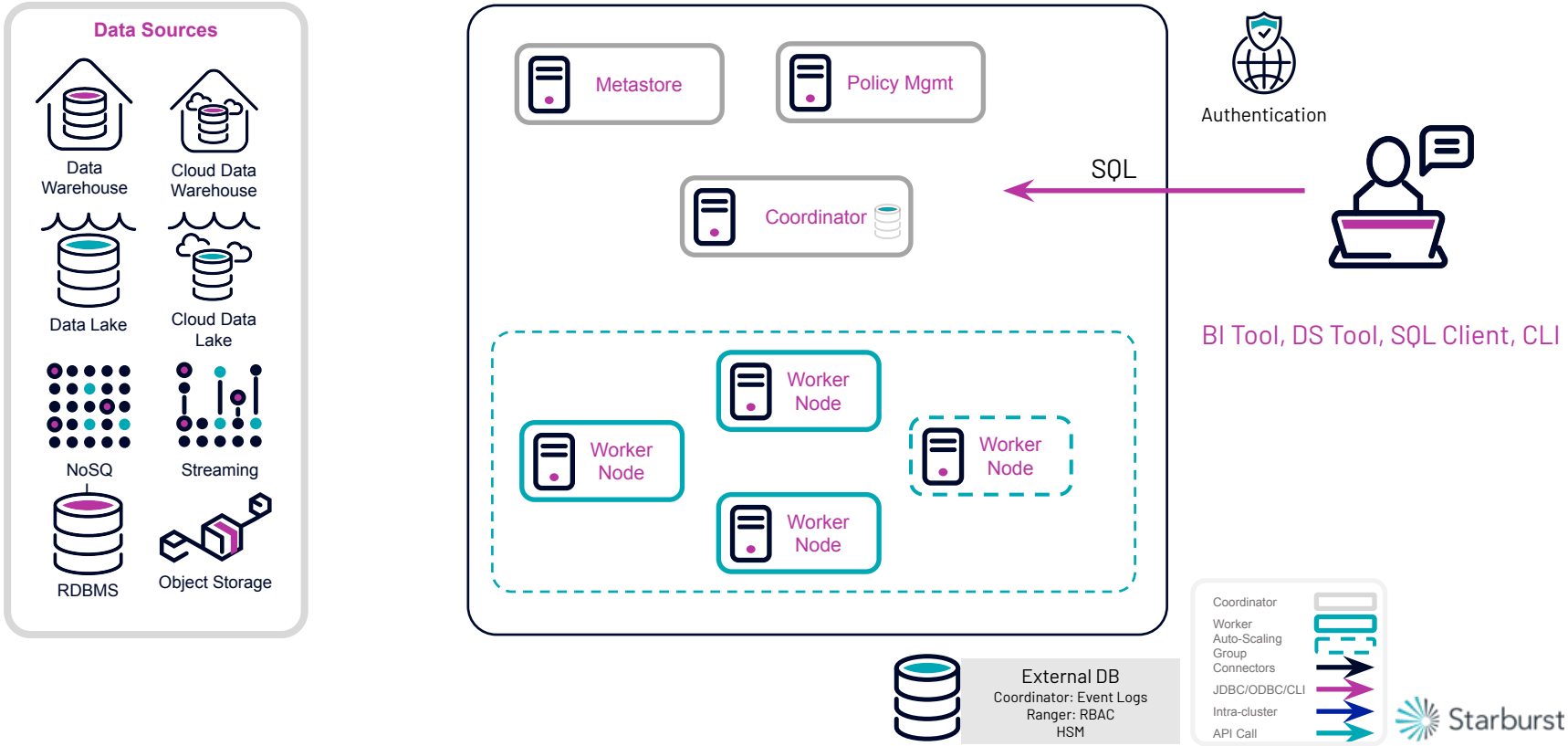
Data sources & tools integrations



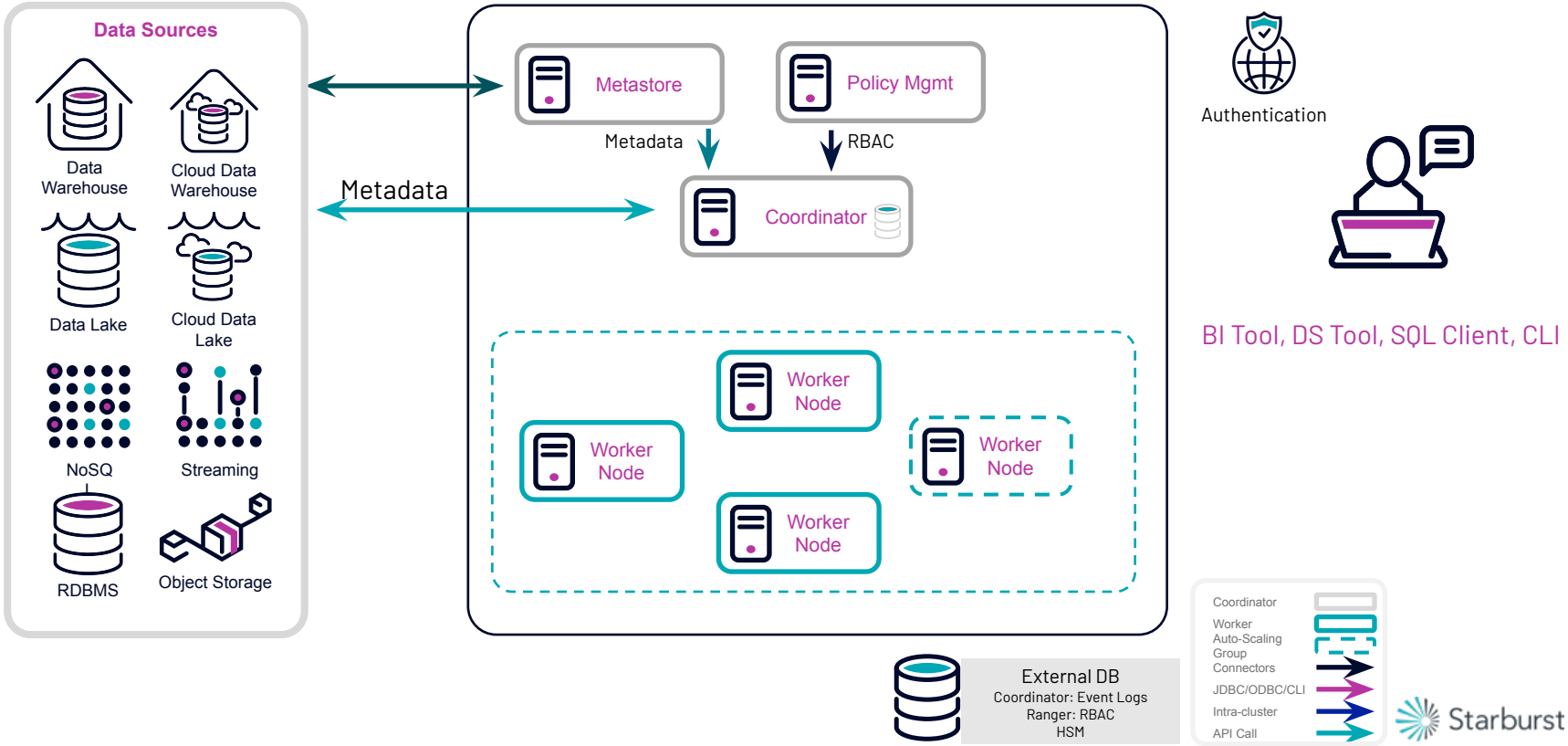
Starburst logical architecture



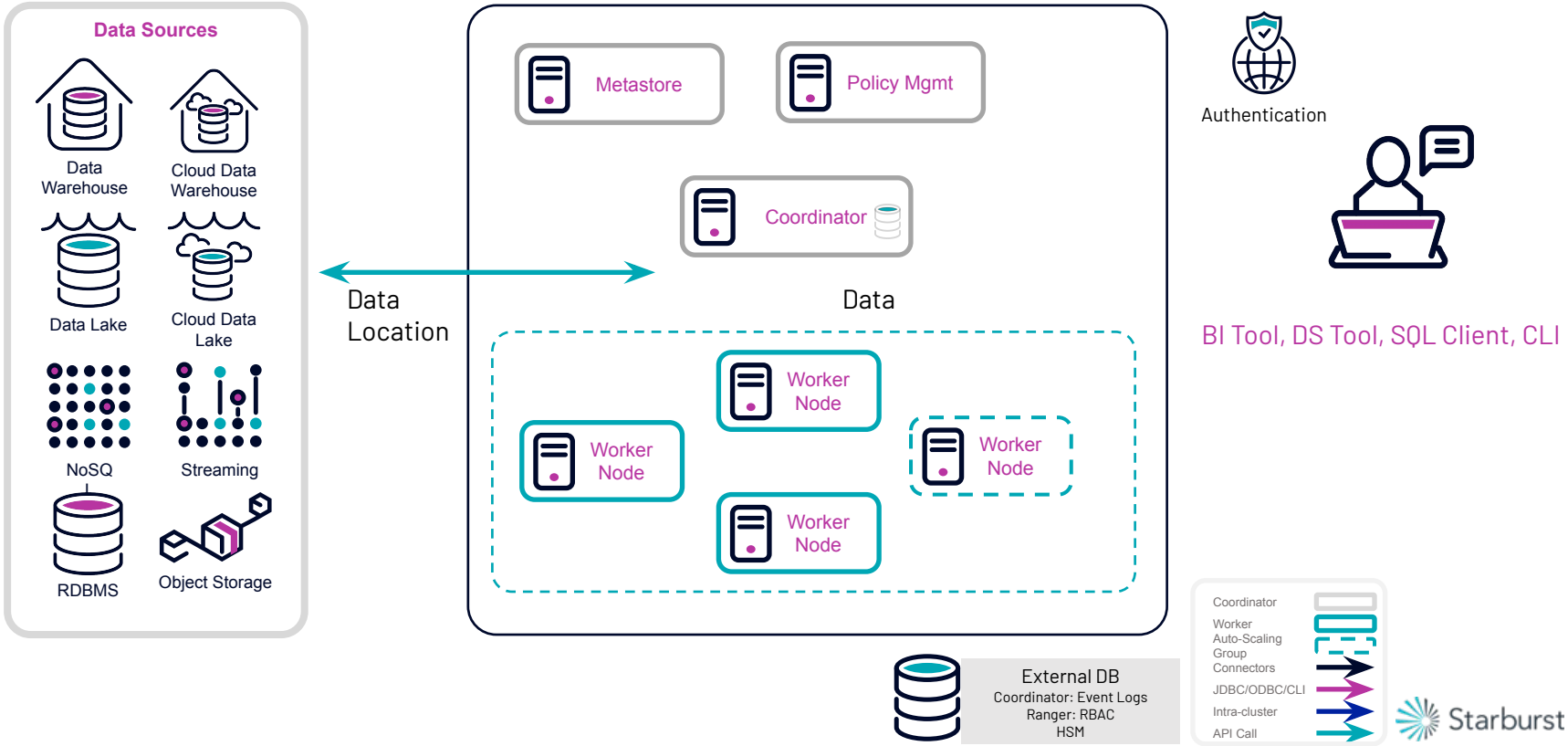
Query step: Statement submitted



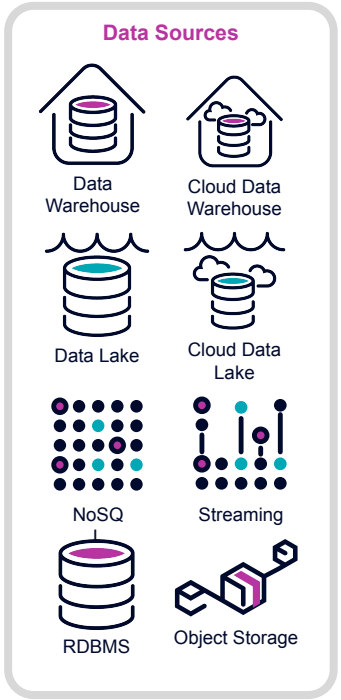
Query step: Query validated

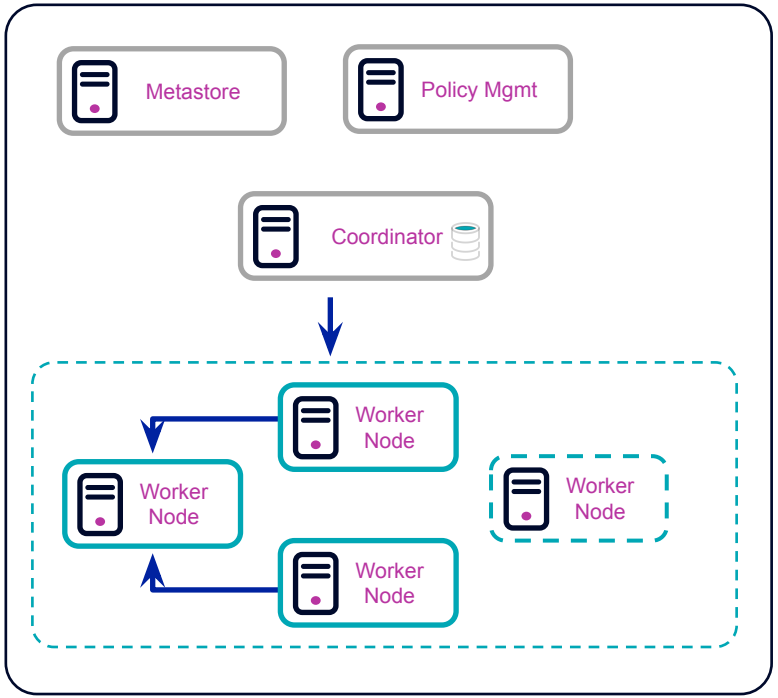


Query step: Schedule created

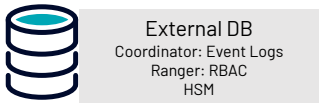


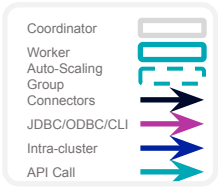
Query step: Tasks assigned





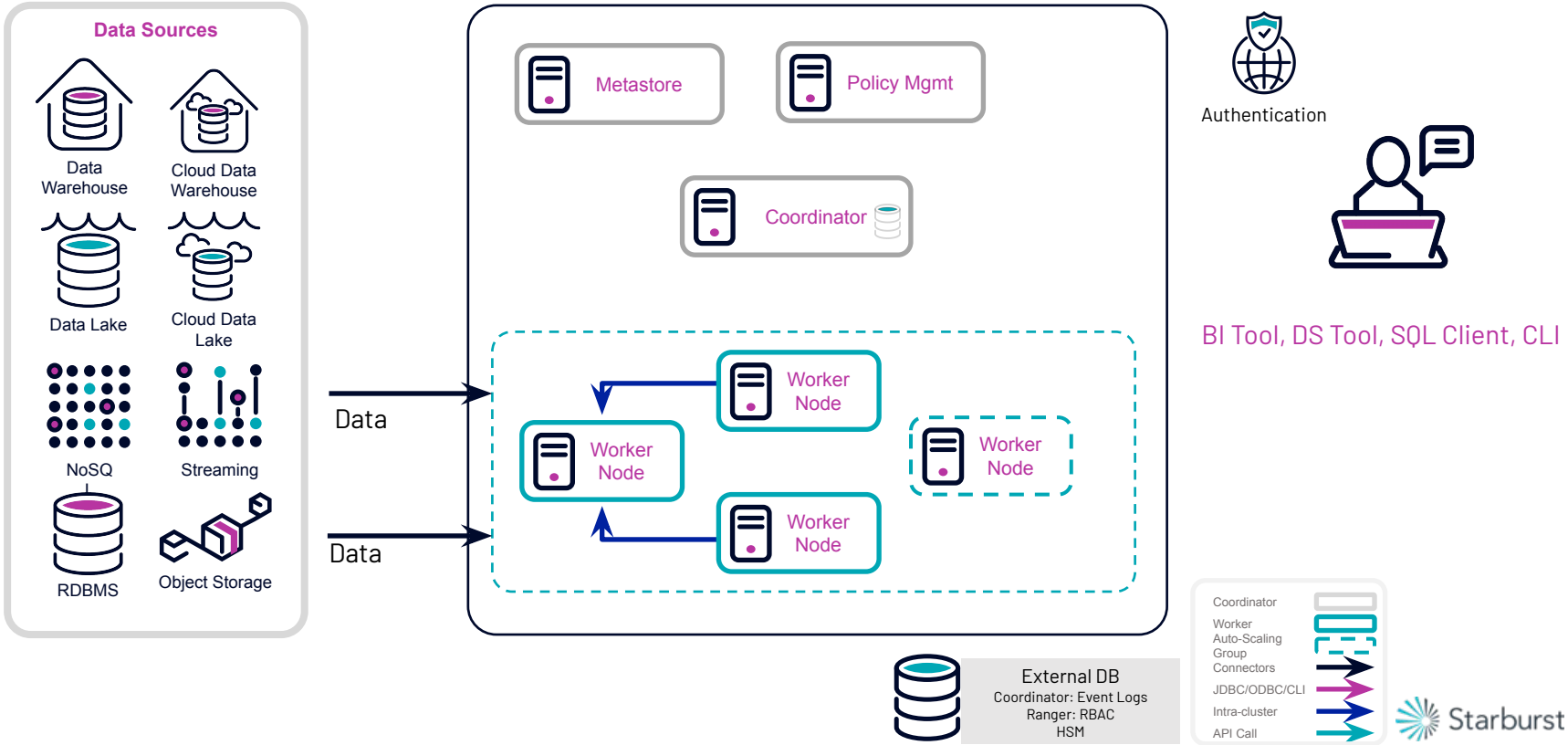
BI Tool, DS Tool, SQL Client, CLI



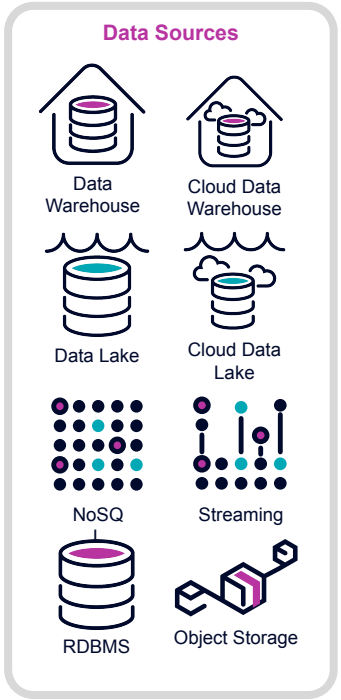


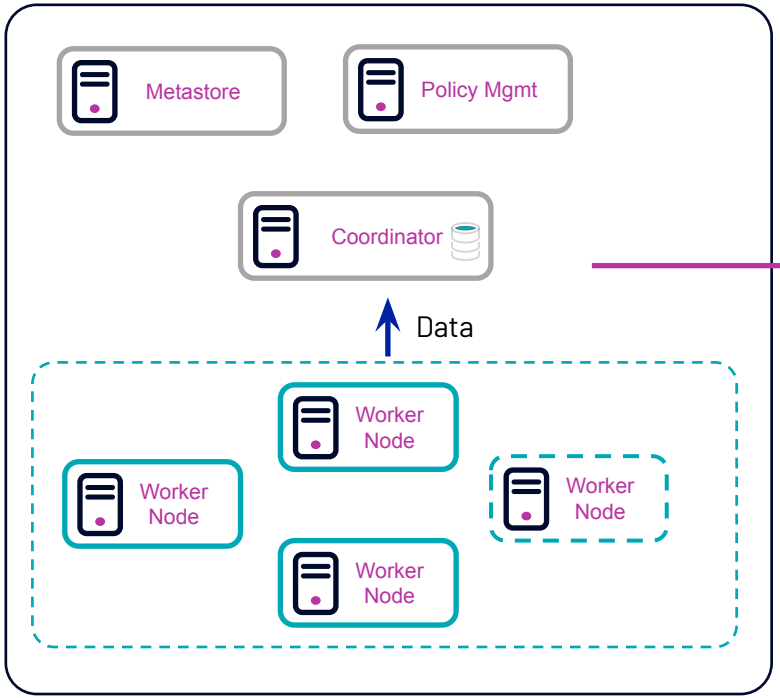
Starburst

Query step: Tasks executed

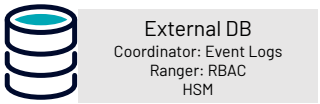


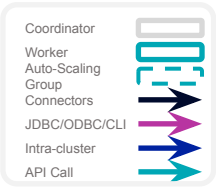
Query step: Results returned





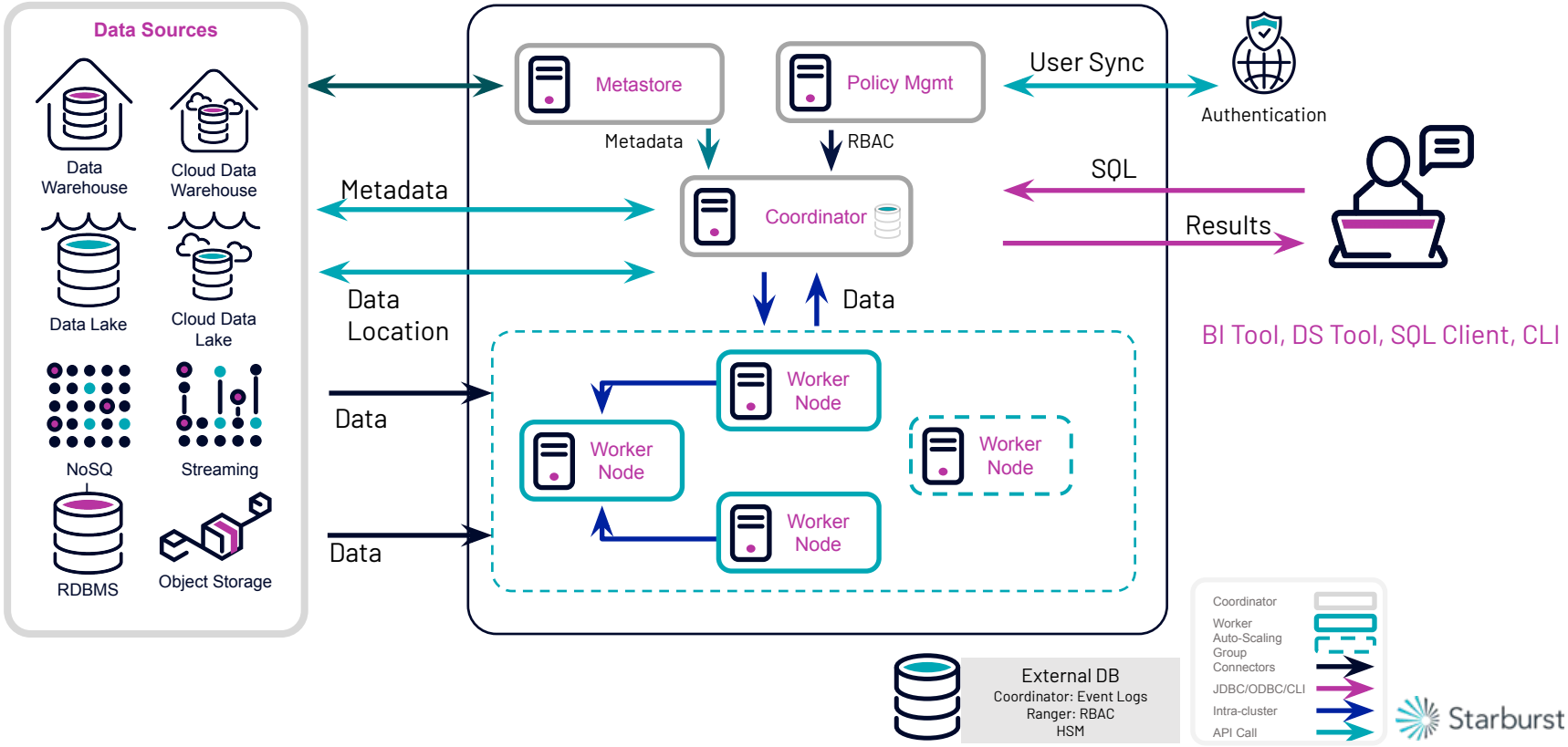
BI Tool, DS Tool, SQL Client, CLI



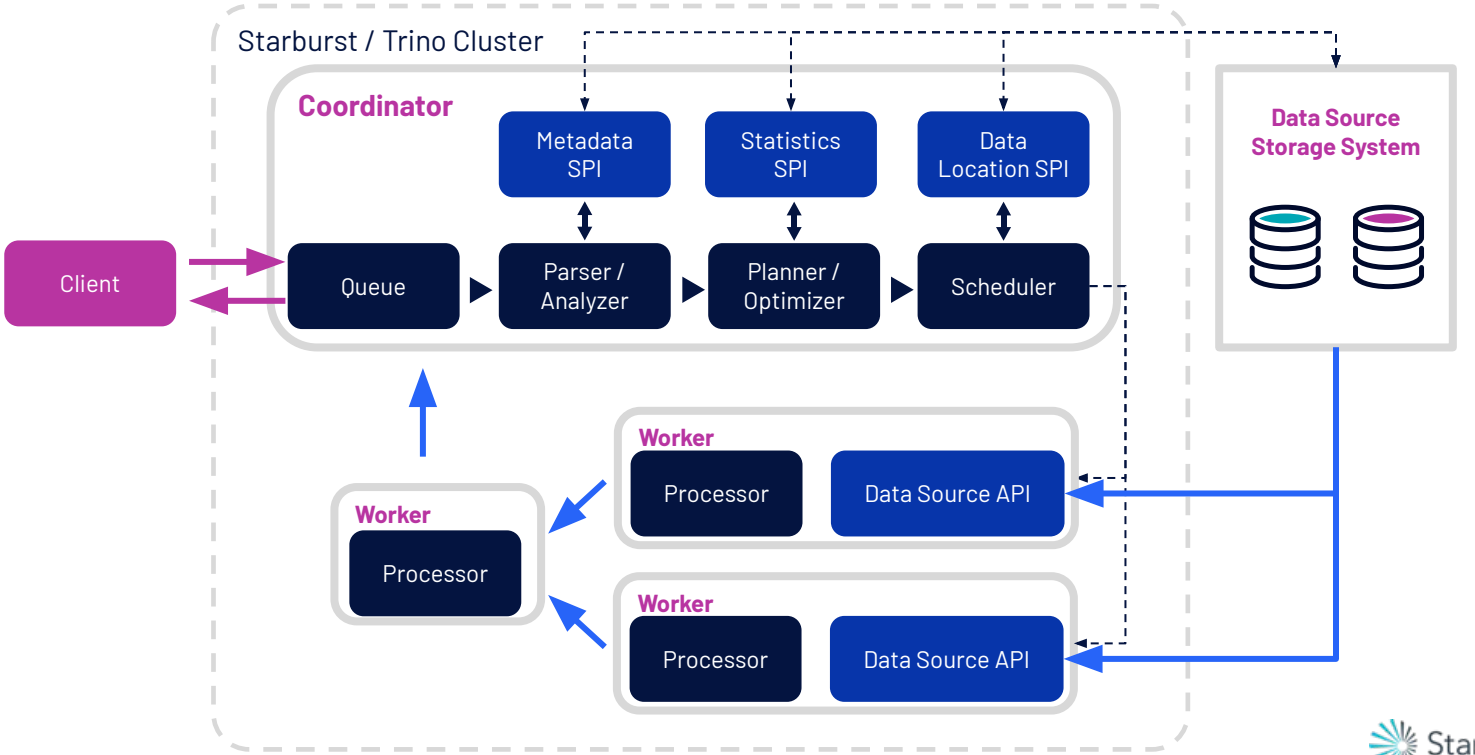


Starburst

Starburst logical architecture



Starburst / Trino execution flow



Starburst

Lesson summary

Starburst features: Architecture

1. Starburst clusters deploy a single coordinator and multiple workers.

2. The coordinator analyzes the user requirements, allocates resources, and distributes tasks to the workers.

3. The workers perform the tasks and return the results to the coordinator.

4. Starburst Galaxy and Starburst Enterprise both allow users to connect to multiple data sources. This is one of the ways in which optionality is ensured.

5. Starburst Galaxy and Starburst Enterprise offer fully-fledged data lake analytics platforms built on top of Trino, an open-source query engine.

Starburst features

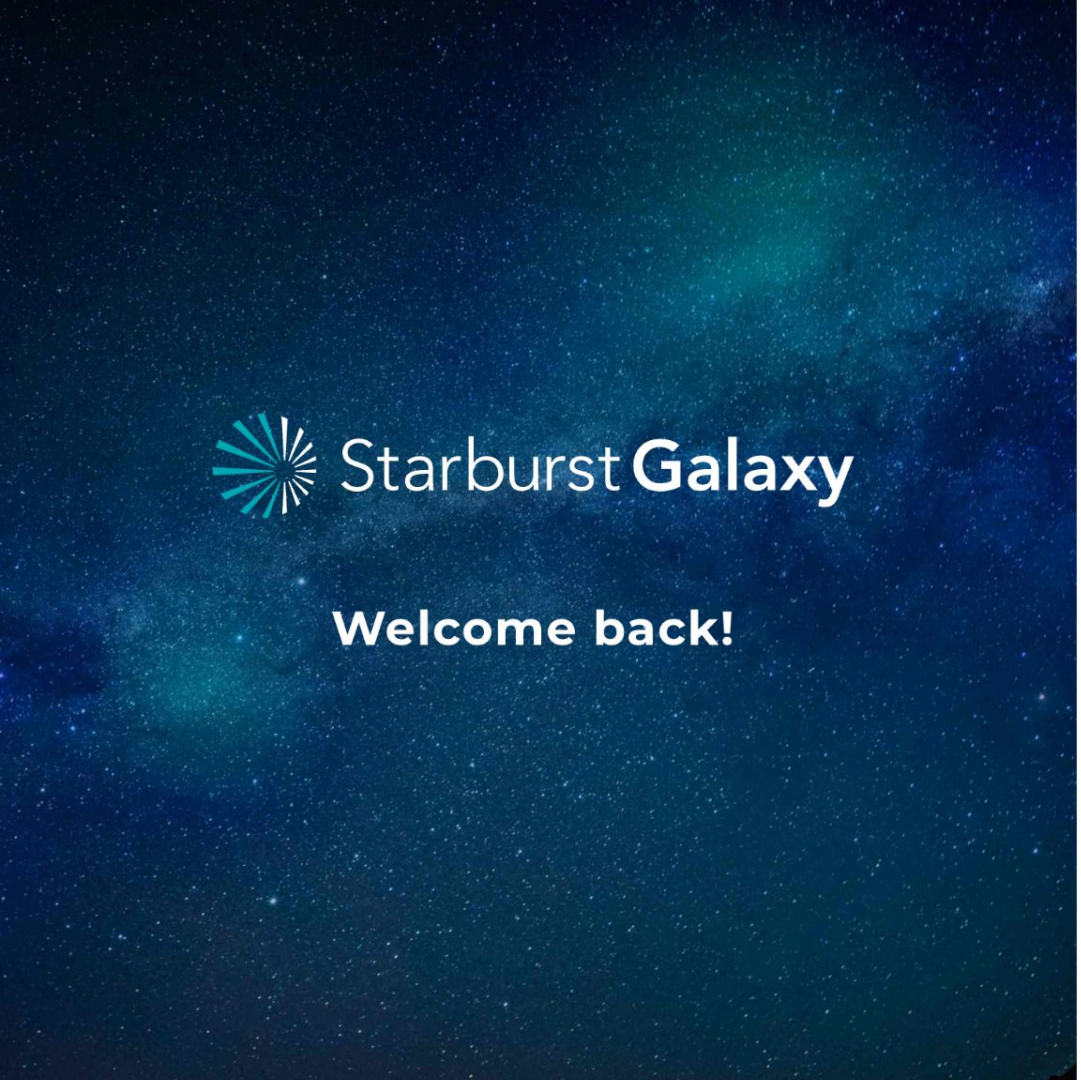
Web UI

Starburst

Lesson objectives

Starburst features: Web UI

1. Understand how to sign into Starburst web UI.
2. Identify the key components of the Starburst web UI.
3. Explain how to input SQL in Starburst web UI.



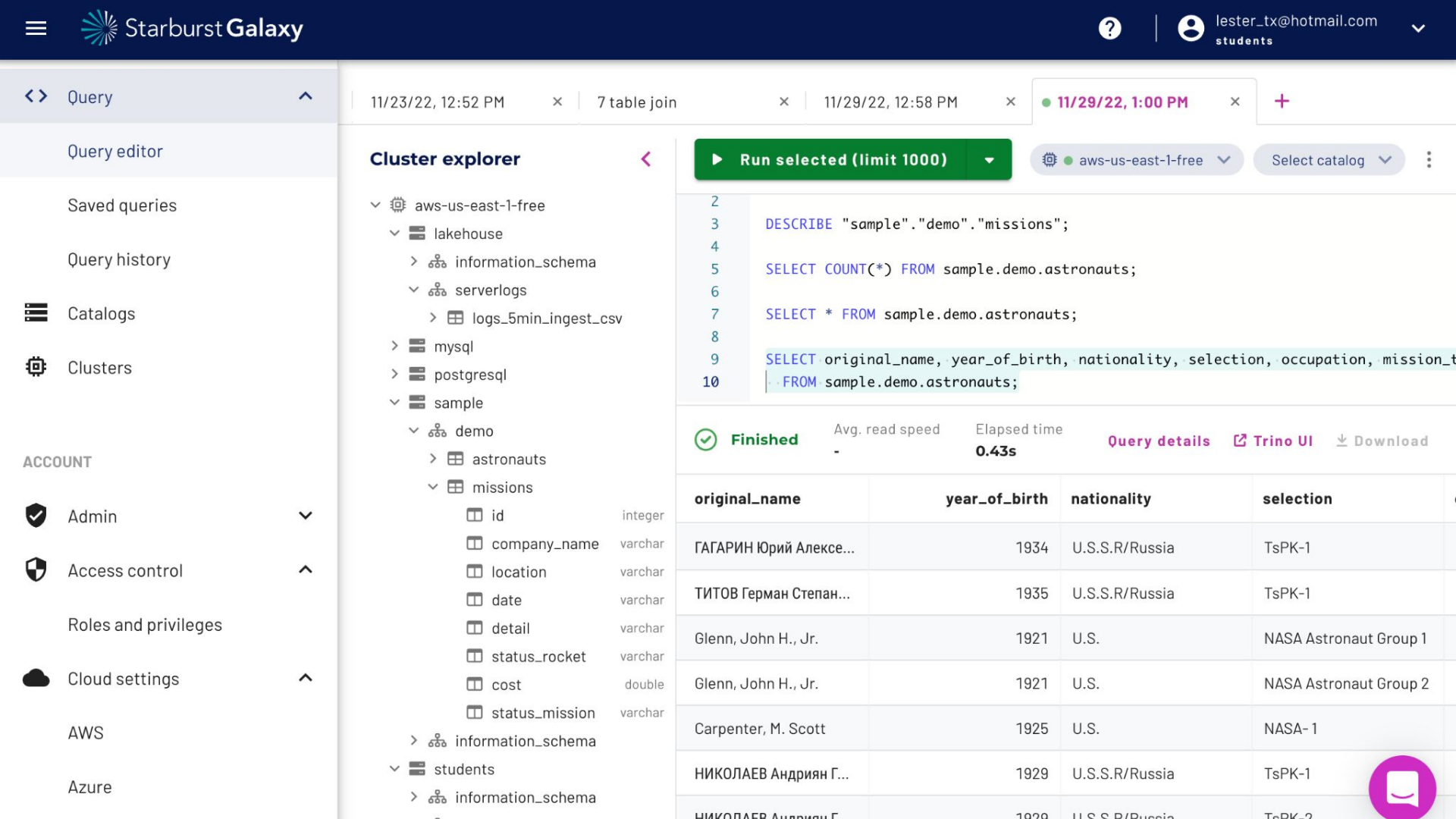
Sign in to Starburst Galaxy

Email *

Password *

Forgot your password?

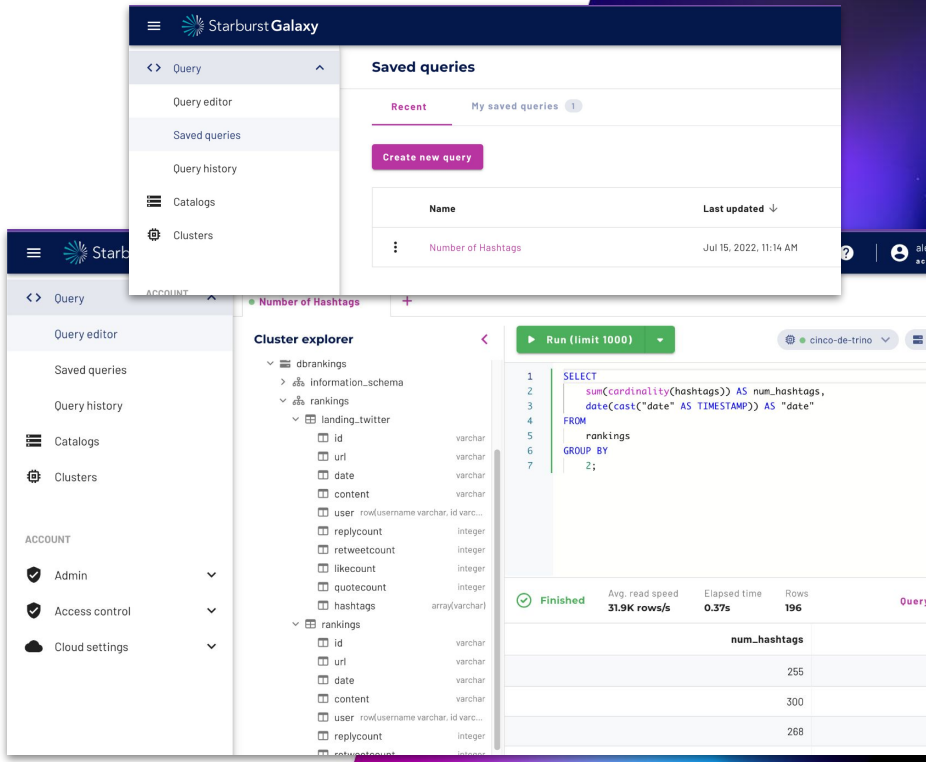
Sign in to Starburst Galaxy


Starburst Galaxy
lester_tx@hotmail.com
students
Query
Query editor
Saved queries
Query history
Catalogs
Clusters
ACCOUNT
Admin
Access control
Roles and privileges
Cloud settings
AWS
Azure
11/23/22, 12:52 PM
7 table join
11/29/22, 12:58 PM
11/29/22, 1:00 PM
Cluster explorer
aws-us-east-1-free
lakehouse
information_schema
serverlogs
logs_5min_ingest_csv
mysql
postgresql
sample
demo
astronauts
missions
id integer
company_name varchar
location varchar
date varchar
detail varchar
status_rocket varchar
cost double
status_mission varchar
information_schema
students
information_schema
Run selected (limit 1000)
aws-us-east-1-free
Select catalog
2
3 DESCRIBE "sample"."demo"."missions";
4
5 SELECT COUNT(*) FROM sample.demo.astronauts;
6
7 SELECT * FROM sample.demo.astronauts;
8
9 SELECT original_name, year_of_birth, nationality, selection, occupation, mission_t
10 FROM sample.demo.astronauts;
Finished
Avg. read speed
-
Elapsed time
0.43s
Query details
Trino UI
Download
original_name
year_of_birth
nationality
selection
ГАГАРИН Юрий Алексе...
1934
U.S.S.R/Russia
TsPK-1
ТИТОВ Герман Степан...
1935
U.S.S.R/Russia
TsPK-1
Glenn, John H., Jr.
1921
U.S.
NASA Astronaut Group 1
Glenn, John H., Jr.
1921
U.S.
NASA Astronaut Group 2
Carpenter, M. Scott
1925
U.S.
NASA- 1
НИКОЛАЕВ Андриян Г...
1929
U.S.S.R/Russia
TsPK-1

Query editor

A full environment to write and execute SQL statements

- Explore clusters and the catalogs, schemas, tables, views, and columns of their connected data sources
- Run and download results
- SQL function and grammar auto-complete
- Manage queries with separate editor tabs
- Review saved queries, the history of the query statuses, and their performance with the query execution diagram



Starburst

SQL's workhorse: the SELECT statement

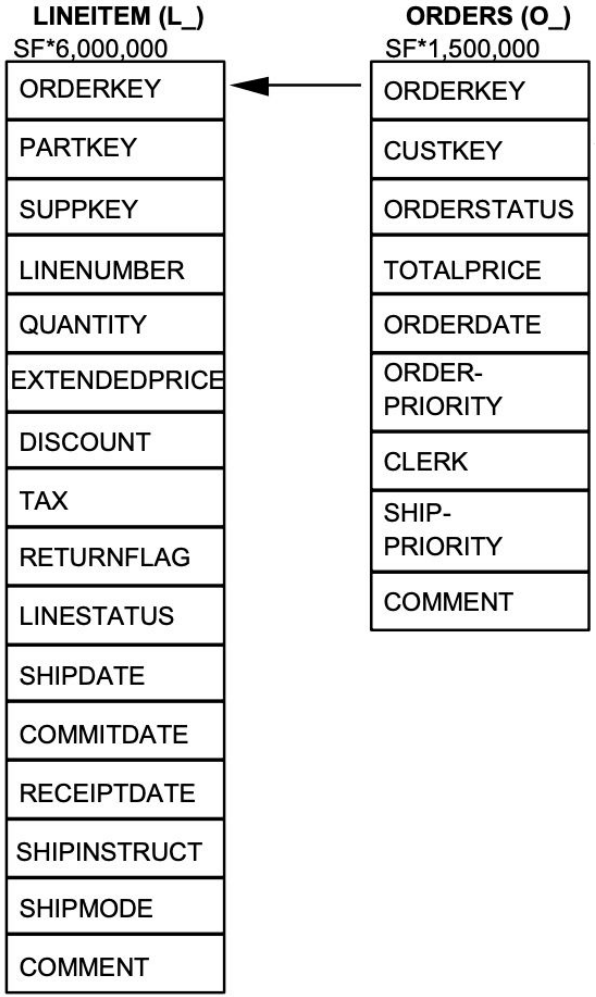
SELECT — Trino Documentation

```
[ WITH [ RECURSIVE ] with_query [, ...] ]
SELECT [ ALL | DISTINCT ] select_expression [, ...]
[ FROM from_item [, ...] ]
[ WHERE condition ]
[ GROUP BY [ ALL | DISTINCT ] grouping_element [, ...] ]
[ HAVING condition]
[ WINDOW window_definition_list]
[ { UNION | INTERSECT | EXCEPT } [ ALL | DISTINCT ] select ]
[ ORDER BY expression [ ASC | DESC ] [, ...] ]
[ OFFSET count [ ROW | ROWS ] ]
[ LIMIT { count | ALL } ]
[ FETCH { FIRST | NEXT } [ count ] { ROW | ROWS } { ONLY | WITH TIES } ]
```

Expected SQL knowledge

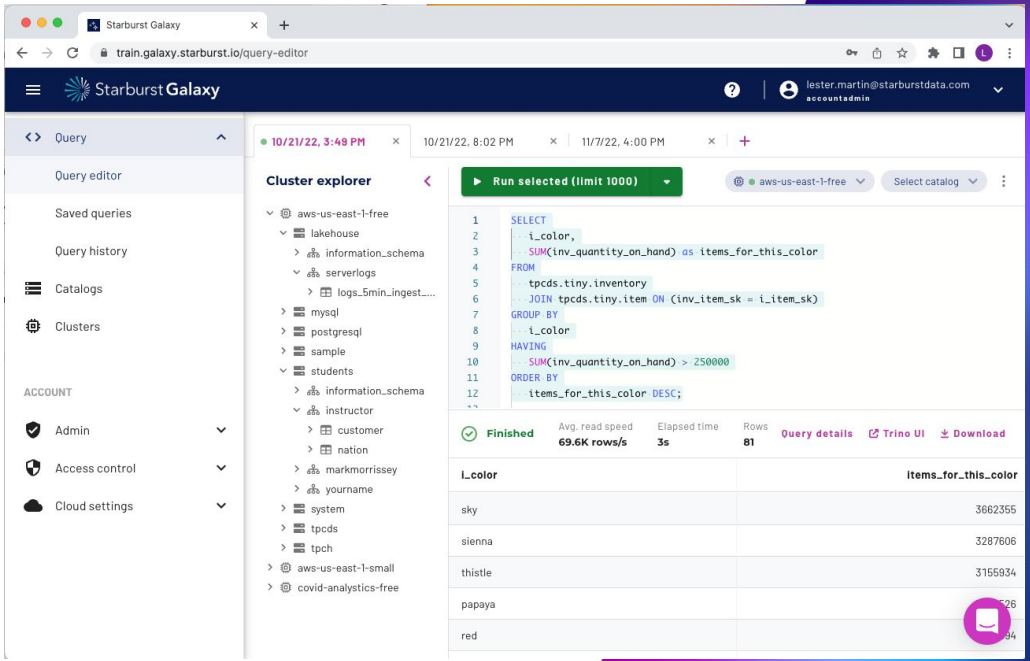
Projecting, filtering, ordering, aggregating and joining

- Basic SELECT statement with single table with specific columns to limit the width of the data returned
- Leveraging WHERE clauses to limit the rows of data
- Sorting the results with ORDER BY
- Performing aggregations such as COUNT, MAX, SUM and AVG
  - Across the entire table population
  - For each rolled up section identified in a GROUP BY clause
- Melding two (or more) tables together with the functionality of the JOIN keyword



Instructor demonstration

Walkthrough of Starburst Galaxy UI (10 mins)



Starburst

Hands-on exercise

Lab 1: Execute queries in Starburst Galaxy (40 mins)

Starburst

Lesson summary

Starburst features: Web UI

1. Starburst can be accessed through a web UI, or other client tool, and requires a username and password to access it.

2. The Starburst Galaxy navigation bar contains controls the query, catalog, cluster, admin, access control, and cloud settings.

3. SQL is input and executed directly in the web interface.

Starburst

Starburst features

Connectors & catalogs

Lesson objectives

Starburst features: Connections & catalogs

1. Explain the difference in cluster management between Starburst Galaxy and Starburst Enterprise.
2. Describe how data sources are integrated into the Starburst cluster.
3. Explain the hierarchy and difference between catalogs, schemas, and tables.
4. Describe how Starburst deploys a single point of access across a rich ecosystem of technologies.
5. Explain the role of query federation in the Starburst cluster, and how it differs from traditional query federation.

Connectors & catalogs

Consumption models

Starburst

Is it a cluster OR does it contain clusters? YES!!

Starburst Enterprise

Starburst Enterprise is deployed as a cluster with flexible configuration options.

Catalogs are configured for the cluster.

The web UI is bound to a specific cluster instance.

Starburst Galaxy

A Starburst Galaxy account can have multiple clusters, each with their own sizing and auto-scaling configurations.

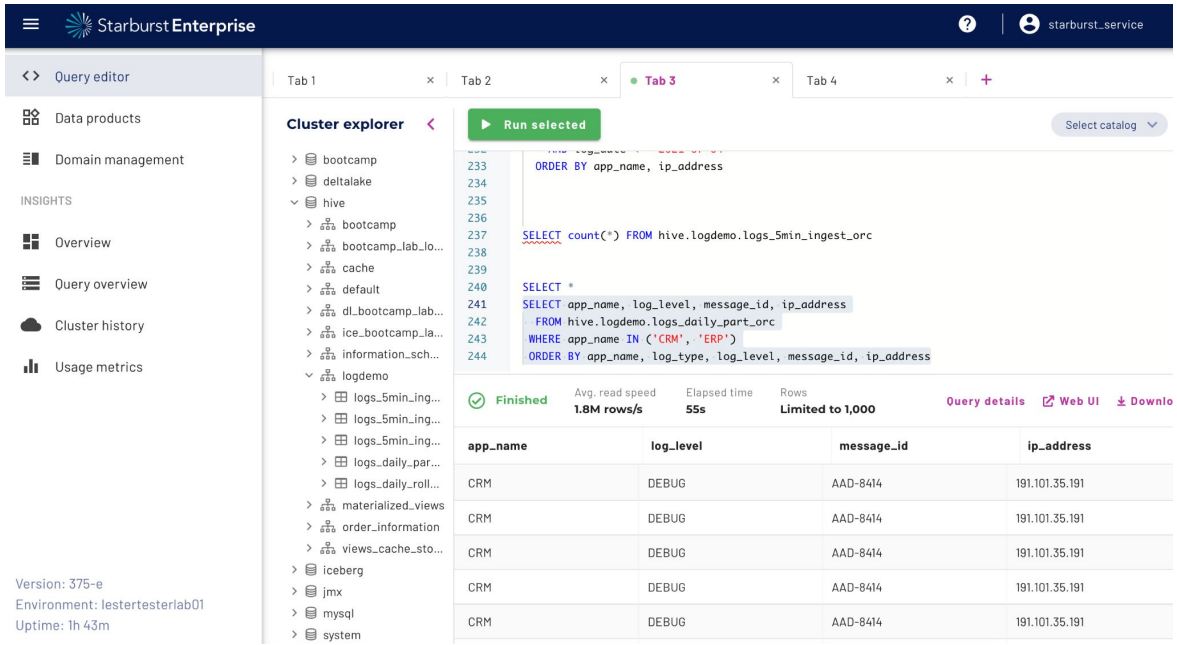
Catalogs are managed independently and can be linked to any number of clusters.

The web UI shows all configured clusters.

Regardless of which consumption model is used, configuring clusters is an administrative function.

Starburst Enterprise – The cluster

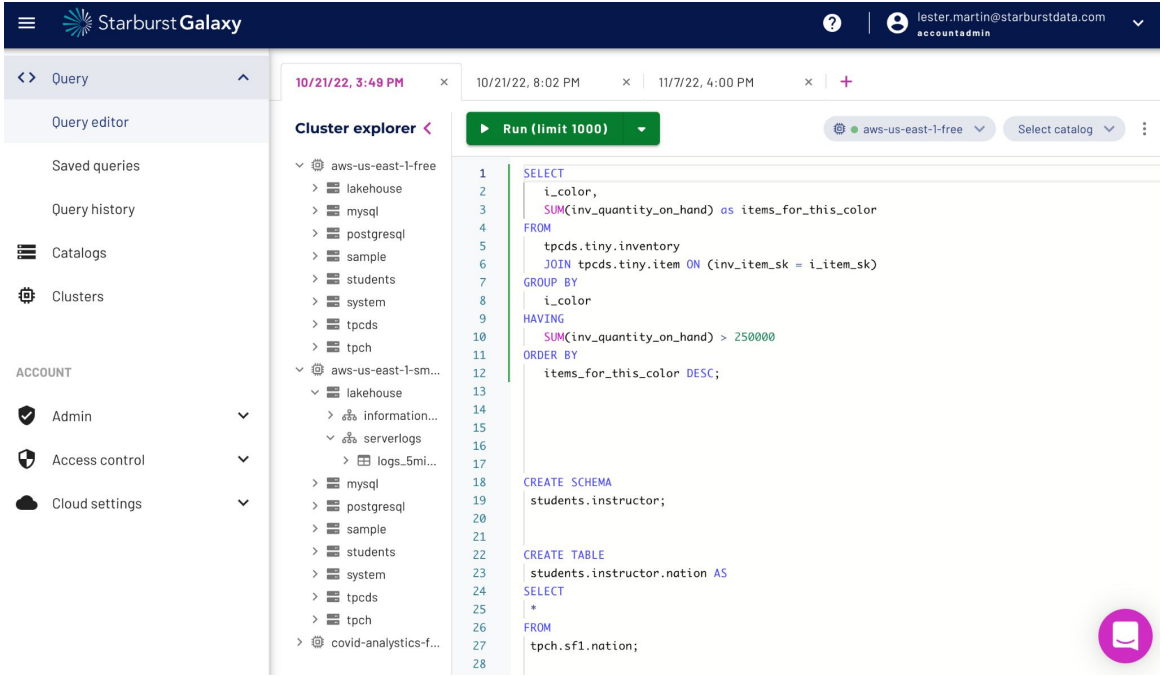
The web UI directly shows the catalogs in the Cluster explorer.



Starburst

Starburst Galaxy – Manages clusters

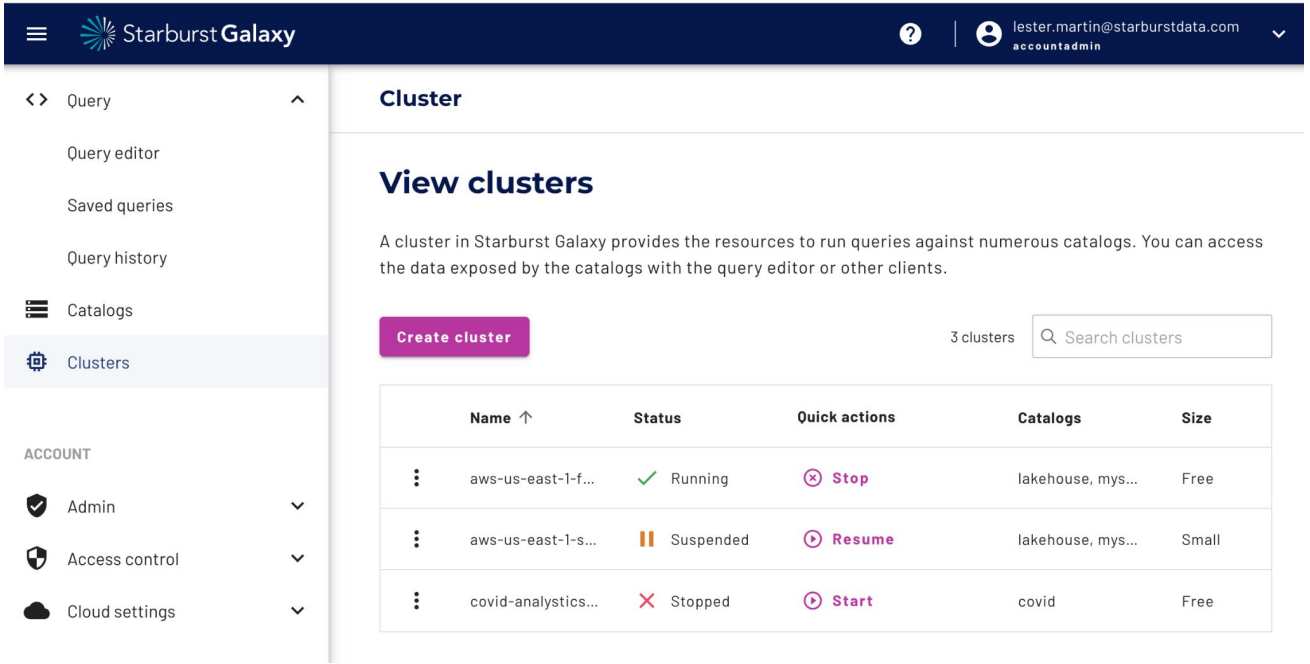
The web UI includes an additional cluster hierarchy in the Cluster explorer.



Starburst

Starburst Galaxy – Cluster list

The web UI allows existing clusters to be managed and new ones to be created.



Starburst

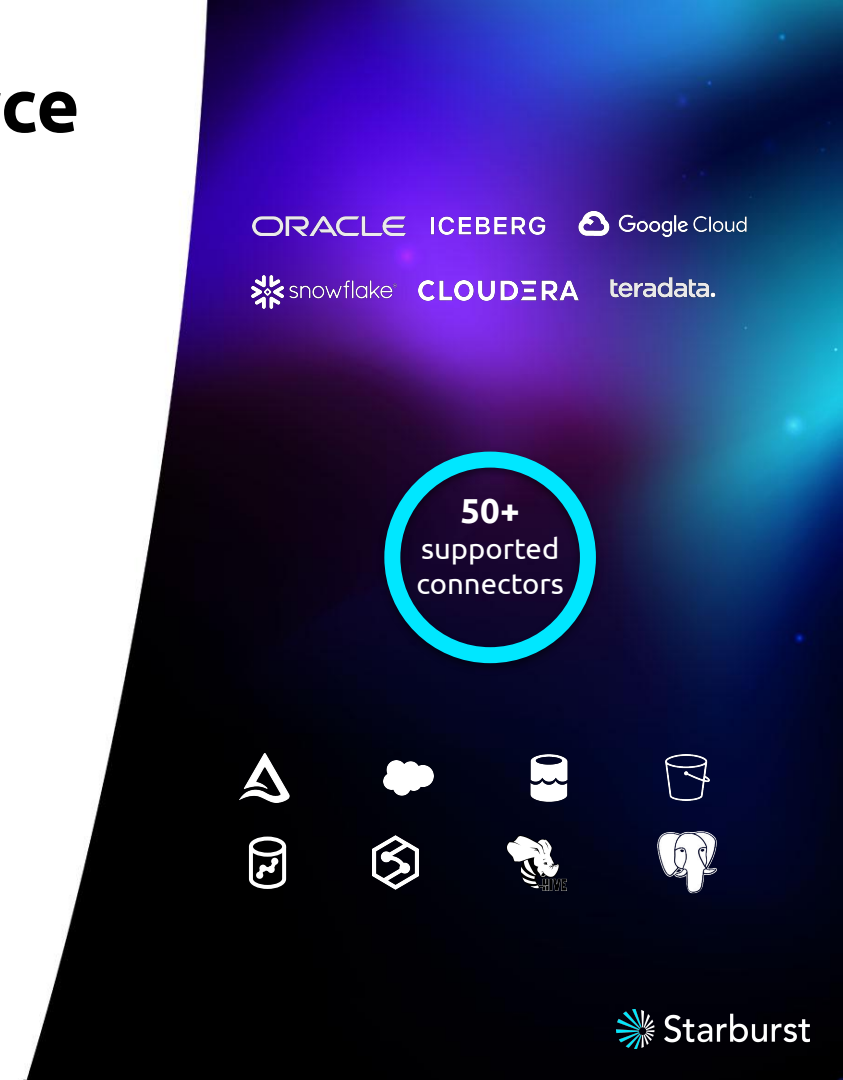
Connectors & catalogs

Data source options

Starburst

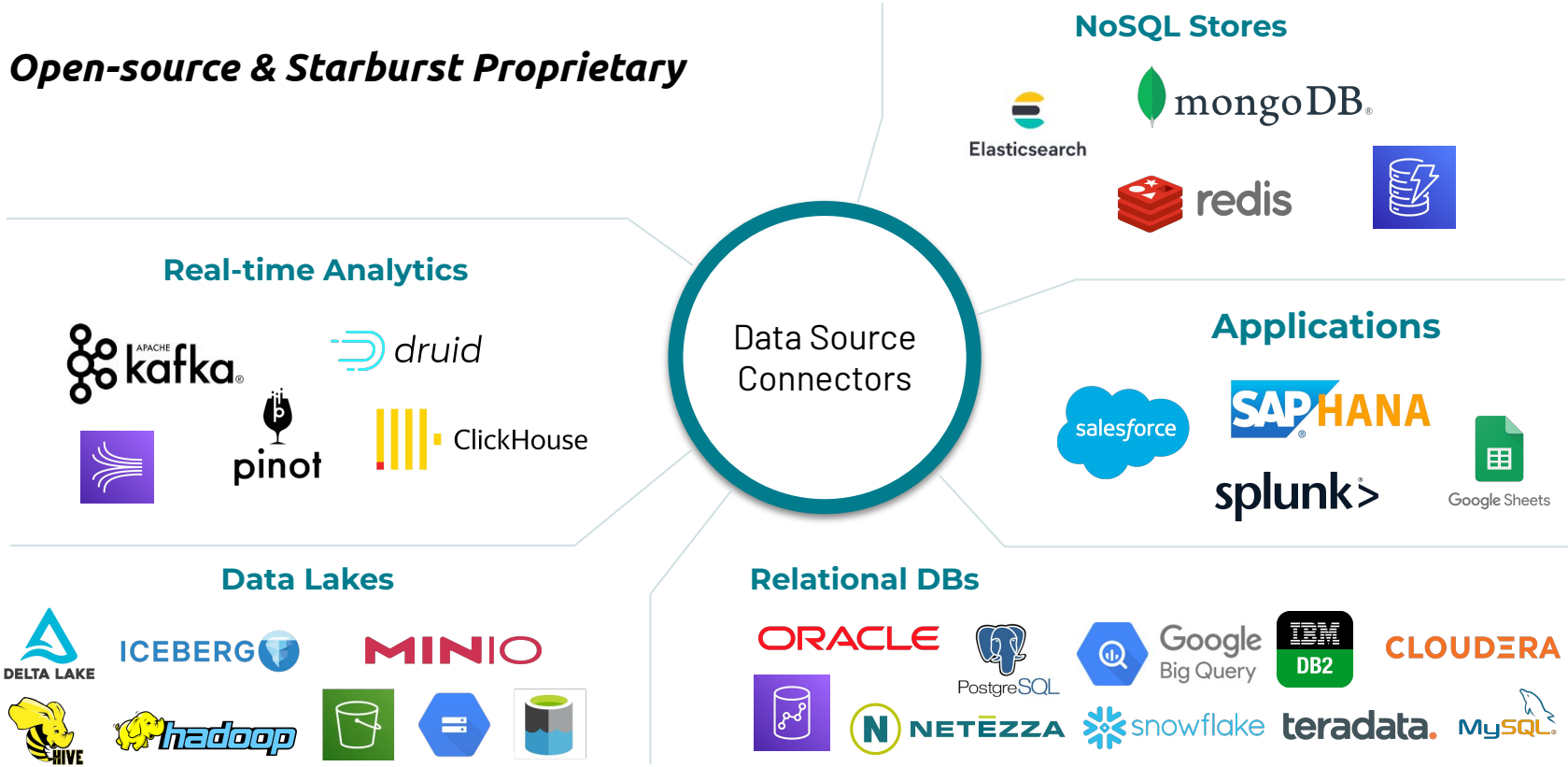
Rich ecosystem of data source connectors

- Live access to 50+ modern and legacy enterprise data sources
- Federate access to multiple sources without moving or copying data
- Combine external data with data that cannot move
- Join data stored in different formats - relational, non-relational, structured, unstructured, streaming, object stores
- Integrate with existing security solutions
- Deliver data warehouse functionality to the data lake
- Continue to use the tools you know and love while getting more value out of your data



Rich ecosystem of data source connectors

Open-source & Starburst Proprietary



Connectors & catalogs

Putting it all together

Starburst

Connecting to data sources

Catalog

A catalog is an instance of a data source connector.

Multiple catalogs can use the same underlying connector with different configuration settings.

Schema

A way to organize tables.

Analogous to the organization concepts in popular RDBMS tools.

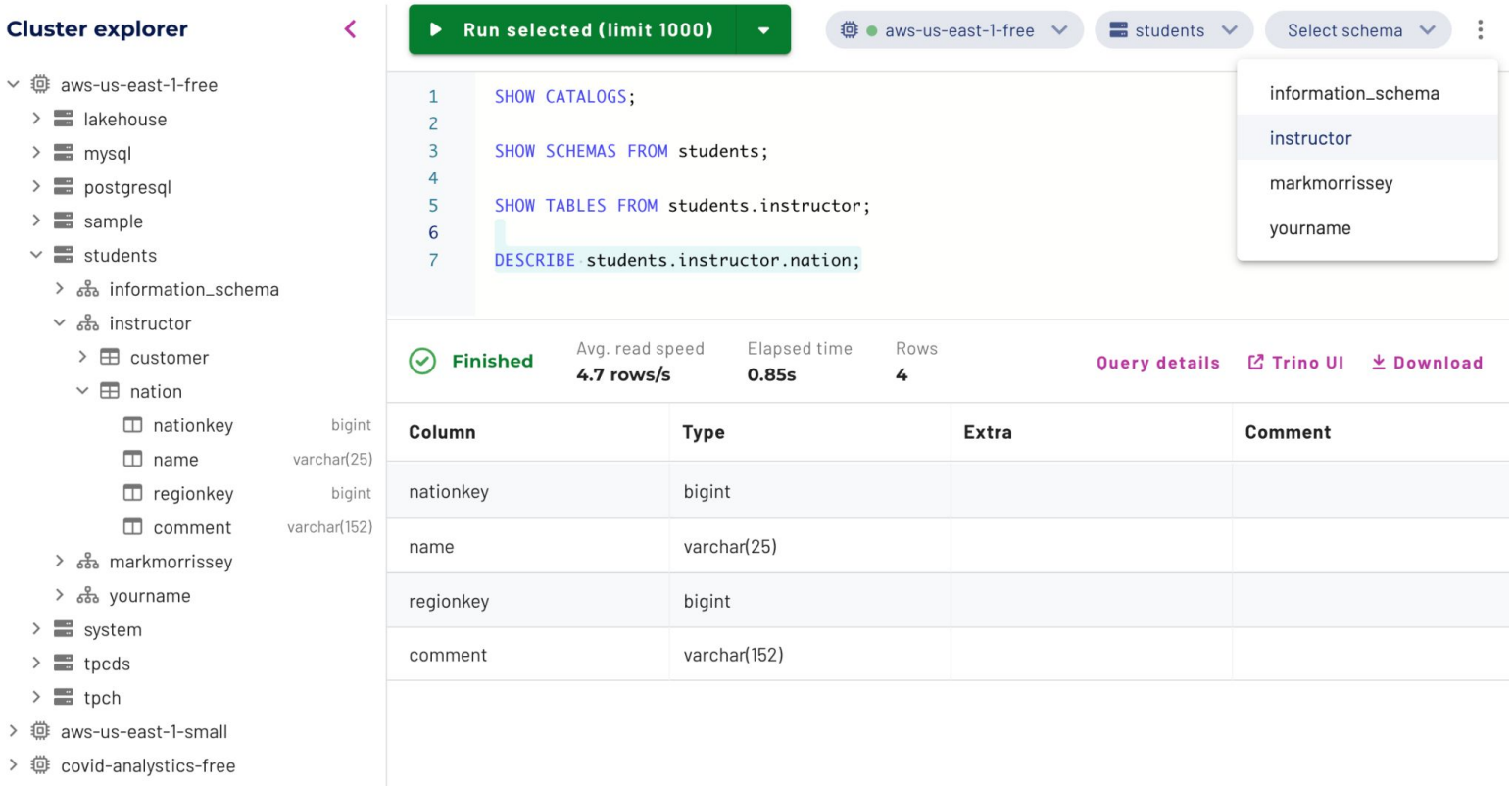
Table

A set of unordered rows, which are organized into named columns with data types.

Includes views.

Three-part name for a table's unique identifier: catalog.schema.table

Multiple ways to reference tables & views



Starburst

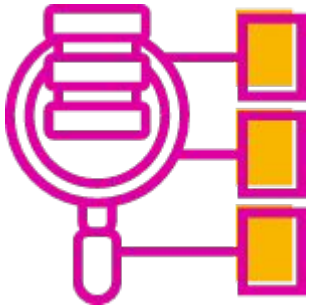
What can we do with multiple catalogs?

Single point of access for a variety of data sources

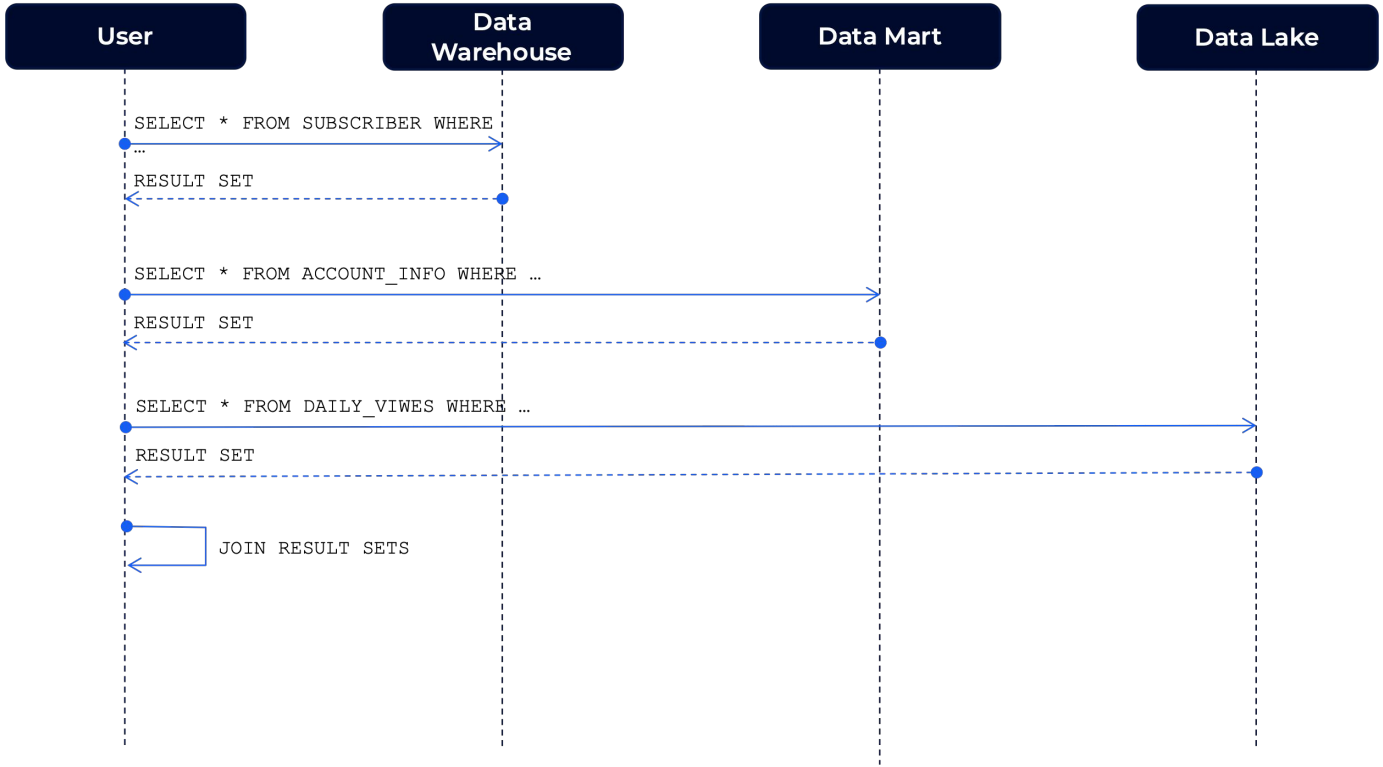
- Same UI/CLI/API for access all of your data
- Configure security and governance in one place

Query federation

- Access data from multiple systems within a single query
  - For example, join historic log data stored in an S3 object storage with customer data stored in a MySQL database

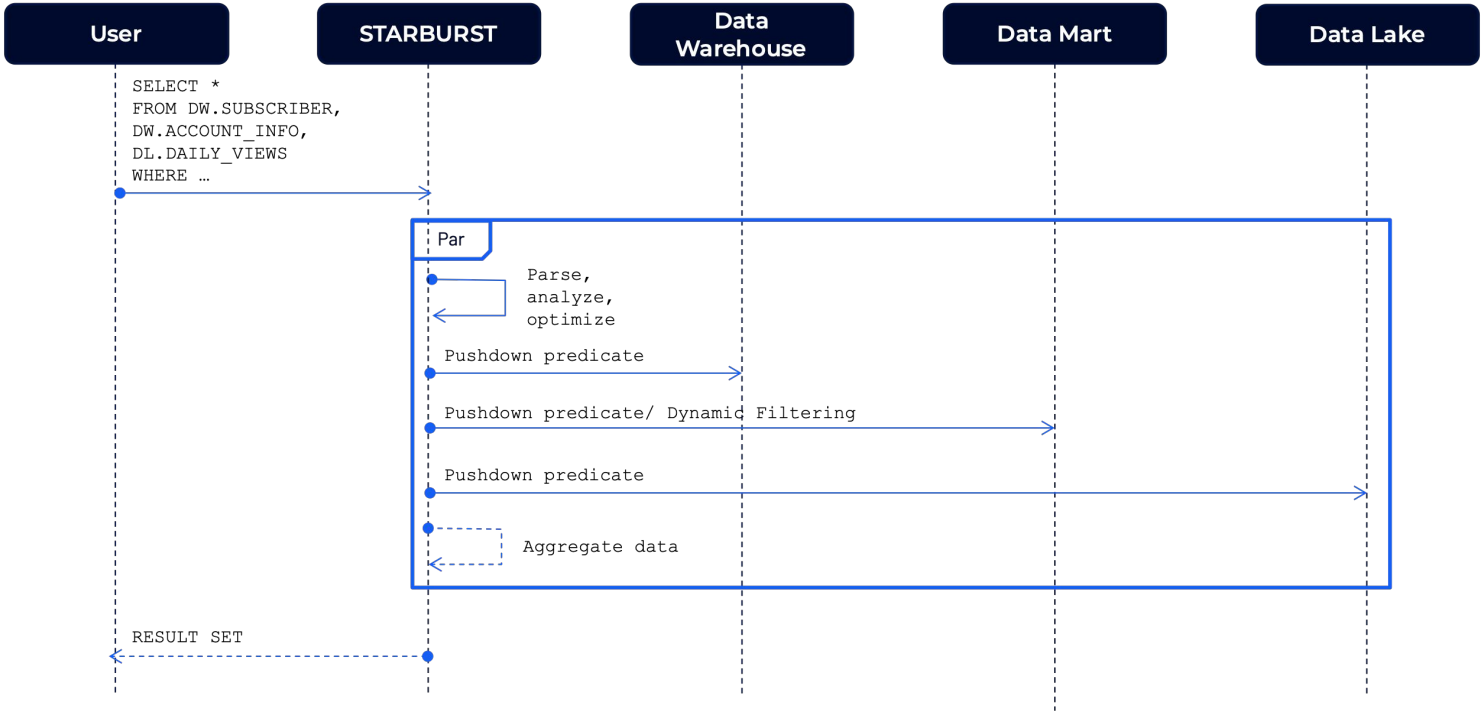


Query federation the traditional way



Starburst

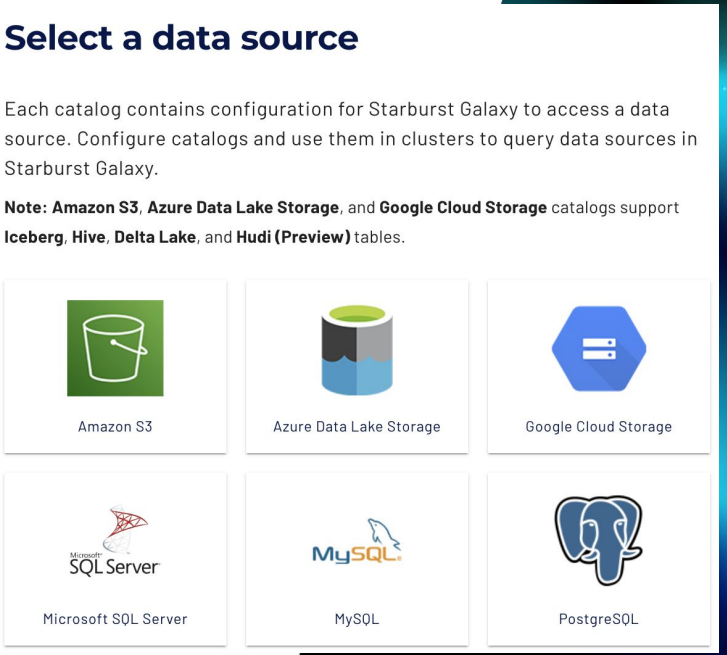
Query federation the starburst way



Starburst

Instructor demonstration

Create a catalog and a federated query (10 mins)



Starburst

Hands-on exercise

Lab 2: Exploring federated queries (15 mins)

Starburst

Lesson summary

Starburst features: Connectors & catalogs

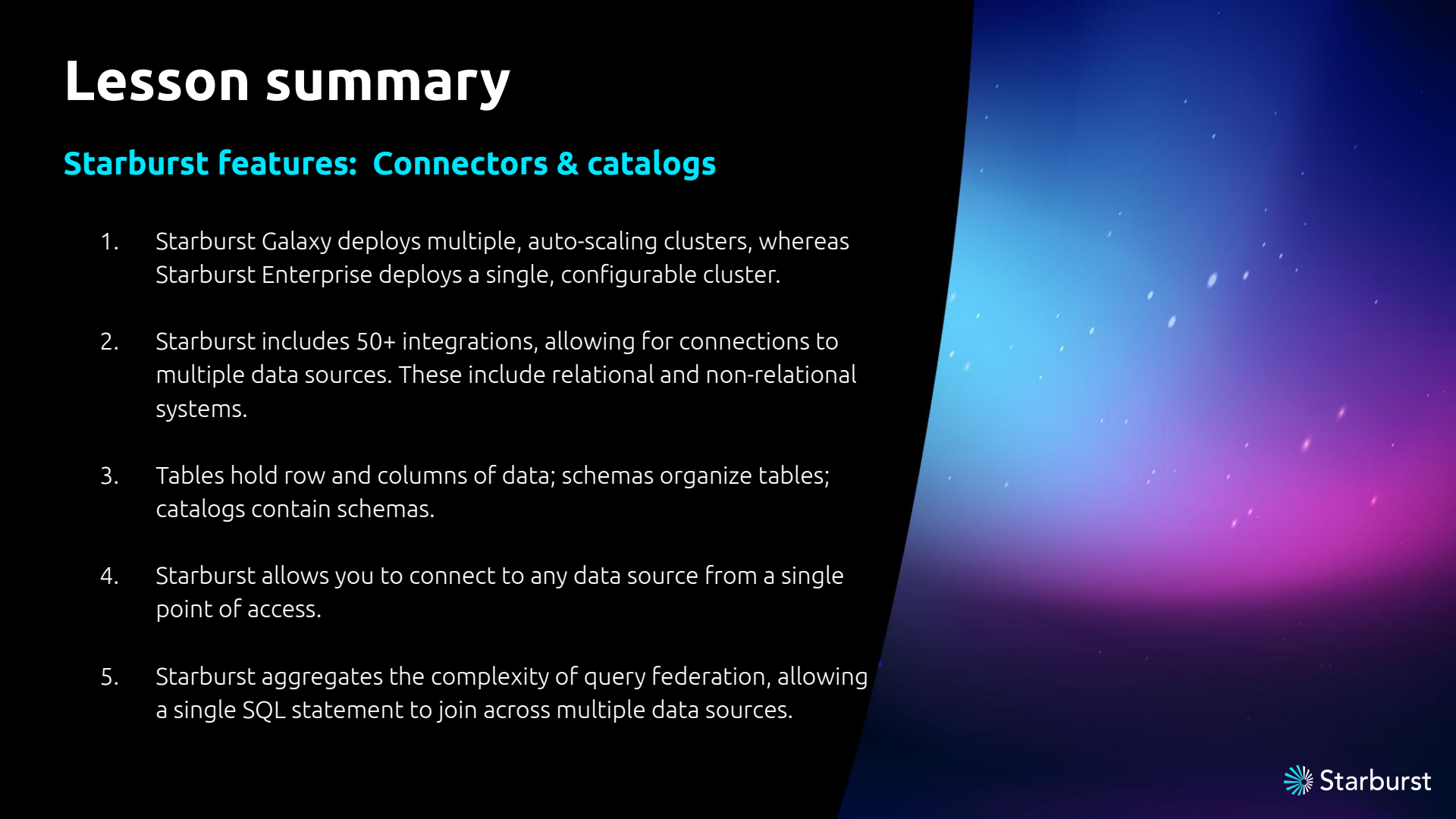
1. Starburst Galaxy deploys multiple, auto-scaling clusters, whereas Starburst Enterprise deploys a single, configurable cluster.

2. Starburst includes 50+ integrations, allowing for connections to multiple data sources. These include relational and non-relational systems.

3. Tables hold row and columns of data; schemas organize tables; catalogs contain schemas.

4. Starburst allows you to connect to any data source from a single point of access.

5. Starburst aggregates the complexity of query federation, allowing a single SQL statement to join across multiple data sources.



Starburst

Starburst features

Client tools integration

Starburst

Lesson objectives

Starburst features: Client tools integration

1. Understand how client tools integrate with Starburst, and which tools can be used.

2. Explain the impact that client tool integrations like Tableau and DBeaver have for data producers and data consumers.

3. Explain how Starburst Galaxy integrates with both JDBC and ODBC connectors.

4. Describe how Starburst products can be accessed via the Python client.

Connect with client tools

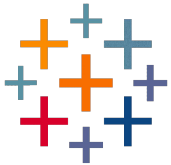
Data Engineers

- CLI, API and REST access
- SQL clients
  - DBeaver
  - dbVisualizer
  - etc

DBeaver

Data Analysts

- Business Intelligence tools
  - Tableau
  - Power BI
  - etc



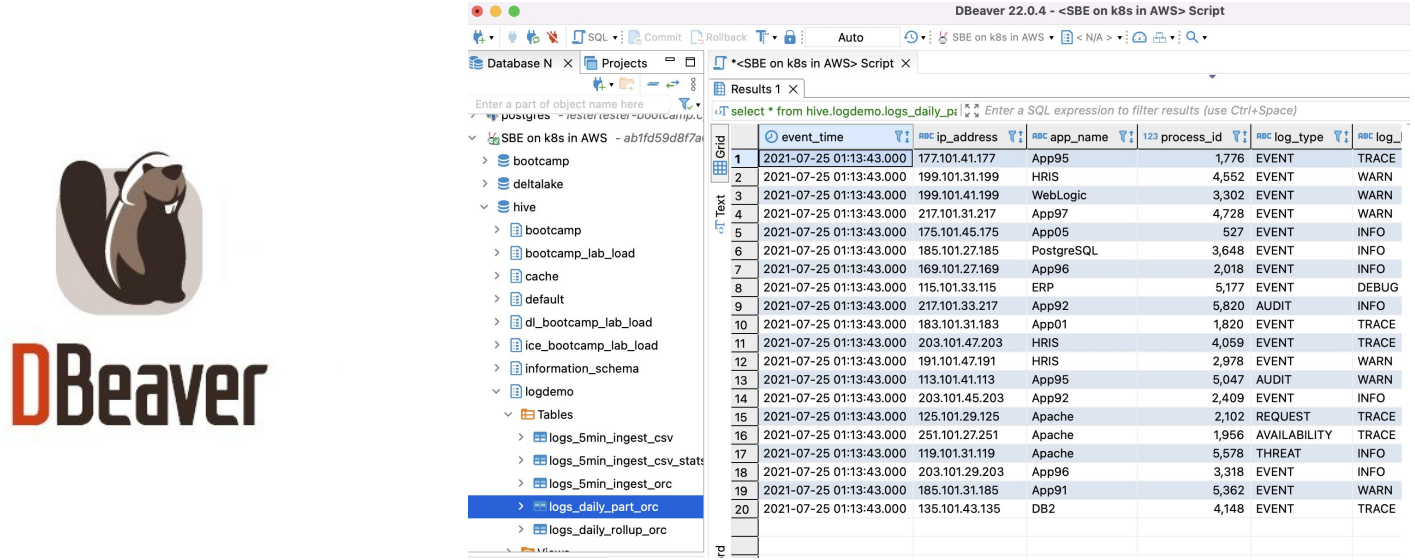
tableau

Data Scientists

- Web-based notebooks
  - Jupyter
  - IPython
  - Zeppelin
  - etc

Starburst

Connect via DBeaver



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2	2021-07-25 01:13:43.000	199.101.31.199	HRIS	4,552	EVENT	WARN
3	2021-07-25 01:13:43.000	199.101.41.199	WebLogic	3,302	EVENT	WARN
4	2021-07-25 01:13:43.000	217.101.31.217	App97	4,728	EVENT	WARN
5	2021-07-25 01:13:43.000	175.101.45.175	App05	527	EVENT	INFO
6	2021-07-25 01:13:43.000	185.101.27.185	PostgreSQL	3,648	EVENT	INFO
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11	2021-07-25 01:13:43.000	203.101.47.203	HRIS	4,059	EVENT	TRACE
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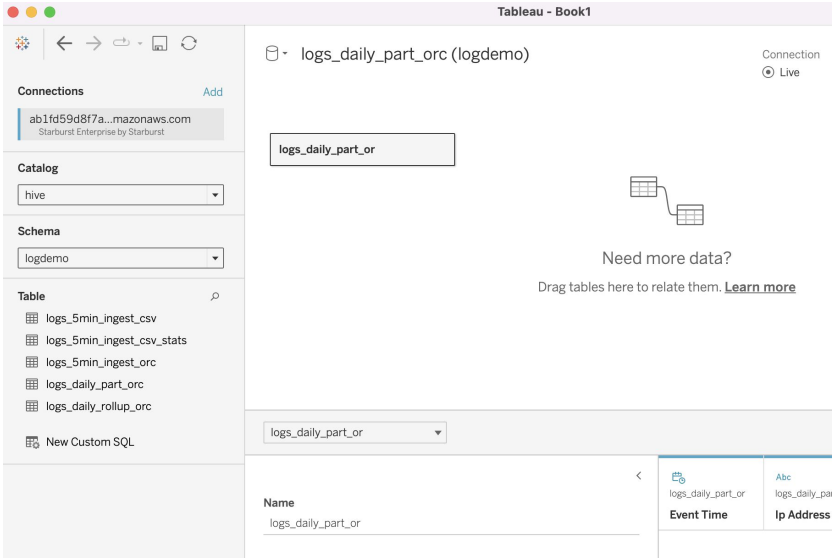
20	2021-07-25 01:13:43.000	135.101.43.135	DB2	4,148	EVENT	TRACE

Artifact: Connecting DBeaver to Starburst Enterprise (YouTube)

Starburst

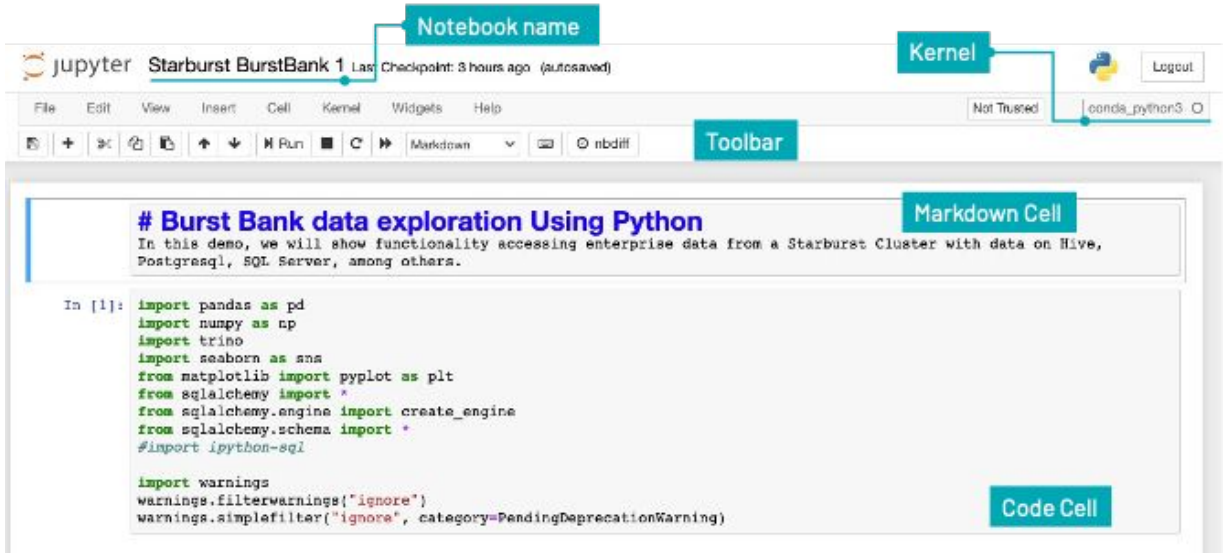
Connect via Tableau



Artifact: Using Starburst Galaxy to Query in Tableau (YouTube)

Starburst

Connect via Jupyter (via Python client)



Artifact: trinodb / trino-python-client (GitHub)

Starburst

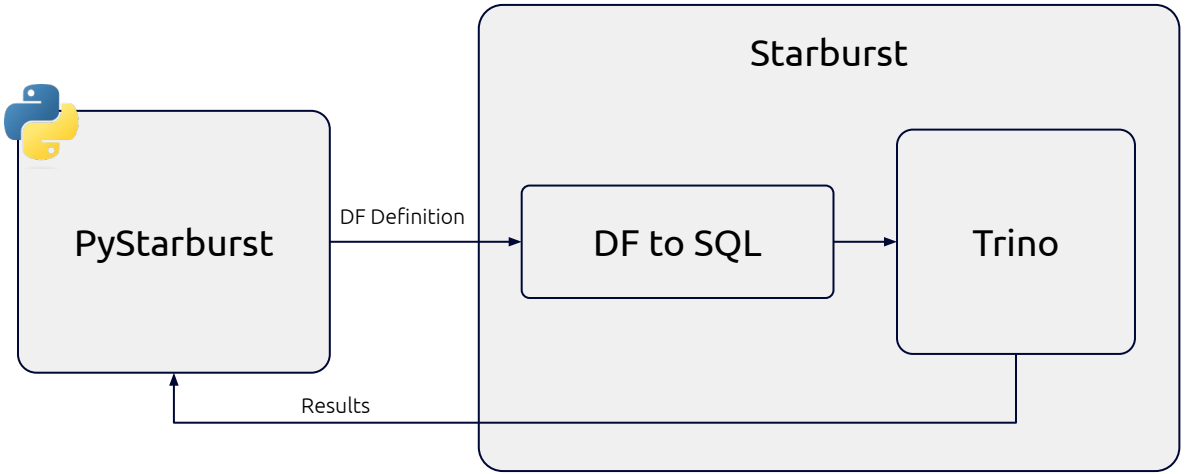
PyStarburst Overview [Data Engineers/Scientists

```
df_missions = df_missions.with_column("date", f.sql_expr("COALESCE(TRY(date_parse(\"date\", '%a %b %d, %Y %H:%i UTC')), NULL)"))

print(df_missions.schema)

df_missions = df_missions\
    .filter(col("date") > datetime(2000, 1, 1))\
    .sort(col("date"), ascending=True)

df_missions.show()
```



- PySpark-like Syntax
- Lazy execution
- Python gets converted to SQL
- Heavy lifting done by Trino

Links: API Docs & Example Code

Currently supported on Starburst Galaxy and Starburst Enterprise.

Starburst

Lesson summary

Starburst features: Client tools integrations

1. Starburst Galaxy integrates with a number of client tools, including DBeaver, Tableau, and Jupyter.

2. Client tools connect via the CLI or one of the supported APIs.

3. Data producers use these tools to support ETL pipelines. Data consumers, including data scientists and analysts, use them to achieve business insights.

4. Starburst makes full use of JDBC and ODBC connectors, both of which are versatile and adaptable.

5. Starburst can be accessed via Python clients, often through web based notebooks.