Data Contracts

JOCHEN CHRIST, ENTROPY DATA
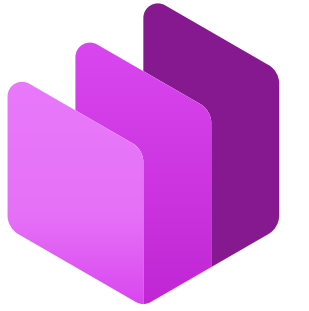
INNOQ

JOCHEN CHRIST
/in/jochenchrist

Hello, I am Jochen

Co-founder and CTO, Entropy Data

External INNOQ Consultant

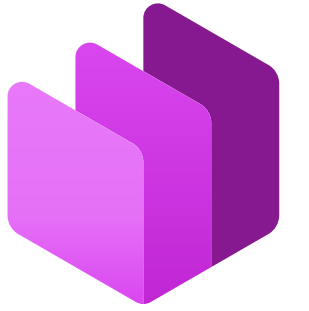Author datamesh-architecture.com

Author datacontract.com

Maintainer Data Contract CLI

TSC Member, Bitol, Open Data Contract Standard

Entropy Data

A solution for managing and sharing data products with data contracts, so everyone in an organization can use data to generate business value.
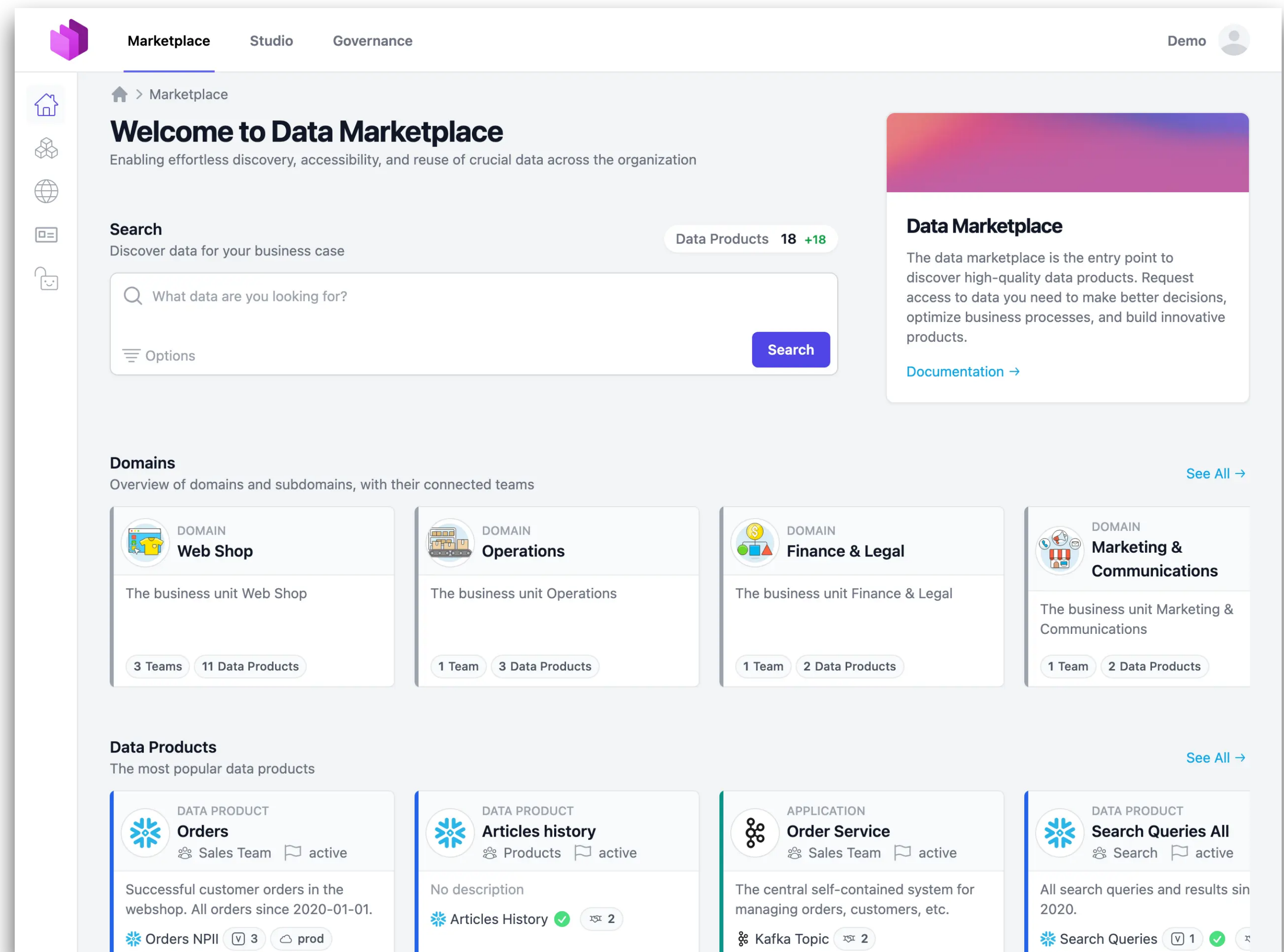
Data Product Marketplace. Self-service marketplace for humans and AI clients to discover, request, and consume data products, with context provided by data contracts.

Industry Standards. Native support for Open Data Product Standard (ODPS) and Open Data Contract Standard (ODCS) with user-friendly editors.

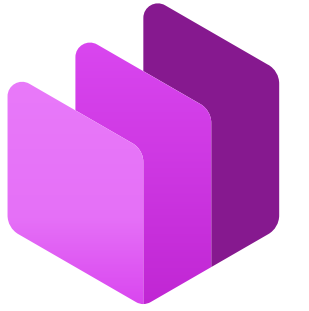**Support for Data Contract CLI.** Automated testing of data contracts to enforce promised data quality and SLAs.

Integrations. Integration with all major data platforms (AWS, GCP, Microsoft, Databricks, Snowflake) and data governance tools.

UX/UI. It looks great.

Marketplace   Studio   Governance   Demo

🏠 > Marketplace

Welcome to Data Marketplace
Enabling effortless discovery, accessibility, and reuse of crucial data across the organization

Search
Discover data for your business case

Data Products   18   +18

🔍 What data are you looking for?

≡ Options   **Search**

Data Marketplace
The data marketplace is the entry point to discover high-quality data products. Request access to data you need to make better decisions, optimize business processes, and build innovative products.

Documentation →

Domains   See All →
Overview of domains and subdomains, with their connected teams

DOMAIN Web Shop	DOMAIN Operations	DOMAIN Finance & Legal	DOMAIN Marketing & Communications
The business unit Web Shop	The business unit Operations	The business unit Finance & Legal	The business unit Marketing & Communications
3 Teams 11 Data Products	1 Team 3 Data Products	1 Team 2 Data Products	1 Team 2 Data Products

Data Products   See All →
The most popular data products

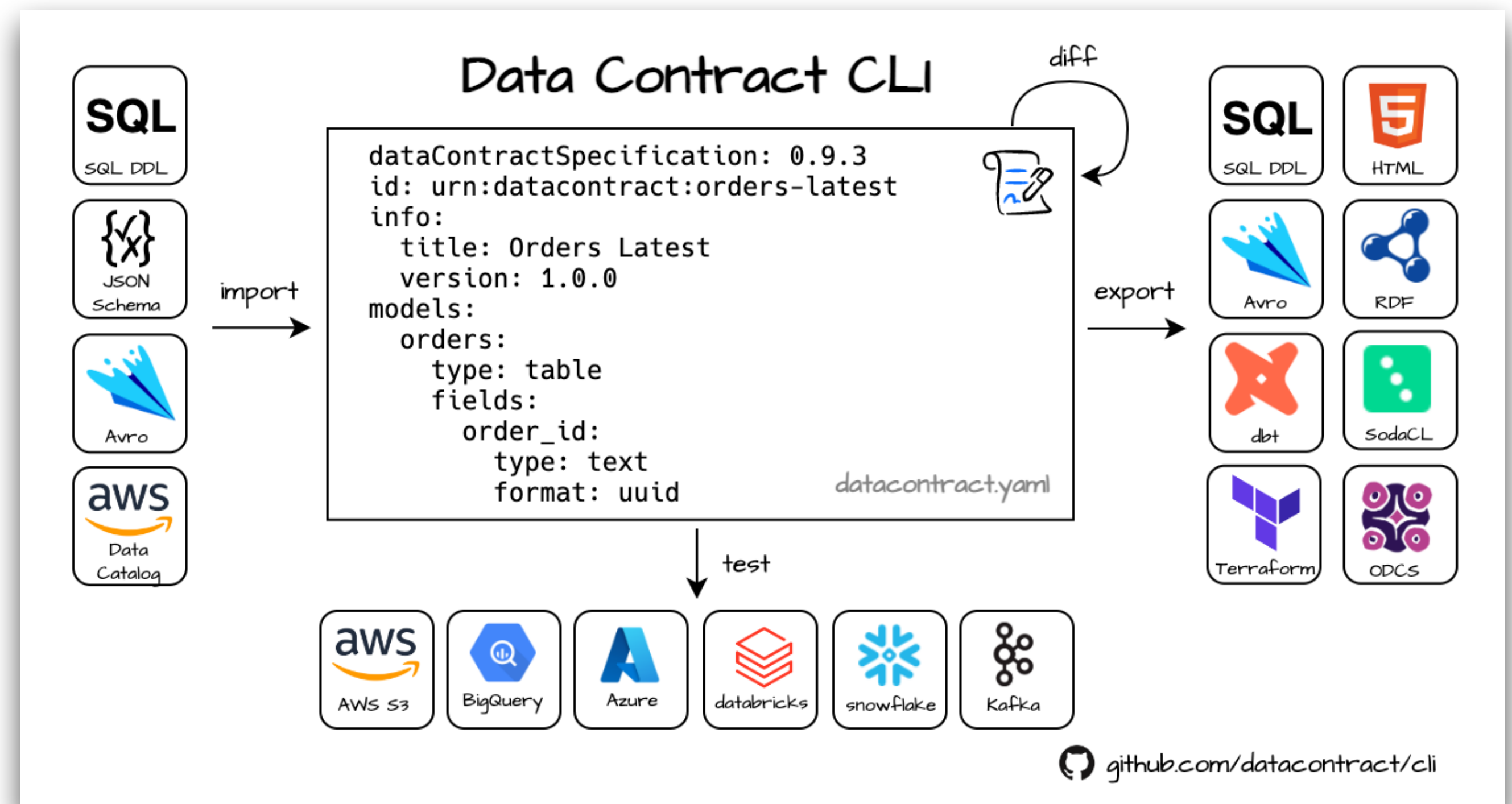| DATA PRODUCT Orders	DATA PRODUCT Articles history	APPLICATION Order Service	DATA PRODUCT Search Queries All
❄ Sales Team ⚑ active	❄ Products ⚑ active	🔗 Sales Team ⚑ active	❄ Search ⚑ active
Successful customer orders in the webshop. All orders since 2020-01-01.	No description	The central self-contained system for managing orders, customers, etc.	All search queries and results sin 2020.
❄ Orders NPII ⓥ 3 ☁ prod	❄ Articles History ✓ ⊠ 2	⚙ Kafka Topic ⊠ 2	❄ Search Queries ⓥ 1 ✓

Data Contract CLI

The popular Data Contract CLI is the most widely used developer tool to manage data contracts.

As it is maintained by us, we ensure tight integration with Entropy Data.

Enforce Data Contracts. Validate data products against their contracts automatically during development and deployment. Run tests on your own servers to ensure data products conform to their specifications before they reach production, catching structural issues, quality problems, and compliance violations early.

Generate Code. Transform data contracts into code artifacts to bootstrap data product implementations. Generate SQL DDL, dbt files, JSON Schema, and more. Data Contract YAMLs are the metadata source of truth for provisioning other systems, such as data catalogs, semantic web technologies, and EAM tools.

Open Source. Python library that can be security assessed and it makes it is easy to extend.

Data Contract CLI

```
dataContractSpecification: 0.9.3
id: urn:datacontract:orders-latest
info:
    title: Orders Latest
    version: 1.0.0
models:
    orders:
        type: table
        fields:
            order_id:
                type: text
                format: uuid
```

datacontract.yaml

github.com/datacontract/cli

Data Contract

```yaml
apiVersion: v3.1.0
kind: DataContract
id: fulfillment_shipments_v2
name: Shipments v2
version: 2.0.0
status: draft
description:
  purpose: This data can be used for analytical purposes
  usage: Use this to analyze shipments
  limitations: Not suitable for real-time use cases
  authoritativeDefinitions:
  - type: Data Guidelines
    url: https://example.com/data-guidelines.html
schema:
- name: shipments2
  physicalType: table
  physicalName: shipments_v2
  description: "This table contains shipment data, including details about shipment IDs, associated orders, delive
  dataGranularityDescription: Not Aggregated
  properties:
- name: shipment_id
  businessName: Shipment ID
  logicalType: string
  physicalType: uuid
  description: Unique identifier for each shipment.
  primaryKey: true
  classification: internal
  examples:
  - 123e4567-e89b-12d3-a456-426614174000
  authoritativeDefinitions:
  - type: definition
    url: https://datamesh-manager-demo.azurecontainerapps.io/demo911396563392/definitions/fulfillment/shipment_i
```

Data Contracts = API, but for Data

APIs

OPENAPI INITIATIVE

Messages
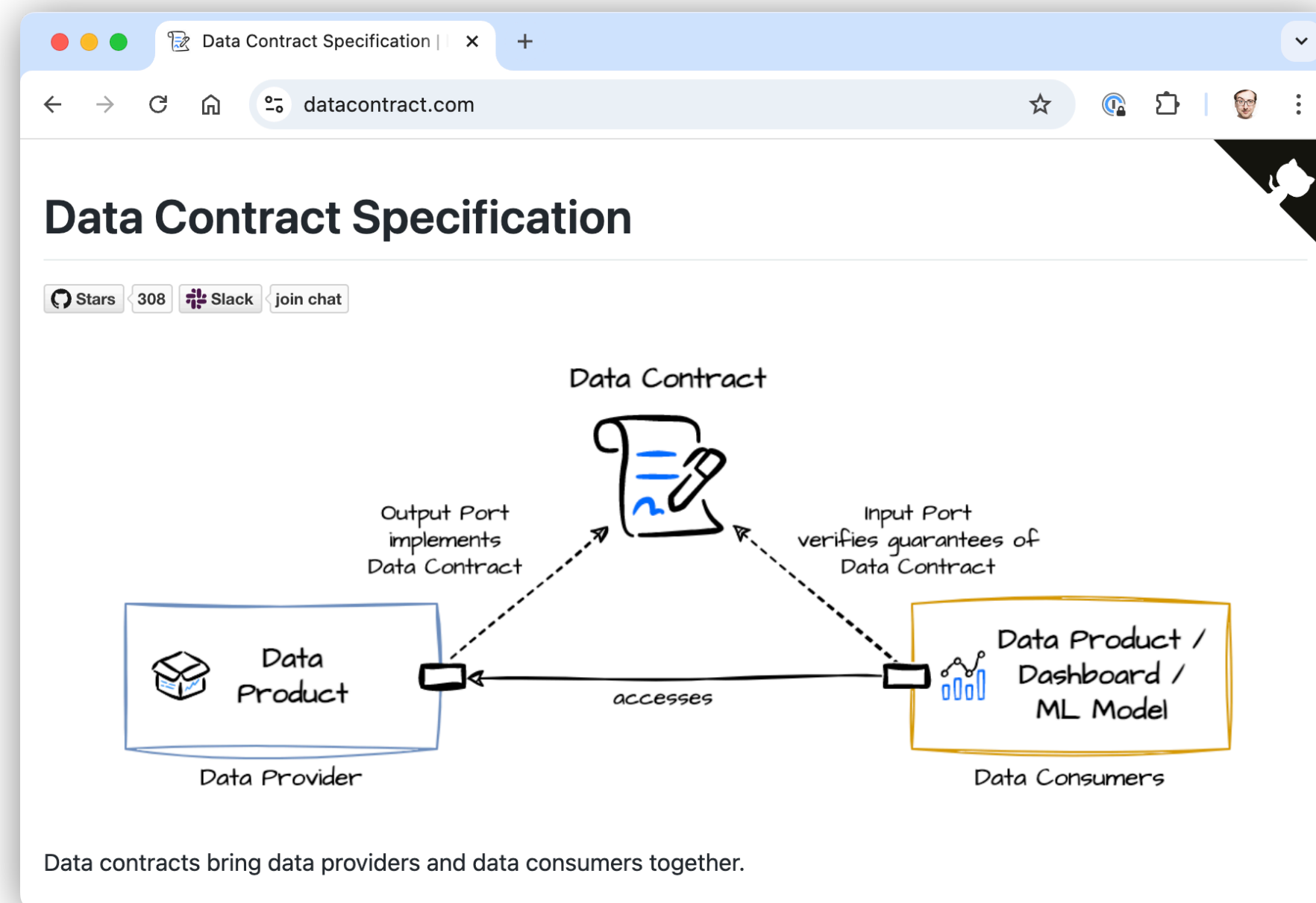
AsyncAPI

Data

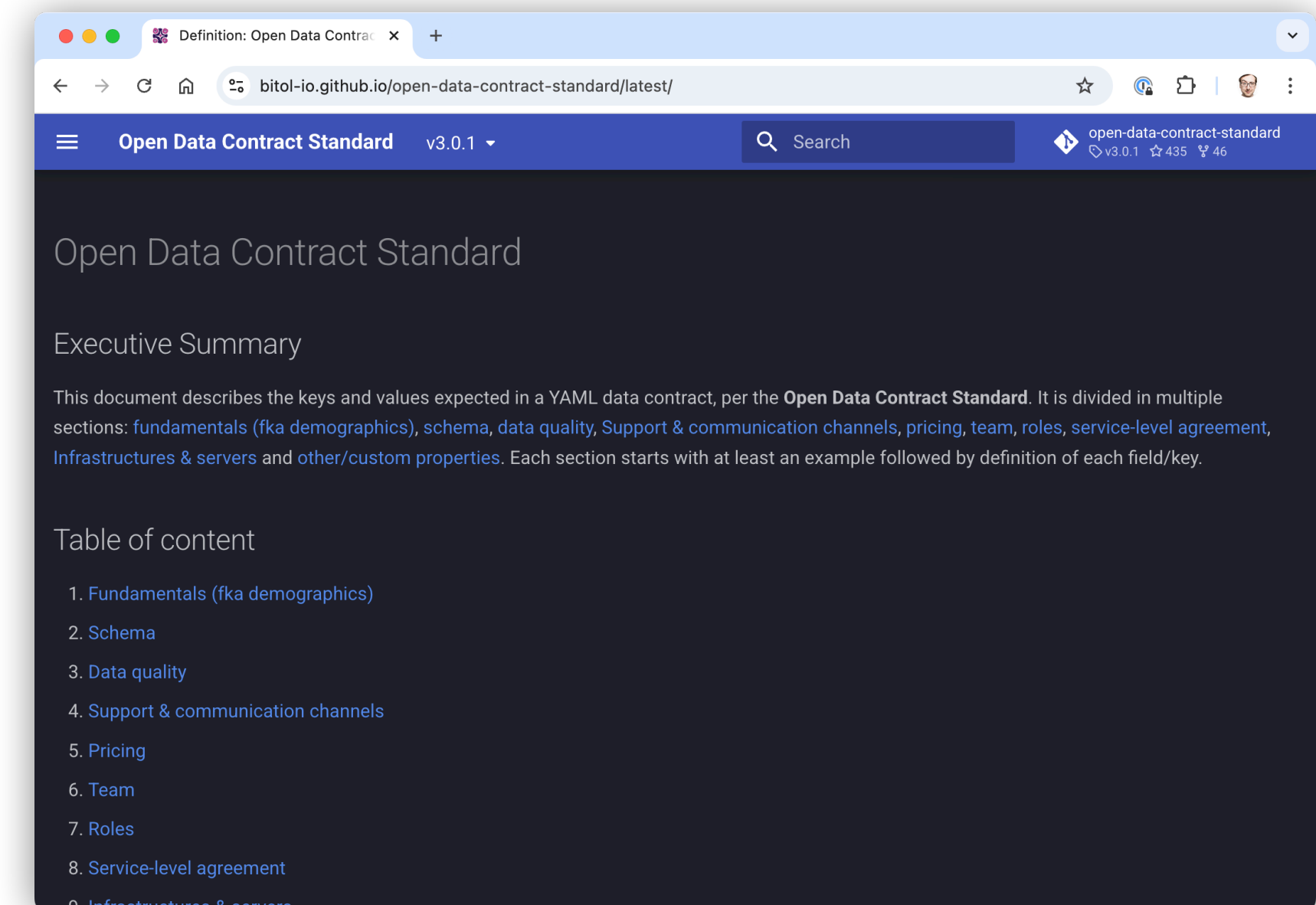Bitol Open Data Contract Standard

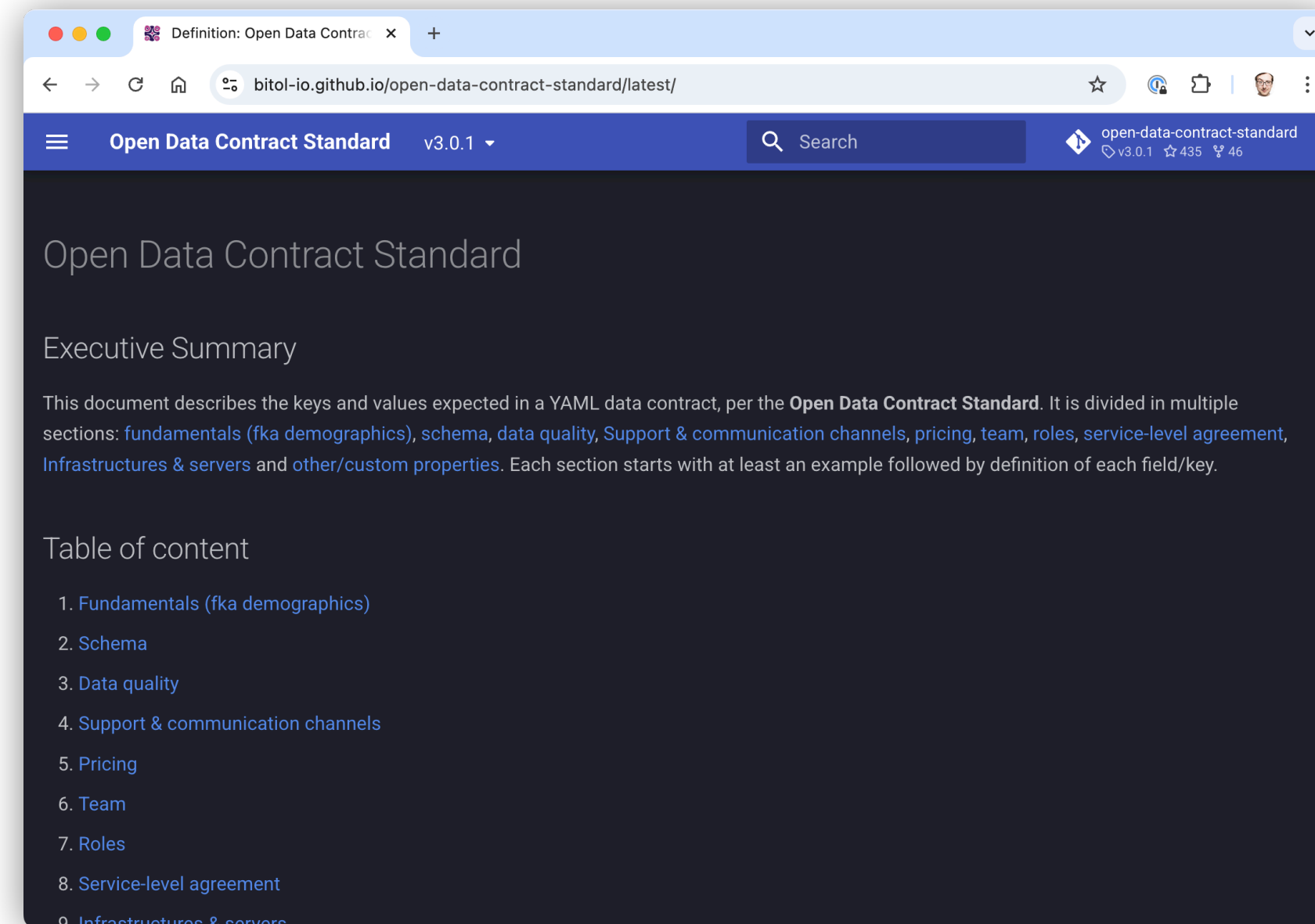# Data Contract Standards

Data Contract Specification

datacontract.com

bitol-io.github.io/open-data-contract-standard/

Data Contract Standard

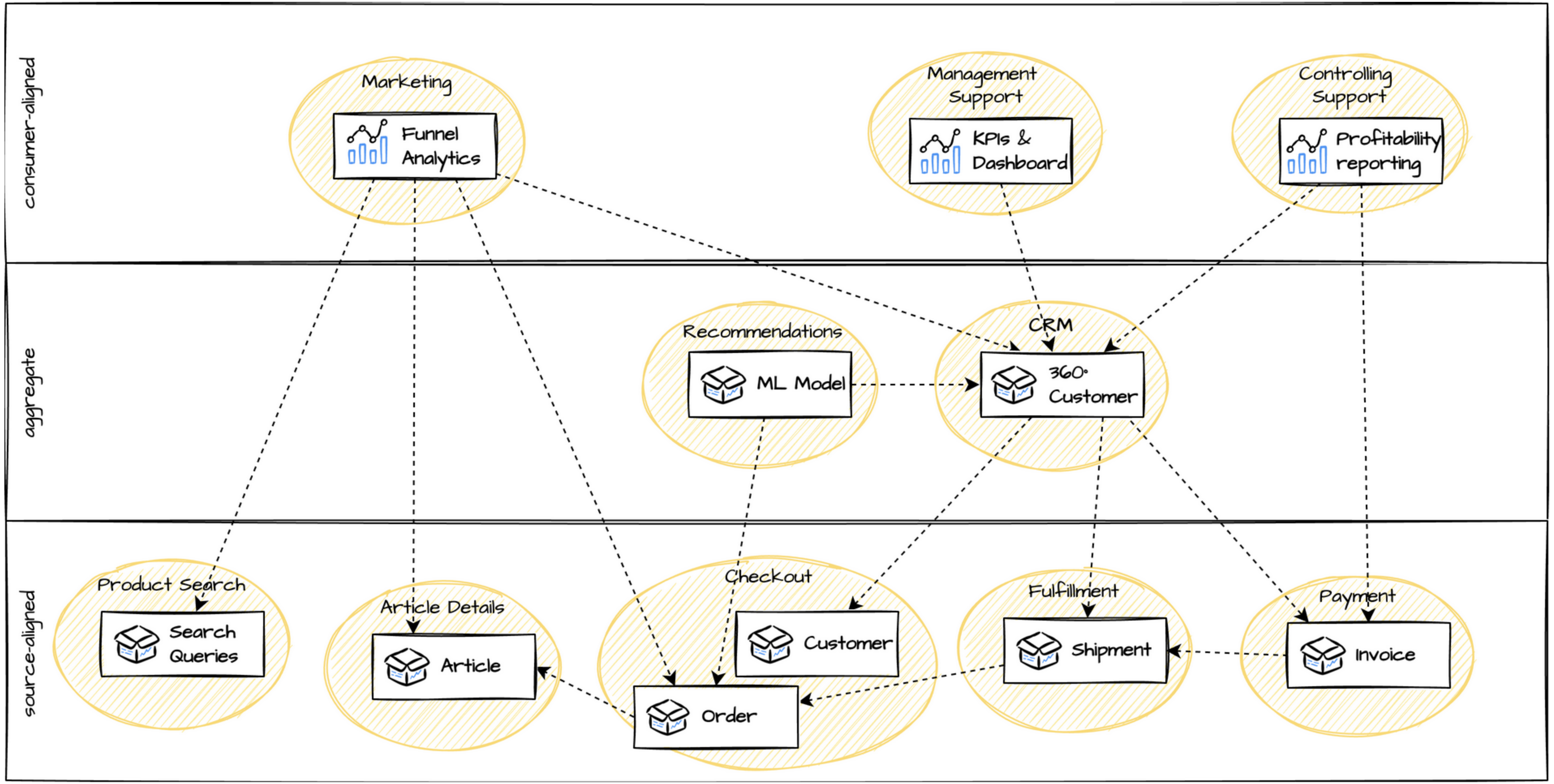bitol-io.github.io/open-data-contract-standard/

Approaches

Data-first
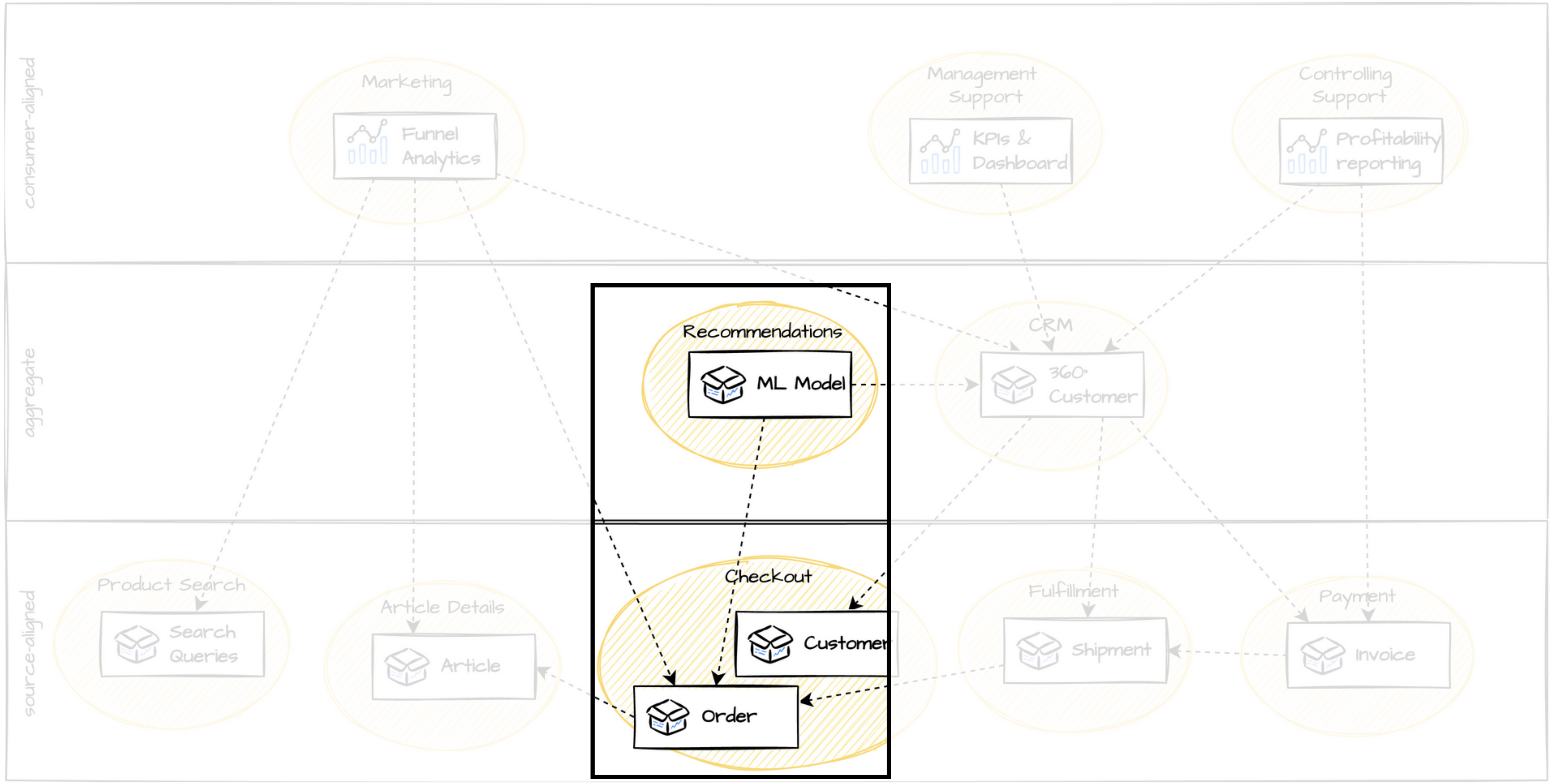
You have a data set.
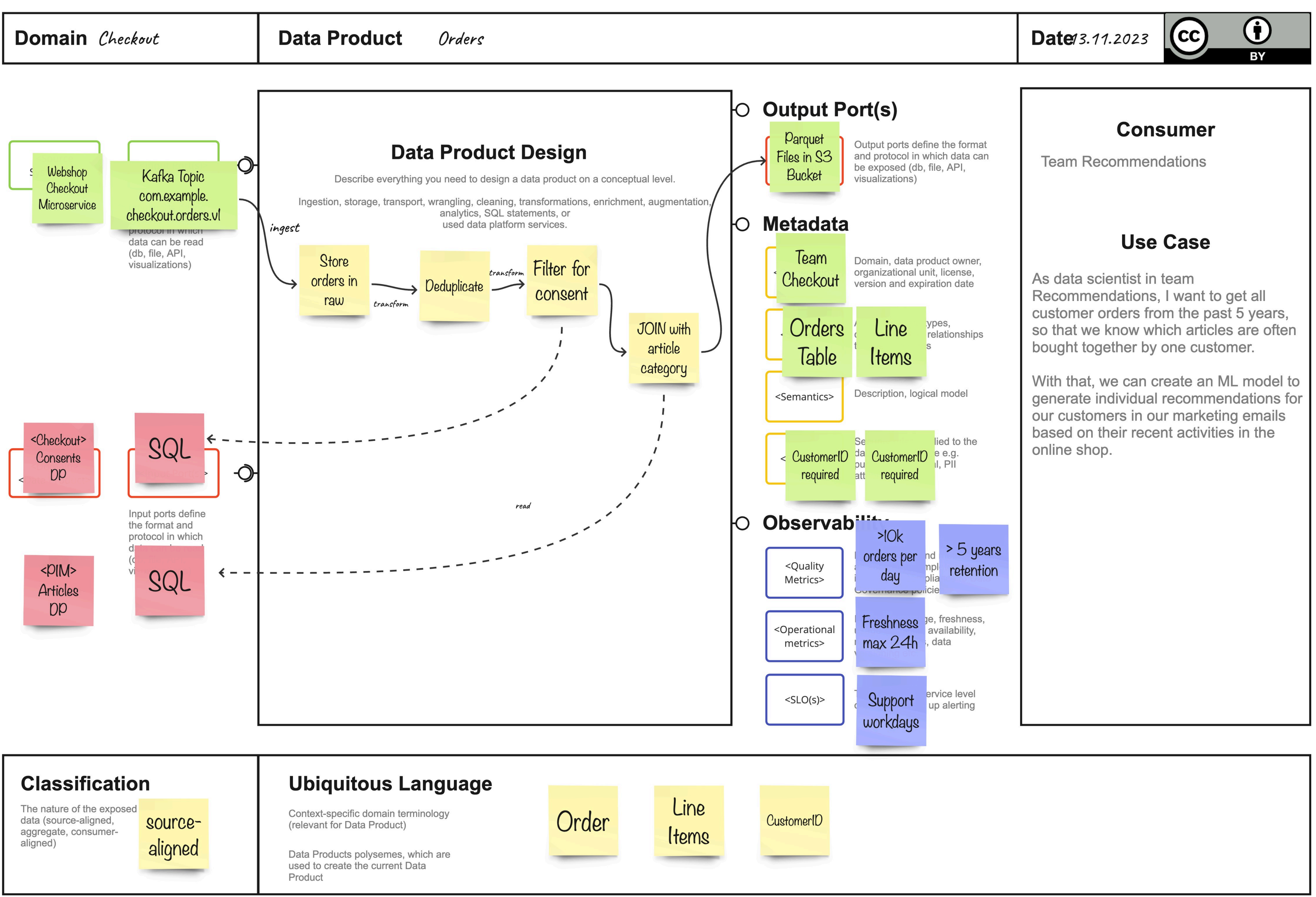Now you add the metadata.

Contract-first

You define requirements as data contract.
Then you build a data product.

Example

Data Product Orders
for Team Recommendations

Domain *Checkout* | **Data Product** *Orders* | **Date** *13.11.2023*

Data Product Design

Describe everything you need to design a data product on a conceptual level.

Ingestion, storage, transport, wrangling, cleaning, transformations, enrichment, augmentation, analytics, SQL statements, or used data platform services.

- Webshop Checkout Microservice
- Kafka Topic com.example. checkout.orders.v1

ingest

- Store orders in raw → *transform* → Deduplicate → *transform* → Filter for consent → JOIN with article category

transform
read

- <Checkout> Consents DP
- SQL
- <PIM> Articles DP
- SQL

Input ports define the format and protocol in which data can be read (db, file, API, visualizations)

Output Port(s)

- Parquet Files in S3 Bucket

Output ports define the format and protocol in which data can be exposed (db, file, API, visualizations)

Metadata

- Team Checkout

Domain, data product owner, organizational unit, license, version and expiration date

- Orders Table
- Line Items

types, relationships

- <Semantics>

Description, logical model

- CustomerID required
- CustomerID required

Se... ...lied to the da... ...e e.g. ...l, PII

Observability

- <Quality Metrics>
- <Operational metrics>
- <SLO(s)>

- >10k orders per day
- > 5 years retention
- Freshness max 24h
- Support workdays

...ge, freshness, ... availability, ... data

service level ...up alerting

Consumer

Team Recommendations

Use Case

As data scientist in team Recommendations, I want to get all customer orders from the past 5 years, so that we know which articles are often bought together by one customer.

With that, we can create an ML model to generate individual recommendations for our customers in our marketing emails based on their recent activities in the online shop.

Classification

The nature of the exposed data (source-aligned, aggregate, consumer-aligned)

- source-aligned

Ubiquitous Language

Context-specific domain terminology (relevant for Data Product)

Data Products polysemes, which are used to create the current Data Product

- Order
- Line Items
- CustomerID

datamesh-architecture.com/data-product-canvas

Drive Data Product Development by Business Case

"As data scientist in team Recommendations, I want to get all webshop orders from the past 5 years, so that we know which articles (categories) are often bought together by one customer.

With that, we can create an ML model to generate individual recommendations for our customers in our marketing emails based on their recent activities in the online shop."

Sophia, Data Scientist

Ownership

```yaml
apiVersion: v3.1.0
kind: DataContract
id: orders
name: Orders
version: 1.0.0
status: active
tenant: company-A
team:
  name: sales-team
tags:
- datalocation:EU
```

Data Model

```yaml
schema:
- name: shipments_v2
  physicalType: table
  description: "This table contains shipment data, including details about shipment IDs."
  properties:
  - name: shipment_id
    businessName: Shipment ID
    description: Unique identifier for each shipment.
    logicalType: string
    physicalType: uuid
    primaryKey: true
    partitioned: false
    classification: internal
    examples:
    - 123e4567-e89b-12d3-a456-426614174000
    tags:
    - pii:false
    authoritativeDefinitions:
    - type: definition
      url: https://demo.datamesh-manager.com/demo948744545264/definitions/fulfillment/shipment_id
  - name: order_id
    physicalName: oid
    physicalType: text
    primaryKey: false
```

Quality

```yaml
- name: delivery_date
  businessName: Delivery Date
  description: The actual or expected delivery date of the shipment.
  logicalType: date
  physicalType: timestamp_tz
  required: false
  classification: internal
  examples:
    - 2023-10-01T10:00:00Z
  quality:
    - type: sql
      description: The delivery_date is expected to be not before and not more than 30 days after the order_date in 95% of all shipments.
      query: |
        SELECT
        (
          COUNT(*) FILTER (WHERE delivery_date >= order_date AND delivery_date <= DATEADD(DAY, 30, order_date)) * 100.0
          / COUNT(*)
        ) AS percentage_within_range
        FROM shipments_v2
      mustBeGreaterThan: 95
```

Drive Data Product Development by Business Case

"As data scientist in team Recommendations, I want to get all webshop orders from the past 5 years, so that we know which articles (categories) are often bought together by one customer.

With that, we can create an ML model to generate individual recommendations for our customers in our marketing emails based on their recent activities in the online shop."
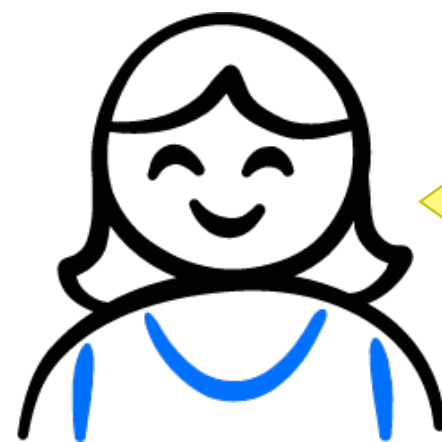
Ah, good to know. That is OK for us.

Sophia, Data Scientist

"Sorry, we cannot give you *all* orders, but only orders when the customer expressed their consent for analytical use. That are around 80% of all orders.

John, Product Owner Team Checkout

Terms of Use

```yaml
description:
  purpose: analytical
  usage: The data can be used for analytical purposes and AI use cases
  limitations: |
    As the dataset is filtered, these daset cannot be used for financial KPIs
  authoritativeDefinitions:
  - type: GDPR Policies
    url: https://example.com/gdpr-policies.html
```

Service Levels

```yaml
servicelevels:
  availability:
    description: The server is available during support hours
    percentage: 99.9%
  retention:
    description: Data is retained for one year
    period: P1Y
    unlimited: false
  frequency:
    description: Data is delivered once a day
    type: batch
    cron: 0 0 * * *
  support:
    description: The data is available during typical business hours at headquarters
    time: 9am to 5pm in EST on business days
    responseTime: 1h
  backup:
    description: Data is backed up once a week, every Sunday at 0:00 UTC.
    interval: weekly
    cron: 0 0 * * 0
    recoveryTime: 24 hours
    recoveryPoint: 1 week
```

Servers (Physical Endpoints)

```yaml
servers:
  production:
    type: BigQuery
    project: acme_sales_prod
    dataset: orders_latest_pii_v1
```

```yaml
apiVersion: v3.1.0
kind: DataContract
id: fulfillment_shipments_v2
name: Shipments v2
version: 2.0.0
status: draft
description:
  purpose: This data can be used for analytical purposes
  usage: Use this to analyze shipments
  limitations: Not suitable for real-time use cases
  authoritativeDefinitions:
  - type: Data Guidelines
    url: https://example.com/data-guidelines.html
schema:
- name: shipments2
  physicalType: table
  physicalName: shipments_v2
  description: "This table contains shipment data, including details about shipment IDs, associated orders, delive
  dataGranularityDescription: Not Aggregated
  properties:
- name: shipment_id
  businessName: Shipment ID
  logicalType: string
  physicalType: uuid
  description: Unique identifier for each shipment.
  primaryKey: true
  classification: internal
  examples:
  - 123e4567-e89b-12d3-a456-426614174000
  authoritativeDefinitions:
  - type: definition
    url: https://datamesh-manager-demo.azurecontainerapps.io/demo911396563392/definitions/fulfillment/shipment_i
```

Excel Template

https://github.com/datacontract/open-data-contract-standard-excel-template

A data contract
is not a contract

A data contract
is not a contract in a legal sense

A data contract
is an offer

A data contract

is an offer

for consumers to use data with guarantees under specified terms and conditions

A data contract
is an interface specification

Benefits

Why Data Contracts became important?
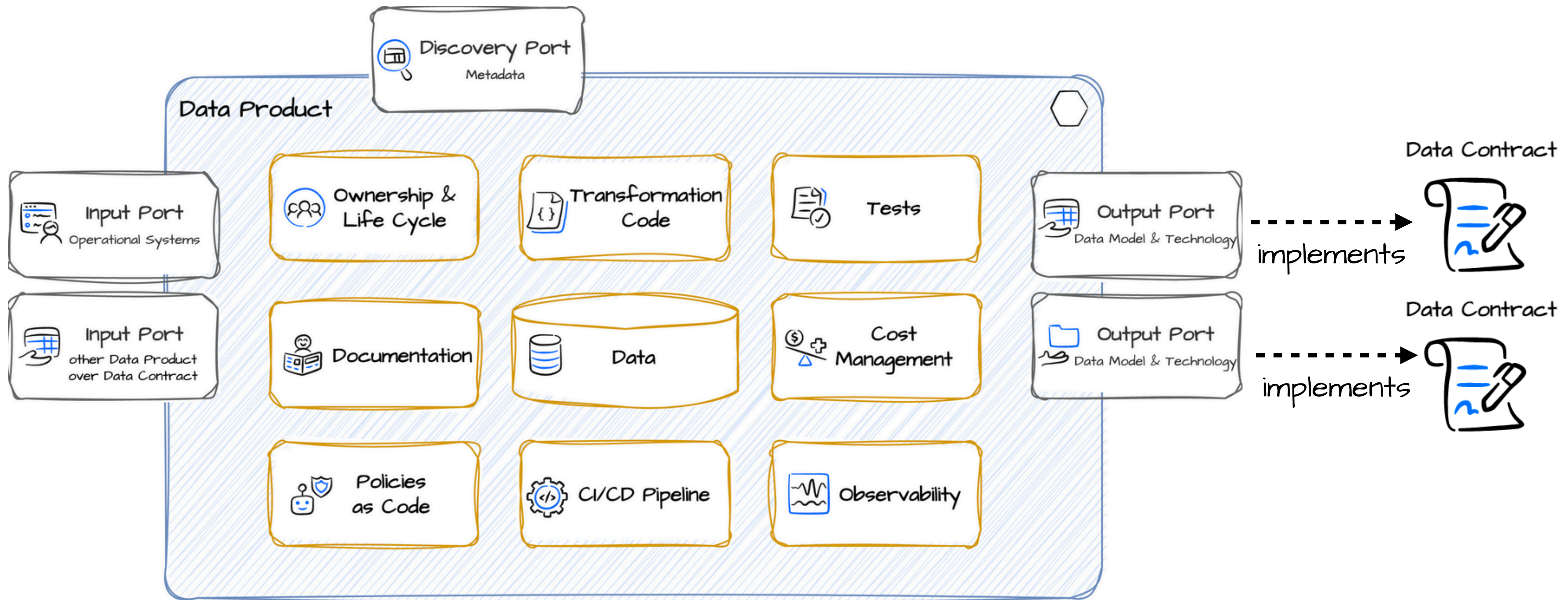
Data Contracts are the Metadata Foundation for Sharing Data with other Teams (and AI)
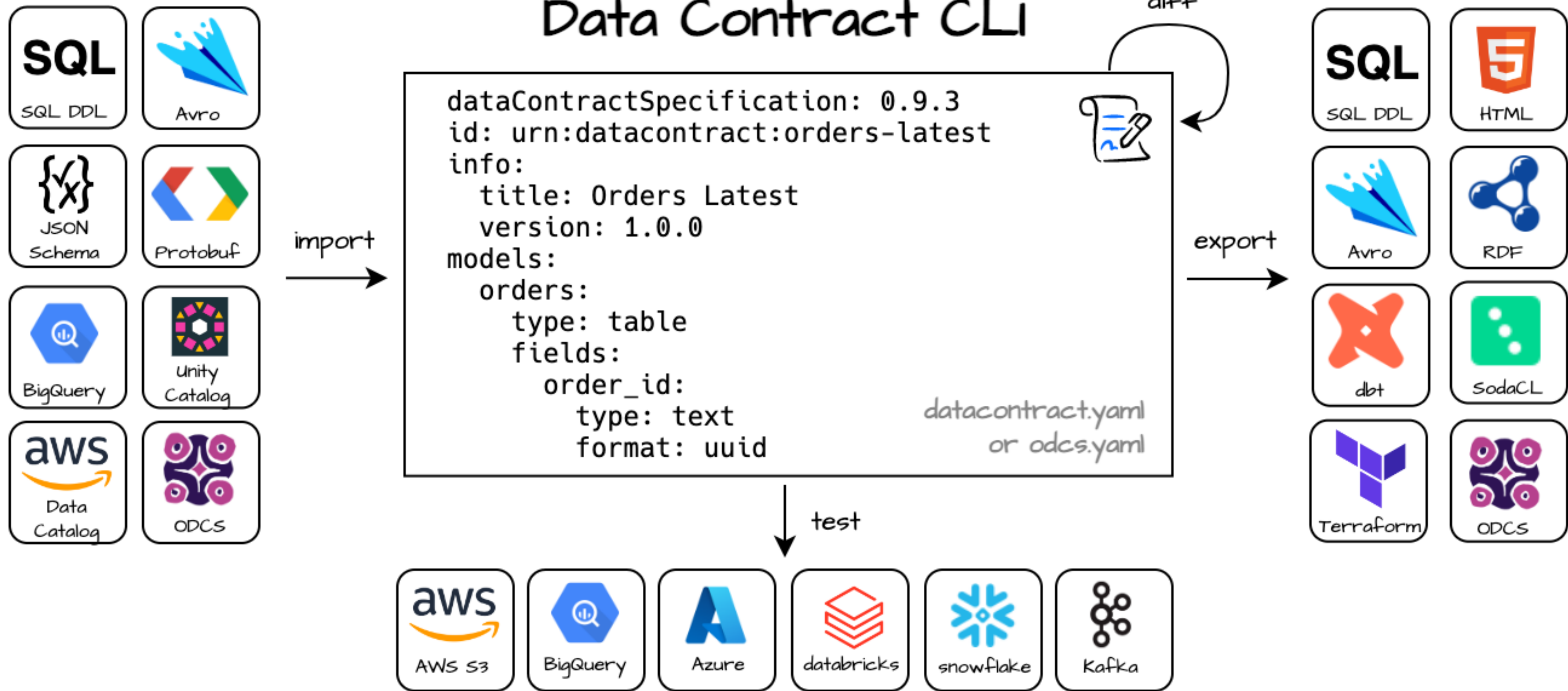
- **Communication:** Collaboration & Requirements Engineering (Excel!)

- **Trust:** Data Contract Testing (CLI!)

- **Discover:** Enterprise Data Marketplace (Entropy Data!)

- **Context:** Semantics, Structure, and SLAs (MCP!)

- **Governance:** Terms of Use (Entropy Data MCP!)

Contract Testing

A data product implements a data contract

Data Product

Discovery Port
Metadata

Input Port
Operational Systems

Input Port
other Data Product
over Data Contract

Ownership &
Life Cycle

Transformation
Code

Tests

Documentation

Data

Cost
Management

Policies
as Code

CI/CD Pipeline

Observability

Output Port
Data Model & Technology

Output Port
Data Model & Technology

Data Contract

Data Contract

implements

implements

datamesh-architecture.com

Data Contract CLI


```
dataContractSpecification: 0.9.3
id: urn:datacontract:orders-latest
info:
  title: Orders Latest
  version: 1.0.0
models:
  orders:
    type: table
    fields:
      order_id:
        type: text
        format: uuid
```

datacontract.yaml
or odcs.yaml

diff

import

export

test

SQL DDL · Avro · JSON Schema · Protobuf · BigQuery · Unity Catalog · aws Data Catalog · ODCS

SQL DDL · HTML · Avro · RDF · dbt · SodaCL · Terraform · ODCS

aws AWS S3 · BigQuery · Azure · databricks · snowflake · Kafka

github.com/datacontract/cli

datacontract test

```
$ datacontract test datacontract.yaml
```

```yaml
order_total:
  description: Total amount the smallest monetary unit (e.g., cents)
  type: long
  required: true
customer_id:
  description: Unique identifier for the customer.
  type: text
  minLength: 10
  maxLength: 20
customer_email_address:
  description: The email address, as entered by the customer. The em
  type: text
  format: email
  required: true
```

```yaml
order_total:
  description: Total amount the smallest monetary unit (e.g., cents).
  type: long
  required: true
  examples:
    - 9999
  quality:
    - type: sql
      description: 95% of all order total values are expected to be between 10 and 499 EUR.
      query: |
        SELECT quantile_cont(order_total, 0.95) AS percentile_95
        FROM orders
      mustBeBetween: [1000, 49900]
```

Data Contract Testing

```
[jochen@Jochens-MacBook-Pro-2 ~ % datacontract test https://datacontract.com/examples/orders-latest/datacontract.yaml
Testing https://datacontract.com/examples/orders-latest/datacontract.yaml
```

Result	Check	Field	Details
passed	Check that JSON has valid schema	orders	All JSON entries are valid.
passed	Check that JSON has valid schema	line_items	All JSON entries are valid.
passed	Check that field order_id is present	orders	
passed	Check that field order_timestamp is present	orders	
passed	Check that field order_total is present	orders	
passed	Check that field customer_id is present	orders	
passed	Check that field customer_email_address is present	orders	
passed	Check that field processed_timestamp is present	orders	
passed	row_count >= 5	orders	
passed	Check that required field order_id has no null values	orders.order_id	
passed	Check that unique field order_id has no duplicate values	orders.order_id	
passed	duplicate_count(order_id) = 0	orders.order_id	
passed	Check that required field order_timestamp has no null values	orders.order_timestamp	
passed	Check that required field order_total has no null values	orders.order_total	
passed	Check that required field customer_email_address has no null values	orders.customer_email_address	
passed	Check that required field processed_timestamp has no null values	orders.processed_timestamp	
passed	Check that field lines_item_id is present	line_items	
passed	Check that field order_id is present	line_items	
passed	Check that field sku is present	line_items	
passed	values in (order_id) must exist in orders (order_id)	line_items.order_id	
passed	row_count >= 5	line_items	
passed	Check that required field lines_item_id has no null values	line_items.lines_item_id	
passed	Check that unique field lines_item_id has no duplicate values	line_items.lines_item_id	

```
🟢 data contract is valid. Run 23 checks. Took 6.776398 seconds.
jochen@Jochens-MacBook-Pro-2 ~ %
```

❌ datacontract-test

✅ **Data Contract Test Results**

GitHub Actions / Data Contract Test Results
succeeded 1 minute ago in 0s

27 passed, 1 failed and 0 skipped

`tests` `27 passed, 1 failed`

❌ ./TEST-datacontract.xml

28 tests were completed in **4s** with **27** passed, **1** failed and **0** skipped.

Test suite	Passed	Failed	Skipped	Time
snowflake_orders_pii_v2	27✅	1❌		4s

❌ snowflake_orders_pii_v2

```
orders.ORDER_ID
  ✅ orders__ORDER_ID__field_is_present
  ✅ orders__ORDER_ID__field_type
  ✅ orders__ORDER_ID__field_required
orders.PREVIOUS_ORDER_ID
  ✅ orders__PREVIOUS_ORDER_ID__field_is_present
  ❌ orders__PREVIOUS_ORDER_ID__field_type
        Type Mismatch, Expected Type: NUMBER; Actual Type: TEXT
orders.CUSTOMER_ID
  ✅ orders__CUSTOMER_ID__field_is_present
  ✅ orders__CUSTOMER_ID__field_type
  ✅ orders__CUSTOMER_ID__field_required
```

localhost:8080/demo129500424135/dataproducts/orders/outputports/60107bb0-6711-4d30-8357-d2acac96fc74/checks

Search **Data Contracts** Data Products Data Governance [AI] More ⌄

ACME

🏠 > Data Products > Orders > Output Ports > snowflake_orders_pii_v2 > Checks

Checks

d8445796-d5f0-4b31-9e78-a932dc2a5977

Info
Information about the checks

Overall Result	Last Run
✅ Passed	9 minutes ago

Server

orders/snowflake_orders_pii_v2

Data Contract
Defines the syntax, semantics, and quality

Orders
All order-created events, with PII.

Checks
Test summary

Result	Check	Details
✅ Passed	Check that the datacontract.yaml is valid	
✅ Passed	Check that the field order_id exists ⊞ orders ▢ orders_id	
✅ Passed	Check that the values in field order_id are unique ⊞ orders ▢ orders_id	
✅ Passed	Custom Query: select count(*) from orders > 1000000 ⊞ orders	
✅ Passed	freshness	

Enterprise Data Marketplace

(Commercial Tooling*)

Data Products

Discover data products for your business case and request access.

Add Data Product ⌄

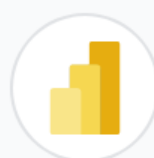🔍 Search   Owner ⌄   Type ⌄   Status ⌄   Output Port ⌄   Environment ⌄   Tag ⌄

Download   📖 ☰ ⊞

DATA CONSUMER
Article Profitability Analysis
👥 Controlling Team   🚩 active

A PowerBI report that combines revenue, cost, and margin to deliver actionable insights into the profitability of each article. It is designed to help...

● demo

APPLICATION
Article Service
👥 Products   🚩 active

The central self-contained system for articles.

⚙️ Articles API   🔀 1

● demo

DATA PRODUCT
Articles history
👥 Products   🚩 active

No description

❄️ Articles History ✅   🔀 2

● demo

DATA PRODUCT
Articles latest
👥 Products   🚩 active

No description

❄️ Articles Latest ✅   🔀 1

● demo

DATA PRODUCT
Customer Cohorts
👥 Marketing   🚩 active

No description

❄️ Customer Cohorts   🔀 1

● demo

DATA PRODUCT
Customers
👥 Sales Team   🚩 active

Customers are registered users and unregistered guest buyers in the online shop. Dataset all customers since launch of the online shop.

🛢️ Customers History NPII   Ⓥ 1 ✅
🛢️ Customers History PII   Ⓥ 1
❄️ Customers Latest NPII   Ⓥ 1 ✅
❄️ Customers Latest PII   Ⓥ 1 ✅   🔀 1

DATA CONSUMER
Funnel Analytics
👥 Marketing   🚩 active

No description

● demo

DATA CONSUMER
Monthly Target Performance Report
👥 Controlling Team   🚩 active

No description

APPLICATION
OpenSearch
👥 Search   🚩 active

The index for the ecommerce search

🔍 Elasticdump   🔀 1

● demo

🏠 › Studio › Data Contracts › Orders v2

Orders v2

snowflake_orders_pii_v2 2.0.0

👥 Sales Team   ◈ Connected to Git   ⚑ active   PII   ☁ Sensitive   Data Contract Specification 1.1.0

👁 Watching 6 ▾

✎ Edit ▾

Request Access

enlarge   apply layout

orders

ORDER_ID 🔑	string
PREVIOUS_ORDER_ID	string
CUSTOMER_ID	string
EMAIL	string
PHONE_NUMBER	text
INVOICE_ADDRESS	object
└ ADDRESS_LINE	text
└ CITY_LINE	text
ORDER_DATE	timestamp
ORDER_TOTAL	decimal

line_items

LINE_ITEM_ID 🔑	string
ORDER_ID	string
ARTICLE_SKU	string

React Flow

Info

Information about the data contract

Description

All order-created events, with PII.

Tags

● popular

Terms

Terms and conditions of the data contract

Usage

Max. 10x queries per day

Billing

$1000 / month

Limitations

Not suitable for real-time use cases

Notice Period

3 months

Data Product

The data product with this data contract

Orders PII (Orders)
ORDER_DB.ORDERS_PII_V2

Passed 32 checks
4 months ago

✅ Passed

Run Data Contract Test

Use Data Contract CLI API to run data contract tests.

Versions

Shows details about other major versions of this data contract

Orders v2 Ⓥ   Create v3   Show Changes

demo.datamesh-manager.com/demo882420088379/datausageagreements/request-acc...

Request Access

You are requesting access to the data product **Orders** on output port **snowflake_orders_npii_v2** .

The system will create a data usage agreement for the team **Checkout** to approve.

Consumer   Required

Data Product	Team	User
Request access for one of your data products.	Request access for everybody in your domain team.	Request access for yourself.

Consumer Data Product   Required

Recommendations ML Model (Team Recommendations) ⌄

Select your data product that needs to access and use the provided data.

Purpose   Required

We need to get all webshop orders from the past 5 years so that we know which articles (categories) are often bought together by one customer. With that, we can create an ML model to generate individual recommendations for our customers in our marketing emails based on their recent activities in the online shop. ✓

Why do you want access and what do you want to do with the data?

Cancel   Customize   Request access

Approve Access Request

Team **Recommendations** requests access to data product **Orders**.

As data product owner, you can approve or reject this request to grant access to your data product.

Approve   Reject

Data Platform

Status of the data platform integration

Status

✅ Permissions granted

Updated

1 minutes ago

Role

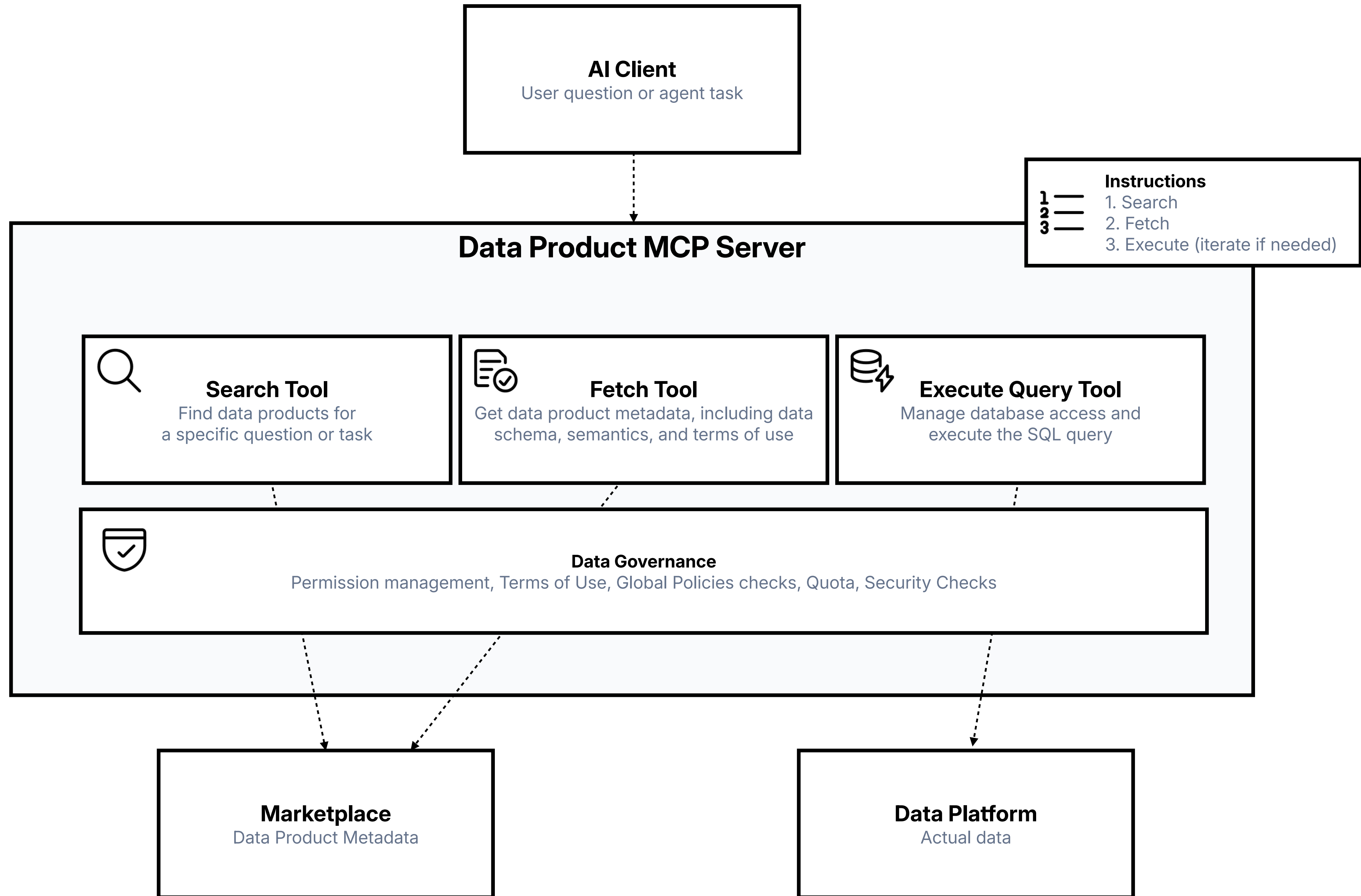agreement_55gCnBIHYdUWnUJJKYbYIs_role

Agent

Data Mesh Manager Platform Agent v0.1

Details

CREATE ROLE agreement_55gCnBIHYdUWnUJJKYbYIs_role;
GRANT ROLE op_orders_snowflake_orders_npii_v2_role TO ROLE
agreement_55gCnBIHYdUWnUJJKYbYIs_role;
GRANT ROLE agreement_55gCnBIHYdUWnUJJKYbYIs_role TO ROLE ;

Connect AI
with Business Data
(securely)

AI Client
User question or agent task

Data Product MCP Server

Instructions
1. Search
2. Fetch
3. Execute (iterate if needed)

Search Tool
Find data products for a specific question or task

Fetch Tool
Get data product metadata, including data schema, semantics, and terms of use

Execute Query Tool
Manage database access and execute the SQL query

Data Governance
Permission management, Terms of Use, Global Policies checks, Quota, Security Checks

Marketplace
Data Product Metadata

Data Platform
Actual data

✳ Good afternoon, Jochen

Sonnet 4.5

Good afternoon, Jochen

Create a CSV for mailchimp with our top 5000 customers.

Sonnet 4.5

Data Governance ✦

(Commercial Tooling)

Terms & Conditions

```yaml
terms:
  usage: "The data can be used for analytical and data science use cases, as the customer has expressed their consent."
  limitations: |
    As the dataset is filtered, these data set cannot be used to aggregate financial KPIs.
    Not suited for real-time use cases.
  billing: $1000 per month
  noticePeriod: P3M
```

Data Contracts Cover Governance Aspects

- **Ownership** Who is responsible for providing data? **Ownership (Info)**

- **Quality** What quality do we provide? **Quality Attributes & Contract Testing**

- **Compliance** What are we allowed to do with data? **Terms and Conditions**

- **Legal** In which region may data be stored? **Terms and Conditions**

- **Privacy** What is personal (PII) data? **Data Model Attribute**

- **Classification** What sensitivity level has my data? **Data Model Attributes**

- **Security** Who has access to which data and why? **--> Access Requests**

Data Contracts are the Metadata Foundation for Sharing Data with other Teams (and AI)

- **Communication:** Collaboration & Requirements Engineering (Excel!)
- **Trust:** Data Contract Testing (CLI!)
- **Discover:** Enterprise Data Marketplace (Entropy Data!)
- **Context:** Semantics, Structure, and SLAs (MCP!)
- **Governance:** Terms of Use (MCP!)

Summary

Data Contract
~ API for data

Data Contract
promotes collaboration

Data Contract
enforces data quality

Data Contract
is not a contract

Links

Open Source

- https://bitol-io.github.io/open-data-contract-standard/latest/

- https://bitol-io.github.io/open-data-product-standard/latest/

- cli.datacontract.com

Commercial

- entropy-data.com

- https://entropy-data.com/learn/mcp

Data Contracts

JOCHEN CHRIST, ENTROPY DATA

INNOQ

JOCHEN CHRIST
/in/jochenchrist