Data Processing and Interoperability Services in DataPorts

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DataPorts
Data Platform for the Connection of Cognitive Ports

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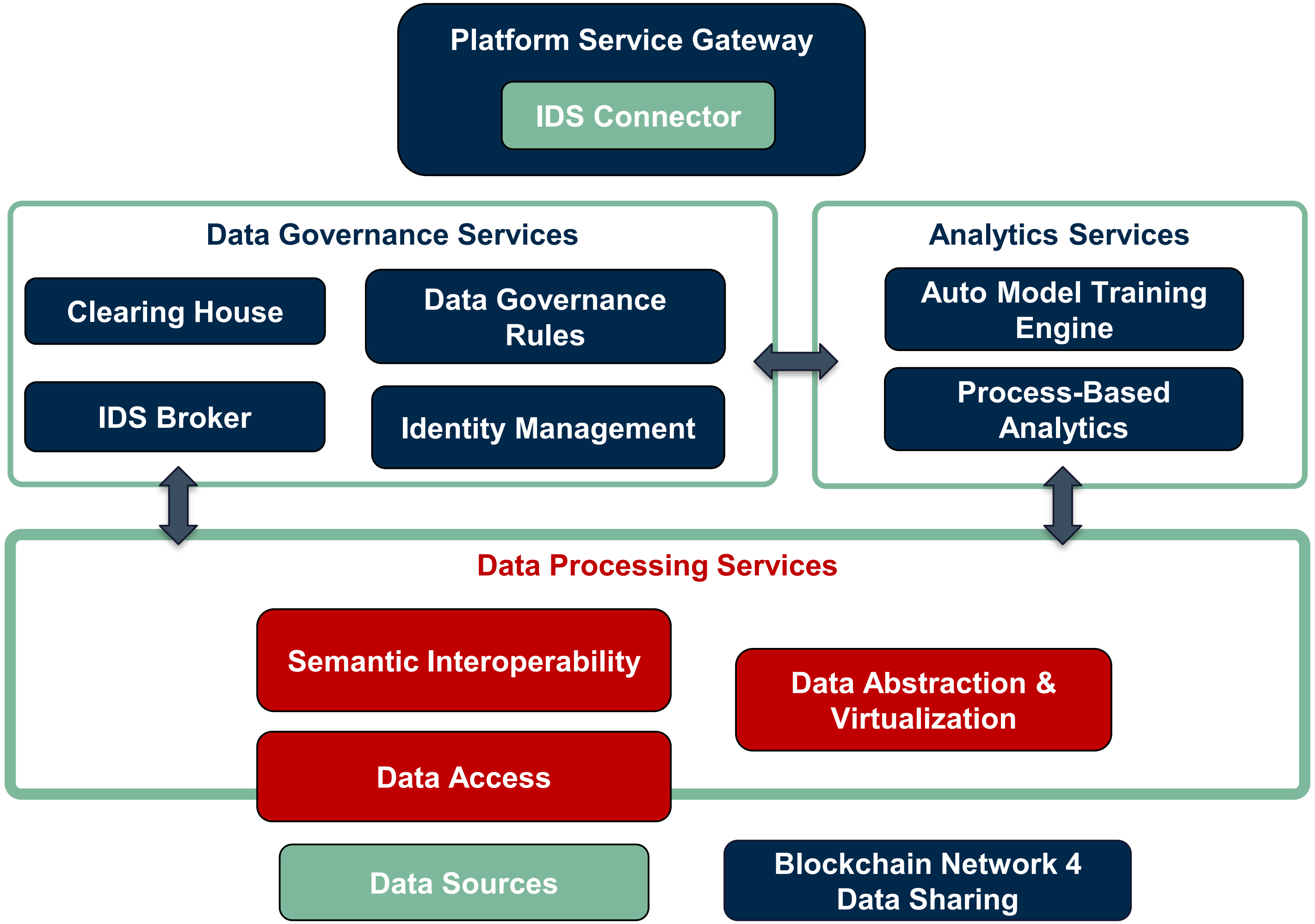
DataPorts Architecture



Semantic Interoperability

- **Scope**
  - **To define an unambiguous way to interpret the data that are being exchanged between computer systems**
- **Goal**
  - **To simplify the reuse of data by other applications and components, within the smart ports domain**
- **Challenge**
  - **Enabling interoperability not a trivial task, because different organizations in transportation and logistics do not follow a common standard**
    - **They have their own vocabularies, with poor definition of semantics, or no explicit semantic formulation at all**

Data Modeling

- ## Goal
  - To describe ports data in a systematic and standardized way, with mappings to standard vocabularies in order to facilitate interoperability with other systems

- ## Process
  - Identify and analyze the different data sources to be integrated in the DataPorts platform, considering the meaning and format of the data
  - Review of existing ontologies and vocabularies in the application domain for potential reusability

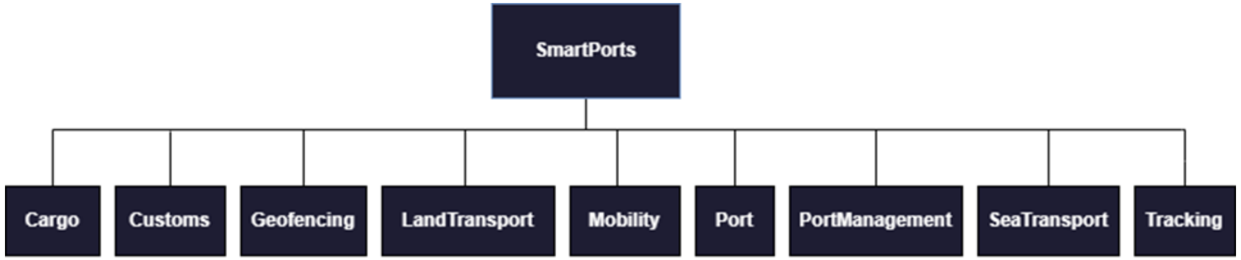
- ## Tangible Outcome
  - DataPorts Common Data Model

DataPorts Common Data Model (1/2)

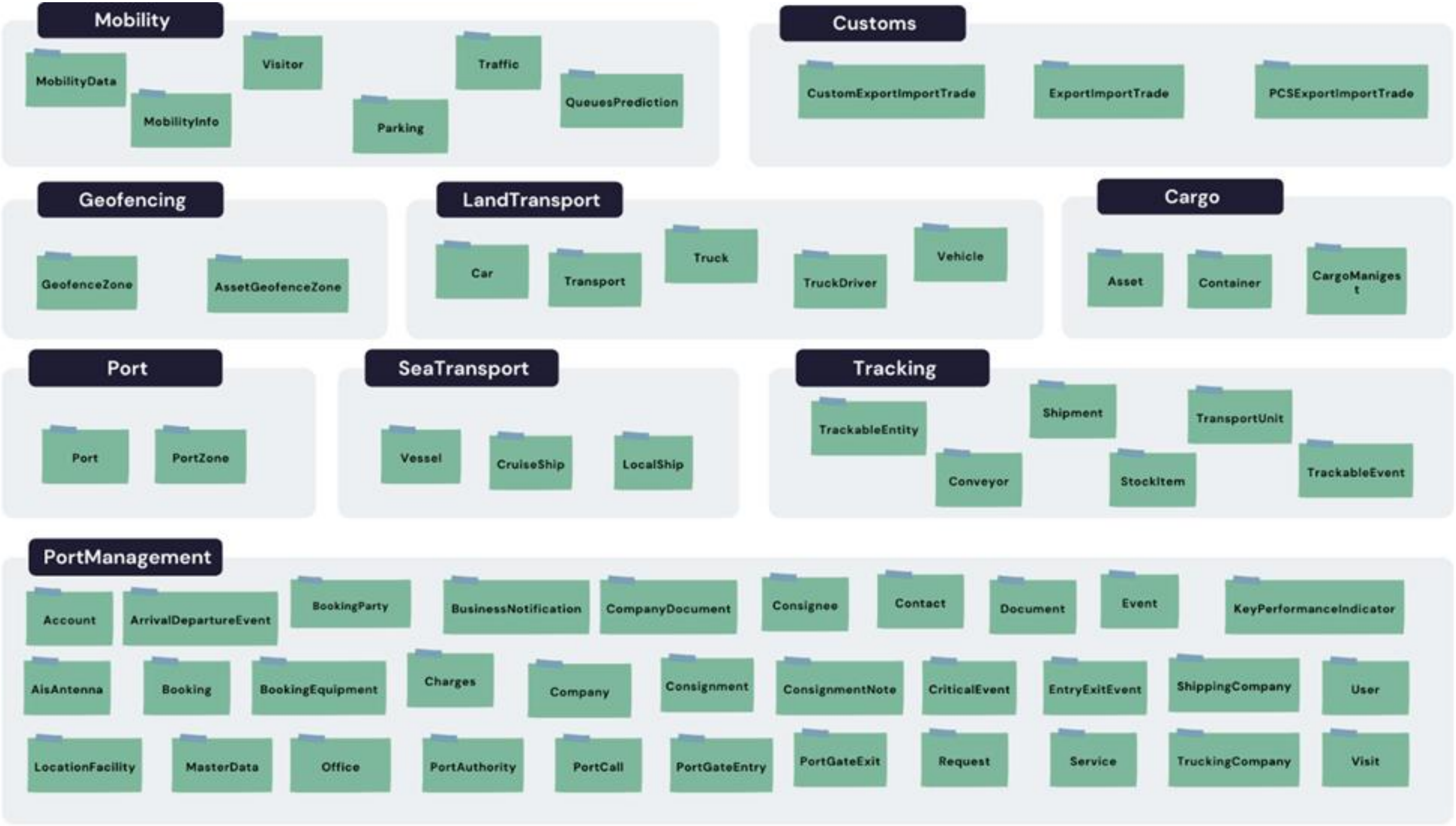
- **Based on Fiware Smart Data Models guidelines**

- **Also fully compatible with other standards and initiatives**
  - **e.g. the Context Information Management API standard (NGSI-LD), set by the European Telecommunications Standards Institute (ETSI)**

- **The *SmartPorts* domain includes many subjects, each one contains different entity types**
  - **e.g. *SeaTransport subject* provides access to *Vessel, CruiseShip, LocalShip entities***



DataPorts Common Data Model (2/2)



Mobility

- MobilityData
- MobilityInfo
- Visitor
- Parking
- Traffic
- QueuesPrediction

Customs

- CustomExportImportTrade
- ExportImportTrade
- PCSExportImportTrade

Geofencing

- GeofenceZone
- AssetGeofenceZone

LandTransport

- Car
- Transport
- Truck
- TruckDriver
- Vehicle

Cargo

- Asset
- Container
- CargoManigest

Port

- Port
- PortZone

SeaTransport

- Vessel
- CruiseShip
- LocalShip

Tracking

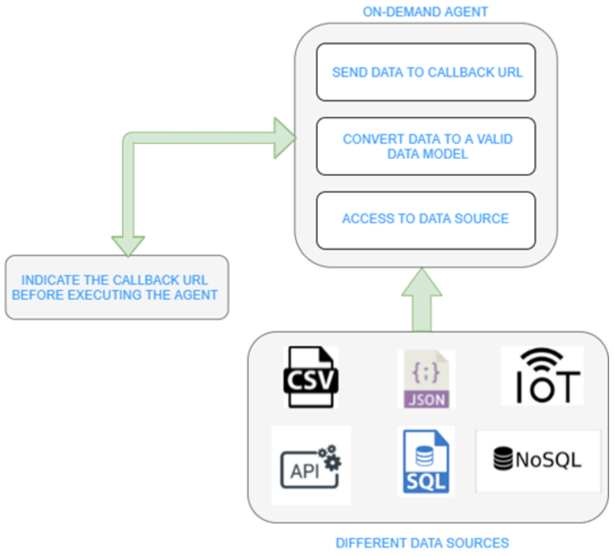
- TrackableEntity
- Conveyor
- Shipment
- StockItem
- TransportUnit
- TrackableEvent

PortManagement

- Account
- ArrivalDepartureEvent
- BookingParty
- BusinessNotification
- CompanyDocument
- Consignee
- Contact
- Document
- Event
- KeyPerformanceIndicator
- AisAntenna
- Booking
- BookingEquipment
- Charges
- Company
- Consignment
- ConsignmentNote
- CriticalEvent
- EntryExitEvent
- ShippingCompany
- User
- LocationFacility
- MasterData
- Office
- PortAuthority
- PortCall
- PortGateEntry
- PortGateExit
- Request
- Service
- TruckingCompany
- Visit

Data Access Component

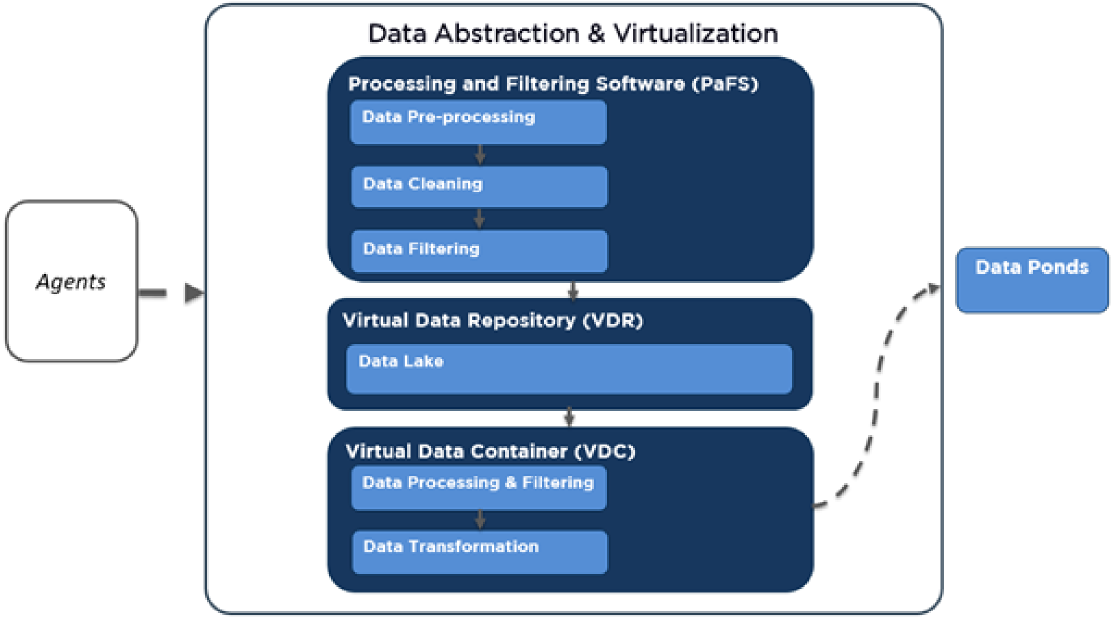
- **Scope**
  - **To connect heterogeneous (in terms of interfaces, formats and models) data sources to the DataPorts platform**
- **Goal**
  - **To develop a scalable software component that obtains data from a source, translates them into the DataPorts Common Data Model and make them available to the processing layer via a unified API**
- **Tangible Outcome**
  - **Dockerized agents to access Data Sources, through a GUI and SDK management framework**


ON-DEMAND AGENT
SEND DATA TO CALLBACK URL
CONVERT DATA TO A VALID DATA MODEL
ACCESS TO DATA SOURCE
INDICATE THE CALLBACK URL BEFORE EXECUTING THE AGENT
CSV
JSON
IoT
API
SQL
NoSQL
DIFFERENT DATA SOURCES

Data Abstraction and Virtualization

- **Scope**
  - **To offer the translated and harmonized Data as a Service, putting emphasis on QoD and QoS**

- **Goal**
  - **To provide an abstraction layer between data providers and consumers**
    - **Let the application developers just define the content and the format of the needed data**
    - **Rely on the proposed middleware to deliver those data, encapsulating all the underlying technical complexity**

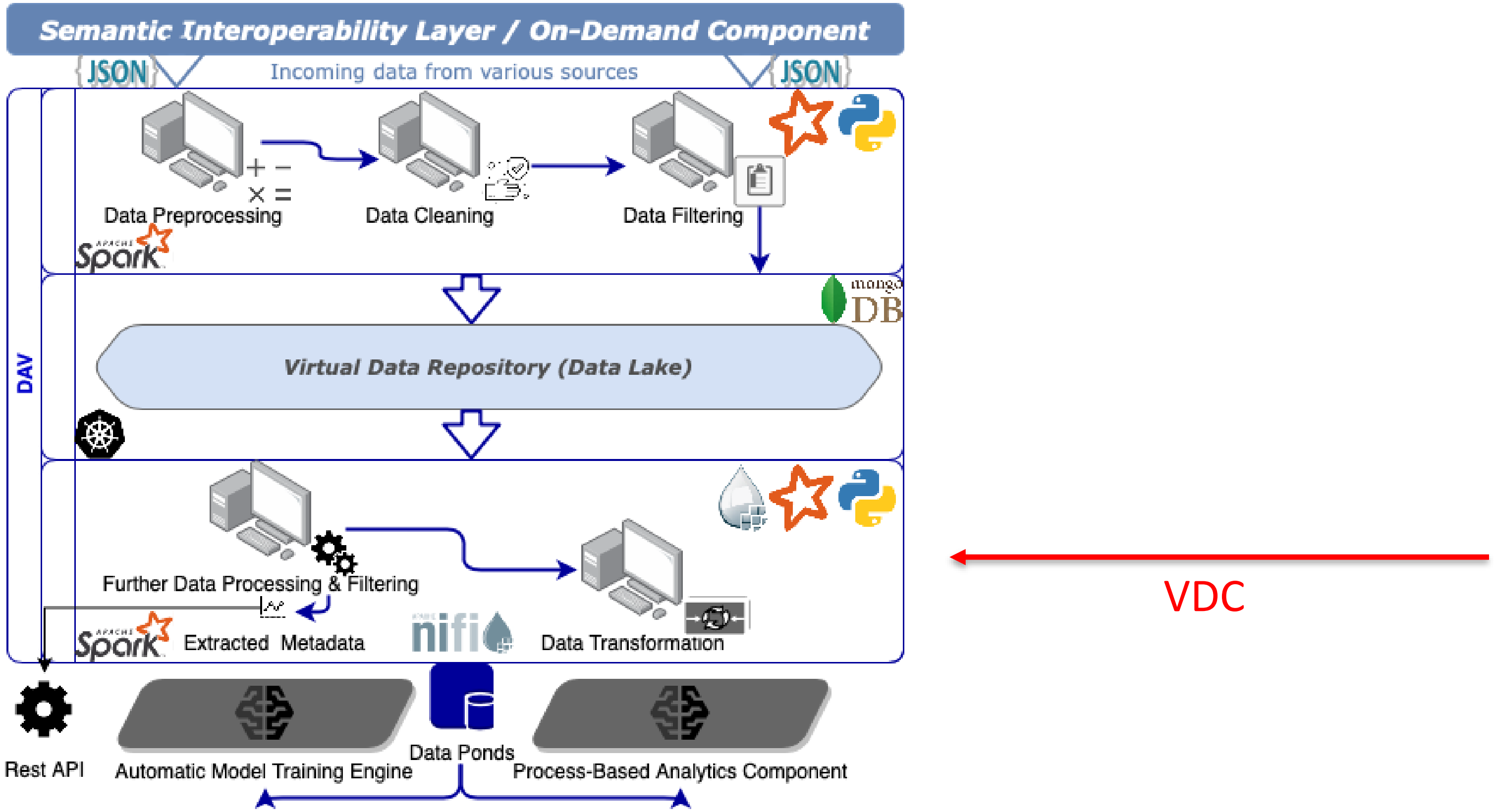

Data Abstraction & Virtualization
Processing and Filtering Software (PaFS)
Data Pre-processing
Data Cleaning
Data Filtering
Virtual Data Repository (VDR)
Data Lake
Virtual Data Container (VDC)
Data Processing & Filtering
Data Transformation
Agents
Data Ponds

Data Processing and Storage

- ## Pre-Processing and Filtering Software
  - Responsible for the initial pre-processing, cleaning and filtering of the incoming data
  - To improve the quality of the data and thus to increase the performance of the applications built on top of them
- ## Virtual Data Repository
  - Distributed infrastructure to store the pre-processed, cleaned, and filtered data
    - Data Lake
  - Capable of upscaling or downscaling in a fully automated way according to the workload
    - Resource optimization
    - Low response times
    - High availability

Virtual Data Container - Overview

- The interface between the middleware and the data consumers (analytics)
- Further process, filter and then serve the needed information as data ponds, by applying specific filtering rules to the data
- Transforms the data to the requested format (JSON, Parquet or CSV)


Semantic Interoperability Layer / On-Demand Component
JSON
Incoming data from various sources
JSON
Data Preprocessing
Data Cleaning
Data Filtering
Spark
mongoDB
DAV
Virtual Data Repository (Data Lake)
Further Data Processing & Filtering
Spark
Extracted Metadata
nifi
Data Transformation
Rest API
Automatic Model Training Engine
Data Ponds
Process-Based Analytics Component
VDC

Virtual Data Container – Filtering Rules

- ## Goal
  - To enable the consumers retrieve only the portion of data they are interested in, thus minimizing the processing and the network workload
  - To detect and remove wrong values, most probably caused by sensors malfunction (e.g. temperature at minus 50 degrees Celsius)

- ## Structure
  - Array of JSON Objects
  - Follow the *subject* – *operator* – *object* syntax (e.g. vessel_arrival_time >= 2022-11-29T08:00:00.000+00:00)
  - Kept simple so that the rules can be specified not only by data scientists and experts, but also by users with limited or no technical background within a port ecosystem

- ## Tangible Outcome
  - A common access layer, where the data consumers simply define queries (in the form of rules) in a unified format
  - VDC designer is responsible for developing the suitable module to execute those queries, according to the selected storage technology (MongoDB in the case of DataPorts)

Thank you for your Attention

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