THE OPEN GROUP

OSDU™

FORUM

Unleashing the Value of Digital Twins with the OSDU™ Data Platform: A Modern Data Management Approach

Karin Becker [1], Givanildo Nascimento [1, 2]

1 - Federal University of Rio Grande do Sul - Brazil

2 - Petrobras - Brazil

The Petwin Cooperation

Academy

UFRGS

UiO : University of Oslo

.inf INSTITUTO DE INFORMÁTICA UFRGS

SIRIUS

Industry

CNPC

equinor

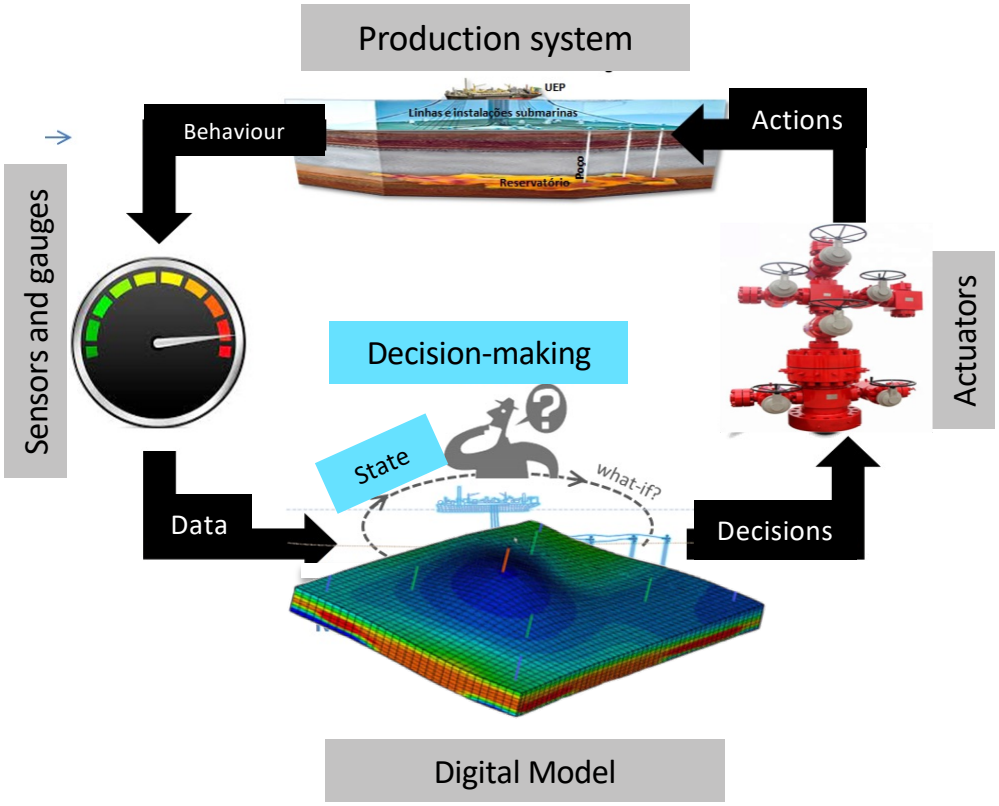
OSDU

Overview

- Digital Twins (DT)
- DT in PETWIN
- DT Data Management Component requirements
- OSDU Data Platform for DTs: Strengths and Opportunities

Digital Twin (DT) for Production system

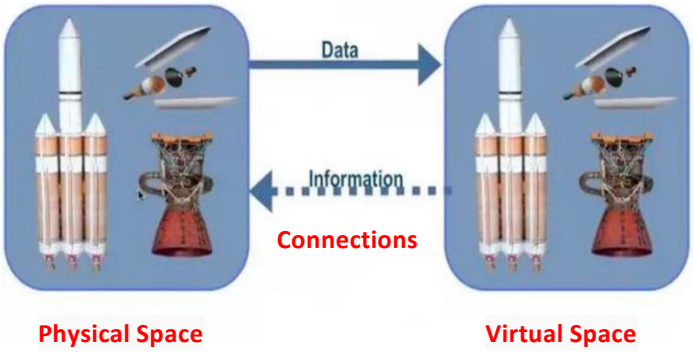
- "A set of adaptive models that emulate the behaviour of a physical system in a virtual system getting real time data to update itself along its life cycle."
- DT as a :
  - Descriptive system
  - Predictive system
  - Prescriptive system



DT Reference Architectures

Earlier architectures

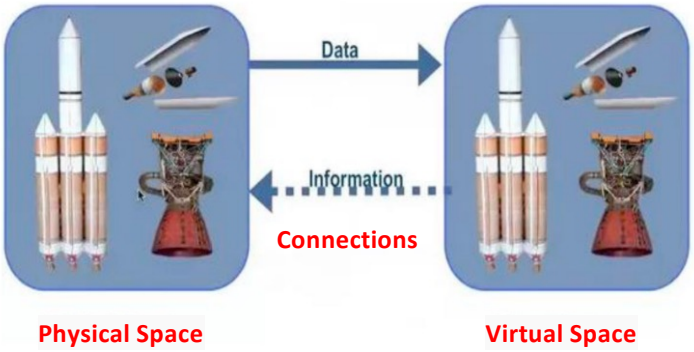
» Three-dimensions (GRIEVES, 2014)



DT Reference Architectures

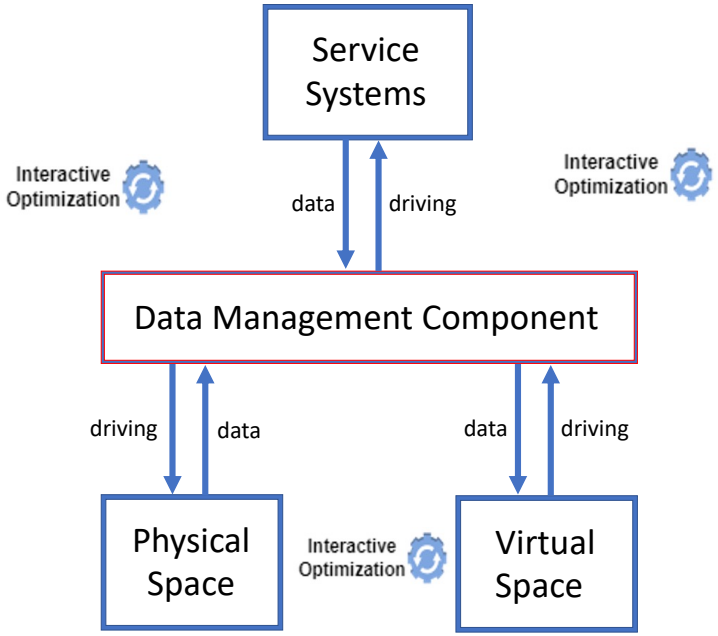
Earlier architectures

» Three-dimensions (GRIEVES, 2014)



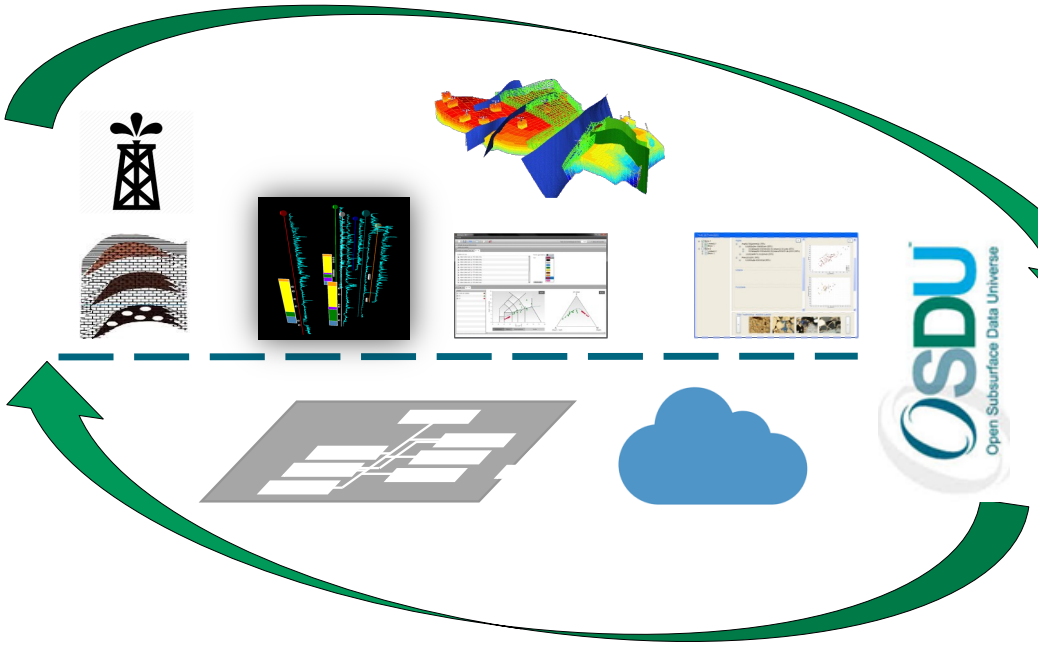
Evolution

» 5-Dimensions (TAO; ZHANG, 2017)

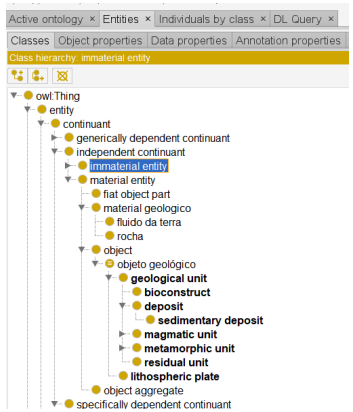


Digital Twin in PETWIN

Application level: data visualization, prediction, simulation, analysis



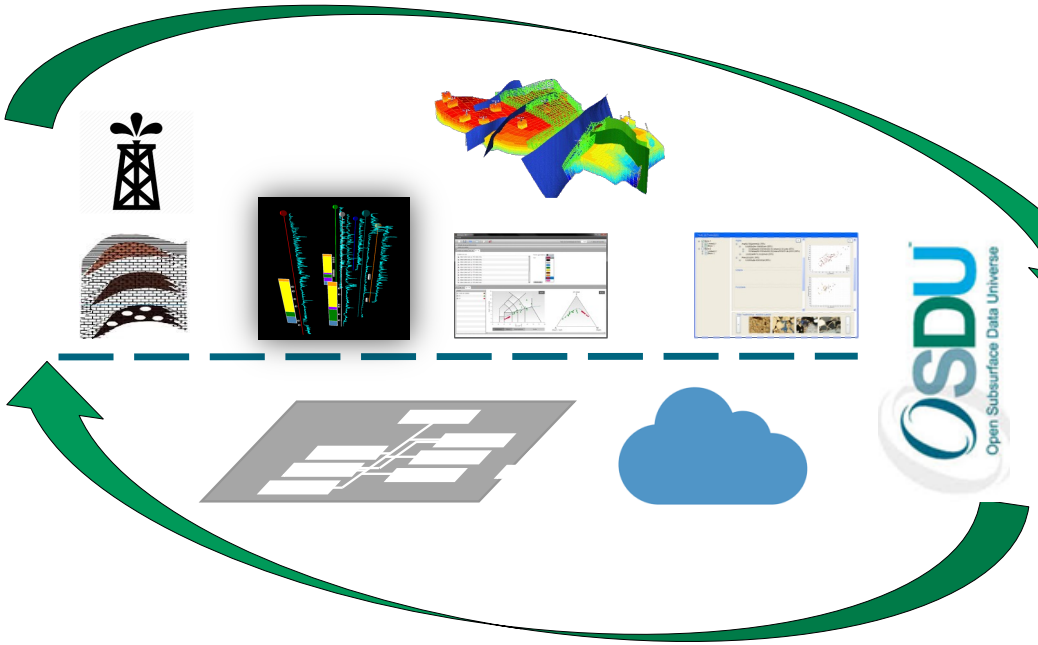
Integrated view: domain ontology



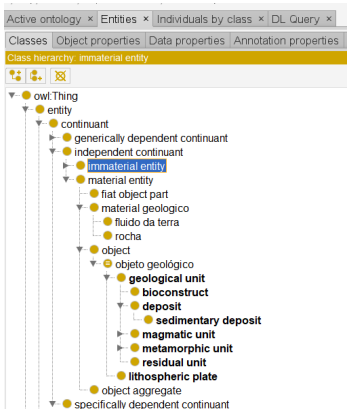
Persistence in corporate and cloud-based databases
Open models and industry standards

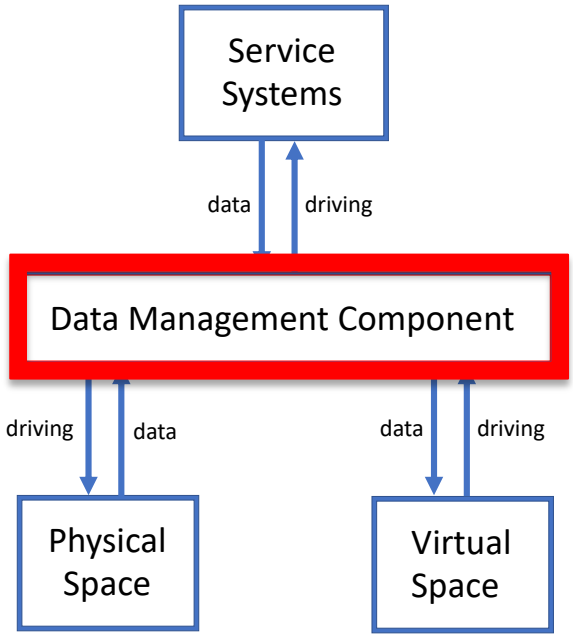
Digital Twin in PETWIN

Application level: data visualization, prediction, simulation, analysis



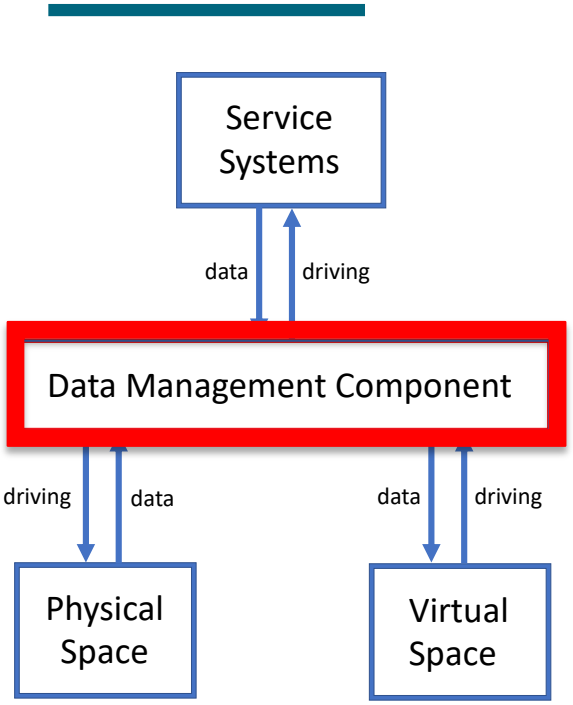
Integrated view: domain ontology





Persistence in corporate and cloud-based databases
Open models and industry standards

DT Data Management requirements



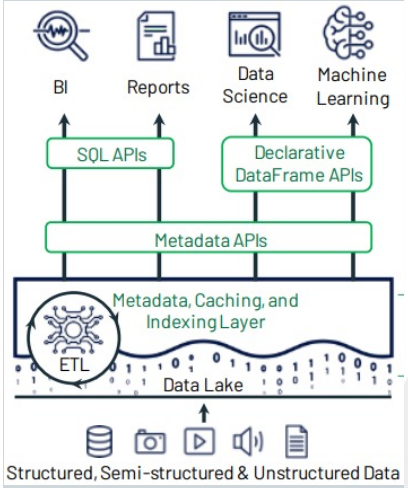
Big data: many V's

- Variety
- Volume
- Velocity
- Value
- Veracity

Big Data Value Chain

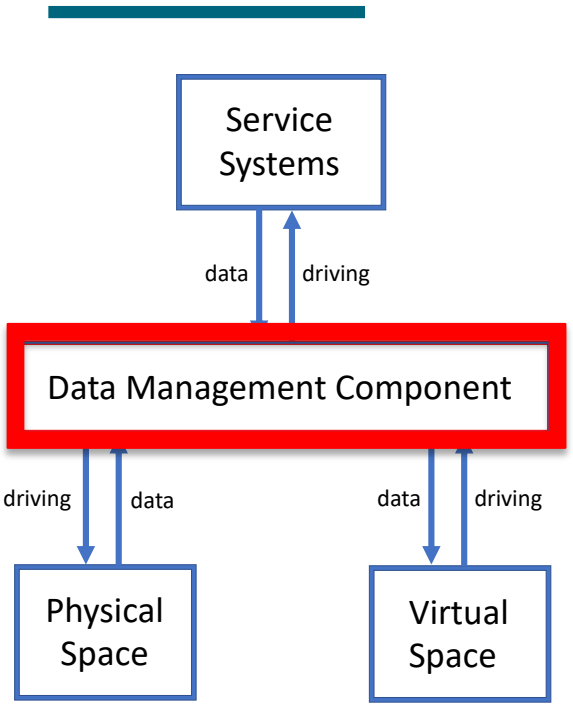
- Acquisition
- Data Analysis
- Data Curation
- Data Storage
- Data Usage (Service Systems)

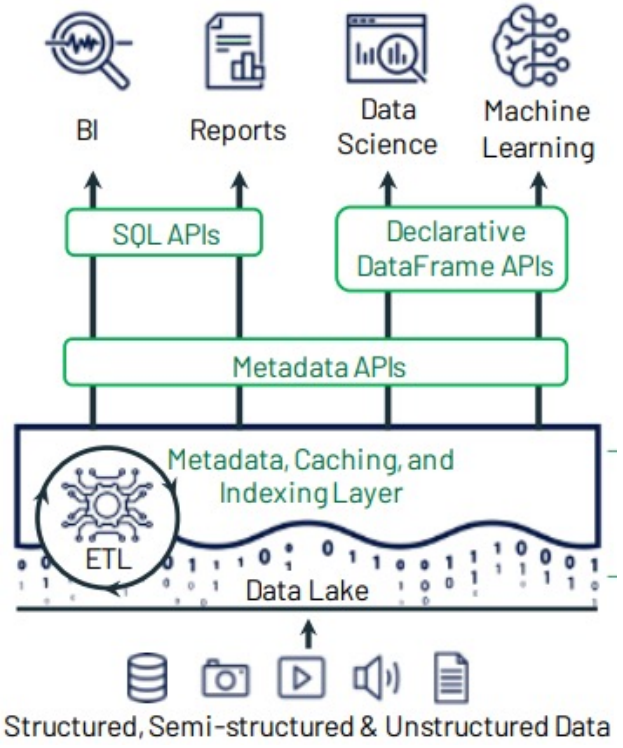
Data Lake(house)



Correia, J.B.; Abel, M.; Becker, K. Data Management in Digital Twins: a Systematic Literature Review. Knowledge and Information Systems, 2023.

DT Data Management requirements



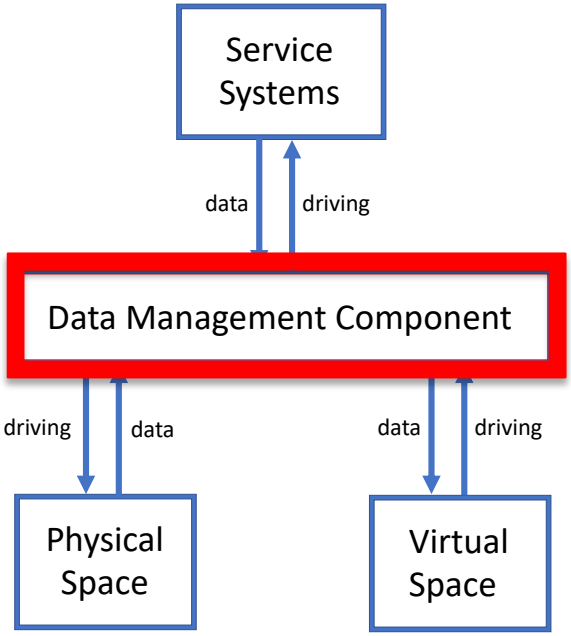


Role and functionality similar to a data lake

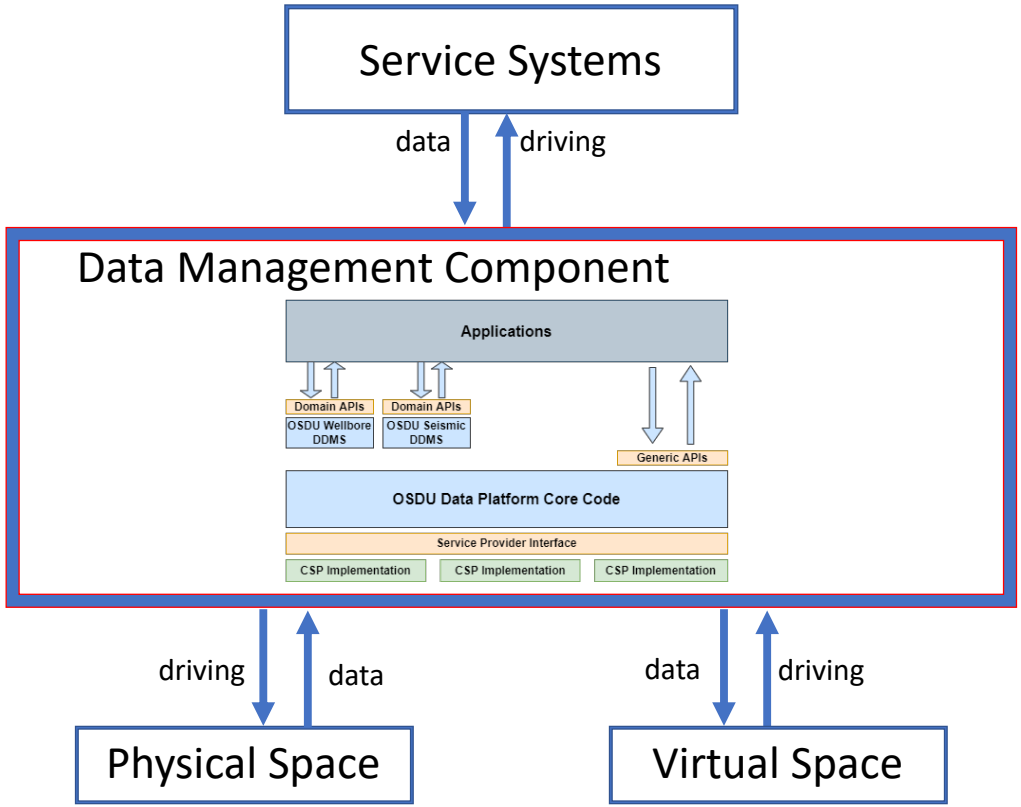
- integration of heterogeneous data (native format)
- support for physical and logical organization
- various user profiles
- metadata and enforced quality
- scalability for storage and processing
- applied to knowledge extraction

DT Data Management Component

- Data at different abstraction levels
  - Data – Information – Knowledge
- Integrate DT data pipelines
- Provide data storage, abstraction, consistency
- Support for data search/discovery and analysis
- Promote interoperability, high cohesion and low coupling among DT systems



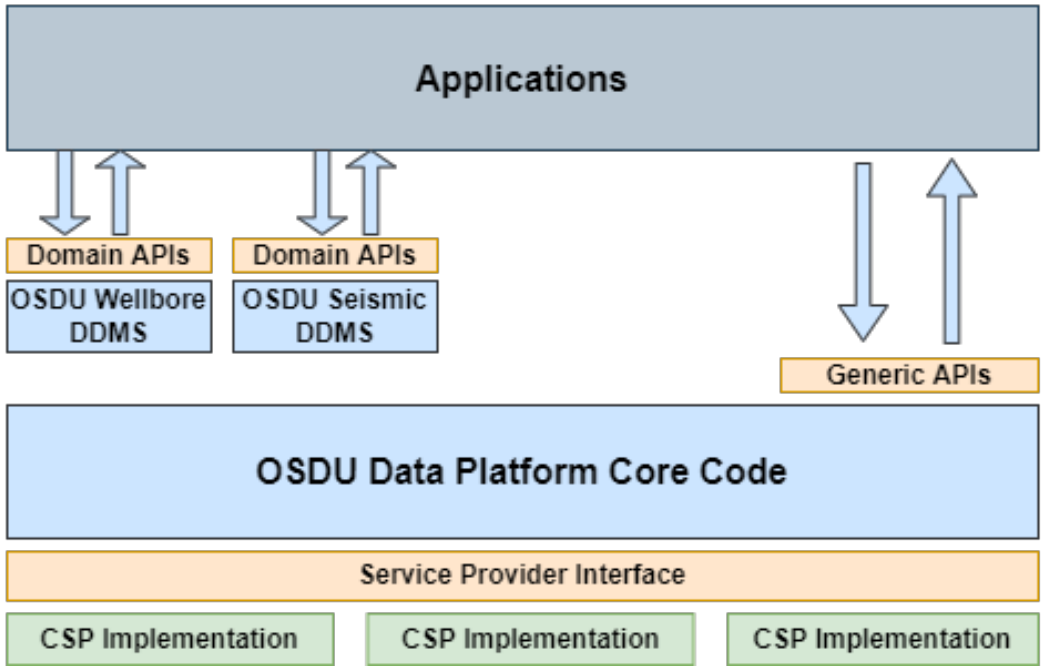
Can OSDU Data Platform provide core functionality?



Correia, J.B.; Becker, K. Data fusion core of a digital twin from the oil and gas industry. SBBD 2021.
Correia, J.B. et al. Data management in Digital Twins for the Oil and Gas Industry: beyond the OSDU Data Platform. JIDM 2022.

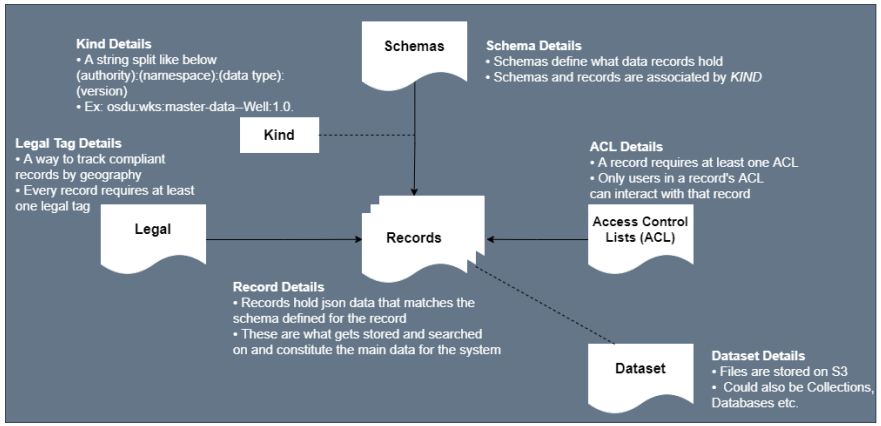
OSDU DP architecture roles

- System of records (SoRc)
  - Microservices architecture
  - Cloud native, provider-agnostic
  - Centralized storage
  - Long-term data
- System of engagement (SoE)
  - Decentralized storage (edge)
  - Real-time short-term data
- System of reference (SoRf)
  - DT Predictive role
  - Trusted source to feed ML with accurate data – Golden Records
  - Related to Data Lake(house)

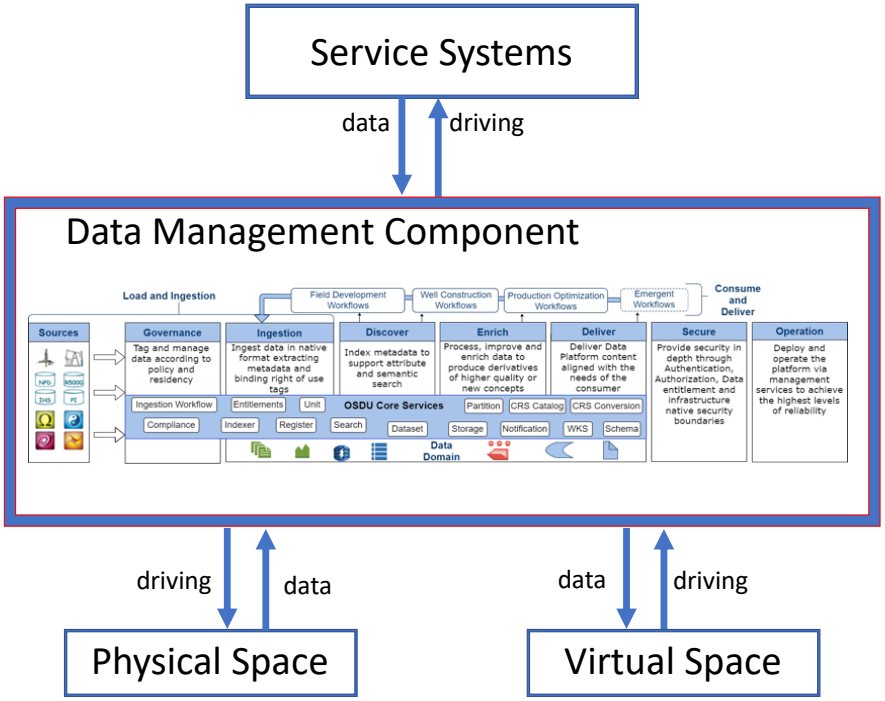


OSDU DP data modelling

- Metadata through schemata describing the business context and the technical aspects
- Significant efforts in aligning schemata with existing standards
  - Reference data vs. PPDM value list
  - Master data vs. previous Energistics standards
  - Master data for production inspired by CFIHOS
  - Etc



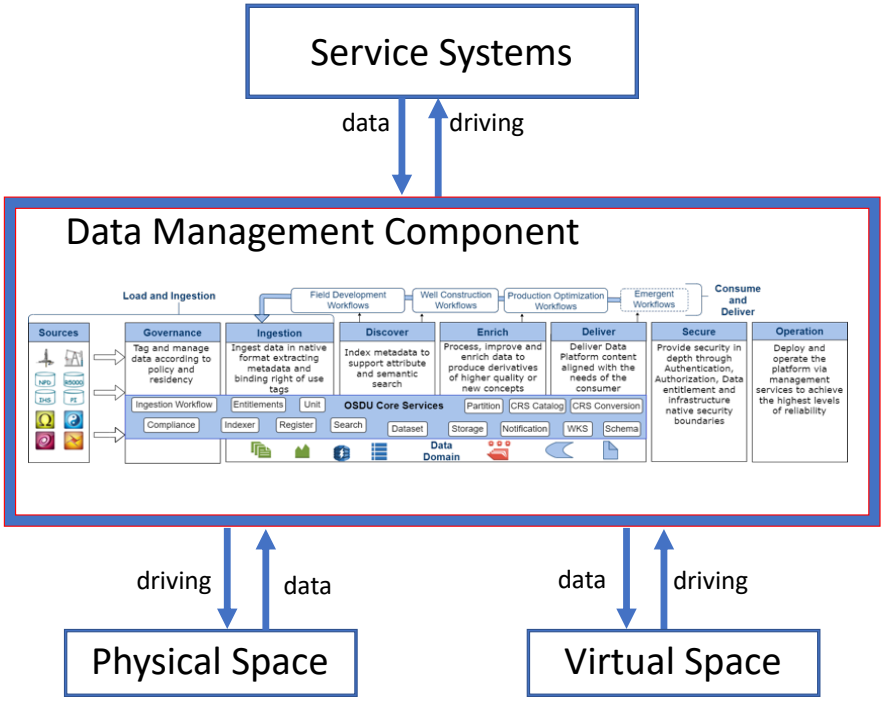
Can OSDU DP provide core functionality?



Benefits

- Ingestion of heterogeneous data in their native format;
- Covers the basic life-cycle
- Provides a SoRc, a SoE and a SoRf;
- Cloud native and provider-agnostic;
- Scalable data storage and processing;
- Breaking down silos
  - All data in a single platform;
  - No manual data transfer among applications;
- Unlock innovation in academia and industry

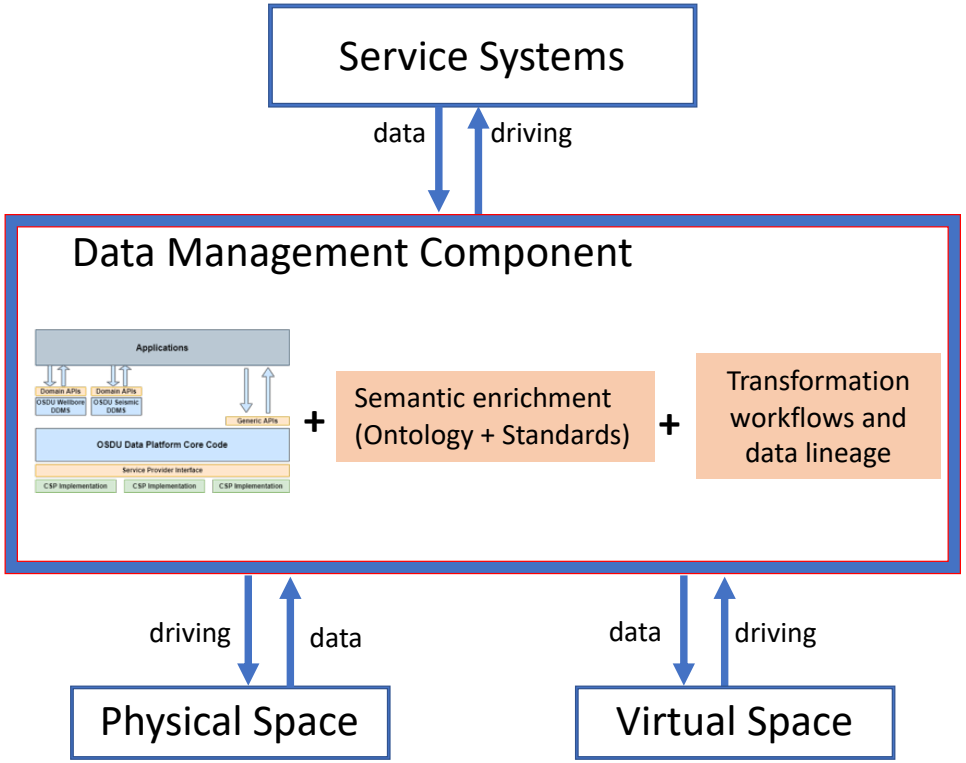
Is OSDU DP enough?



Challenges and opportunities

- Absence of patterns modeling, rigorous semantics for schema definition and extensions (e.g. missing concepts);
  - how to balance flexibility with needs to merge/interoperate (without mapping)?
- Time necessary for addressing schemata for new domains (e.g. production)
  - Significant (hard, hard) work has been done, strategies to accelerate data type definitions are under consideration
  - how to create customized descriptions that can survive overtime?
- Can explicit domain semantics contribute to modeling issues and extend core functionality?
- Are existing lineage mechanisms sufficient for decision-centric environments?

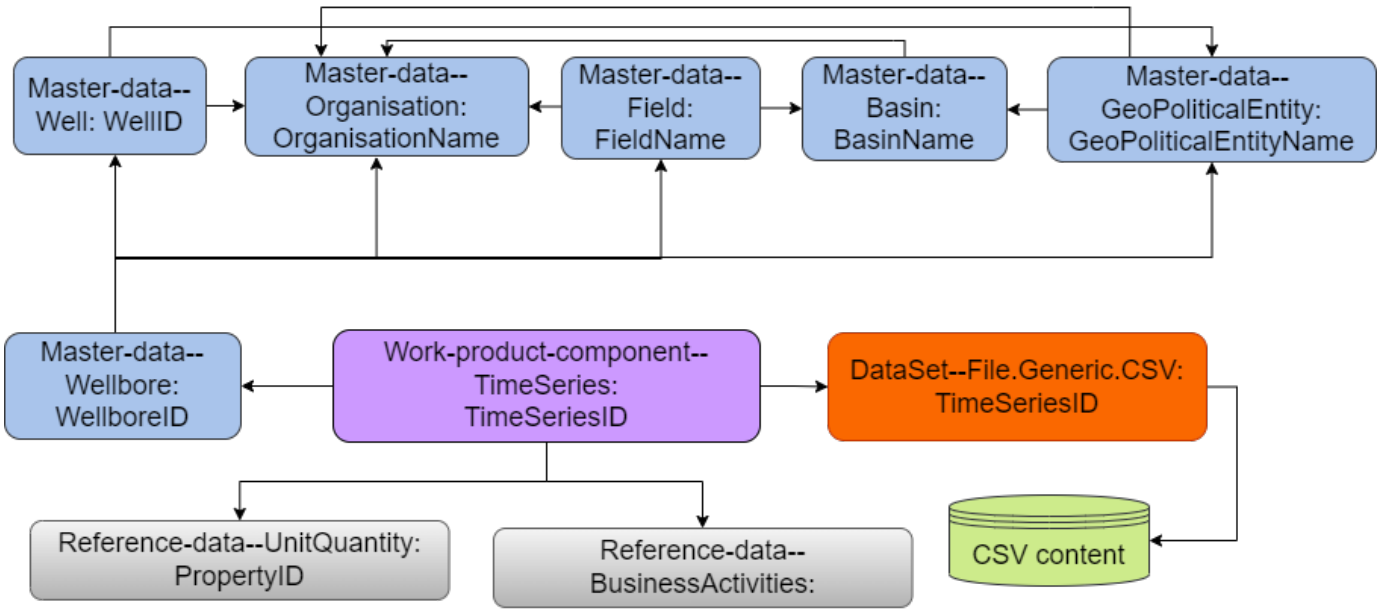
Is OSDU DP enough?



Challenges and opportunities

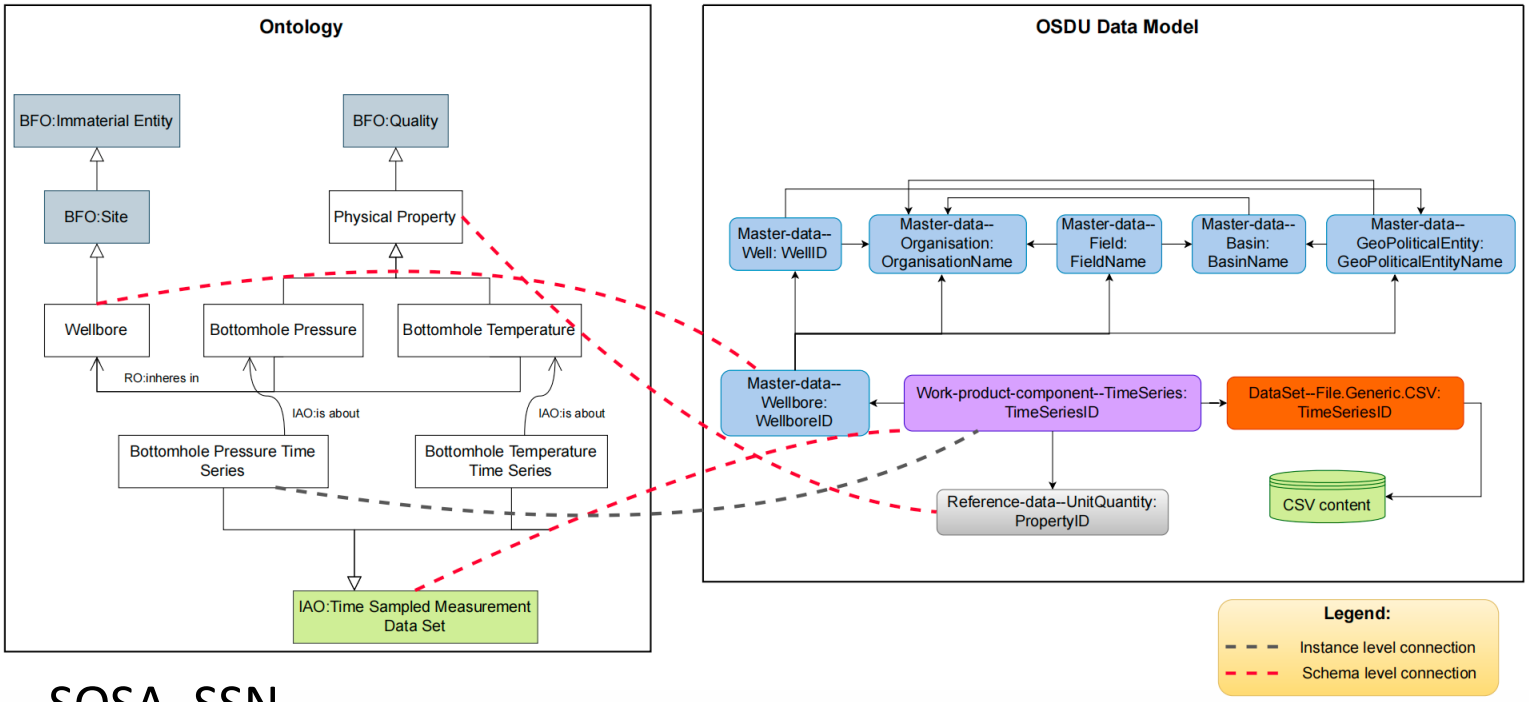
- Absence of patterns modeling, rigorous semantics for schema definition and extensions (e.g. missing concepts);
  - how to balance flexibility with needs to merge/interoperate (without mapping)?
- Time necessary for addressing schemata for new domains (e.g. production)
  - Significant (hard, hard) work has been done, strategies to accelerate data type definitions are under consideration
  - how to create customized descriptions that can survive overtime?
- Can explicit domain semantics contribute to modeling issues and extend core functionality?
- Are existing lineage mechanisms sufficient for decision-centric environments?

OSDU DP modeling



WHAT - Production (Rate m³, pressure psi, temperature °F)
WHERE - Location (field, basin..), wells, perforations intervals
WHO - Operators, organizations, workers (engineer)
WHEN - Time series (timestamp)
WHY - Extended well test

OSDU DP + Ontology



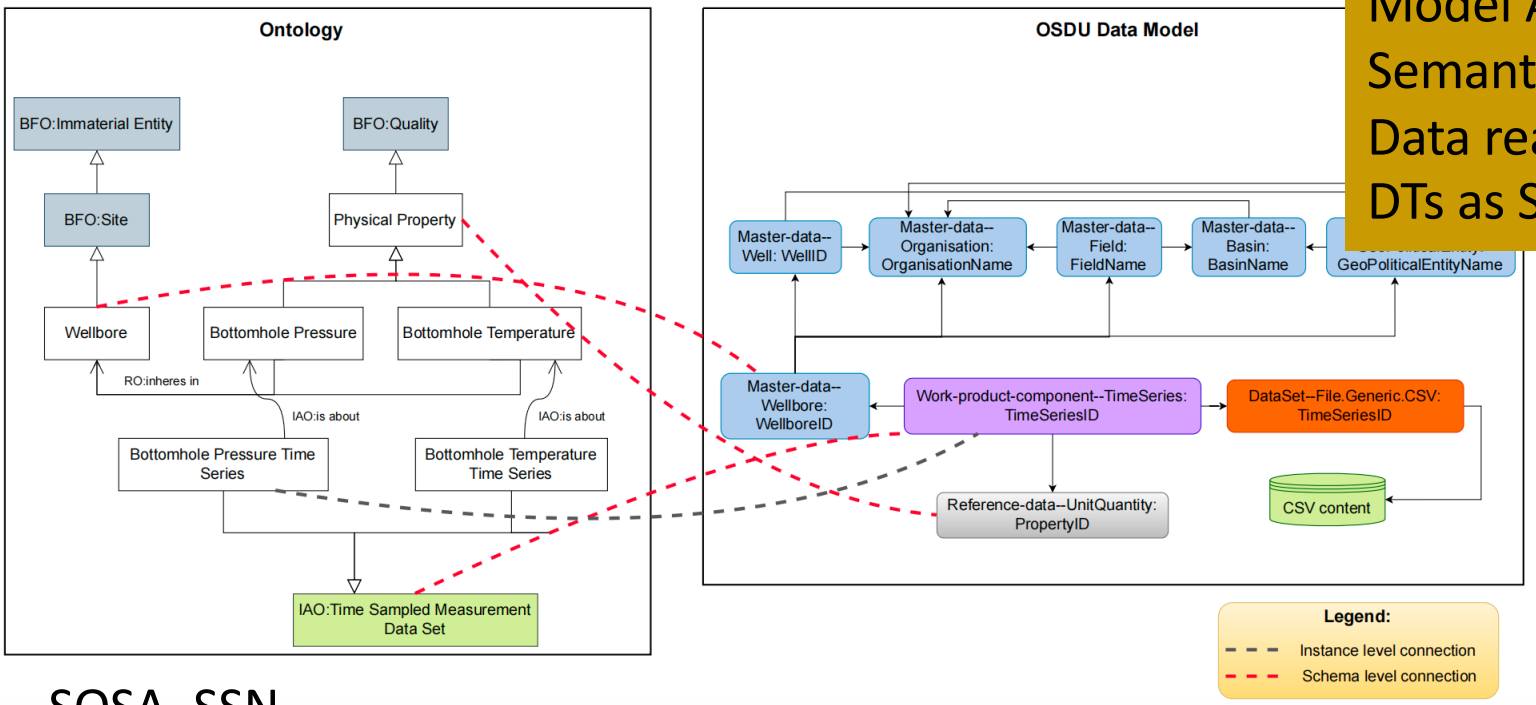
SOSA, SSN

O3PO, OntoTag

Standards: CFIHOS

OSDU DP + Ontology

Modeling Guidance
Consistency Checking
Model Aligments (Mappings)
Semantic Search
Data reasoning
DTs as Systems of Systems



SOSA, SSN
O3PO, OntoTag
Standards: CFIHOS

Questions?

Thanks to all organizations and people who have donated time and effort for this awesome open data platform !