Digital Twin-based Condition Monitoring with Distributed Data Mapping of OPC UA and ISO 10303 STEP Standard

Presenter:

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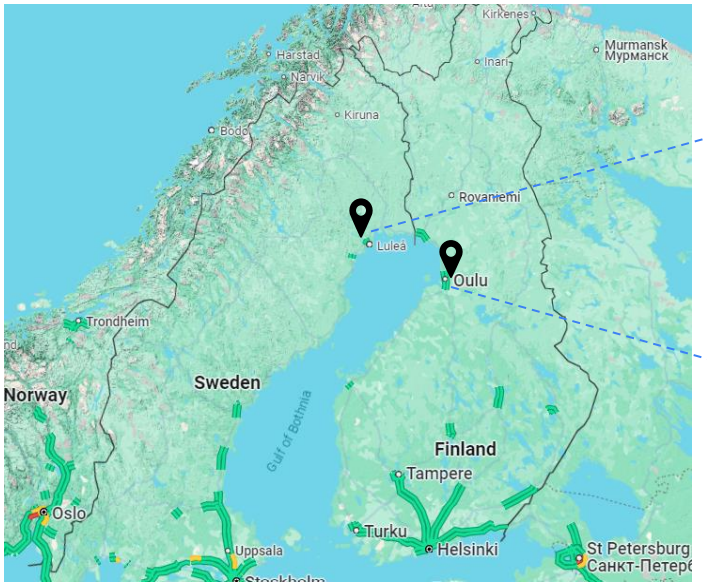

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Background

Digital Twin (DT) & Data Spaces

1. The concept of DT was first proposed by Grieves in 2003 as the PLM concept ideal model.
2. DT consists of five dimensions: physical entity, virtual model of the physical entity, service system, data storage, and connection among these elements.
3. Data management in Digital Twins is backed by the principles of data spaces.
4. Data spaces focus on managing data from heterogeneous sources and identifying possible relationships within them.
5. Two of the crucial components in DT are a data model and an industrial communication mechanism.
6. The ISO 10303 STEP standard emerges as a dominant candidate for data modeling in product DTs
7. The Open Platform Communications Unified Architecture (OPC UA) standard is a prospective contender regarding industrial communication mechanisms.

Background

OPC UA

1. An industrial communication protocol for facilitating data exchange and communication among diverse devices in manufacturing industries and IoT applications.
2. It plays a crucial role in DT by offering a secure, reliable, and standardized communication protocol for seamless interoperability between system components.

ISO 10303 STEP

1. It is a “Standard for the Exchange of Product Model Data”.
2. It ensures that data from different sources can be seamlessly integrated and utilized.
3. It represents and exchanges product data across various stages of the product lifecycle, which is essential for effective data integration and interoperability in data spaces.

Motivation & Technology Gap

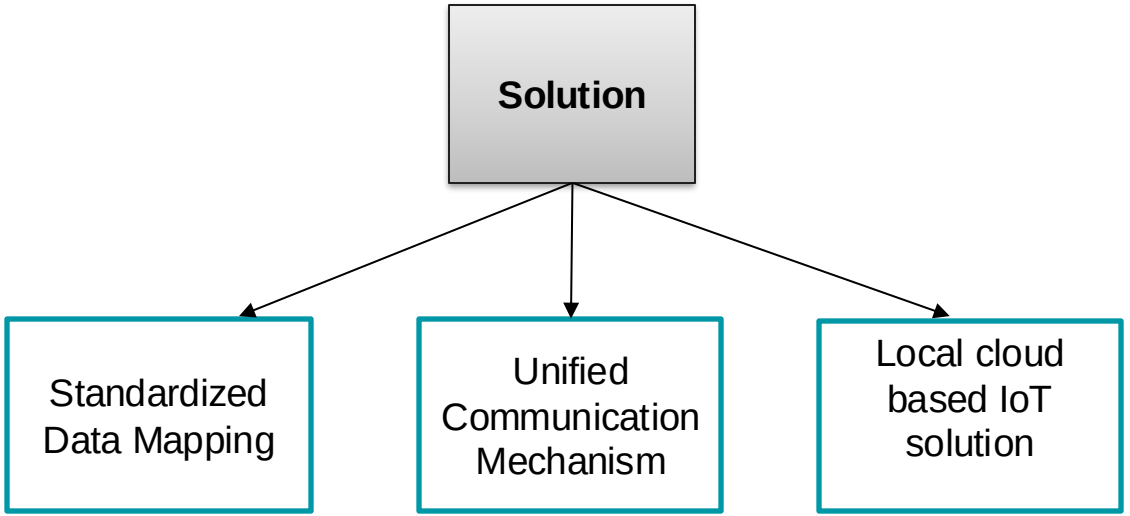
Challenges associated with DT:

- Lack of standardization
- Data security, privacy concerns
- Complex modeling processes, software development, and implementation difficulties
- Real-time synchronization between physical systems and their digital counterparts
- Absence of a unified data communication standard
- Lack of research focused on the industrial implementation of DTs

Challenges with DT & IoT Framework Integration:

- Interoperability
- Security and Data privacy
- Scalability

Motivation & Technology Gap



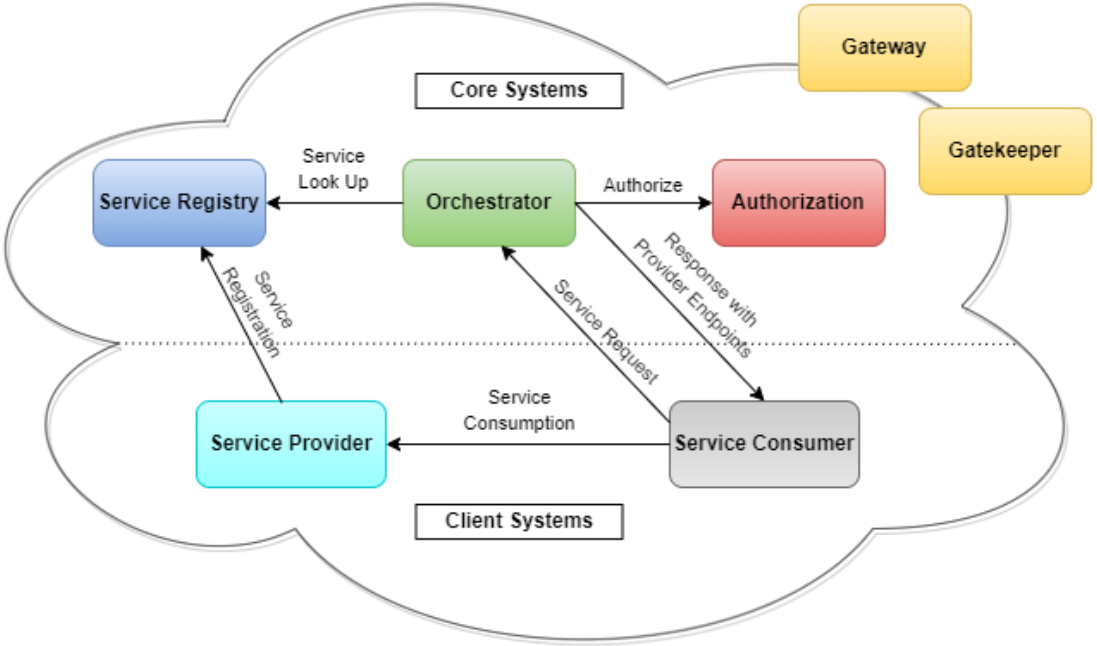
EDMTruePLM

- PLM and data repository software tool developed by Jotne Connect
- Built on the ISO 10303 standard
- It utilizes AP239, the Product Life Cycle Support (PLCS) data model
- Enables standards-based data exchange in a world of heterogeneous systems
- It emphasizes on data interoperability and longevity due to its reliance on open standards
- It can accept data from various applications and provide end-users access to their data in the widely recognized ISO 10303 format, STEP.

The Eclipse Arrowhead Framework (EAF)

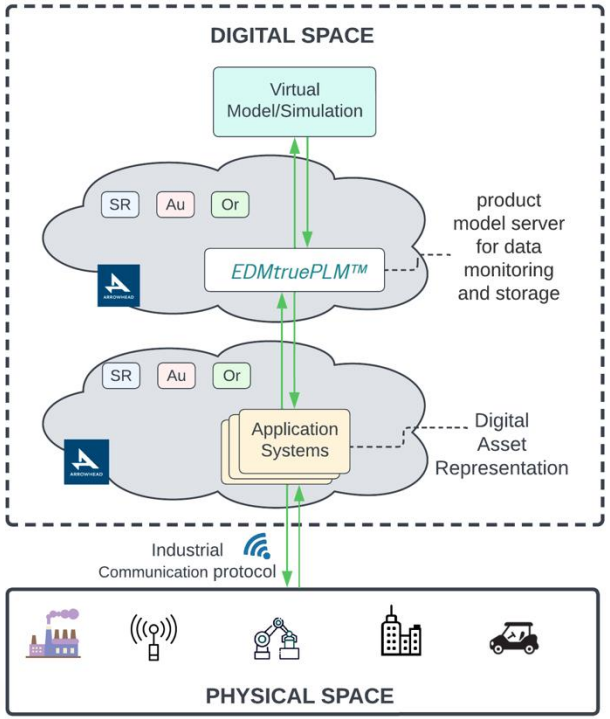
- Interoperable IoT solution
- Aims towards industrial automation, emphasizing security and minimizing latency
- Incorporates Local Cloud Architecture & Systems of Systems (SoS)
- Follows a Service Oriented Architecture (SOA)

The Eclipse Arrowhead Framework (EAF)



[1] Tripathy, Aparajita, et al. "OPC UA Service Discovery and Binding in a Service-Oriented Architecture." *2022 IEEE 5th International Conference on Industrial Cyber-Physical Systems (ICPS)*. IEEE, 2022.

Proposed Solution



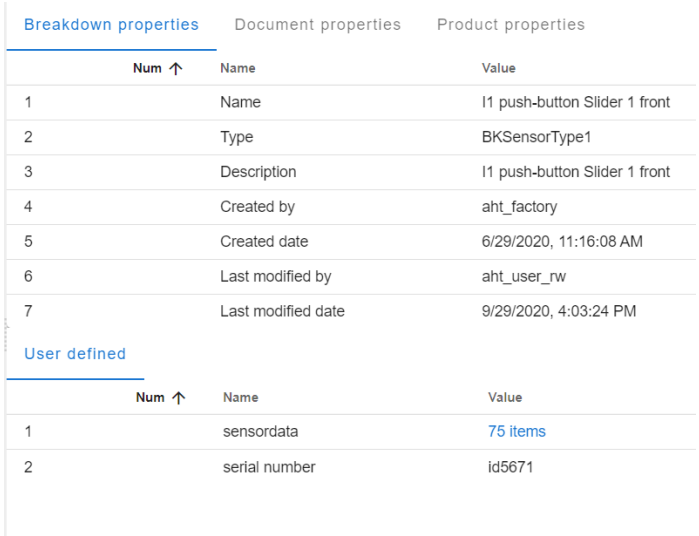
Services offered by EDMTruePLM:

1. trueplm-sensors-in-project-service
2. trueplm-sensor-by-sn-service
3. trueplm-get-sensor-data-service
4. trueplm-add-sensor-data-service

Proposed Solution

Sensor Payload & Data Representation at EDMTruePLM


```
{
  "SensorData": [
    {
      "SensorMeasurement": [
        {
          "Measurement": "state",
          "value": false
        }
      ],
      "timestamp": "09/29/2020, 16:03:24"
    }
  ],
  "SensorType": "BKSensorType1",
  "id": "id5671"
}
```

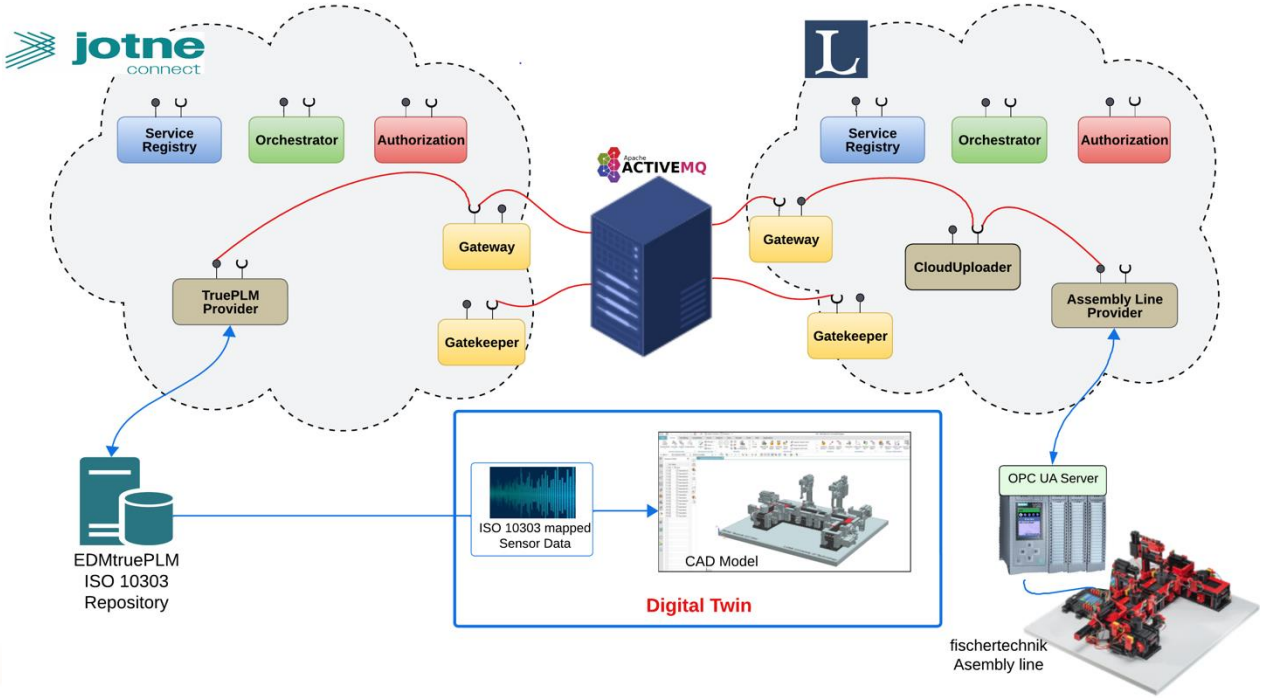
Breakdown properties | Document properties | Product properties

Num	Name	Value
1	Name	I1 push-button Slider 1 front
2	Type	BKSensorType1
3	Description	I1 push-button Slider 1 front
4	Created by	aht_factory
5	Created date	6/29/2020, 11:16:08 AM
6	Last modified by	aht_user_rw
7	Last modified date	9/29/2020, 4:03:24 PM

User defined

Num	Name	Value
1	sensordata	75 items
2	serial number	id5671

Use Case Implementation



Findings

- Interoperability
  1. Communication interoperability with the integration of OPC UA with ISO 10303 STEP
  2. Data interoperability by converting various data formats into a unified structure (STEP)
- Standardized data mapping
  1. Utilizing the ISO 10303 STEP standard to store data within a compatible database guarantees consistency in data storage procedures and streamlines data retrieval and sharing.
- Cyber-security
  1. OPC UA's robust security mechanism
  2. EAF's secure data transmission and data privacy
- Service discovery
  1. EAF's automatic service discovery process
- Low latency
  1. Due to the decentralized nature of the EAF, the tasks are distributed across different Arrowhead application systems, contributing to minimizing latency and promoting efficient operations.

Future Work

- Integration of OPC UA and STEP by establishing a connection between the data in the EDMtruePLM repository and the CAD model of the assembly line using RoboDK simulation software.
- Implement the solution in a NUVE lab use case to develop testing platforms for sustainable utility vehicles. The EAF and STEP standards will play a vital role in the integration and interoperability of multiple digital twins.

Acknowledgement

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Thank you