Alliance for IoT and Edge Computing Innovation

Webinar • 15 October 2024

Presentation of WG Standardisation reports

High-Level Architecture Report R6

Guidance for the Integration of Digital Twins in Data Spaces Report R1

AIOTI

Opening and Welcome

Damir Filipovic, AIOTI Secretary General

AIOTI

Agenda

AICTI

Agenda

13.00 **Opening and Welcome (5 min)**

Damir Filipovic, AIOTI Secretary General

13.05 **Presentation of the High-Level Architecture Report (20 min)**

Georgios Karagiannis (Huawei, AIOTI WG Standardisation Co-Chairman), Paper Editor

13.25 **Presentation of the Guidance for the Integration of Digital Twins in Data Spaces Report (20 min)**

Antonio Kung (Trialog, AIOTI WG Standardisation Chairman), Paper Editor

13.45 **Questions from the audience (10 min)**

Moderated by Antonio Kung (Trialog, AIOTI WG Standardisation Chairman)

13.55 **Wrap up and end of the Webinar (5 min)**

Damir Filipovic, AIOTI Secretary General

About AIOTI
WG Standardisation

AIOTI

About WG Standardisation: Leadership, Vision, Highlights

Leadership:

Chair
Antonio Kung
Trialog

Co-Chair
Georgios Karagiannis
Huawei

Vision:
To be recognized as a major contributor to the worldwide interoperability, security, privacy and safety of IoT and Edge Computing systems and applications, and particularly for the development of the market in Europe

Deliverables:
https://aioti.eu/standardisation/

Highlights:

93 member organisations

194 participants

Main Achievements:

Deliverables	Collaborations	Events
▪ IoT Landscape Reports ▪ High priority gaps Reports ▪ IoT relation and impact on (beyond) 5G Reports ▪ High Level Architecture ▪ Ontology Landscape ▪ Computing Continuum Report	▪ Cooperation with SDOs/Alliances to foster co-creation and interworking (MoUs and Liaisons) ▪ SNS Partnership ▪ one6G ▪ Stand.ICT - EU OS ▪ EGDC ▪ HLF on European Standardisation ▪ ICT MSP	▪ AIOTI signature event 2023 ▪ SC41 Workshop ▪ Standardisation workshop on energy, mobility and buildings ▪ ETSI IoT Week ▪ Webinars to promote reports ▪ AIOTI Days 2024

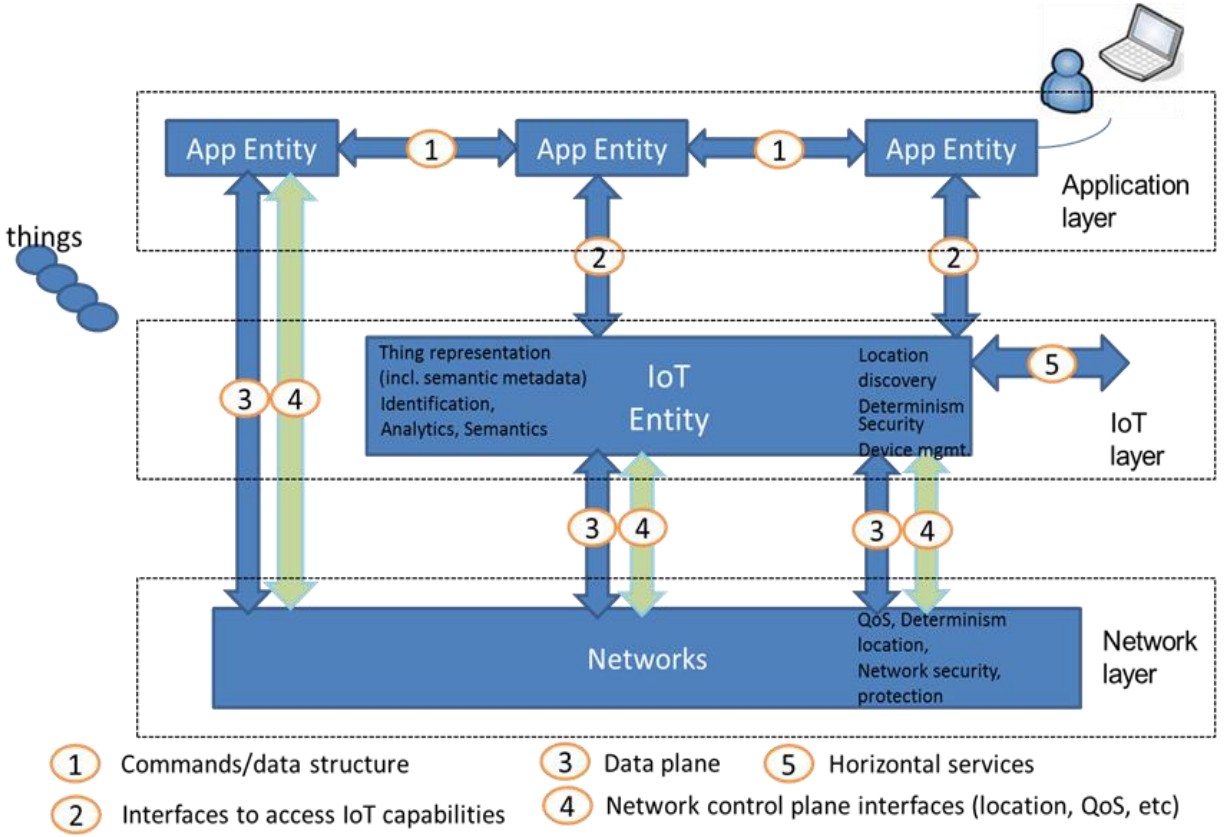
Presentation of the High-Level Architecture Report R6

Georgios Karagiannis (Huawei, AIOTI WG Standardisation Co-Chairman)

AIOTI

Goal and Content of the Report

- **Published on 22 July 2024**: "High Level Architecture (HLA) Report, Release 6.0", **Link to Report**
- **Goal of report:**
  - To present the use of ISO/IEC/IEEE 42010 within the IoT/Edge domain and proposes different deployment options considering architectural matters related to cloud and edge computing & computing continuum, AI, Data Spaces & Big Data, virtualization, security, privacy and (platform) interoperability



AIOTI HLA functional model

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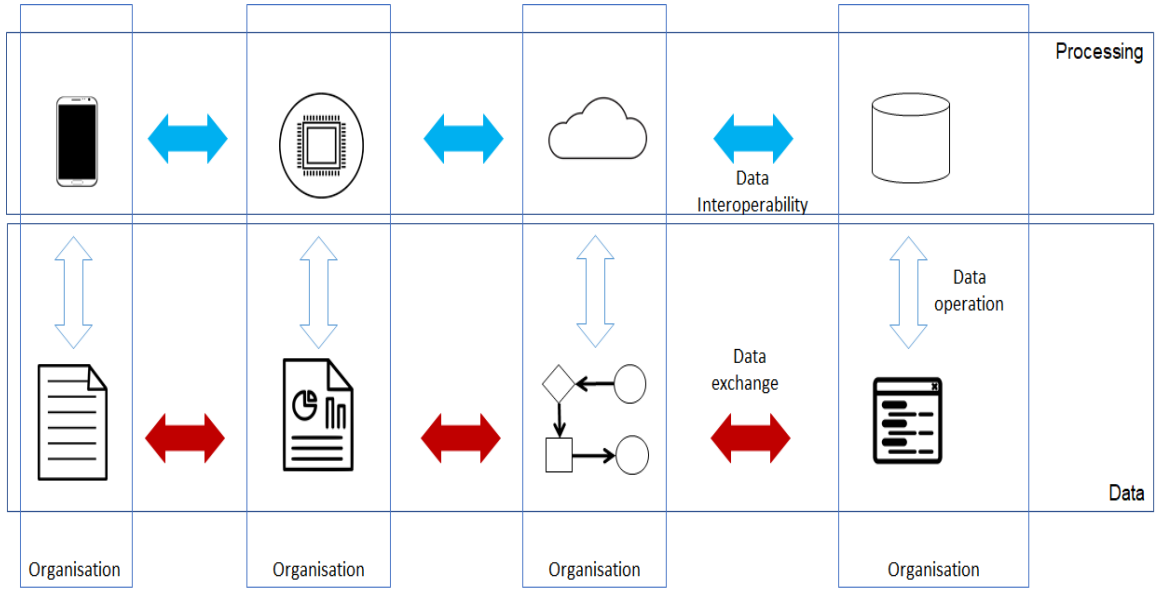
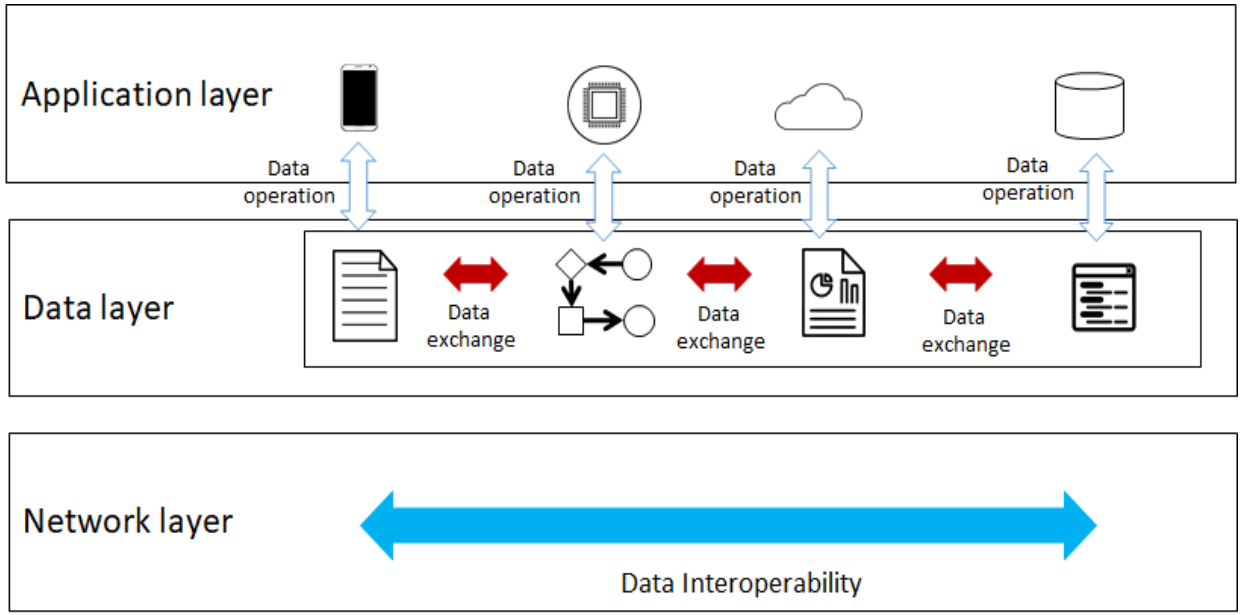
6.8.2 Data Spaces in the AIOTI High-Level Architecture

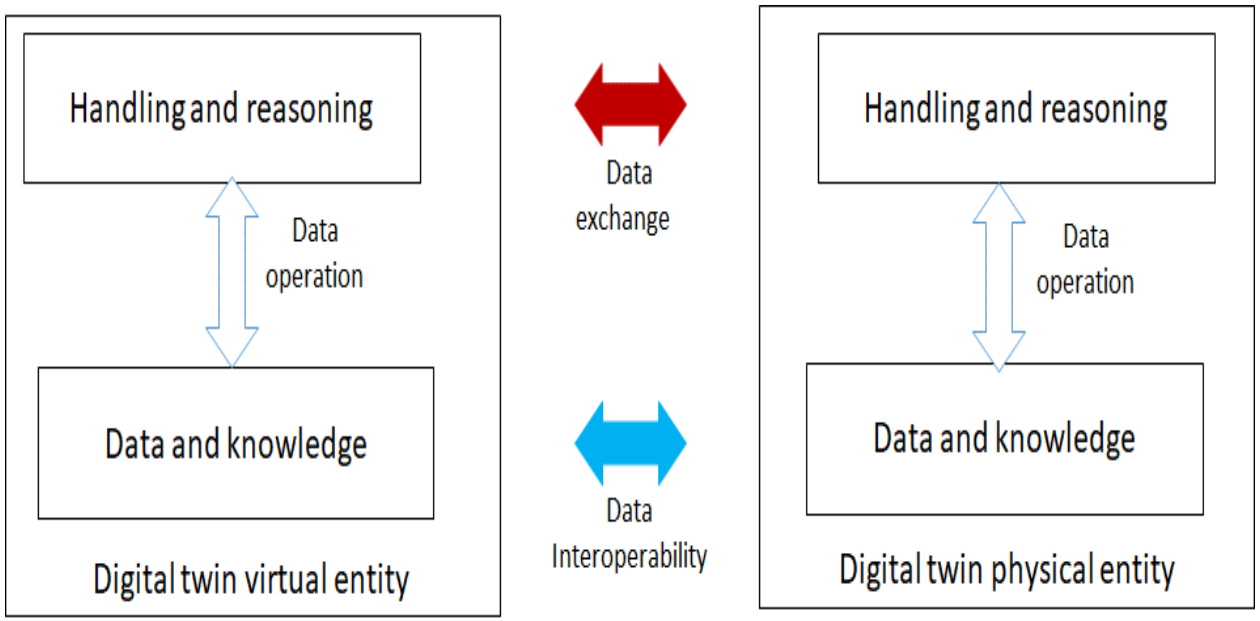


Decentralised data space example

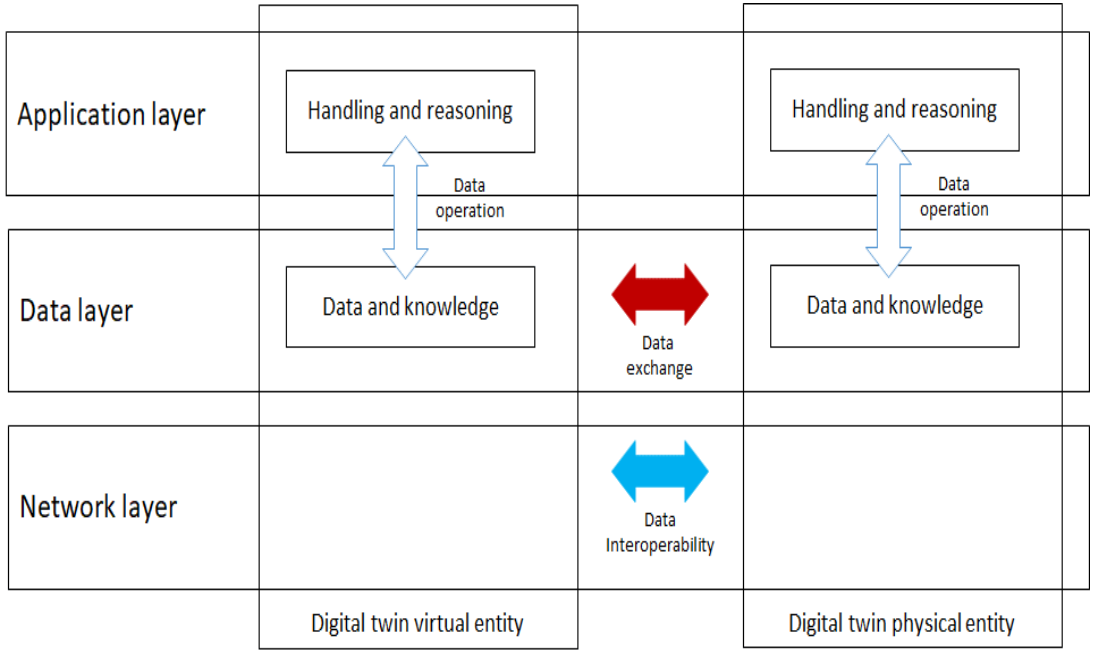


Data space example using the HLA representation

6.8.3 Digital Twin using the HLA representation

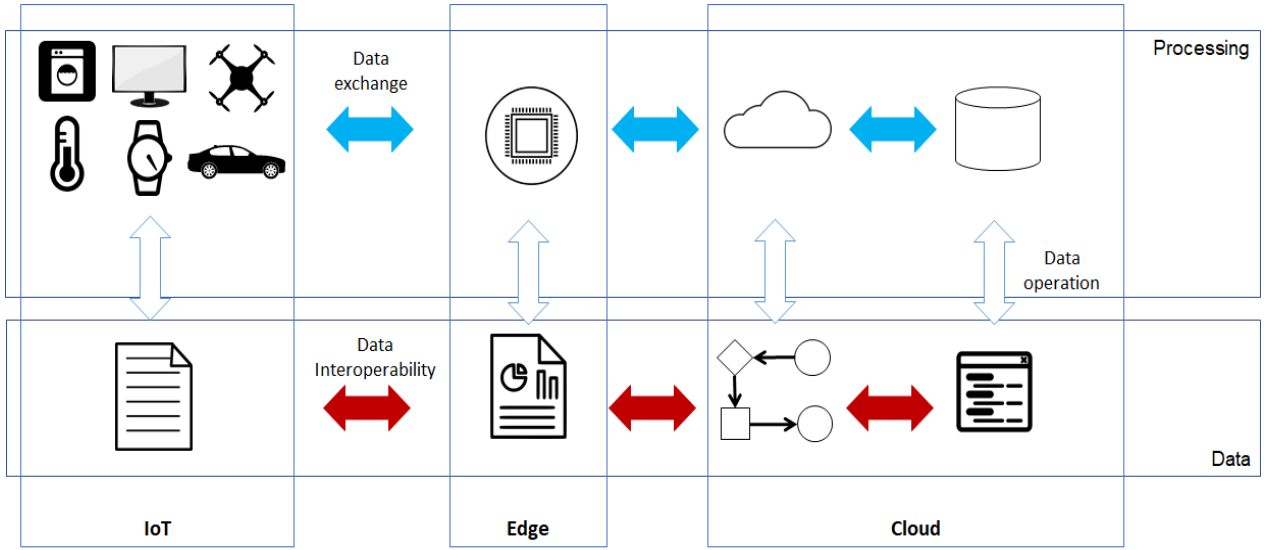


AI capability in a digital twin example

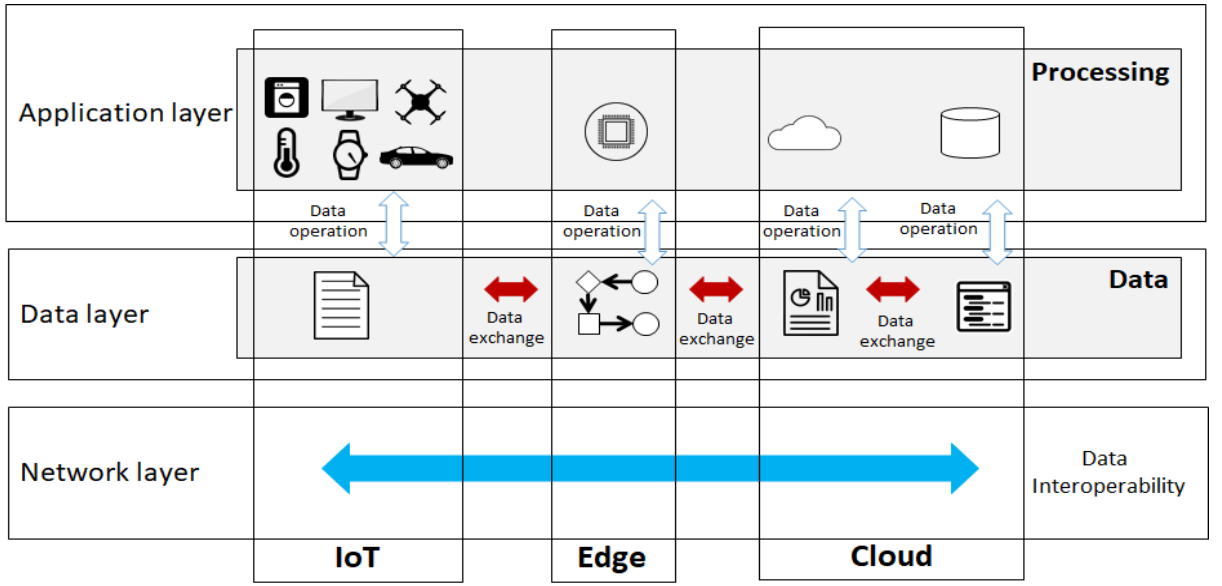


HLA representation of digital twin example

6.8.4 Computing continuum perspective using HLA representation

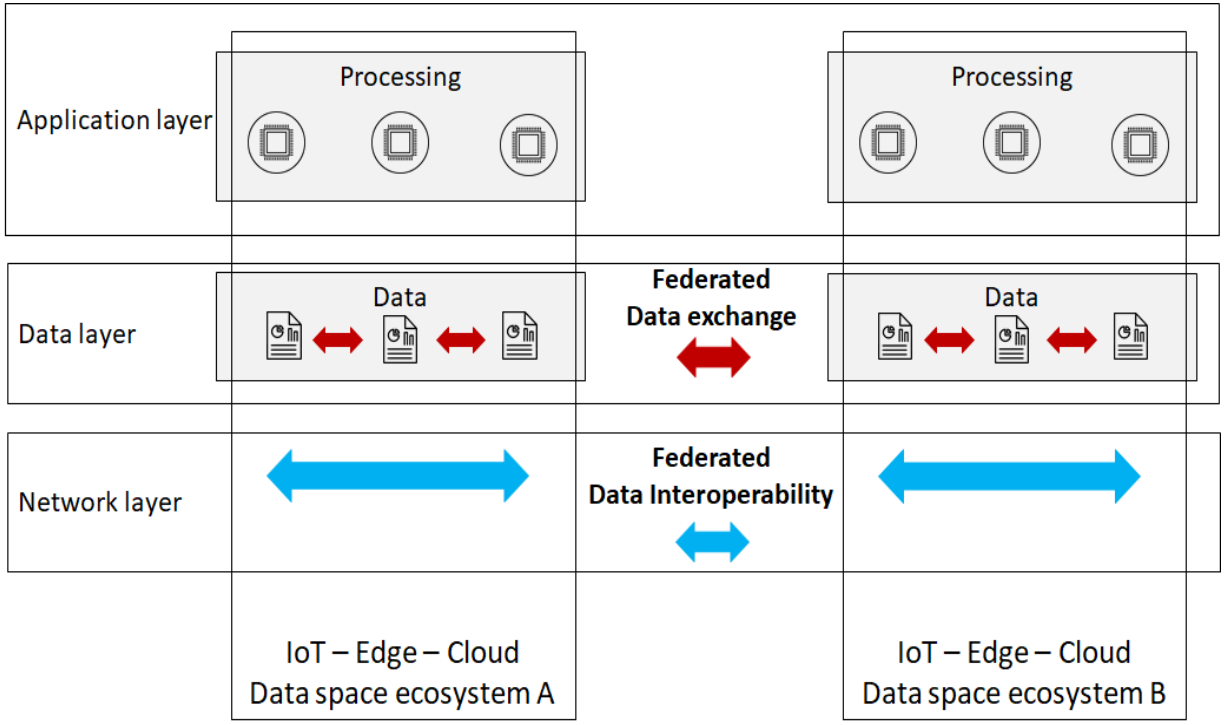


Computing continuum perspective of data spaces

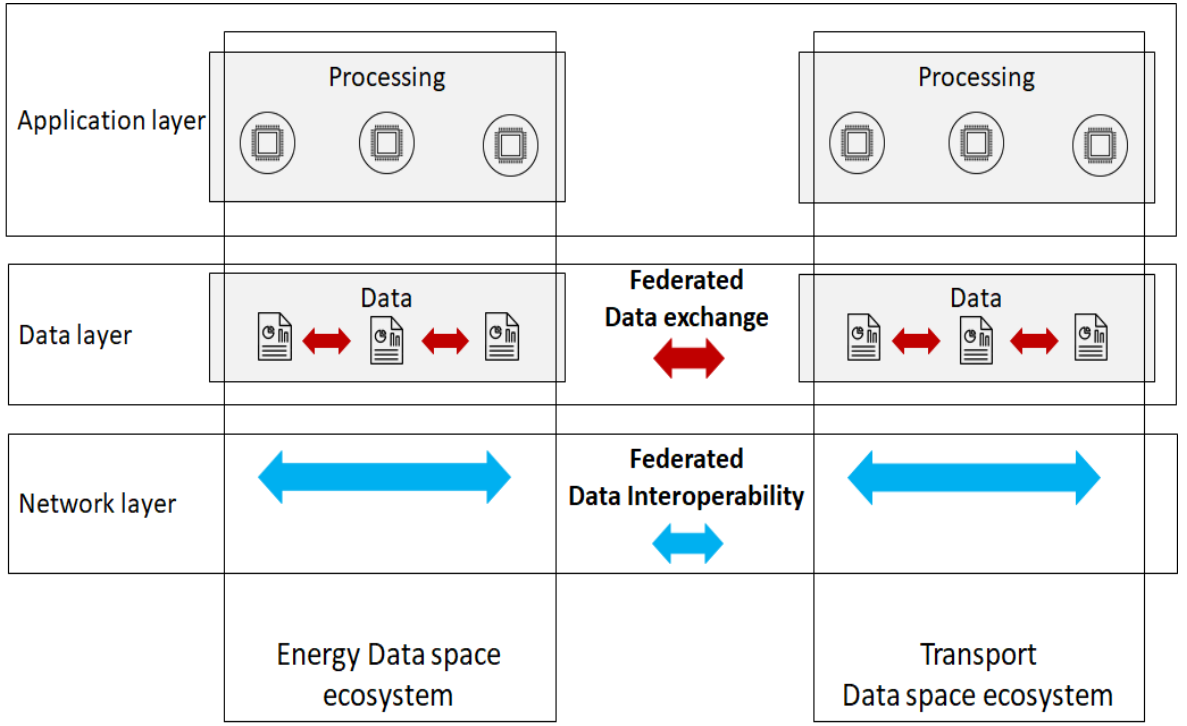


Computing continuum perspective of data spaces based on HLA

6.8.5 Federated Systems Perspective using HLA representation

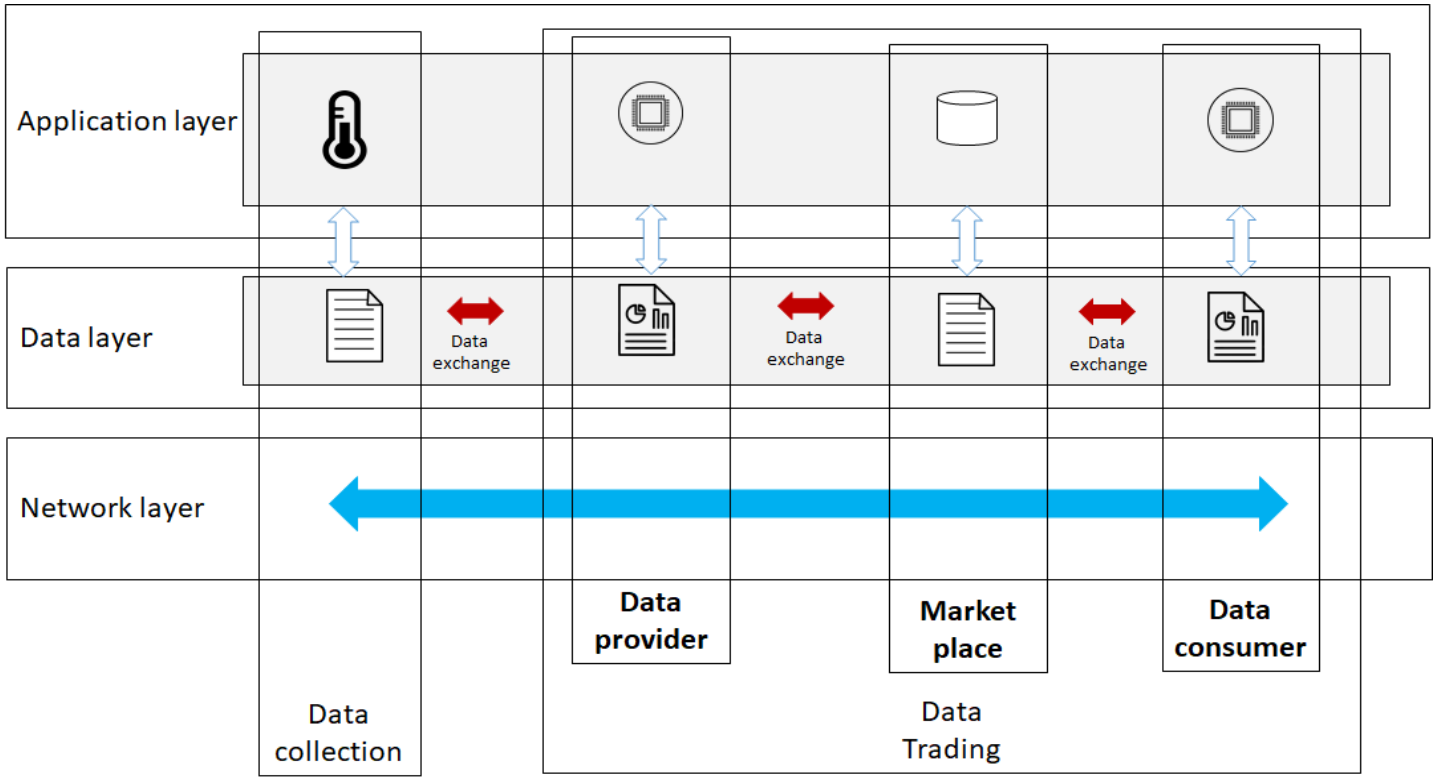


Federated systems perspective of data space



Domain perspective of data spaces

6.8.6 Data Collecting and Trading Perspective using HLA representation



Data collecting system and data marketplace

9. Artificial Intelligence for IoT

- **Data, Information and Knowledge**
  - Data is raw facts and figures:
    - become useful information, data needs to be structured, organised and processed
  - Knowledge is a step further that combines information with metadata such as data handling policies, ontologies and integrity constraints:
    - Knowledge is actionable information
    - A knowledge centred perspective layers on top of virtualisation of sensors and actuators

- **Reasoning:** process of drawing inferences from new and existing information
  - logical reasoning is based upon deductive proof
  - rationally plausible reasoning is based upon prior knowledge, and may need revision as new knowledge is acquired
  - inductive reasoning that generalises across a series of observations, analogical reasoning based upon similarities between different cases abductive reasoning that seeks the best explanations for given observations
  - plausible reasoning is an extension from logic to argumentation, drawing upon metadata to assess certainty of inferences

9. Artificial Intelligence for IoT (2)

- **The Role of AI in Enhancing IoT Capabilities**
  - AI technologies and deep learning provide means to:
    - analyse vast amounts of data generated by IoT devices
    - enable more intelligent decision-making processes and automating complex tasks without human intervention.
    - synergy between AI and IoT enhances:
      - efficiency and effectiveness of IoT solutions
      - unlocks new opportunities for innovation across various sectors
- **The Role of AI for Control of IoT**
  - AI applied to controlling IoT systems through use of lightweight notations for describing system behaviour in terms of abstractions presented by IoT virtualisation:
    - Includes dynamic orchestration for optimising utilisation of resources across the compute continuum
  - Machine learning applied to train real-time models of behaviour, including recognising and acting upon events

9. Artificial Intelligence for IoT (3)

- **Importance of Frameworks and Standards for AI in IoT**
  - **<u>essential to establish robust frameworks and standards that ensure interoperability, security, and privacy</u>**
  - frameworks should facilitate seamless data exchange among diverse IoT devices and platforms while providing a secure environment for AI algorithms to operate
  - deployment of AI in IoT contexts must address governance challenges ensuring that AI applications adhere to ethical guidelines, respect user privacy, and contribute to fair and sustainable economic models
  - development and implementation of AI technologies in IoT to be guided by principles promoting transparency, accountability, and inclusivity, ensuring that benefits of AI are accessible to all stakeholders within the IoT ecosystem
  - integration of AI technologies within IoT offers the promise of more intelligent, efficient, and responsive systems that can better address the complex challenges of modern societies

Highlights and recommendations

- AIOTI WG Standardisation developed a High-Level Architecture (HLA) for IoT, which can be applicable to Pilots within large scale projects, including EU funded projects
- Current version of HLA report provides insights on how frameworks such as Data Spaces, AI, Digital Twin that are applied in IoT systems can be integrated in the AIOTI HLA
- HLA is considering existing SDOs and alliances architecture specifications
- Currently, several IoT related architectures, developed in other SDOs and associations, such as oneM2M, ITU-T, IIC, Industrie 4.0 (RAMI), BDVA, are mapped to the AIOTI HLA
- HLA can basis for further discussion with the relevant EU funded projects, and to promote architectural convergence/synergy with SDOs (such as ITU-T **SG13** and **SG20**, ISO-IEC JTC1 **SC7** and **SC41**), alliances, consortia and other relevant parties
- HLA needs to be continuously updated in order to follow the up to date IoT developments

Next Steps and Discussion

- **Updated version of the report** "High Level Architecture (HLA) Report, Release 7.0" is planned with:
  - HLA needs to be continuously updated in order to follow the up to date IoT developments, e.g., virtual worlds, immersive technologies, new concepts in data spaces, AI, Digital Twin

- **Questions to the audience**
  - Is this report useful for your community?
    - ✓ If yes, we can have one-to-one meetings to discuss details on topics interesting for your community
  - Are there any, up to date, IoT developments, e.g., virtual worlds, immersive technologies, new concepts in data spaces, AI, Digital Twin, known to your community, that might have an impact for HLA activities and need to be included in a subsequent Release?
    - ✓ If yes, we can have one-to-one meetings to discuss the way on how this input can be provided to AIOTI

- **Open Discussion**

Presentation of the Guidance for the Integration of Digital Twins in Data Spaces Report R1

Antonio Kung (Trialog, AIOTI WG Standardisation Chairman)

AIOTI

Joint Undertaking January-June 2024

Alliance for IoT and Edge Computing Innovation

WG Standardisation
Focus Group High Level Architecture

BDV BIG DATA VALUE ASSOCIATION

BDVA Task force Data space, Task force Standards and benchmarking

StandICT.eu

TWG – Digital Twins

HSbooster.eu
Horizon Standardisation Booster

Contributors

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  - Roberto Di Bernardo (Engineering)

Focus: Integration of Digital twins in Data Spaces

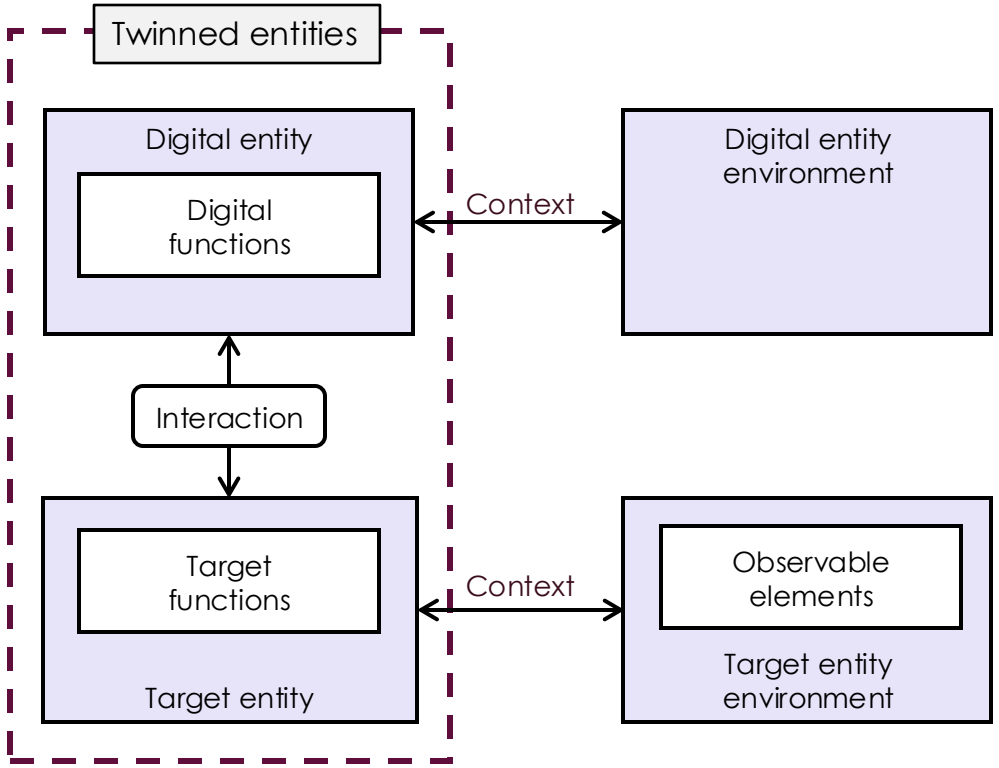
- Context: Standardisation need?
  - Data spaces, Digital twins, IoT and Edge computing
- Architecture approach: Standardisation insight!
  - Use cases: Agriculture, Connected vehicles, Smart cities, Energy, Smart manufacturing
- Previous reports
  - StandICT EUOS June 2022
    - Landscape of Digital Twins
      - https://standict.eu/landscape-analysis-report/landscape-digital-twins
  - AIOTI September 2022
    - Guidance for the Integration of IoT and Edge Computing in Data Spaces
      - https://aioti.eu/wp-content/uploads/2022/09/AIOTI-Guidance-for-IoT-Integration-in-Data-Spaces-Final.pdf
  - BDVA February 2024
    - Data Sharing Spaces and Interoperability
      - https://bdva.eu/news/bdvas-position-paper-on-data-sharing-spaces-and-interoperability

Context

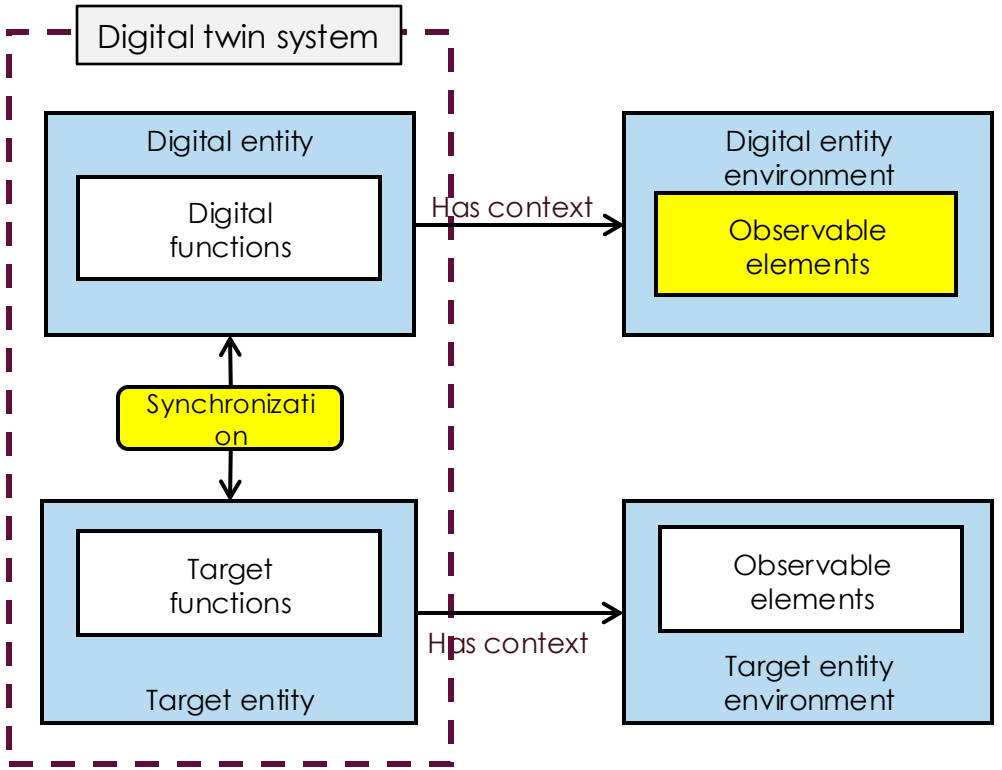
- Data spaces
  - EU Common European Data Space Strategic Initiative
  - Simpl (Cloud-to-edge federations empowering EU data space)
  - Gaia-X
  - DSSC Data space support centre (Horizon Europe project)
  - INT:NET Energy data space support (Horizon Europe project)
  - IDSA International data space association
- Digital twins
- IoT and Edge computing
- Standards
  - ISO/IEC 30141 Ed2 IoT reference architecture
  - ISO/IEC 30164 Edge computing
  - ISO/IEC 30188 Digital twin reference architecture (Working draft)
  - ISO/IEC 20151 Dataspace concepts and characteristics (Working draft)
  - ISO/IEC 30151 Digital twin: extraction and transaction of data products (Approved)
  - ISO/IEC 30152 IoT and digital twin: guidance on the connection to data spaces (Approved)

AIOTI

Digital Twin Architecture: Twinning view

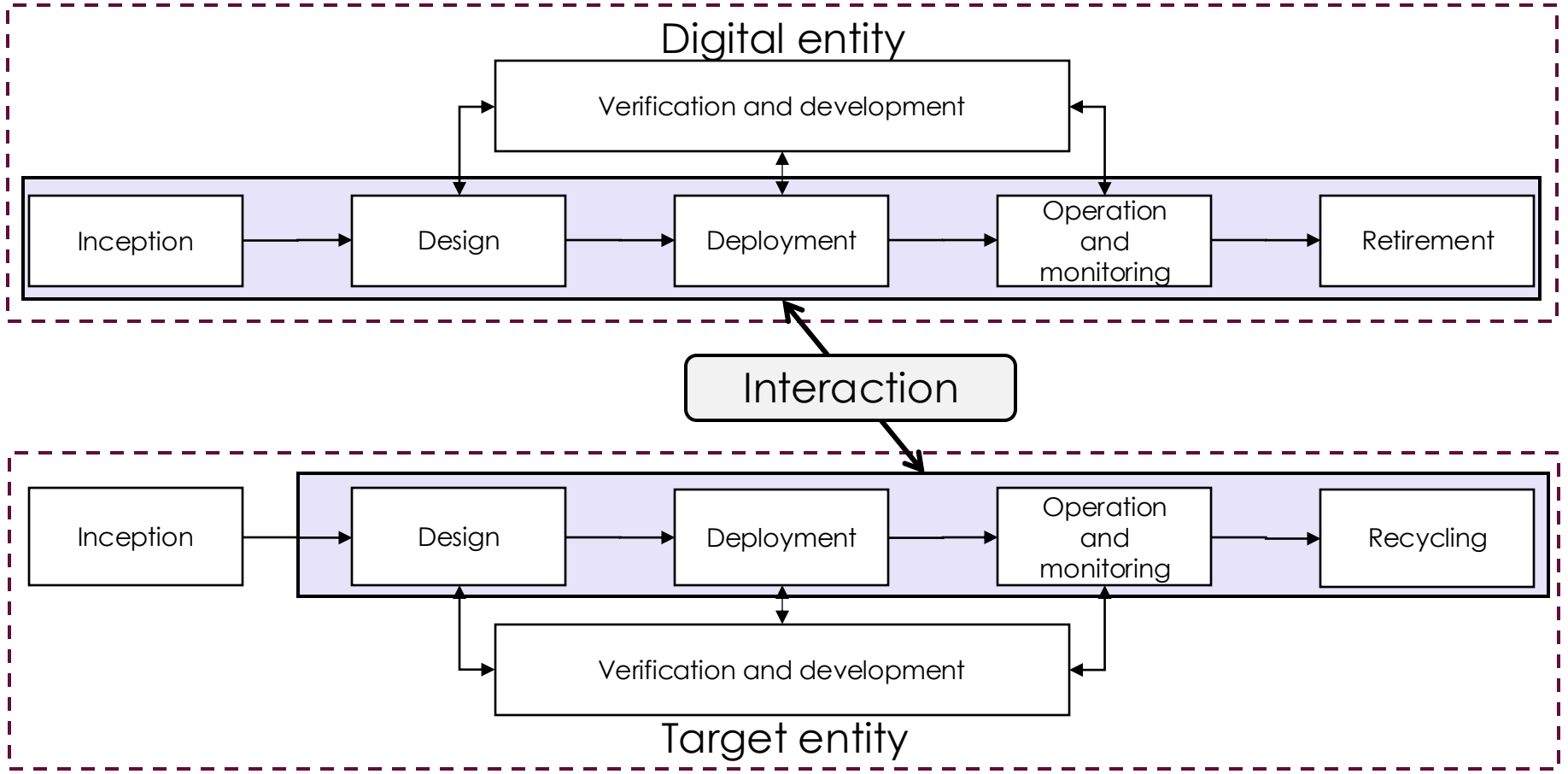


Report (June 2024)



ISO/IEC 30188
Working draft 2 (August 2024)

Digital Twin Architecture: Lifecycle View



Report (June 2024) and ISO/IEC 30188 Working draft 2 (August 2024)

Digital Twin Architecture: Functional View

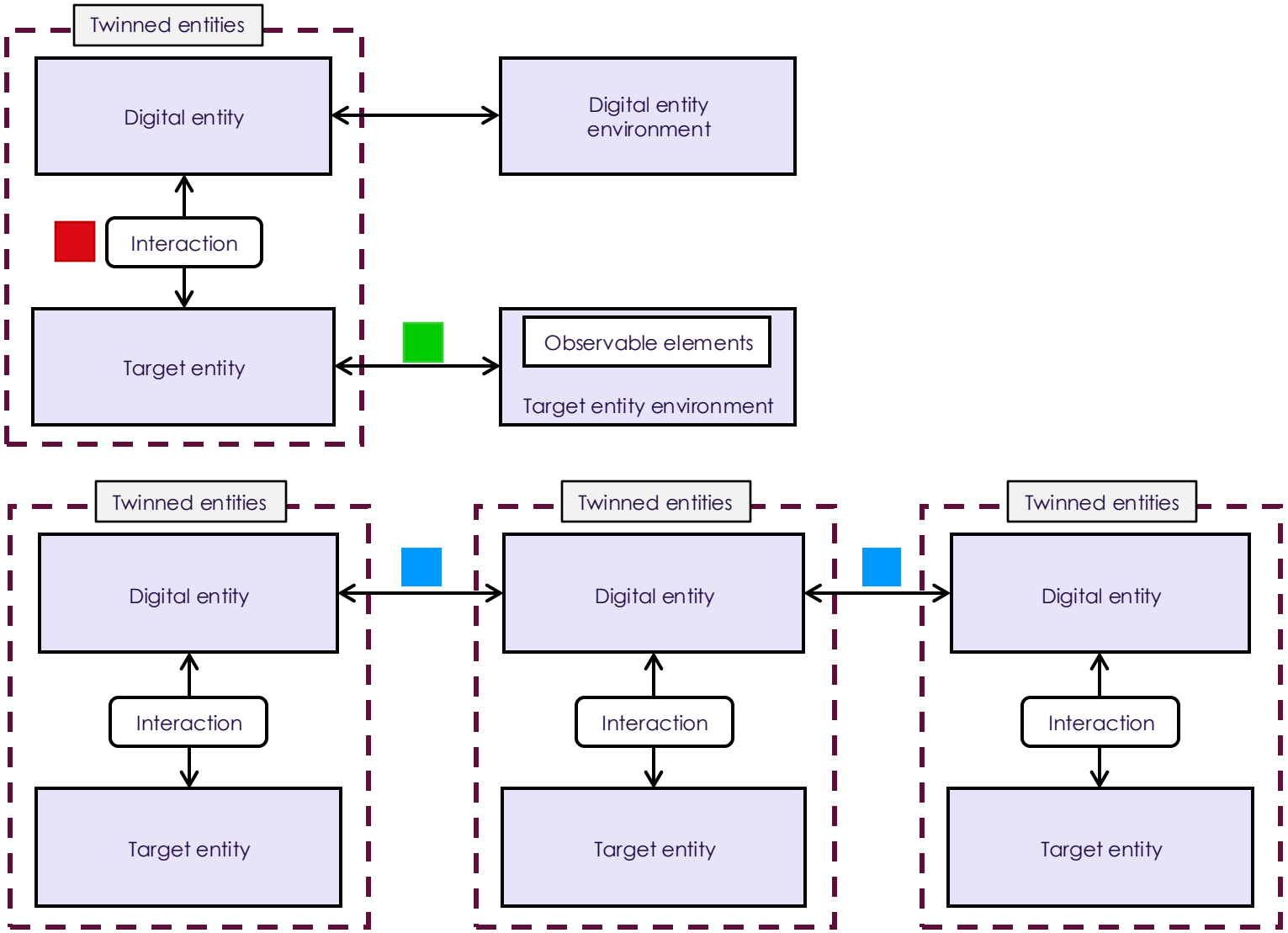
	Define	Execute	Monitor and measure	Analyse	Control	Optimize
Inception	*Profiling business processes* *Definition of goals and needs*	*Profiling business processes* *Definition of goals and needs*	*NA*	*Profiling business processes* *Definition of goals and needs*	*Profiling business processes* *Definition of goals and needs*	*Geometry modelling* *Kinematics*
Design	*Model design* *Digital thread design* *Digital twin system design*	*Better understanding and selection of tools, techniques and data*	*Visual design* *Simulation of digital twin implementation process*	*Better understanding and analysis of physical entities*	*Reduce system cost*	*Realize design optimization*
Deployment	*Modelling and simulation*	*Better use of tools, technology, and data*	*Upgrade visualization*	*Better analysis of generated data and simulation results* *Better evaluation of existing physical entities*	*Better integration of control equipment, systems, environments, etc.* *Reduce system costs*	*Improve implementation efficiency*
Operation and monitoring	*Full interaction with physical entities*	*Construct platform* *Achieve interoperability* *Achieve client availability*	*Real-time and visual monitoring* *Real-time and visual metering*	*Cost estimation* *Failure analysis* *Improved material management* *Operational trade-off analysis*	*Alarming* *Repairing* *Calibrating* *Inventory management* *Troubleshooting* *Planning*	*Reduce operating costs* *Prediction prognosis* *Sustainability* *Enhance user experience* *Reduce carbon emission*
Development and verification	*Model training* *Improve simulation*	*Better use of artificial intelligence, Large-scale models, machine learning, deep learning, and other technologies;* *Upgrade and update digital twin system*	*Visual monitoring* *Safety check* *Health check* *Counterfeit detection*	*Upgrade analysis*	*Upgrade analysis*	*Reduce operating costs* *Prediction prognosis* *Sustainability;* *Enhance user experience;* *Reduce carbon emission*
Retirement	*Replacement by other digital twins*	*Construct historical database*	*Education and training* *Visualization practice and rehearsal*	*Scientific research* *Provide technical support*	*Archiving*	*Utilization for other applications*

Report (June 2024) and ISO/IEC 30188 Working draft 2 (August 2024)

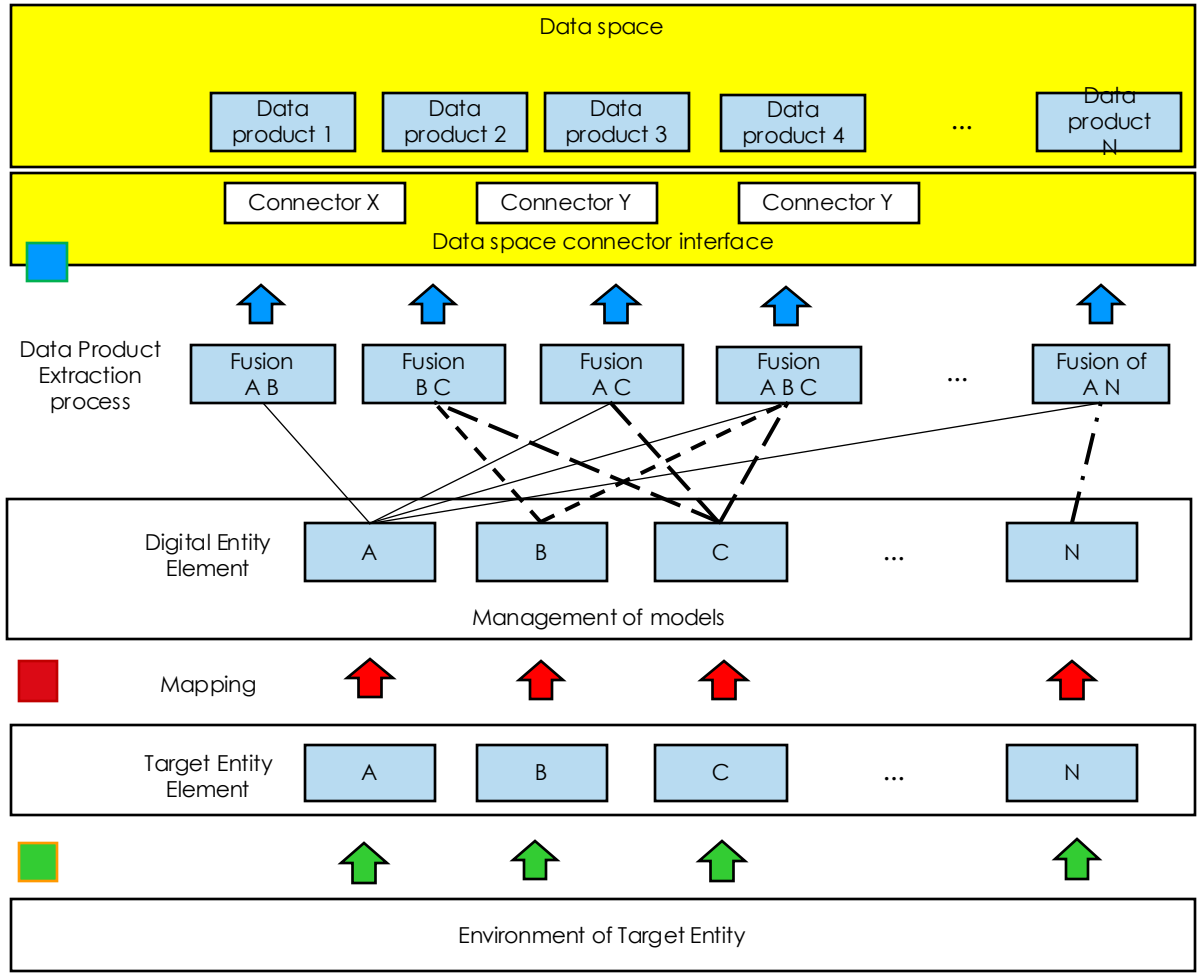
AIOTI

Digital Twin Architecture: Interoperability View

- Inner interoperability
- Outer interoperability
- Transversal interoperability



Integration of Digital Twins in Data Space



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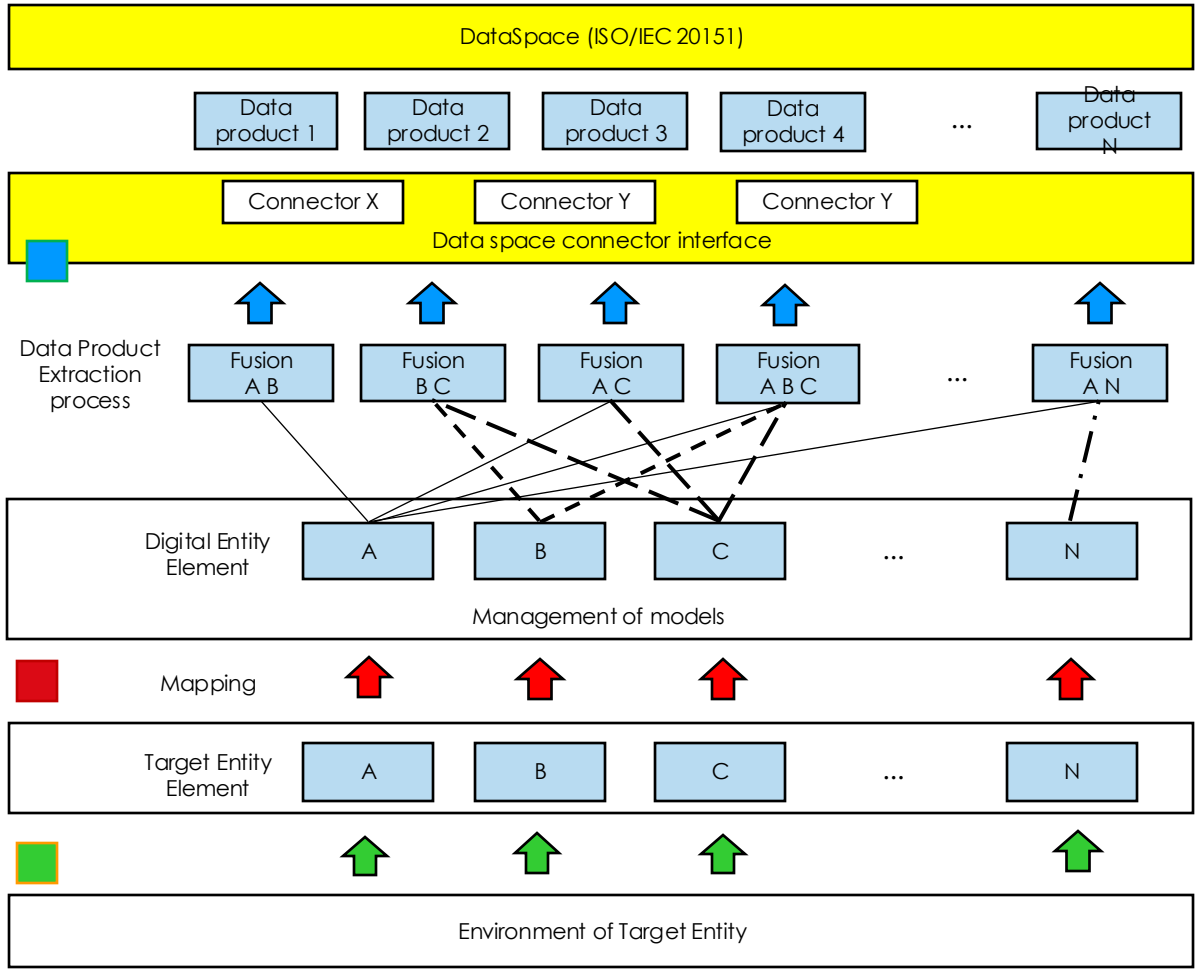

ISO/IEC 20151 (Dataspace concepts and characteristics)

- Inner interoperability
- Outer interoperability
- Transversal interoperability

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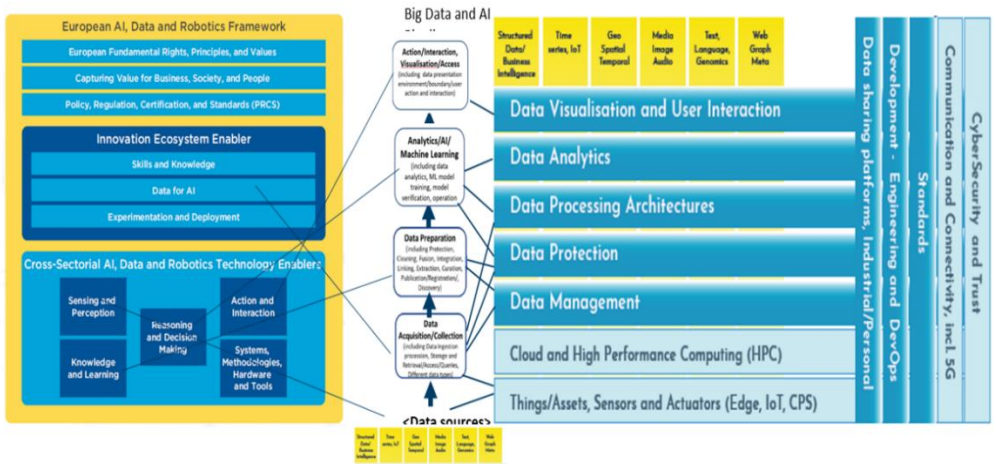
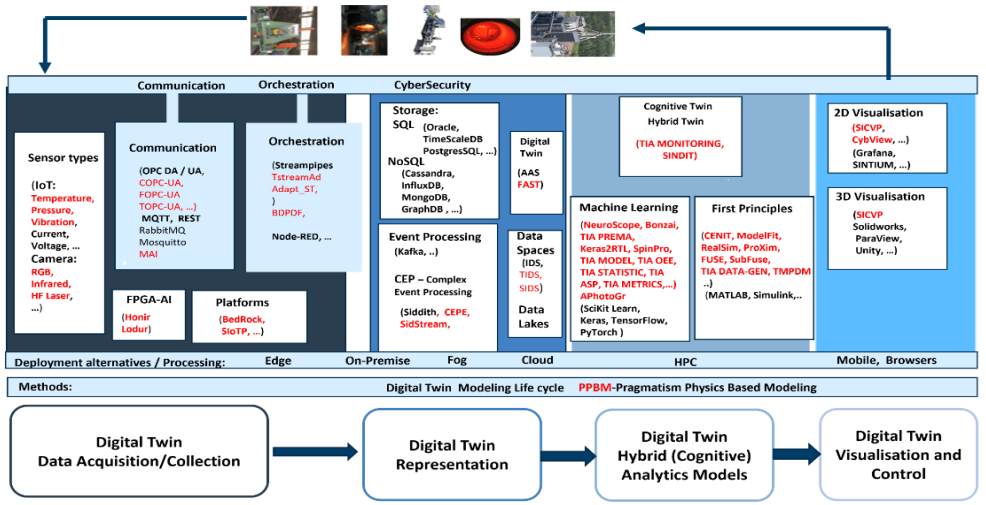
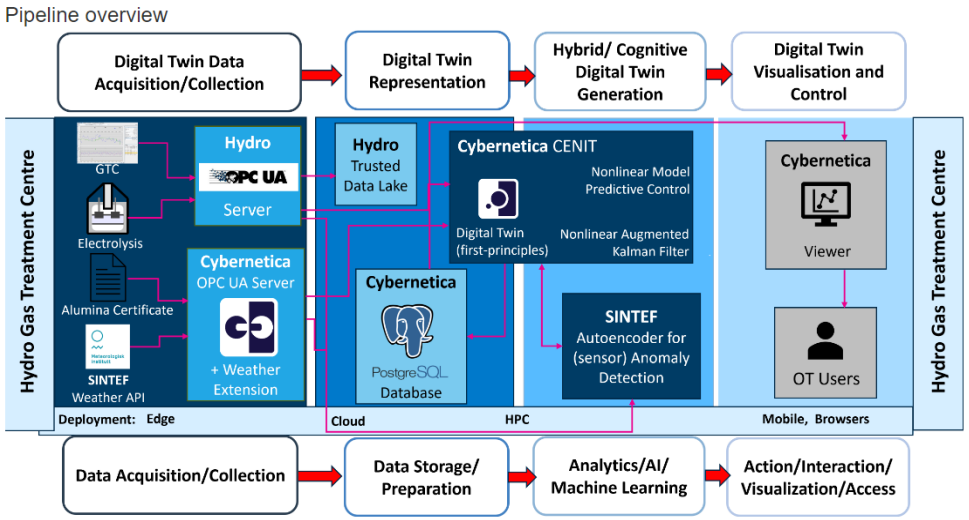
Data Pipeline Architecture Patterns



Data pipeline architecture related to the ADRA and BDVA Reference Models

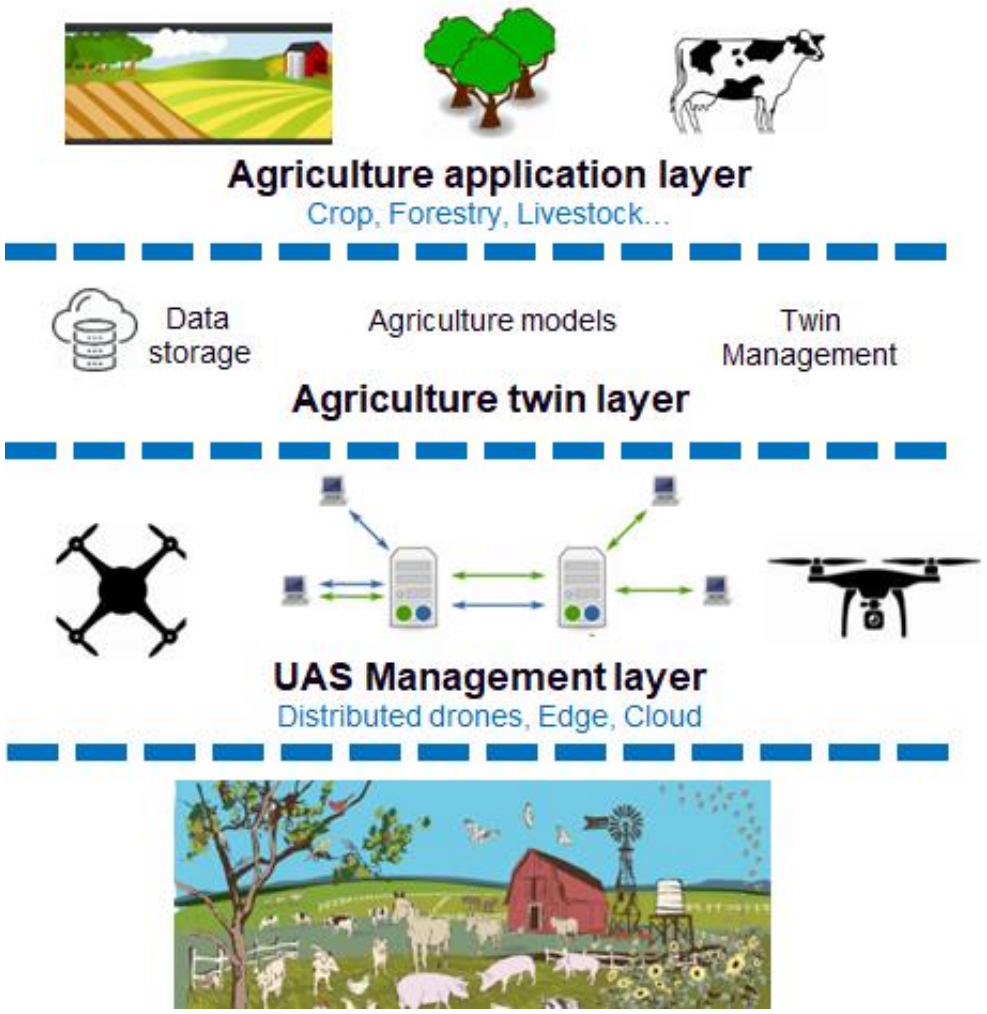


Capabilities of a digital twin data pipeline



Pipeline in a Process Industry digital twin

Digital Twins Project: SPADE (Agriculture) https://spade-horizon.eu/

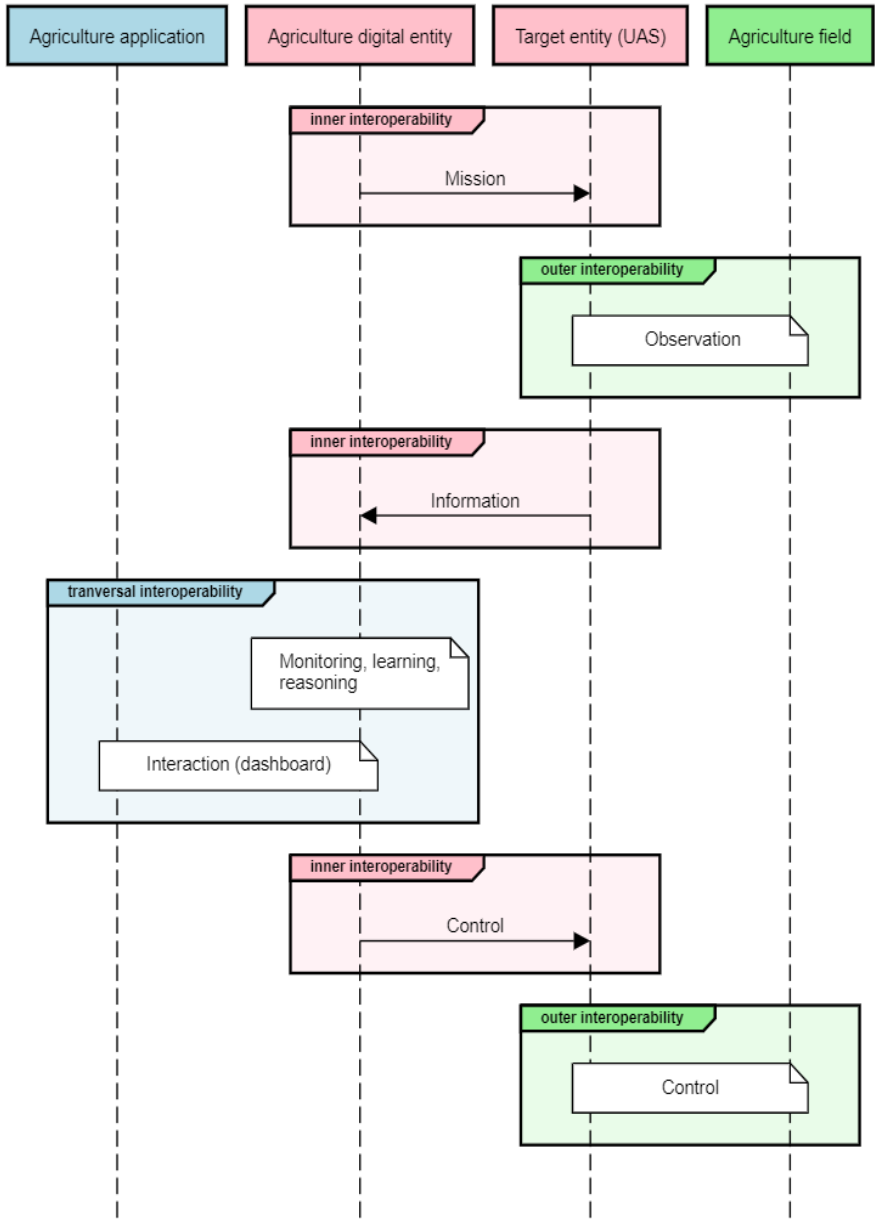


AITI

Inner interoperability

Outer interoperability

Transversal interoperability



Digital Twins Project: Connect (Connected Vehicle)

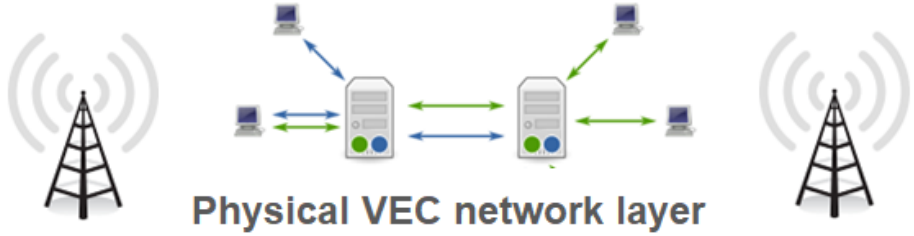
https://horizon-connect.eu/

Vehicular application layer

Navigation, parking, accident warning, blind spot…

Data storage | Virtual model mapping | Twin Management

Digital twin network layer

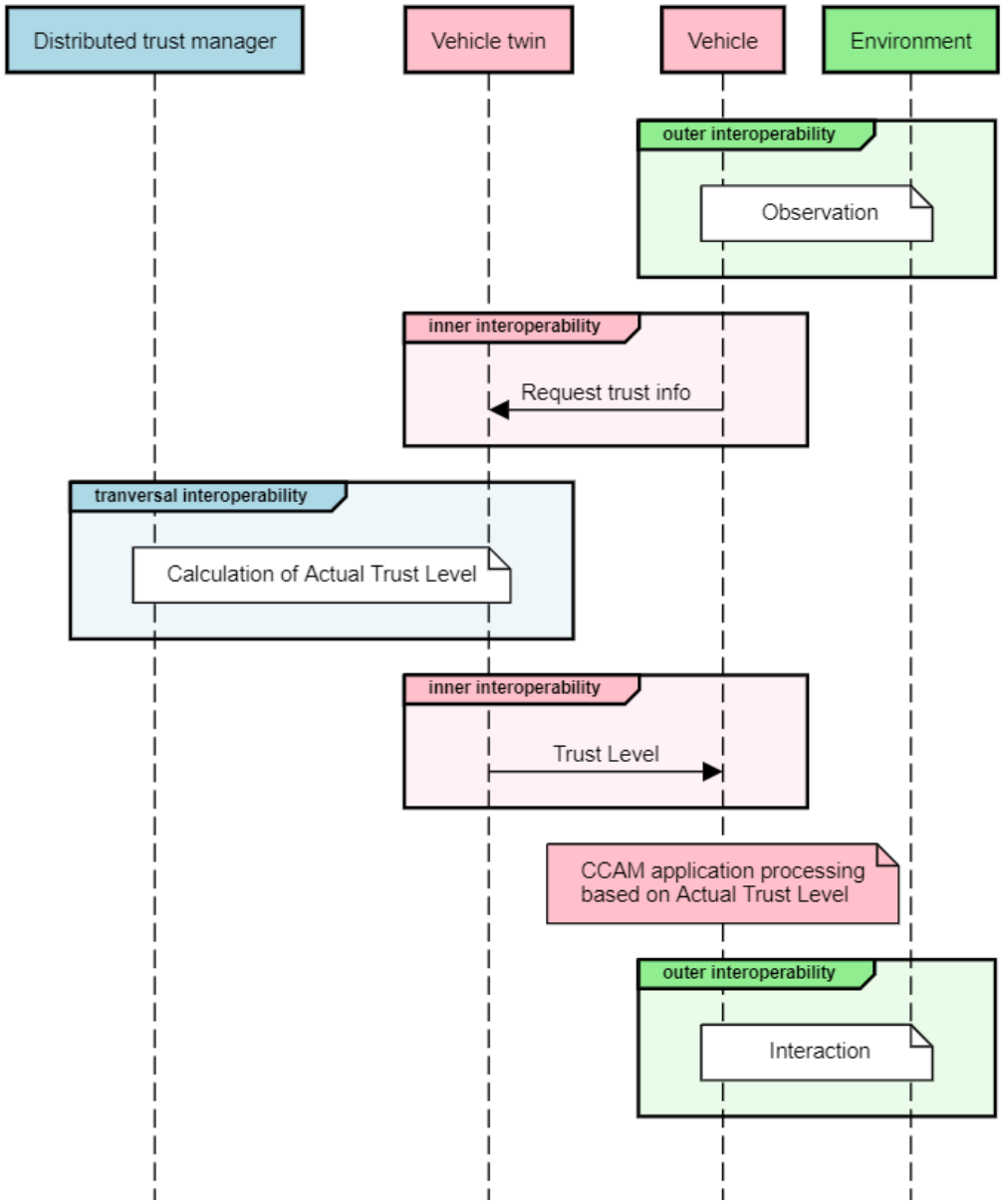


Physical VEC network layer

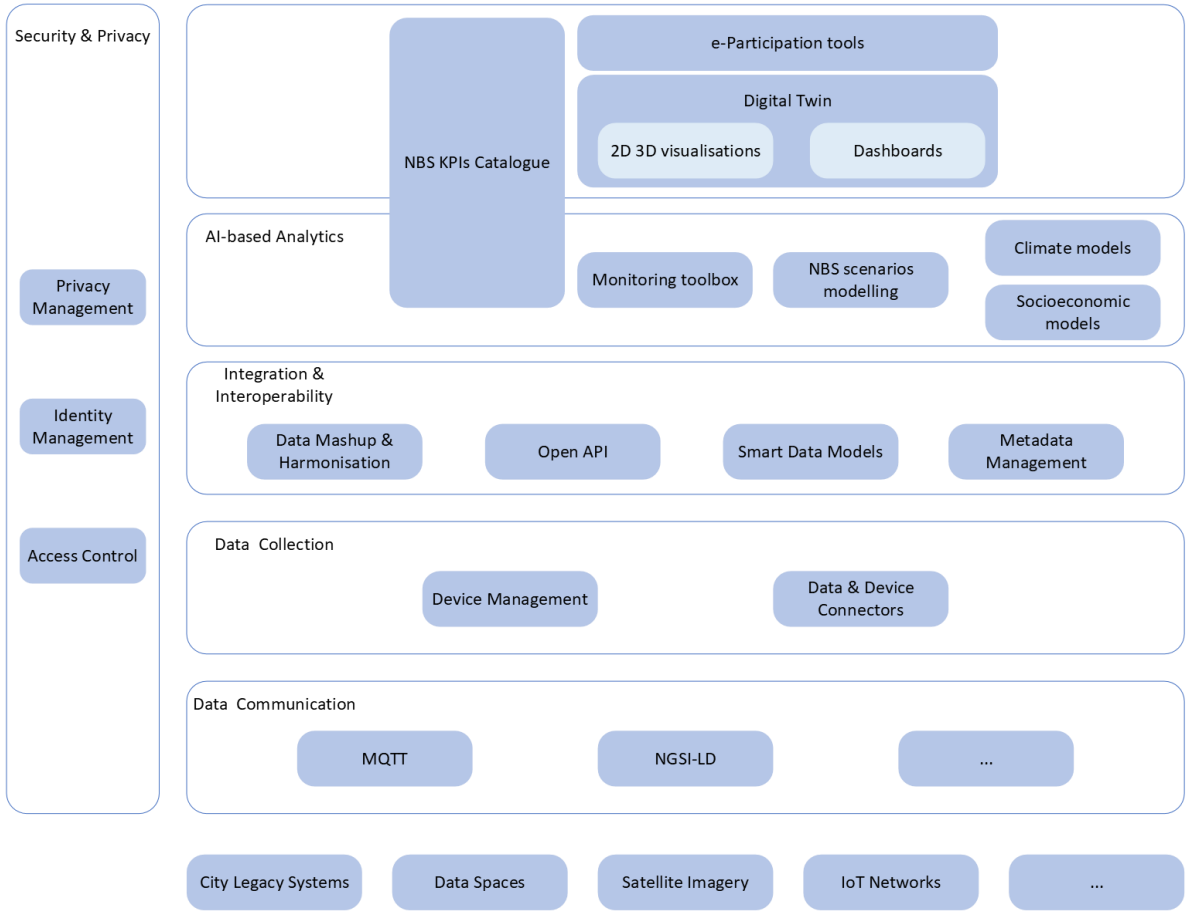
Distributed vehicles, RSUs

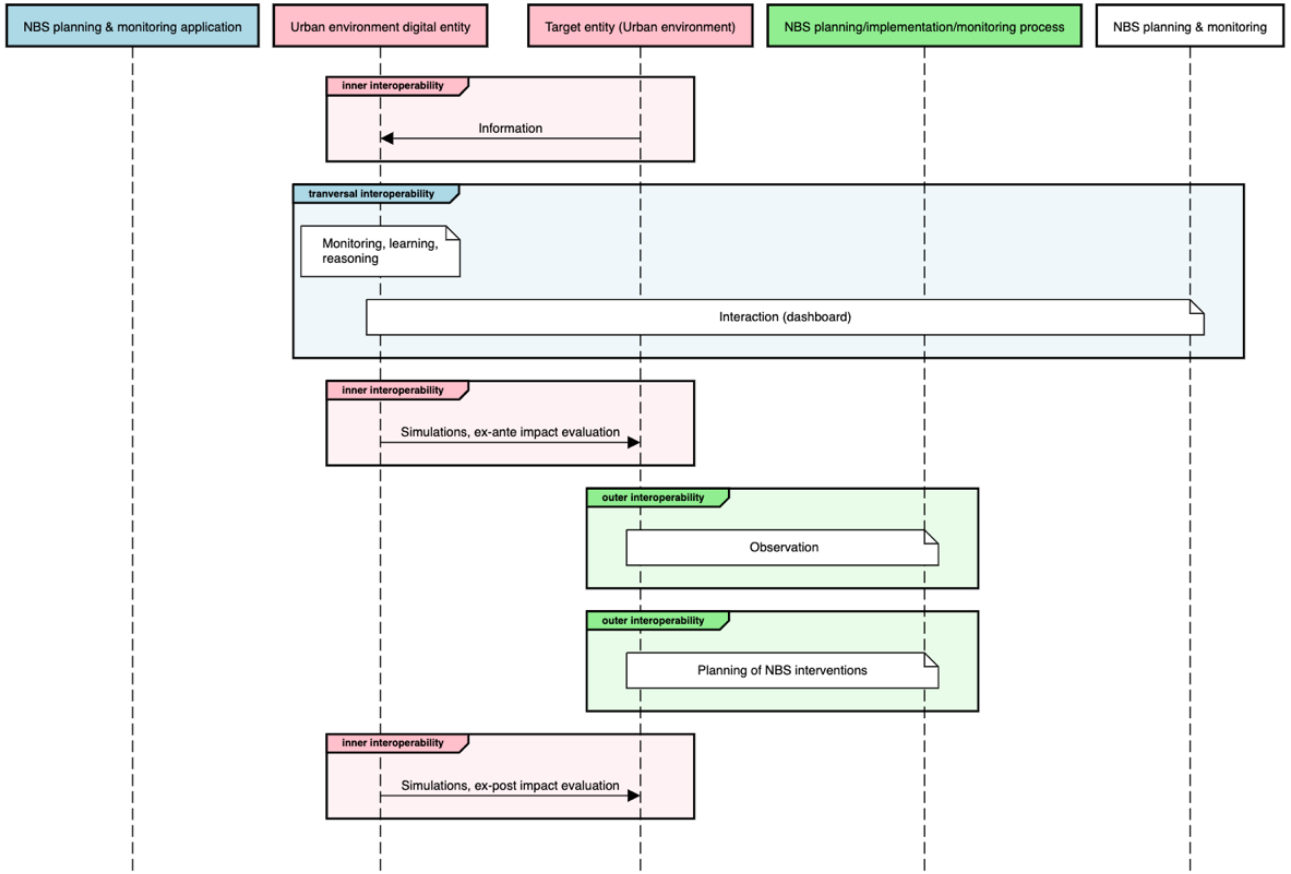
AICTI

- Inner interoperability
- Outer interoperability
- Transversal interoperability



Digital Twins Project: URBREATH (smart city) https://urbreath.eu/





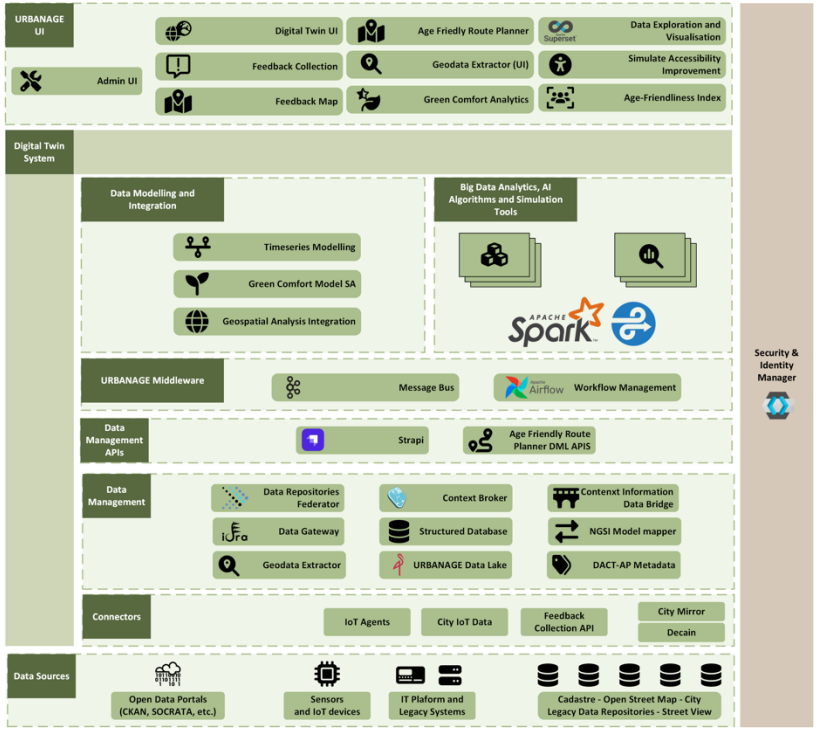
Inner interoperability

Outer interoperability

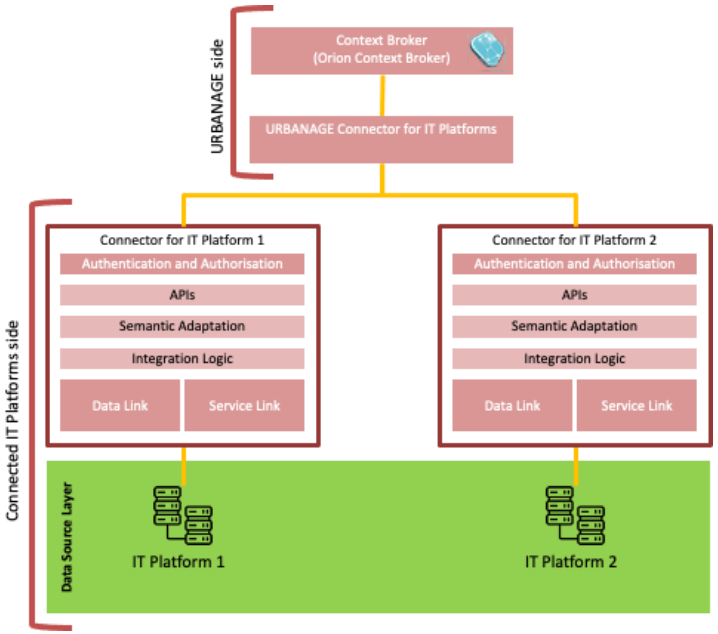
Transversal interoperability

Digital Twins Project: URBANAGE (smart city)

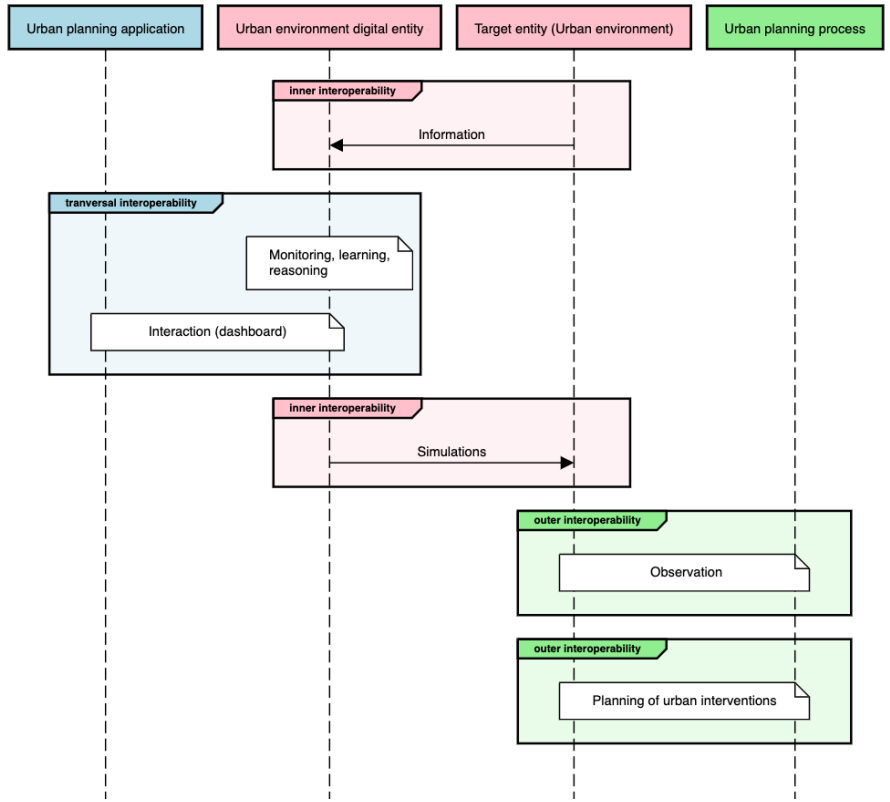
https://www.urbanage.eu/



High level architecture



Connector

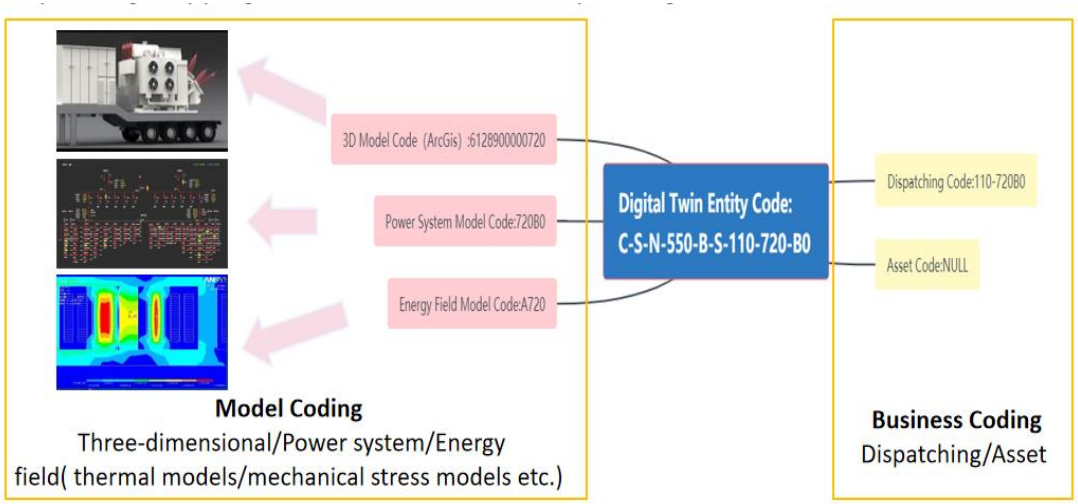


Inner interoperability

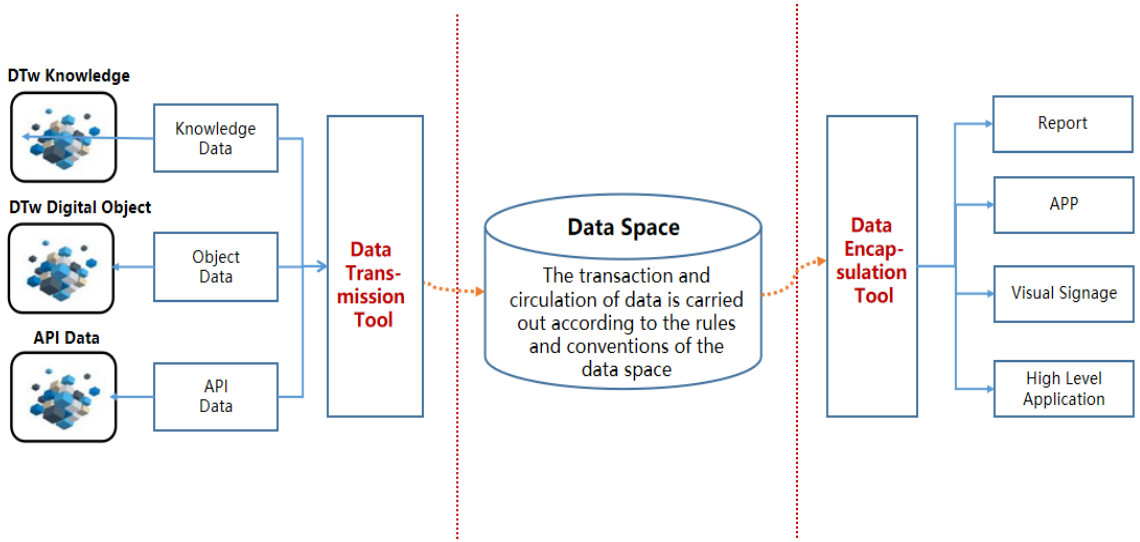
Outer interoperability

Transversal interoperability

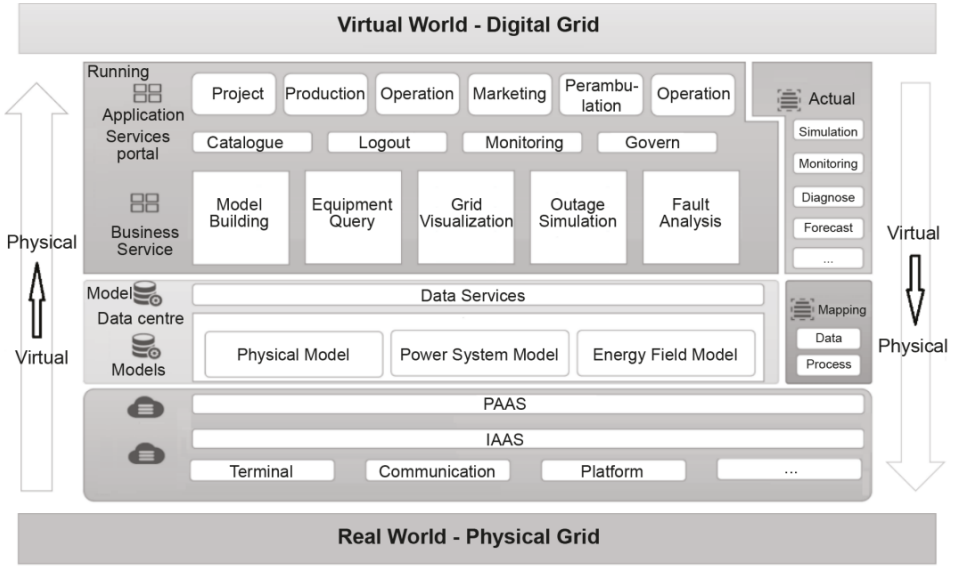
Digital Twins Project: Substation data sharing (energy)



3-D model of power grid



Interoperability approach



IoT and Edge infrastructure

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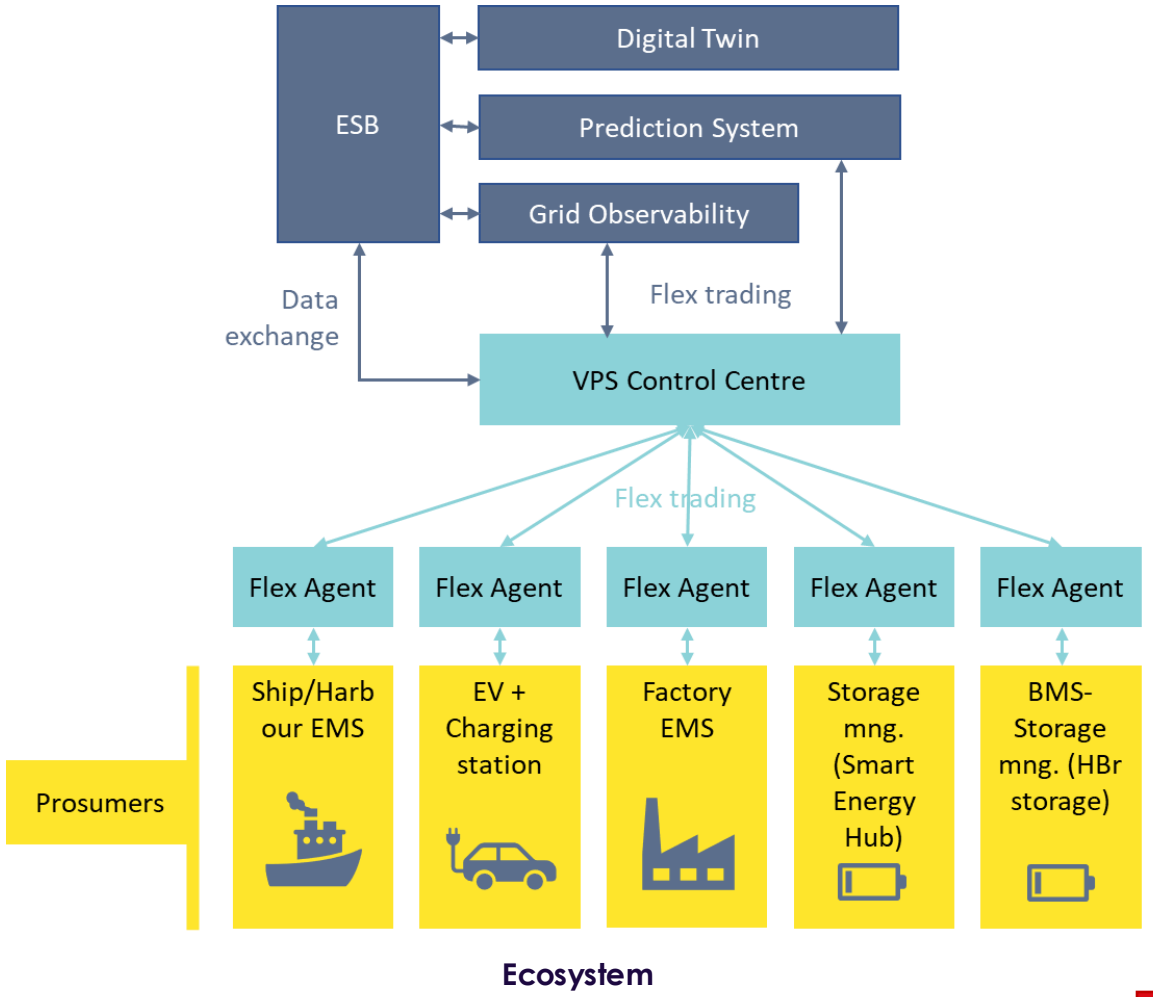
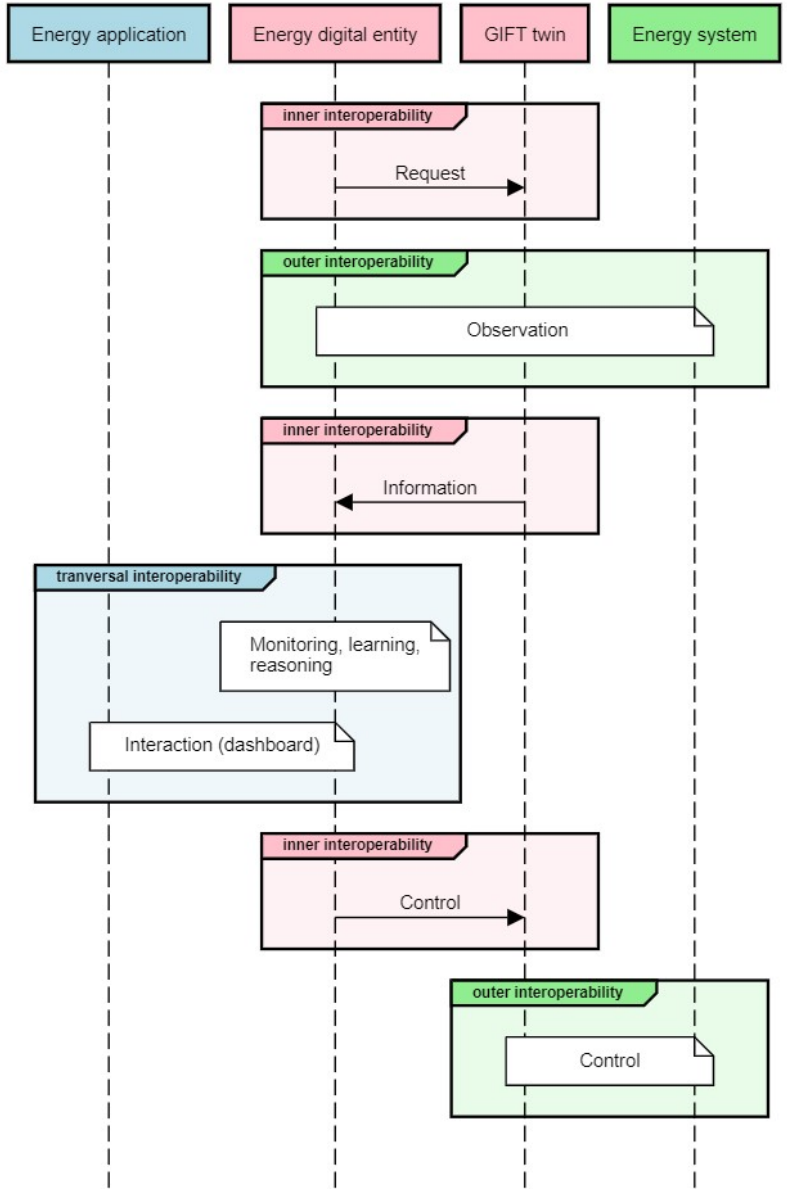
Digital Twins Project: GIFT (energy) gift-h2020.eu



Ecosystem



Inner interoperability

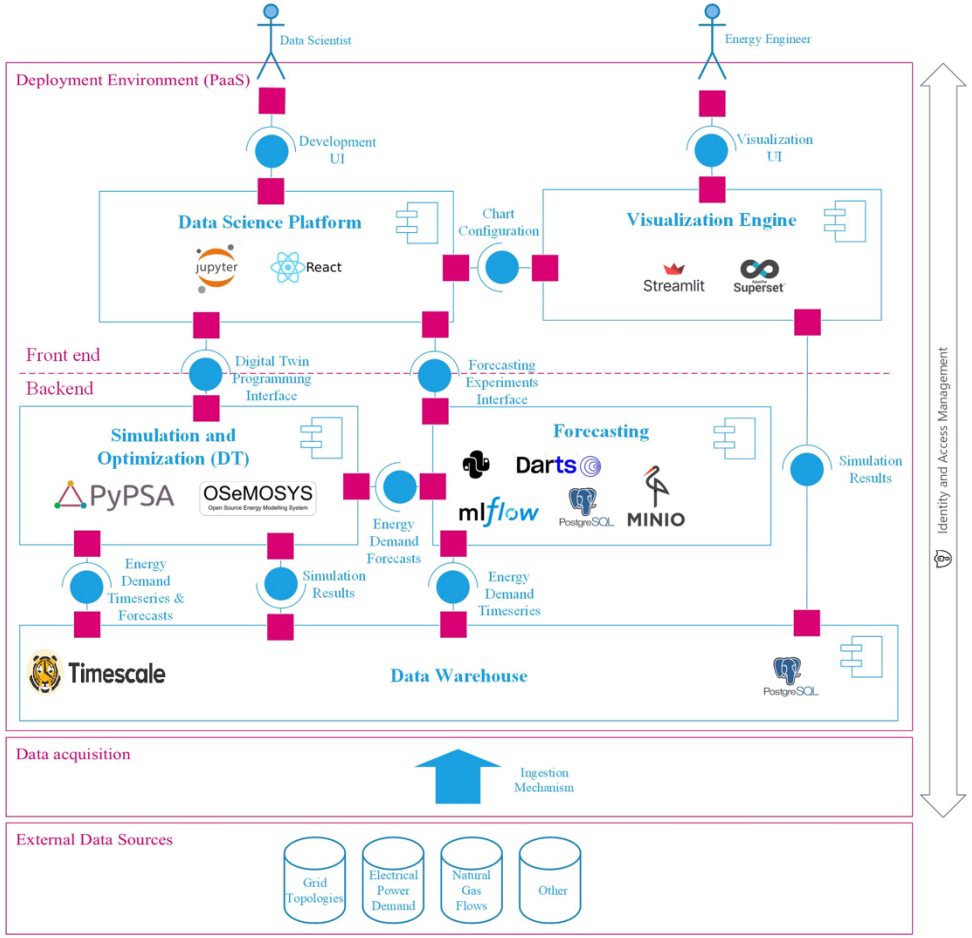
Outer interoperability

Transversal interoperability

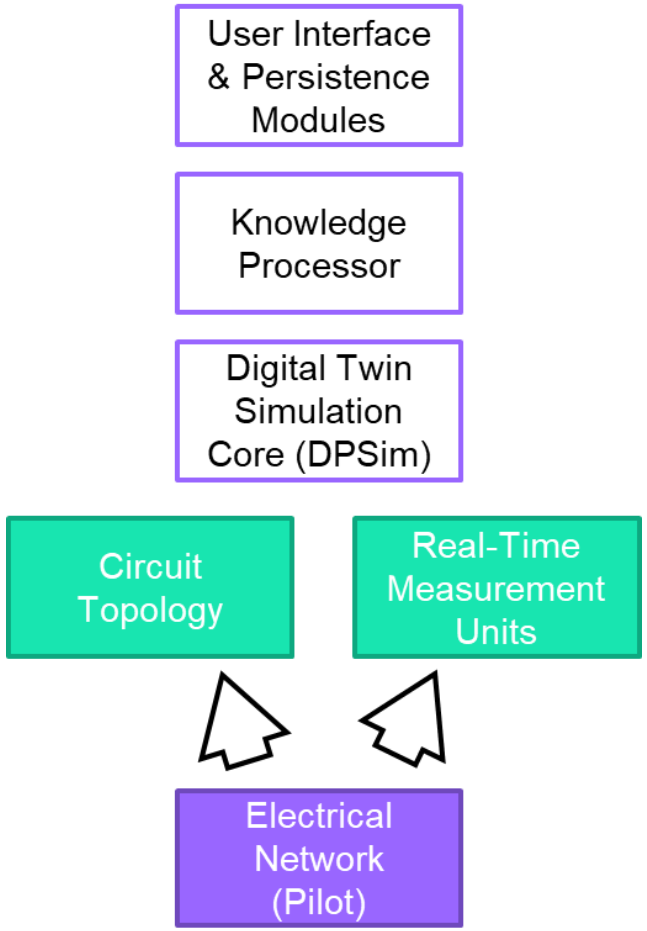
AIOTI

Digital Twins Project: Enershare (energy)

https://enershare.eu/resources/



High-level architecture



High-level architecture

Wind Farm Remote Operations Center (energy)

https://www.digitaltwinconsortium.org/initiatives/technology-showcase/wind-farms-remote-operations-center/

Manufacturing Quality Control Via Remote Operator (smart manufacturing)
https://www.digitaltwinconsortium.org/initiatives/technology-showcase/ai-quality-control/

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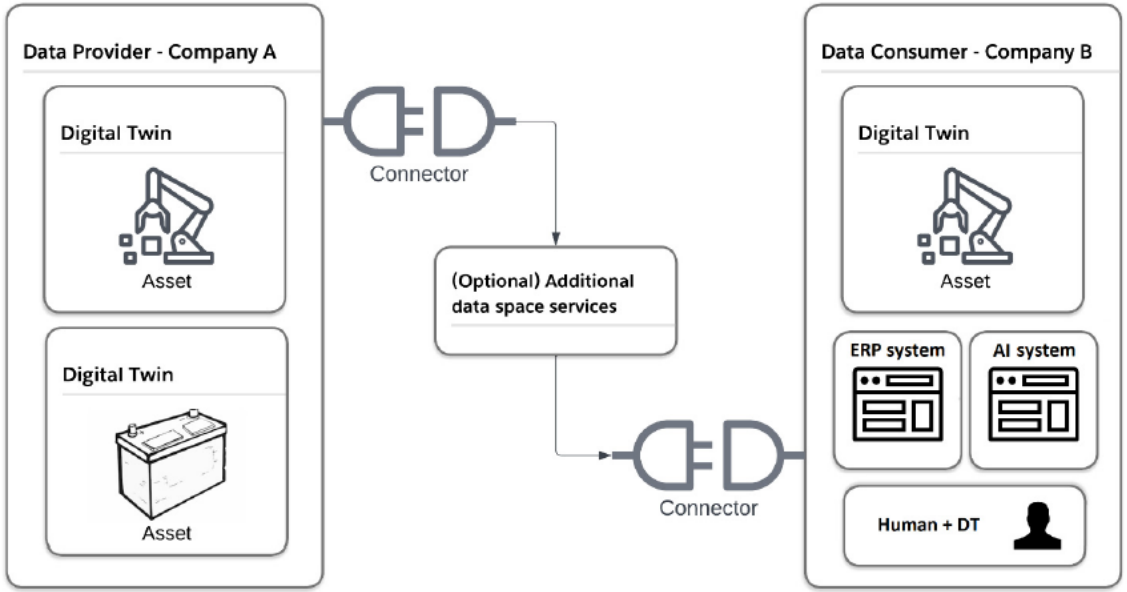
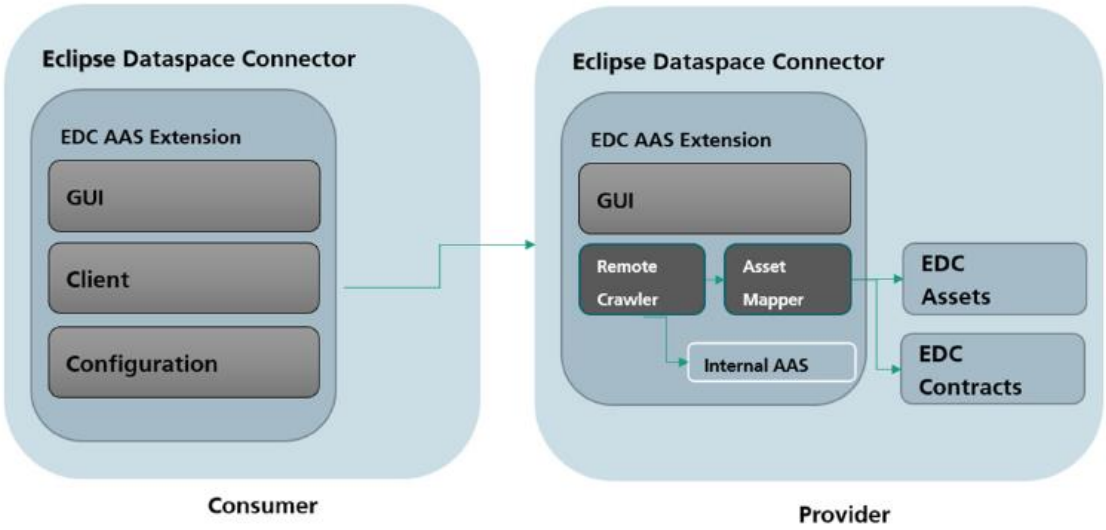
Digital Twins Project: Circular TwAIn (Smart Manufacturing)

https://www.circular-twain-project.eu/

IDTA AAS specifications



Combination of Digital Twins and Data Spaces (simplified)

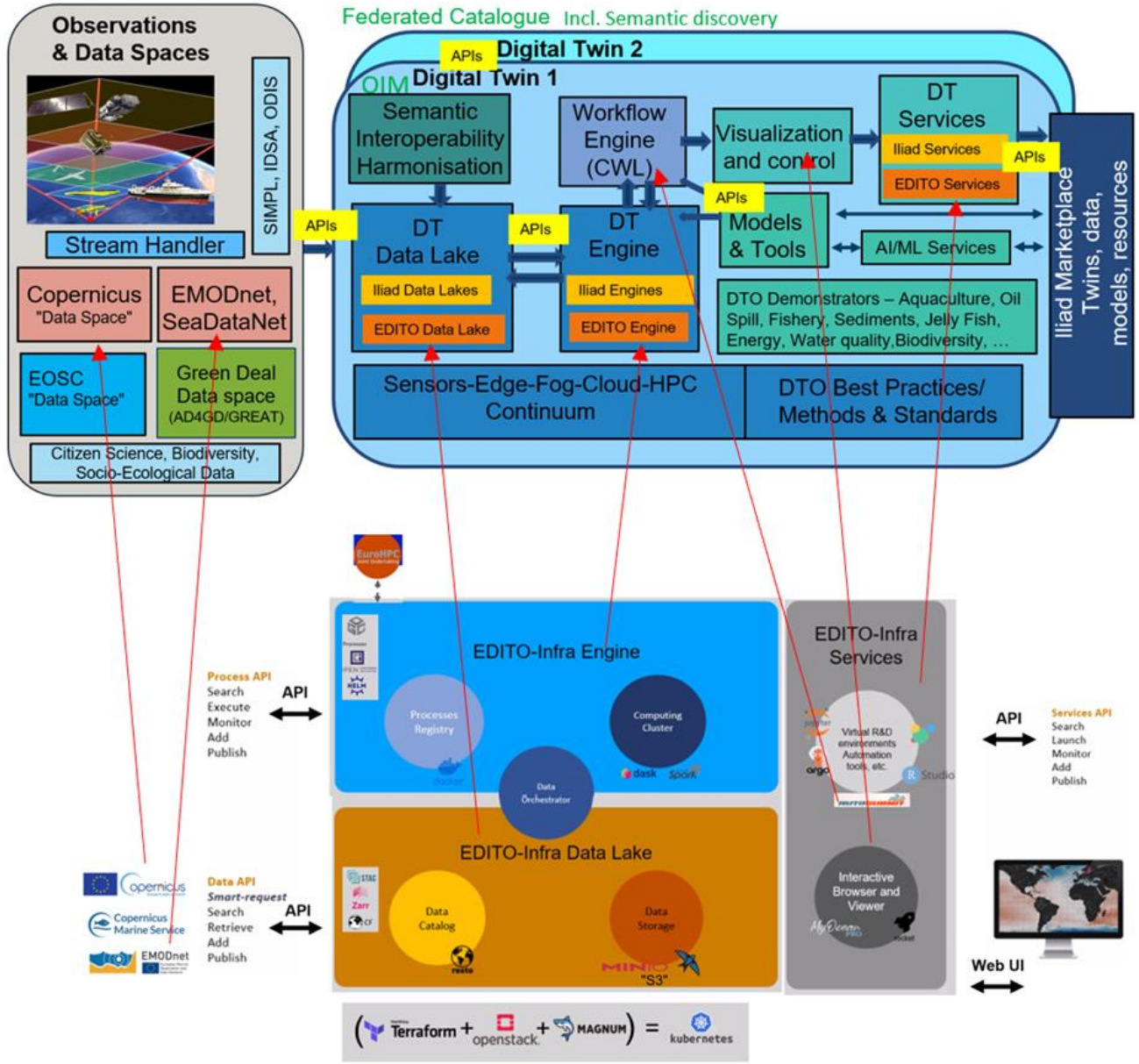


ECLIPSE connector

Digital Twins Project: Iliad Digital Twins of the Ocean

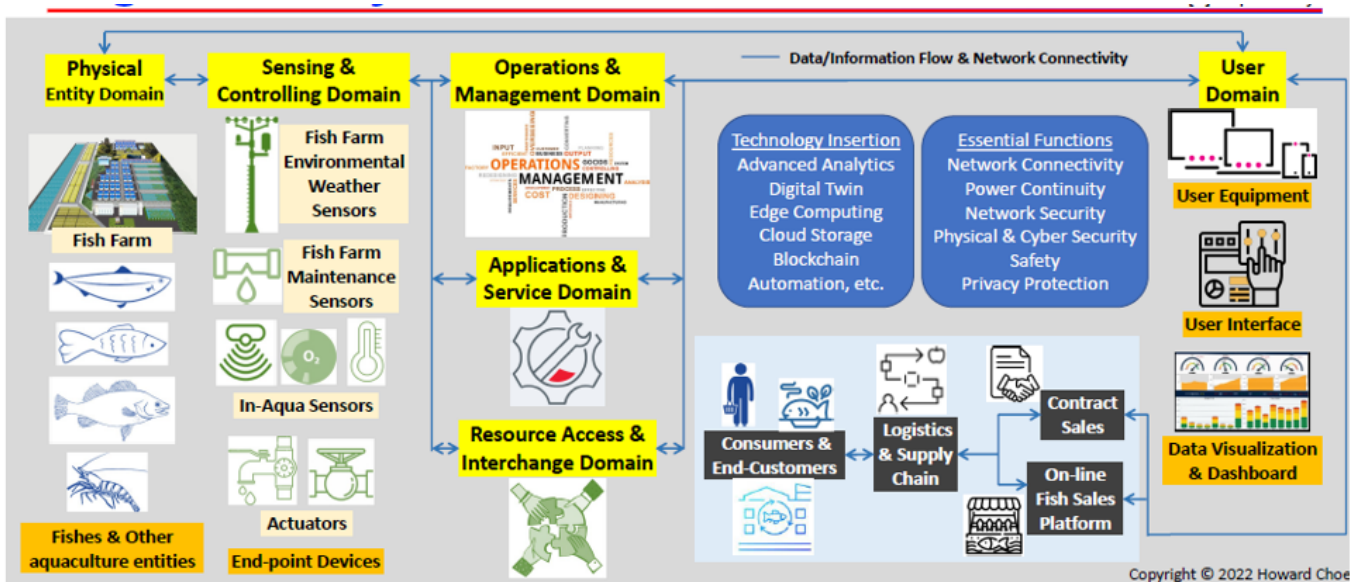
https://ocean-twin.eu/ - https://www.edito.eu/

Interoperability of Iliad and EDITO architecture

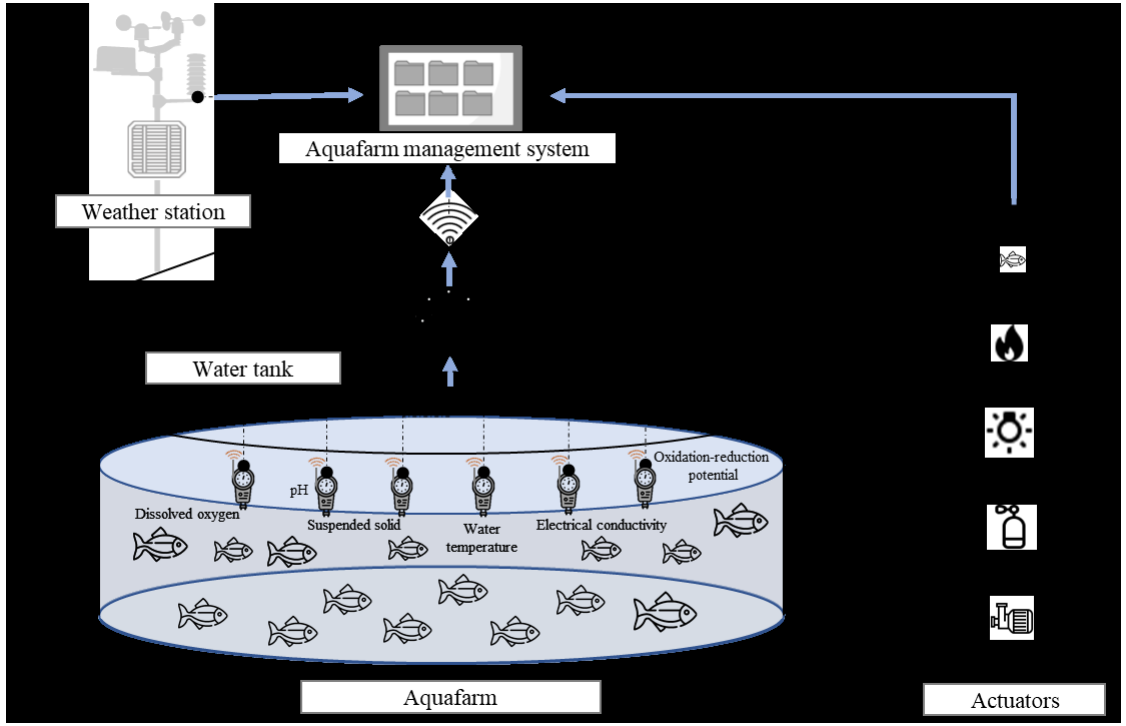


Digital Twins Project: AquaInfra (smart aquaculture)

https://aquainfra.eu/



Aquafarm high-level architecture



Aquafarm digital twin

Recommendations

- AIOTI report: integration of IoT and Edge computing in data spaces
  - R1: agree on data space principles
  - R2: work on data space standards following an architecture of standard
  - R3: integrate IoT, Edge and digital twin concerns in data space standards

- This report
  - R4: create a repository of architecture patterns which capture the different IoT and digital twin approaches to be connected to data spaces.
  - R5: interoperability support, based on international standards, is needed for cross-border data flows, between EU and other markets outside Europe, e.g., EU-USA, EU-Japan, EU-China.

Next Steps

- **Goal of this presentation** is to promote the key results documented in the "High Priority IoT Standardisation Gaps and Relevant SDOs, R3"

- **Questions to the audience:**
  - Is this report useful for your community?
  - Are there any SDO/Alliance/OSS initiatives working on IoT known to your community that need to be included in a subsequent Release?

- **Next meeting (joint meeting AIOTI & Stand.ICT/EUOS):** 3rd May 2024
  - Update of Edge and IoT "gaps" reports

- **Open Discussion**

Questions from the Audience

Moderated by:
Antonio Kung (Trialog, AIOTI WG Standardisation Chairman)

AIOTI

Wrap up and end of the Workshop

Damir Filipovic, AIOTI Secretary General

AIOTI

Thank you for listening

Any questions?

You can find us at @AIOTI_EU or email sg@aioti.eu

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