Semantic interoperability as a key enabler for digital twin collaboration

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AIOTI Workshop 25.3.2026

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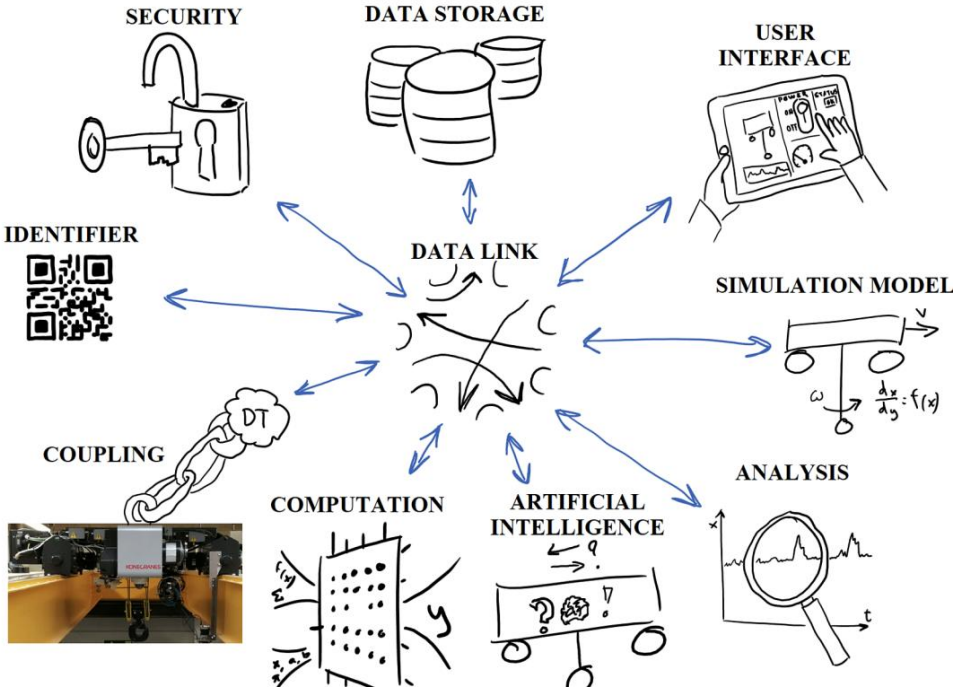
What is a digital twin?

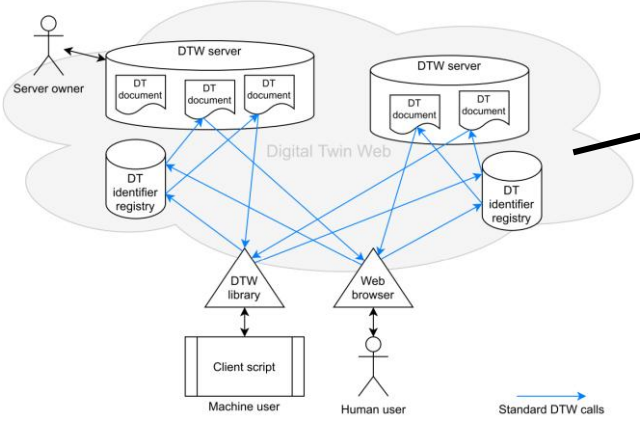


Autiosalo, J., Vepsäläinen, J., Viitala, R. and Tammi, K., 2019. A feature-based framework for structuring industrial digital twins. *IEEE access*, *8*, pp.1193-1208.

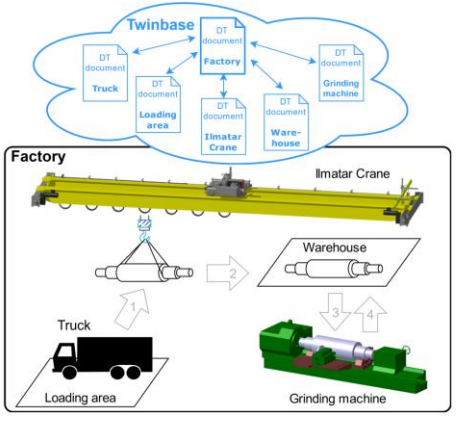
How should digital twins made accessible?

```
version: "1.0"
privacy: "public"
id: "http://d-t.fi/ilmatar-K16052"
name: "Ilmatar crane"
description: "The documentation of Ilmatar overhead crane"
createdMachine: "1605277810"
createdHuman: "2020-11-13T14:30:10.555Z"
modifiedMachine: "1605624649"
modifiedHuman: "2020-11-17T14:50:49.124Z"
owner: "Aalto-yliopistosäätiö"
contact:
  name: "John Doe"
  email: "john.doe@aalto.fi"
location:
  streetAddress: "Otaniemi"
  gpsCoordinates: "60.1841° N, 24.8301° E"
manufacturer: "Konecranes"
features:
  - name: "OSEMA"
    description: "OSEMA allows managing retrofitted sensors
      attached to the crane."
    address: "https://example.sensor.fi/sensors/browse"
    apiAddress: "https://digi.kaksonen.fi/api/v1.0/"
    requirement: "User account is needed."
    documentation: "https://github.com/AaltoIIC/
      OSEMA/blob/master/Documentation.md"
    keywords:
      - "sensor"
      - "management"
      - "retrofit"
      - "sensors"
      - "data"
  - name: "MindSphere"
```

We need to have a standard format for digital twins [1]

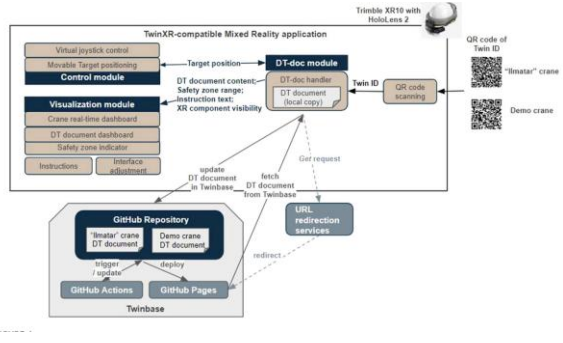


We need to be able to share digital twins [2]



Autonomous collaboration [4]

Using Digital Twins to build XR environments [3]



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[1] Ala-Laurinaho, R., Autiosalo, J., Nikander, A., Mattila, J. and Tammi, K., 2020. Data link for the creation of digital twins. IEEe Access, 8
[2] Autiosalo, J., Siegel, J. and Tammi, K., 2021. Twinbase: Open-source server software for the digital twin web. IEEE access, 9.
[3] Tu, X., Autiosalo, J., Ala-Laurinaho, R., Yang, C., Salminen, P. and Tammi, K., 2023. TwinXR: Method for using digital twin descriptions in industrial eXtended reality applications. Frontiers in Virtual Reality, 4,
[4] Mattila, J., Ala-Laurinaho, R., Autiosalo, J., Salminen, P. and Tammi, K., 2022. Using digital twin documents to control a smart factory: Simulation approach with ROS, gazebo, and Twinbase. Machines, 10(4).

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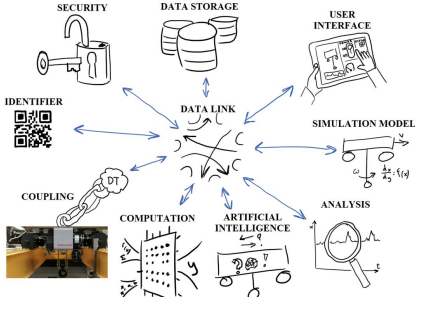
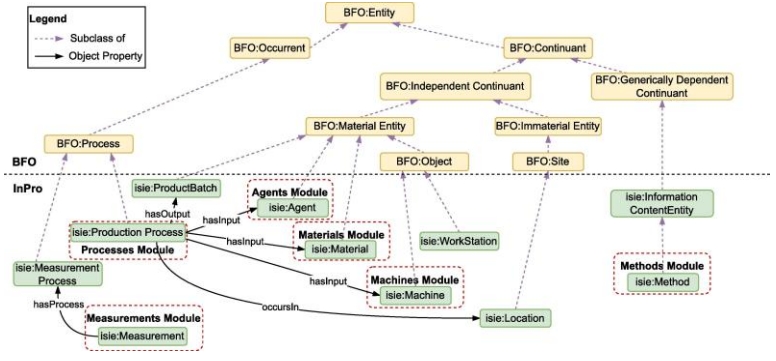
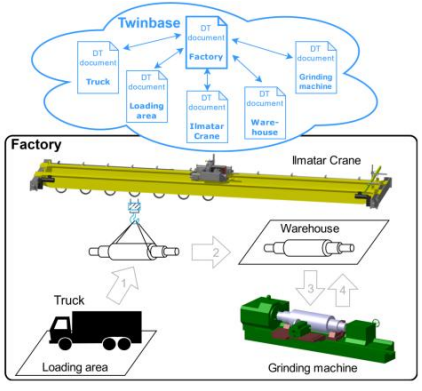




Yang, C., Zheng, Y., Tu, X., Ala-Laurinaho, R., Autiosalo, J., Seppänen, O. and Tammi, K., 2023. Ontology-based knowledge representation of industrial production workflow. *Advanced Engineering Informatics*, *58*, p.102185.



- Digital twins are a new way of structuring information: toward product-centric approach
- The real potential and value can only be unlocked through collaboration
- Ontologies play key role in enabling collaboration between digital twins, which can be located in different (eco-)systems

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Thanks

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