TwinWeb applications and the Digital Twin Web Association

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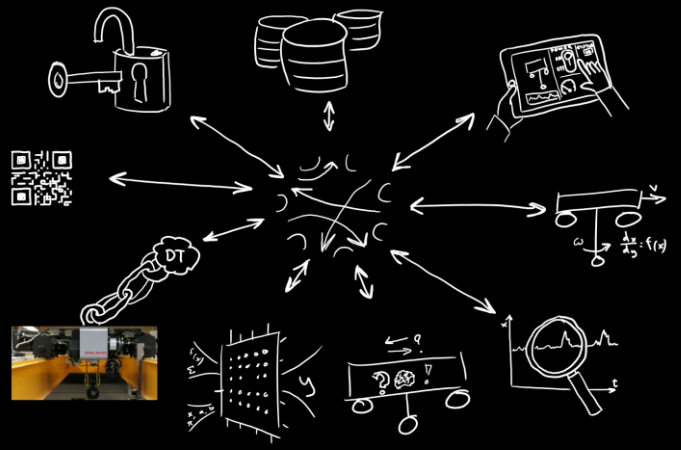
7th April 2022

Demo Day 2022



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Quick intro to Digital Twin Web

Includes material for further reading

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Why Digital Twin Web (DTW)?

Enhance or enable:

1. **Discovery of information**
   for people and machines
2. **Automated processing of information**
   for machines
3. **Presentation of information**
   for people

Image: https://picpedia.org/handwriting/i/information.html

What is Digital Twin Web (DTW)?

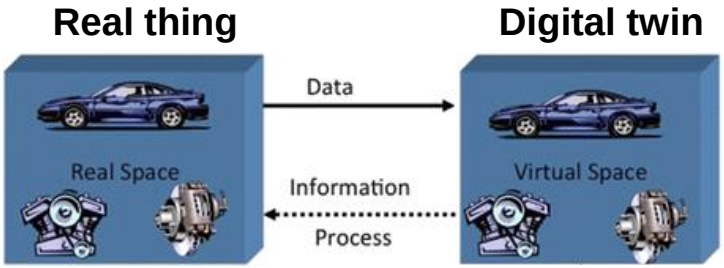
Global network of digital twins

Human and machine-readable

Analogous to the World Wide Web (WWW)

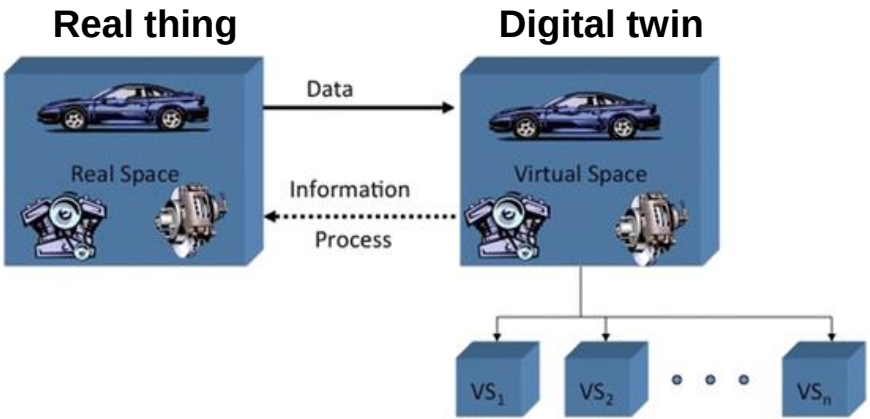
What is a digital twin?

Simple



What is a digital twin?

Further reading



“Conceptual ideal for PLM”

by Dr. Michael Grieves in 2002.

https://doi.org/10.1007/978-3-319-38756-7_4

By NASA in 2010:

“A digital twin is an integrated multi-physics, multi-scale, probabilistic simulation of a vehicle or system that uses the best available physical models, sensor updates, fleet history, etc., to mirror the life of its flying twin. The digital twin is ultra-realistic and…”

https://www.nasa.gov/pdf/501321main_TA11-MSITP-DRAFT-Nov2010-A1.pdf

By Autiosalo *et al.* in 2019:

“Digital twin is a virtual entity that is linked to a real-world entity.
Digital twin consists of various features that are selected and customized to serve the needs of diverse use cases.”

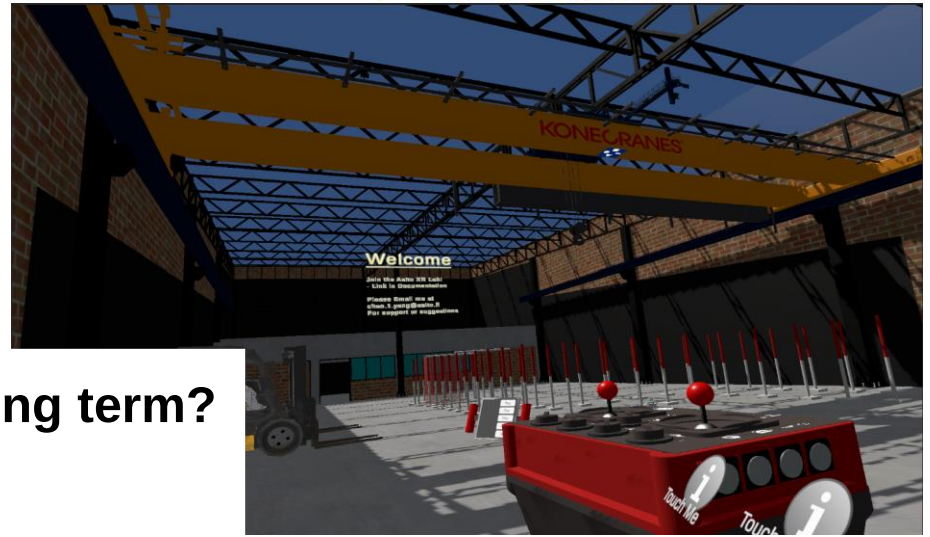
https://doi.org/10.1109/ACCESS.2019.2950507

Definitions seem to be converging towards the latter type of definition, see e.g. Industrial Internet Consortium and Digital Twin Consortium definitions.

PLM = Product Lifecycle Management

What is a digital twin?

In practice



Almost anything...

Just a marketing term?

- **Partly yes**
- **But digital twins also have an important**

conceptual and technical

role in our journey of combining

physical and digital

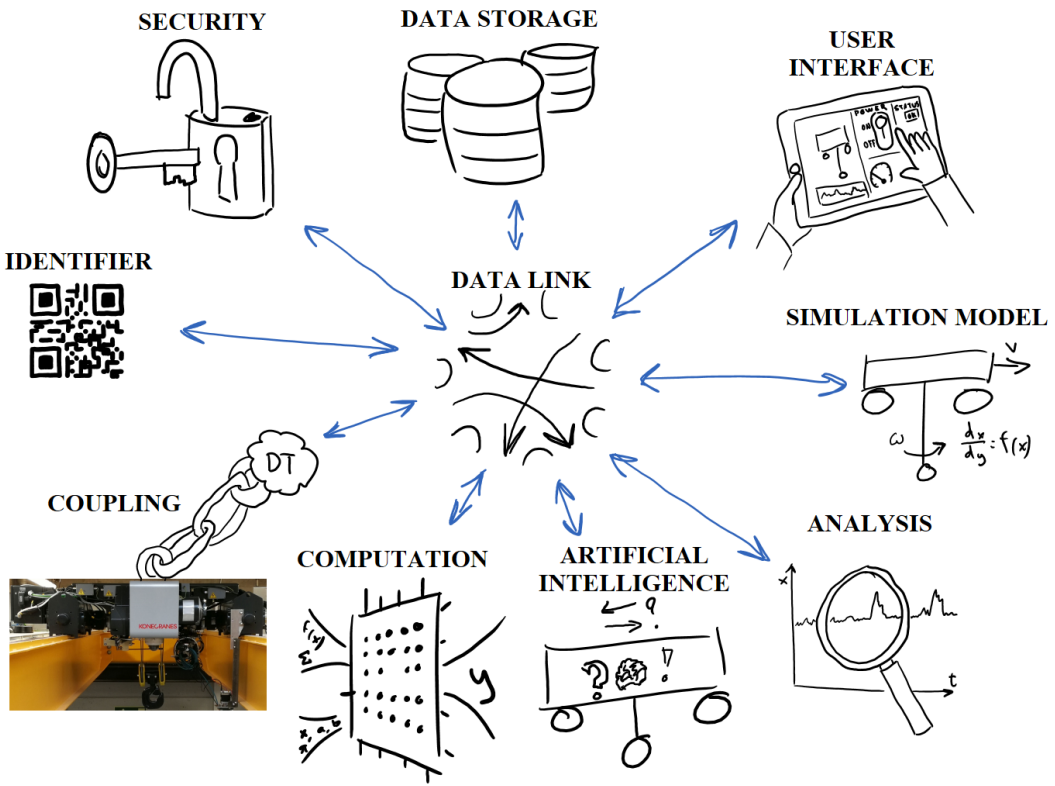
into phygital

What is a digital twin?

My definition

Digital twin is a virtual entity that is linked to a real-world entity.

Digital twin consists of various features that are selected and customized to serve the needs of diverse use cases.



Autiosalo, J., Vepsäläinen, J., Viitala, R., Tammi, K., 2020. A Feature-Based Framework for Structuring Industrial Digital Twins. IEEE Access 8, 1193–1208. https://doi.org/10.1109/ACCESS.2019.2950507

Digital twin document is a text document

Further reading

- **We created a draft specification called “DT document” to link information together**
- **Description of a digital twin in a human and machine readable format**
- **Several standards under development, e.g.:**
  - Industry 4.0: Asset Administration Shell
  - W3C: Web of Things Thing Description
  - Microsoft: Digital Twin Definition Language
- **Goal of digital twin document is to combine the strengths of the standards and create “HTML for digital twins”**

Sketch of a DT document for Ilmatar crane

```
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"
```

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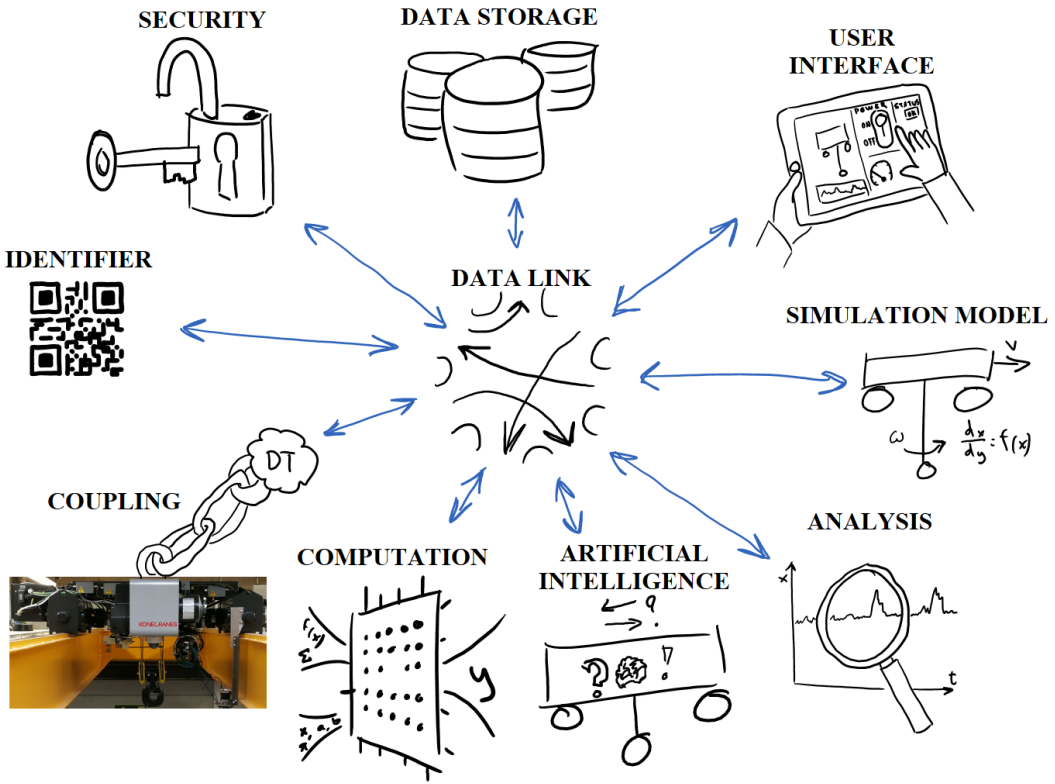
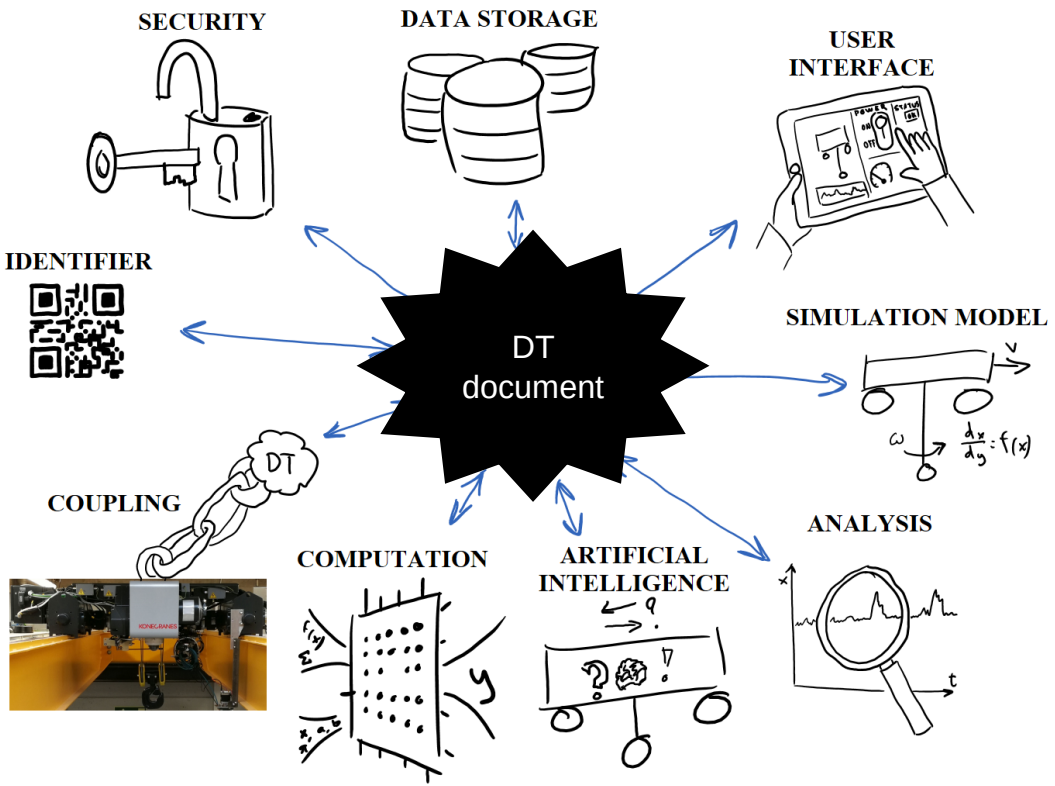
Ala-Laurinaho, R., Autiosalo, J., Nikander, A., Mattila, J., Tammi, K., 2020. Data Link for the Creation of Digital Twins. IEEE Access 8, 228675–228684. https://doi.org/10.1109/ACCESS.2020.3045856

Digital twin document



Digital twin document

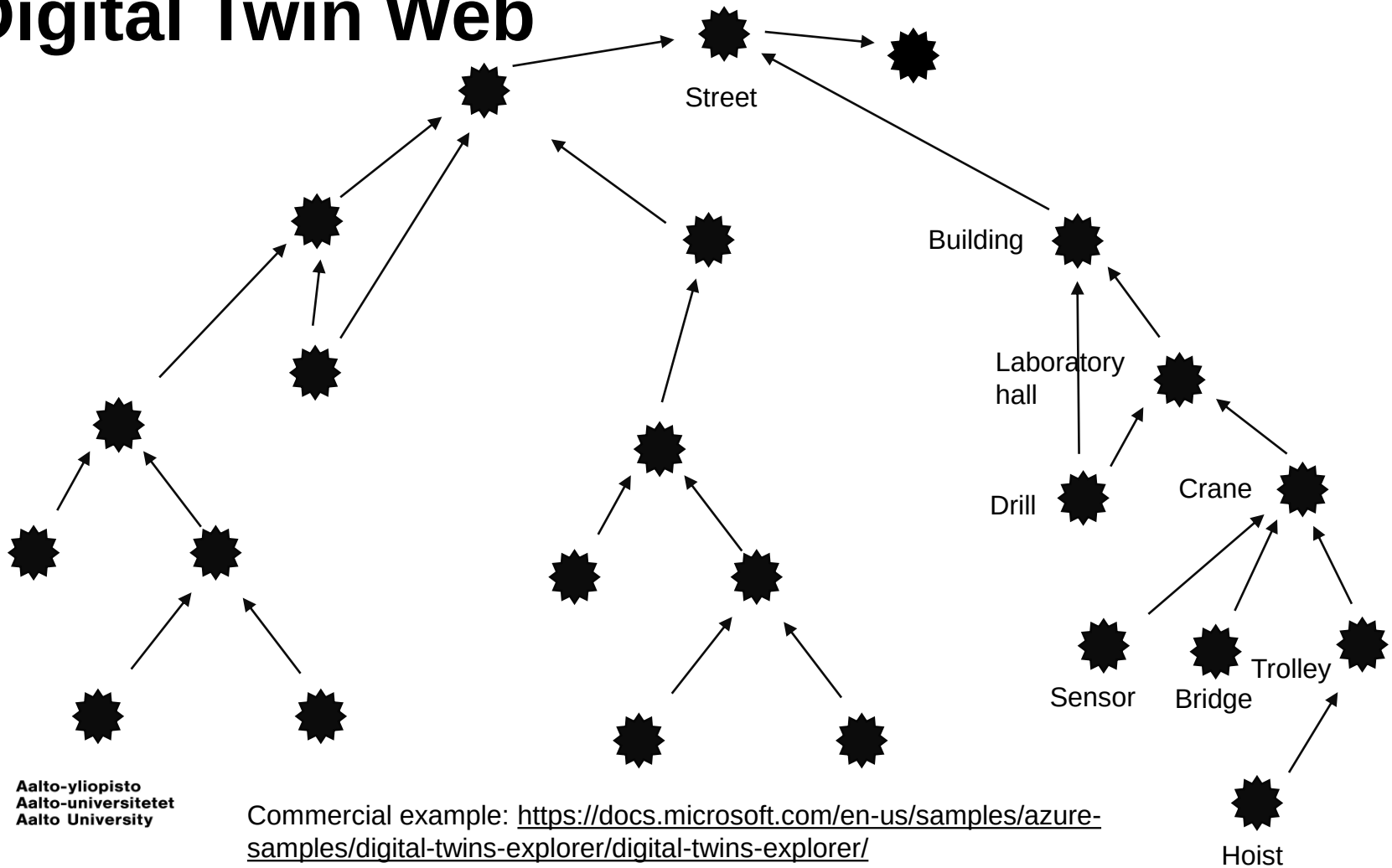
...describes a digital twin



Digital Twin Web

Digital Twin Web

Digital Twin Web



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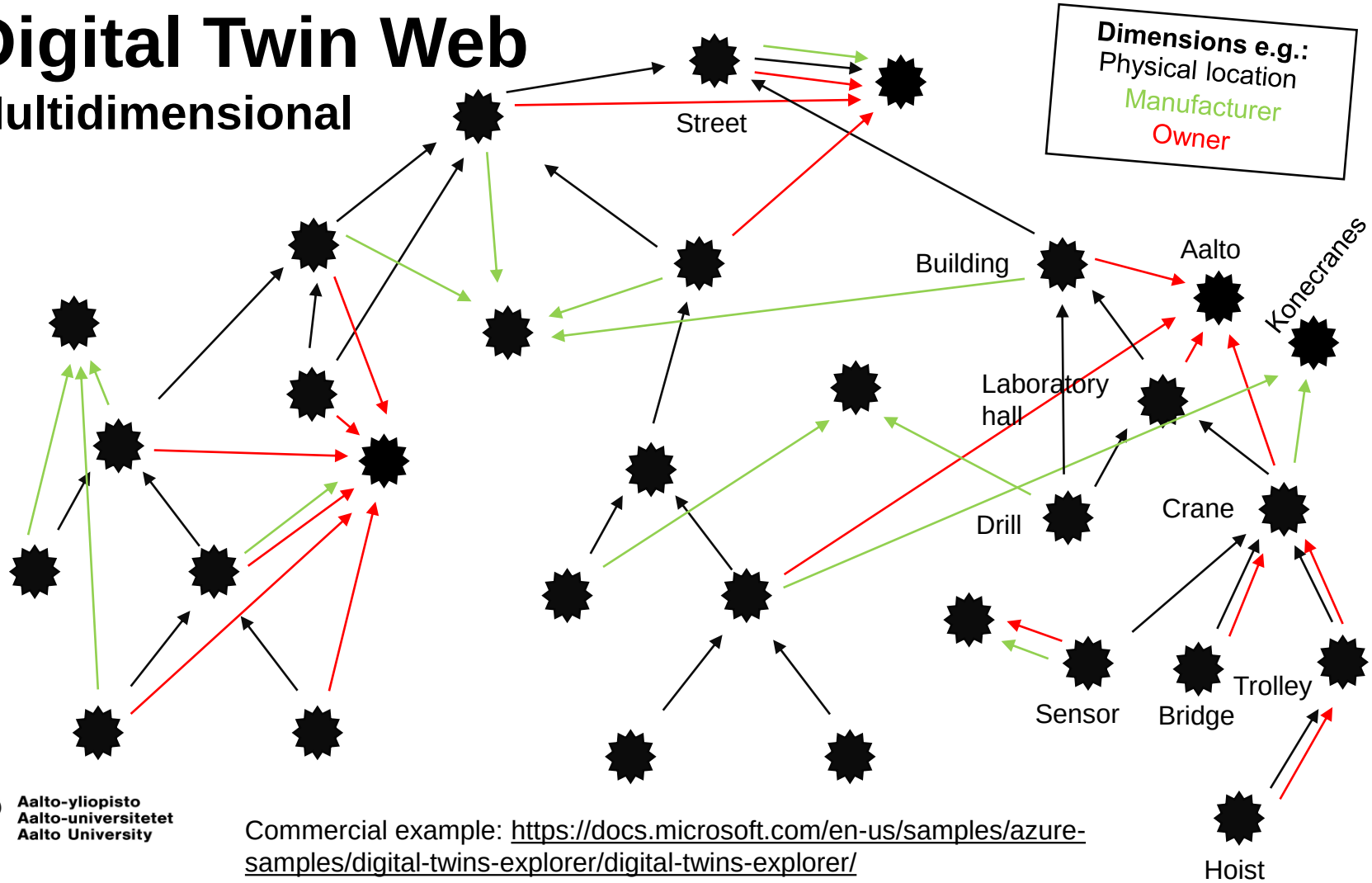
Commercial example: https://docs.microsoft.com/en-us/samples/azure-samples/digital-twins-explorer/digital-twins-explorer/

Digital Twin Web

Multidimensional



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Commercial example: https://docs.microsoft.com/en-us/samples/azure-samples/digital-twins-explorer/digital-twins-explorer/

TwinWeb applications

- Mixed reality app with twin documents
- Factory control with twin documents
- Describing Machinaide ecosystem
- Traffic radar data discovery

Mixed reality app with twin documents

Purpose:

Scale the development and updating of mixed reality applications.

Functionality:

Mixed reality application fetches the twin document of a thing and shows its content to the user.

Case:

Mixed reality control of an overhead crane with HoloLens.

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Crane Twin ID:

https://dtid.org/9239c7e4-8f96-449a-8f34-3e2d84cea4ff

Factory control with twin documents

Purpose:

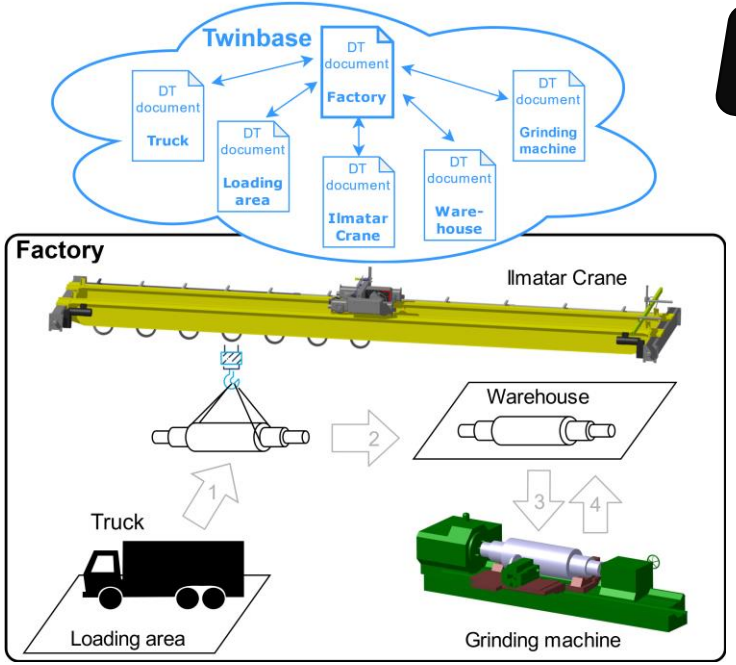
Enable decentralized control of machines, including the seamless introduction of new machines.

Functionality:

Machines fetch the twin documents of other machines and communicate according to the their content.

Case:

Decentralized control of the ”Machinaide Finland factory”



Demo available!

Factory Twin ID: https://dtid.org/d1816959-8a88-40b1-9bfd-8a670b629083

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Article published!

Mattila, J.; Ala-Laurinaho, R.; Autiosalo, J.; Salminen, P.; Tammi, K. Using Digital Twin Documents to Control a Smart Factory: Simulation Approach with ROS, Gazebo, and Twinbase. *Machines* **2022**, *10*, 225. https://doi.org/10.3390/machines10040225

Describing Machinaide ecosystem

Work in progress!

Purpose:

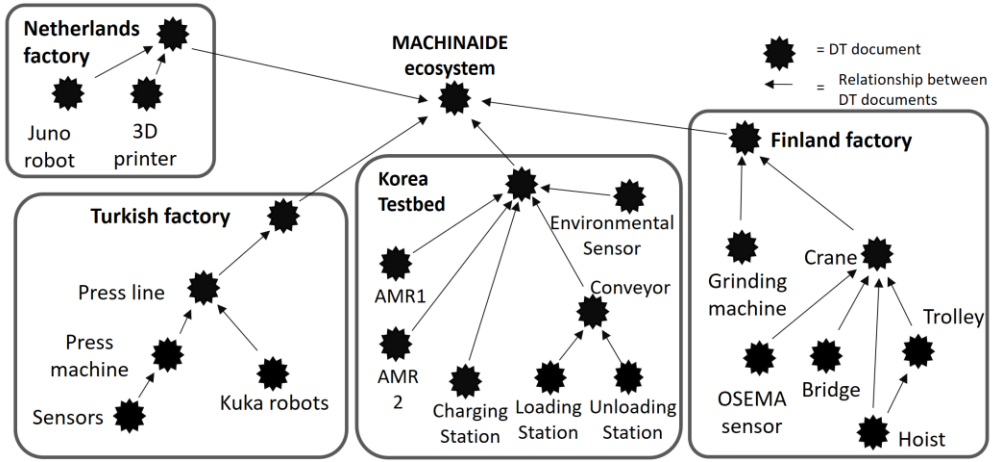
Provide a comprehensive description of a project, supply chain, etc.

Functionality:

Twin documents are linked together, they provide descriptions of relevant data sources etc.

Case:

The global Machinaide ecosystem.



Ecosystem Twin ID:

https://dtid.org/e0fd6ea0-a610-4680-9c75-2911f34f71b9

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Traffic radar data discovery

Work in progress

Purpose:

Enable the effortless discovery of sensor data.

Functionality:

Describe the interfaces of sensor devices and link them together semantically.

Case:

Describe a traffic radar in a semantic twin document.

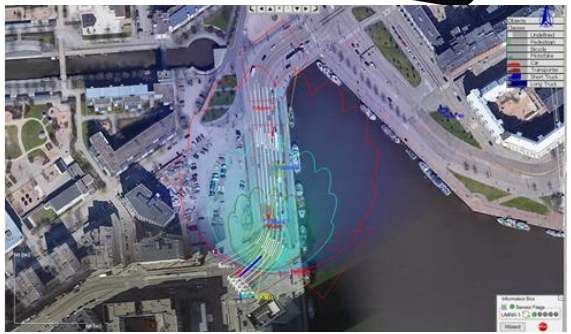

Image: https://www.aalto.fi/fi/rakennetun-ympariston-laitos/smart-junction

Early example of related device:

https://github.com/IoT-NGIN/twin-examples/blob/main/camera/twin.yaml

Implemented in IoT-NGIN project, collaboration with Smart Junction project and Conveqs Oy

Digital Twin Web Association

One-slider

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Digital Twin Web Association

We are founding a global association

The purpose of the association is to develop, maintain and promote the Digital Twin Web initiative.

The association facilitates the development of the Digital Twin Web into a global network of digital twins that is human and machine-readable.

More than 100 people signed up for the constitutive meeting!

More info: https://www.dtwa.org/2022-02-02-invitation-to-constitutive-meeting

Webinar on Wednesday 13th April, sign up at:

https://dtwa.org/webinar

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DIGITAL TWIN
WEB ASSOCIATION

Logo draft by Santtu Teerihalme

Future of TwinWeb?

- Standardize twin documents
- Build applications
- Generalize user interfaces

Photo by Pratik Hublikar

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Juuso Autiosalo

7th April 2022

Questions?

aalto.fi

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