# Twinbase

## Research to business project

**Juuso Autiosalo**
**13.4.2023**

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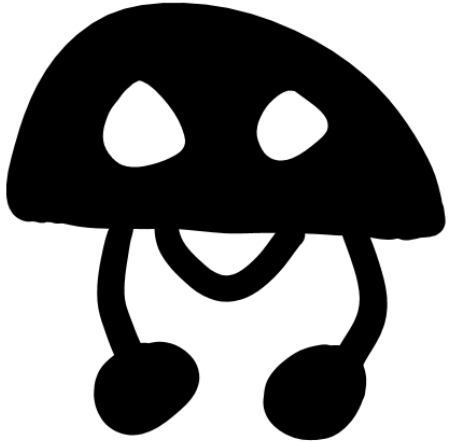
Aalto University

**Funded by**

BUSINESS FINLAND



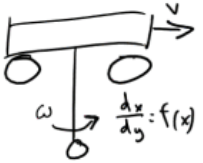
TWINBASE

*Make your twins talk to other twins*

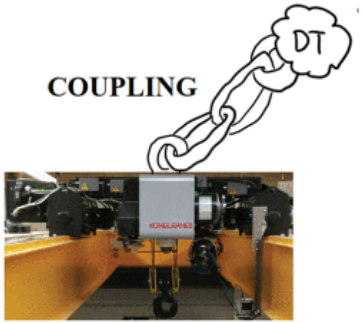
# Do you have a digital twin?

DATA STORAGE

SIMULATION MODEL

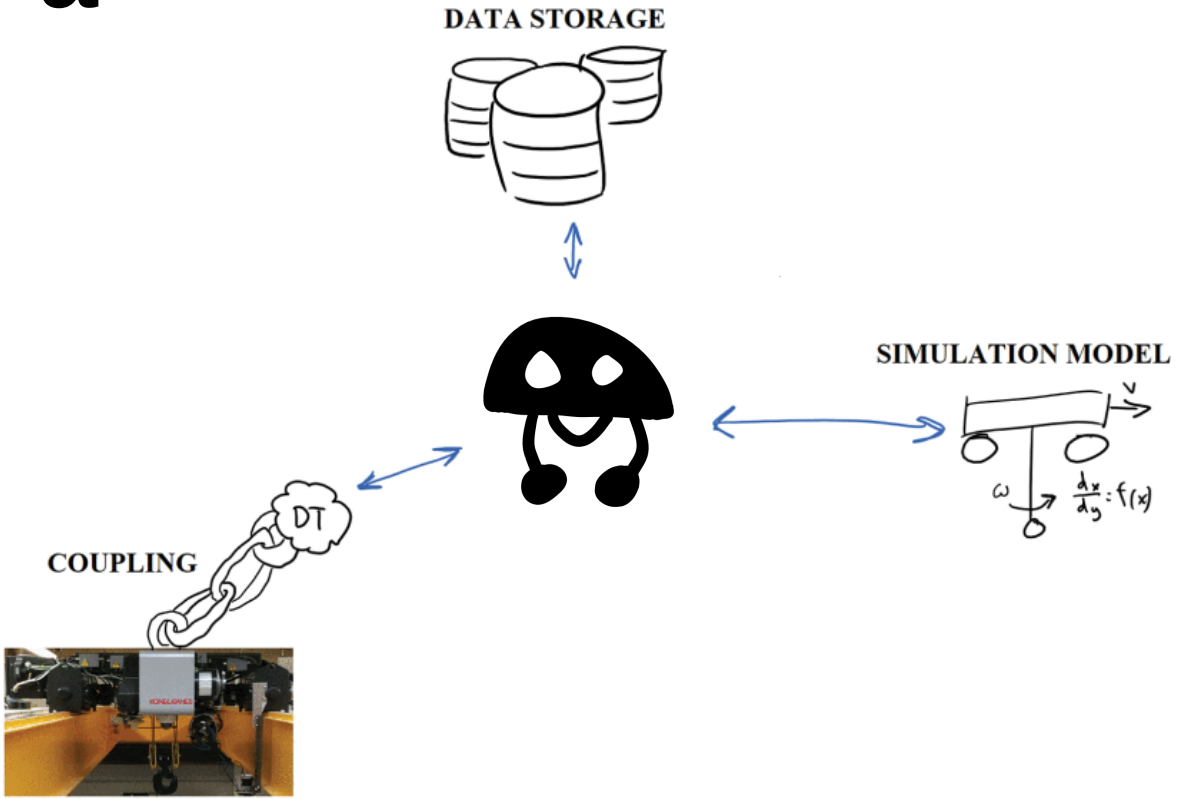



COUPLING



# Do you have a digital twin?

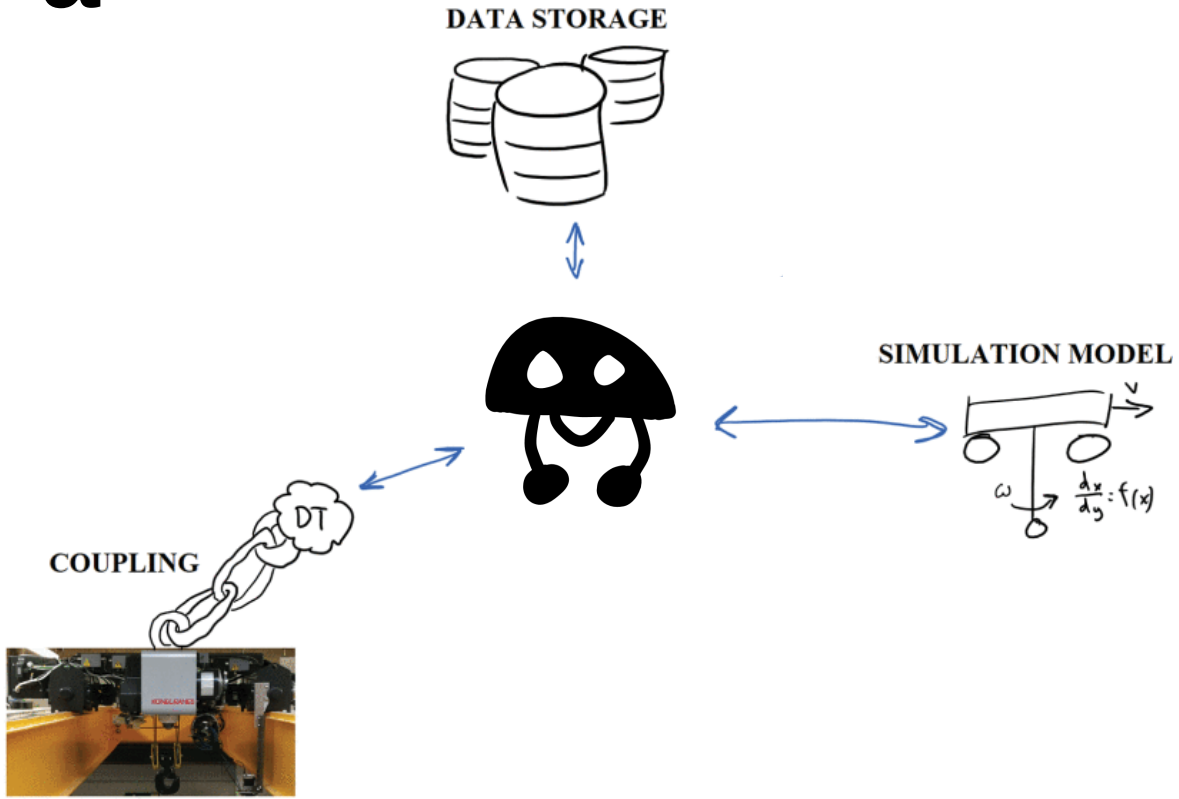
**With Twinbase, you do!**



# Do you have a digital twin?

**Almost any digital service can be a part of digital twin!**

**Twinbase links the parts together**



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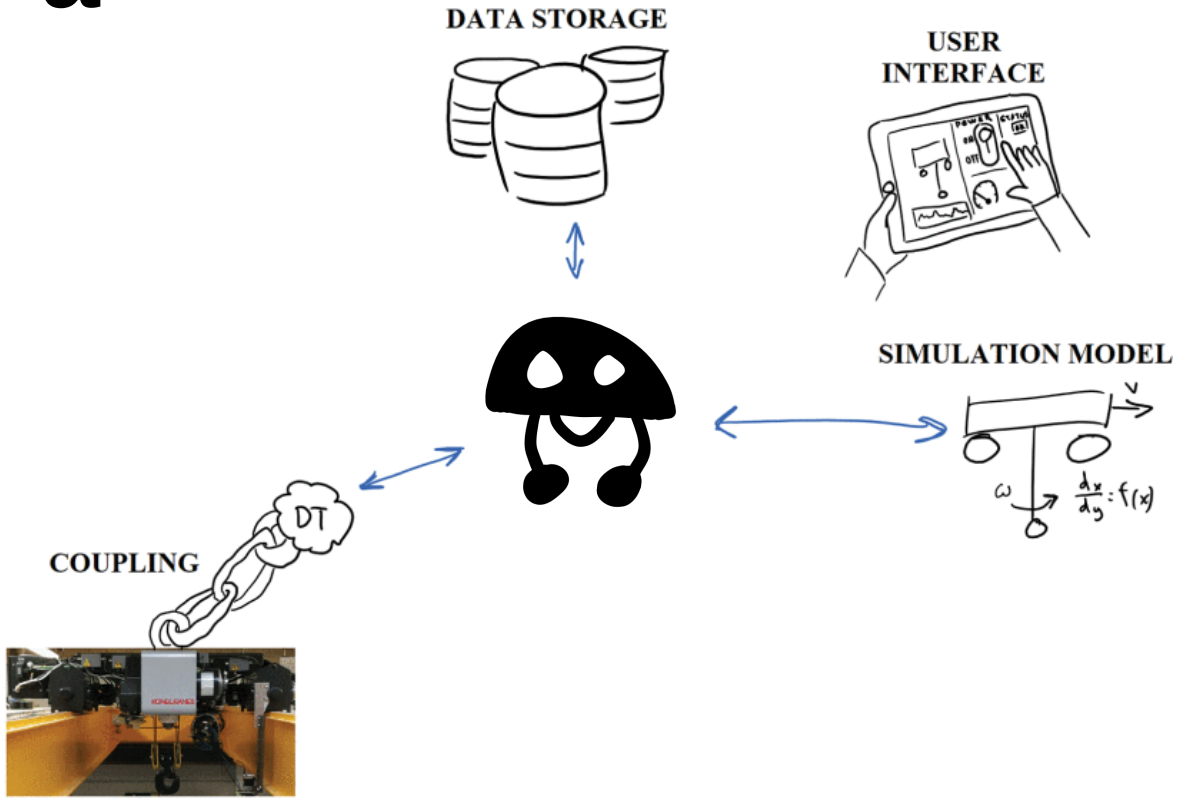

# Are you creating machine user interfaces fast enough?

# Use case:

# Developing user interface for a connected machine

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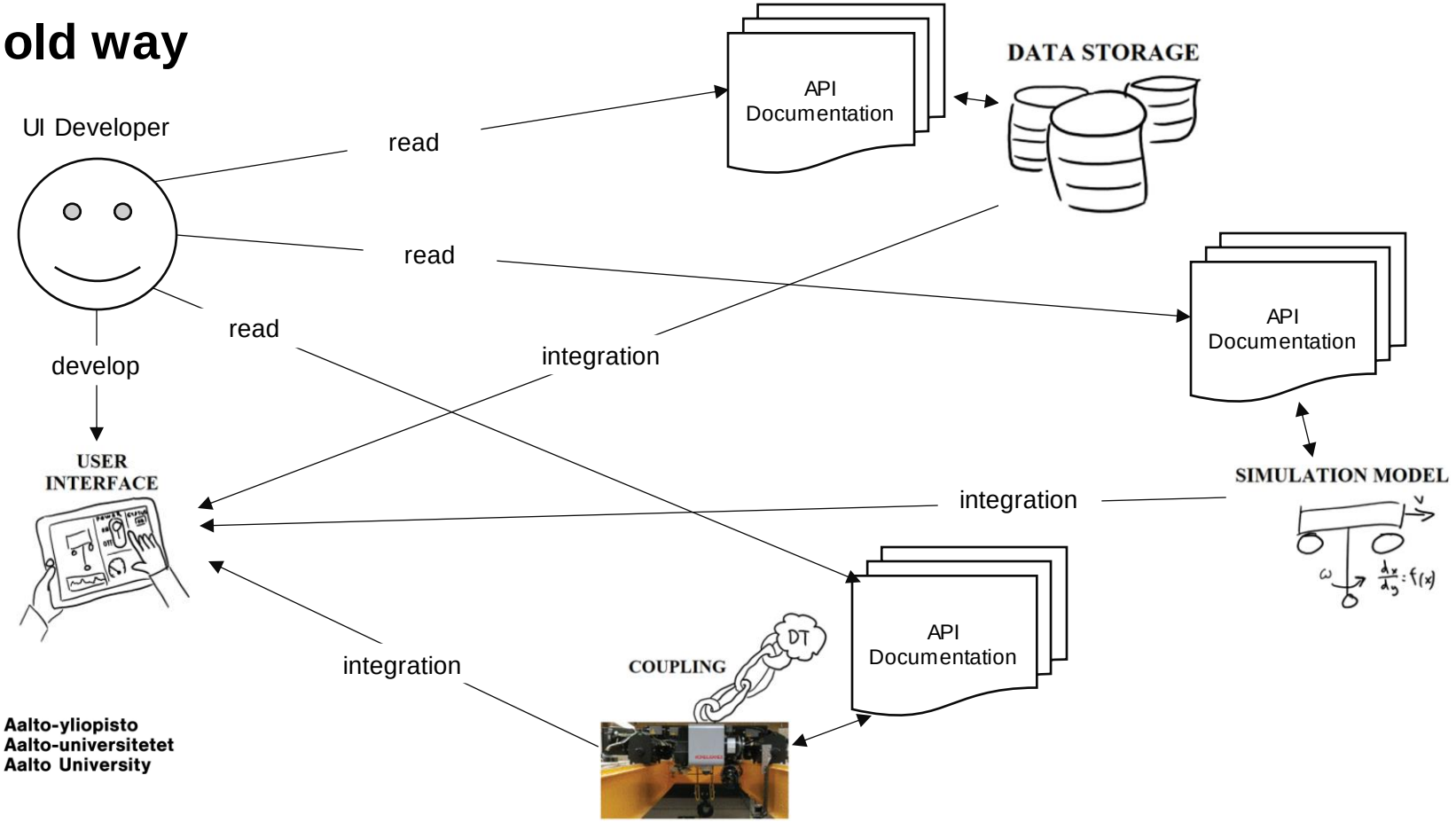
# Adding machine data to a UI

## The old way



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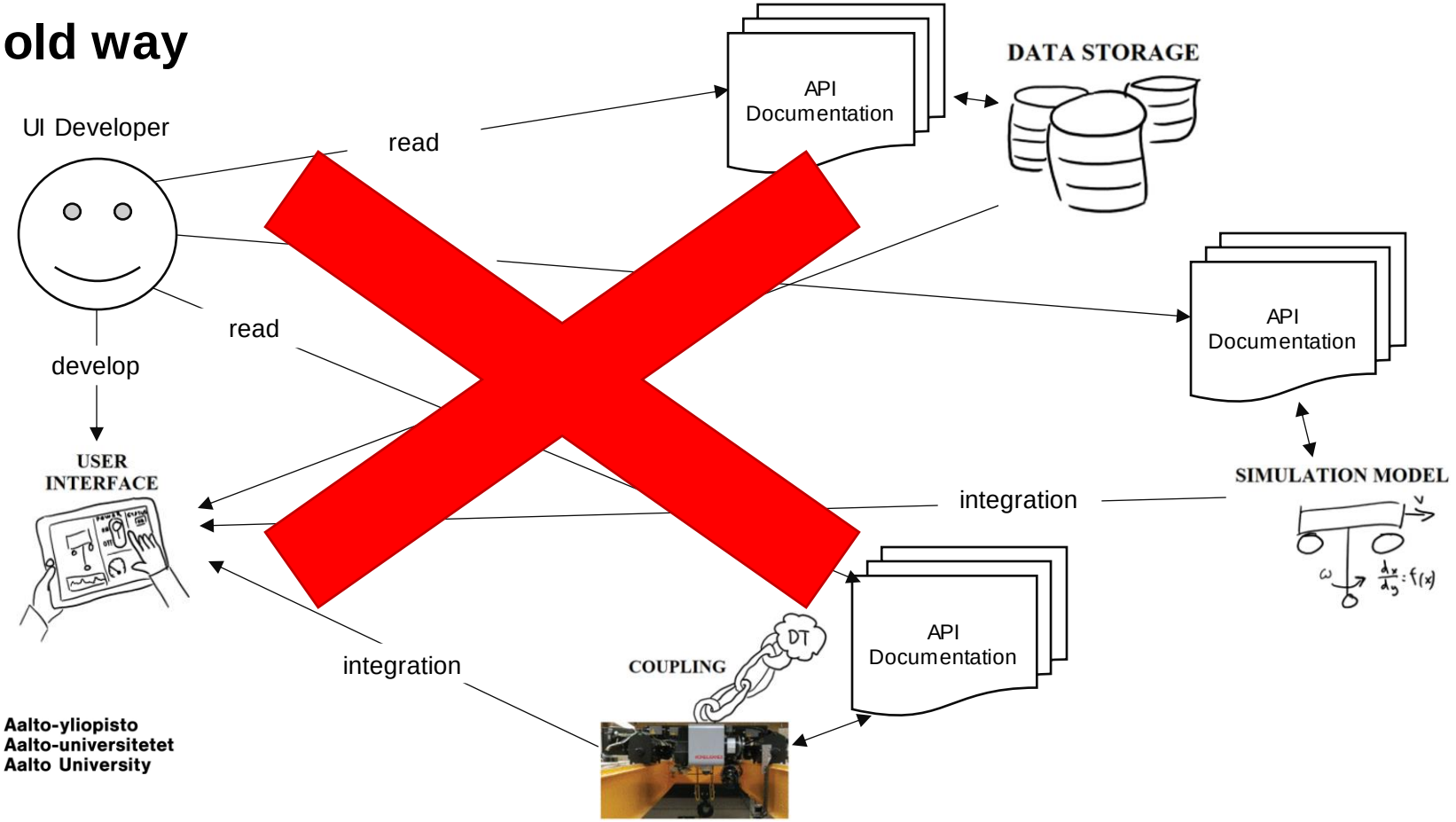
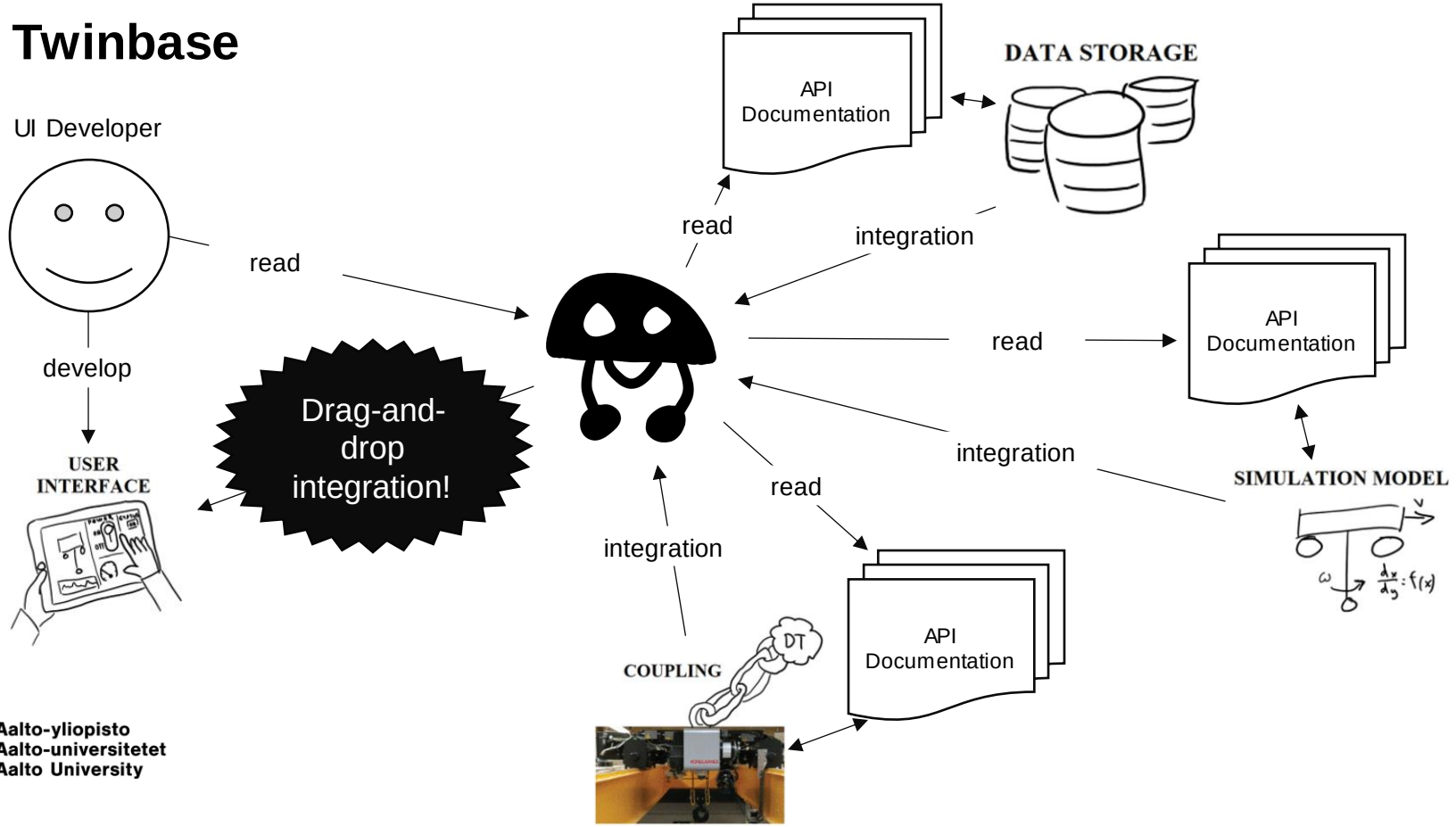


# Adding machine data to a UI

## With Twinbase

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# Adding machine data to a UI

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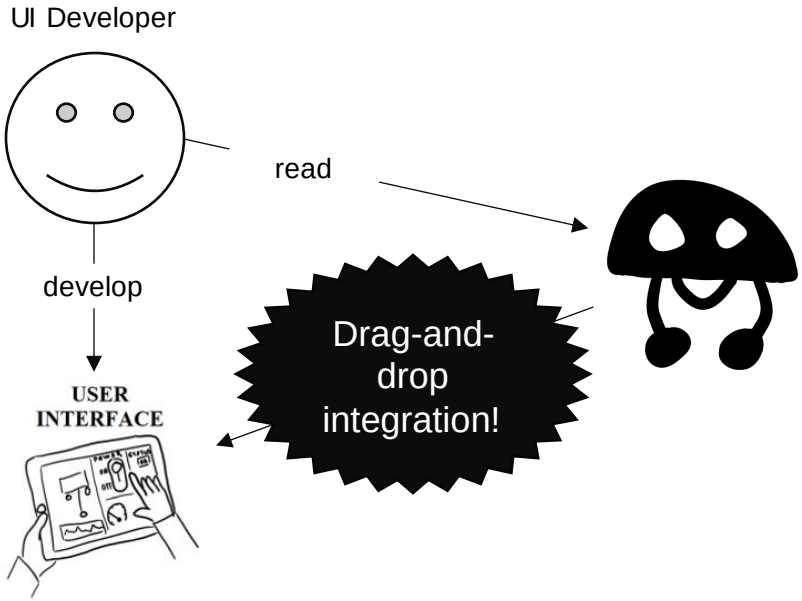
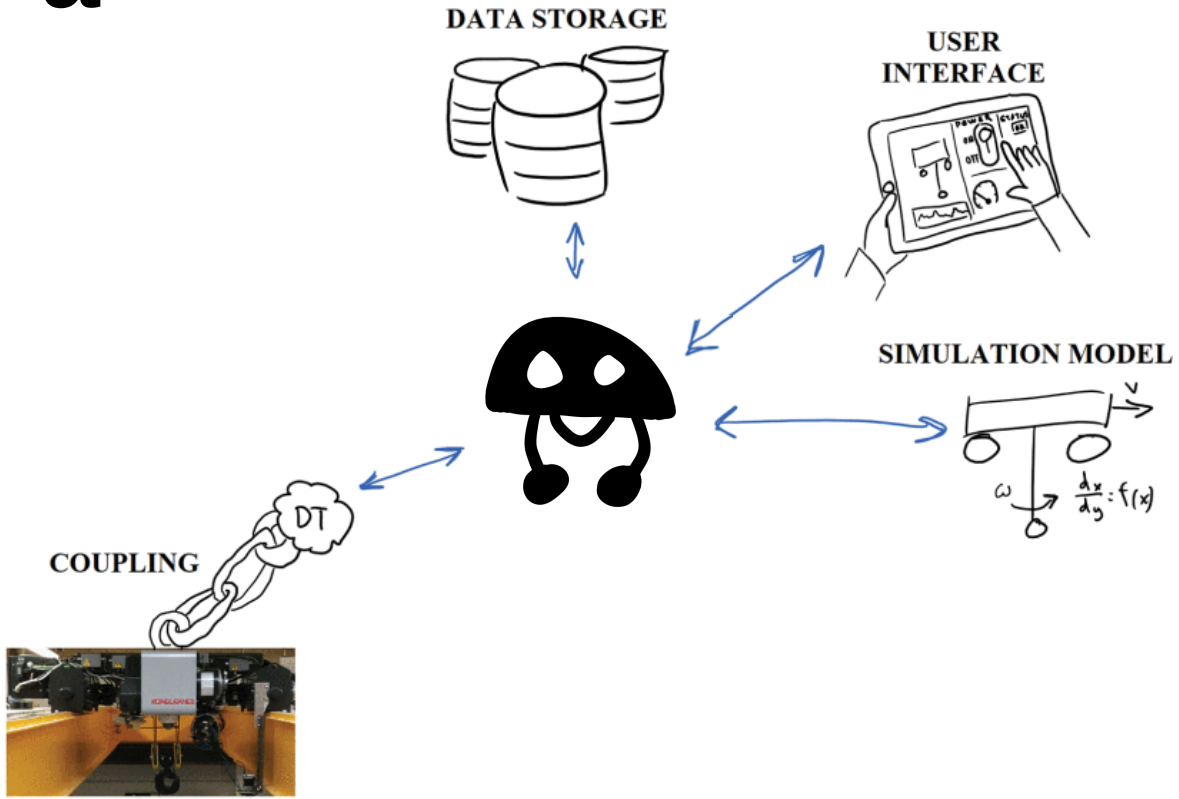


# Do you have a digital twin?

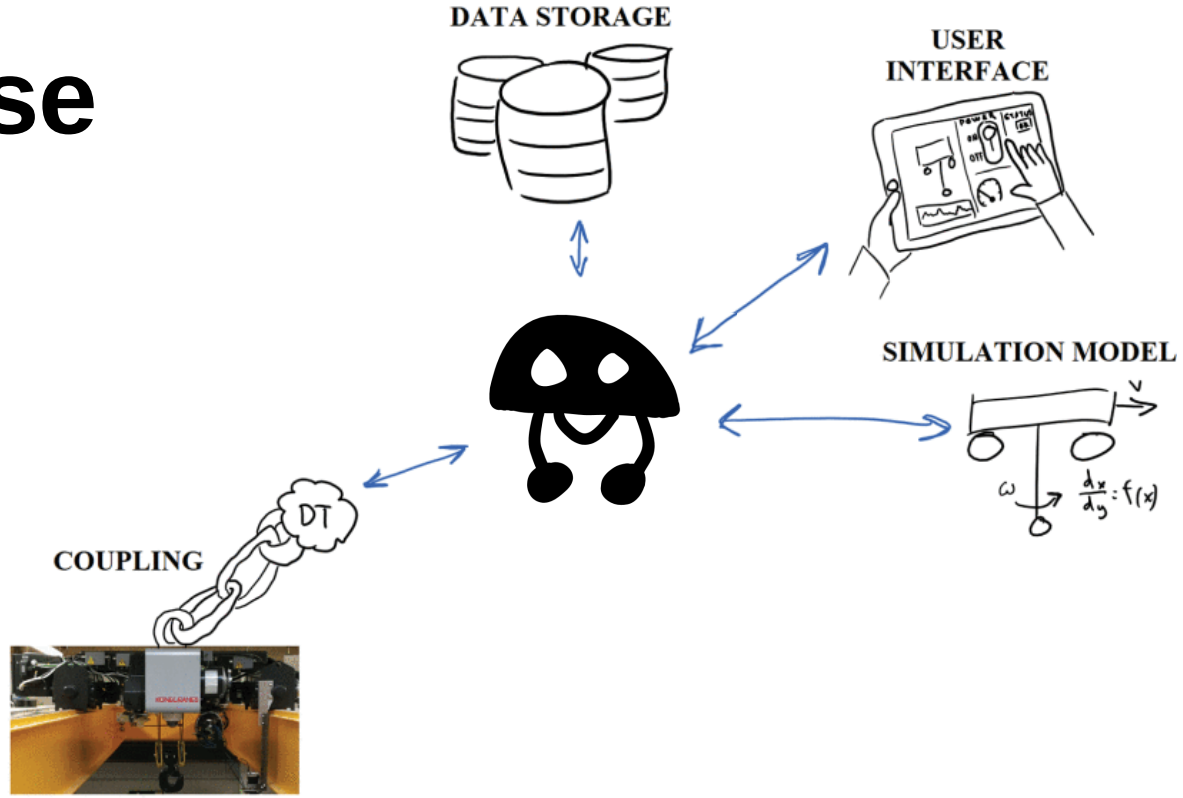
**Yes, with a user interface!**



# Digital twin with Twinbase

**Almost any digital service can be a part of digital twin!**

**Twinbase links the parts together**



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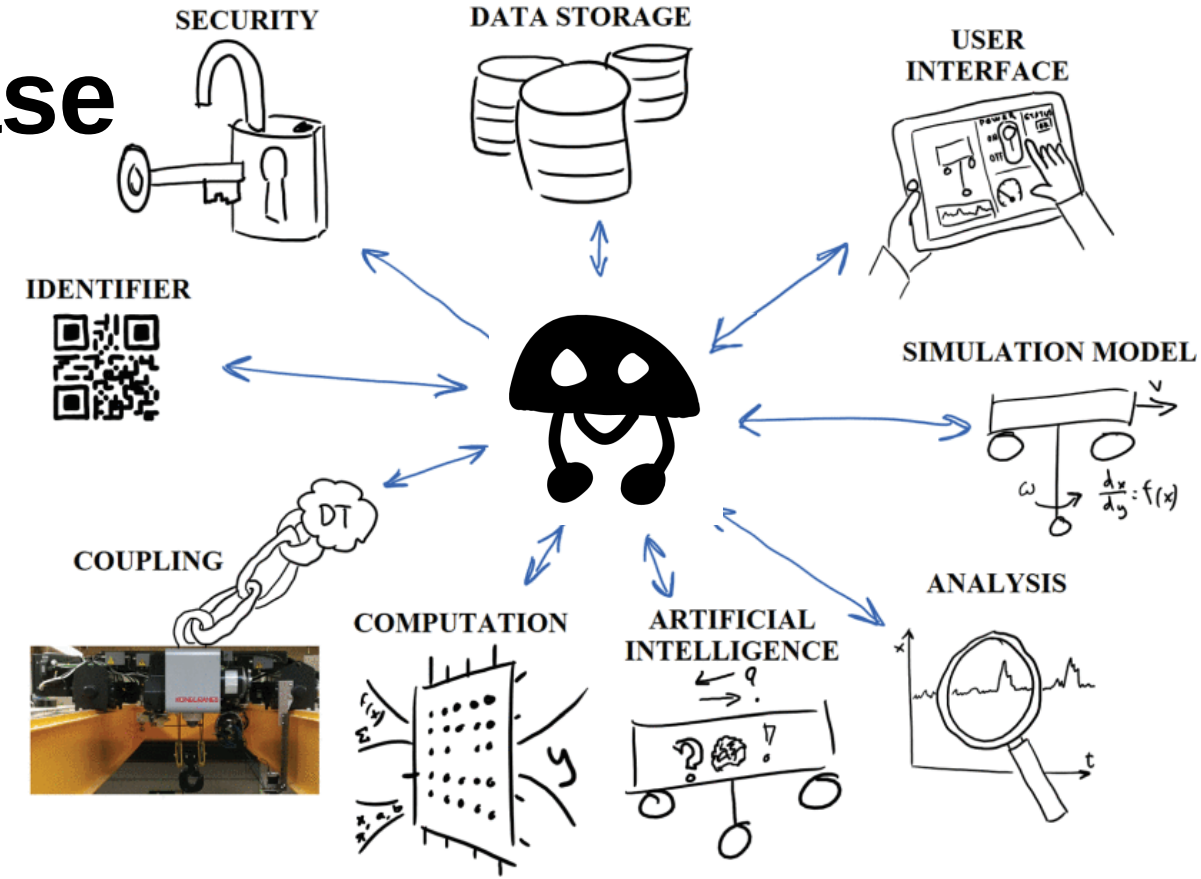


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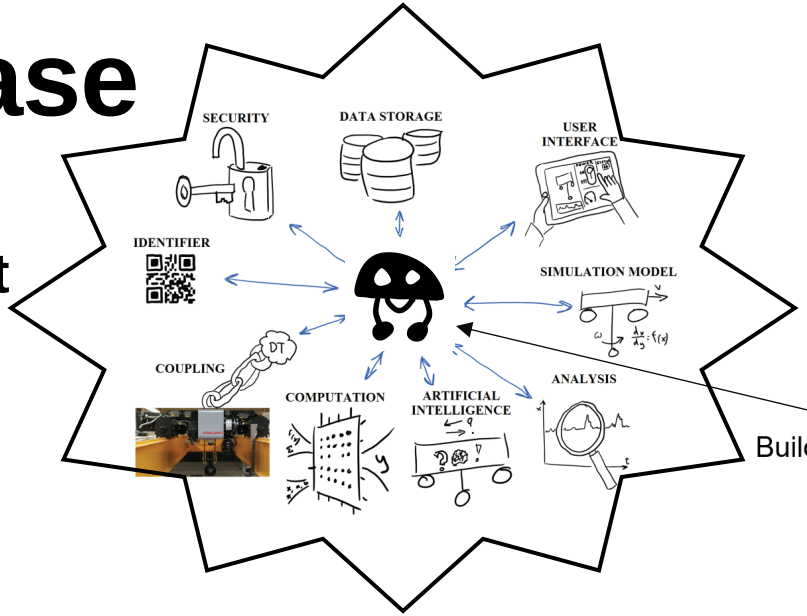
Autiosalo, Juuso, Jari Vepsäläinen, Raine Viitala, and Kari Tammi. "**A Feature-Based Framework for Structuring Industrial Digital Twins**." *IEEE Access* 8 (2020): 1193–1208. https://doi.org/10.1109/ACCESS.2019.2950507.

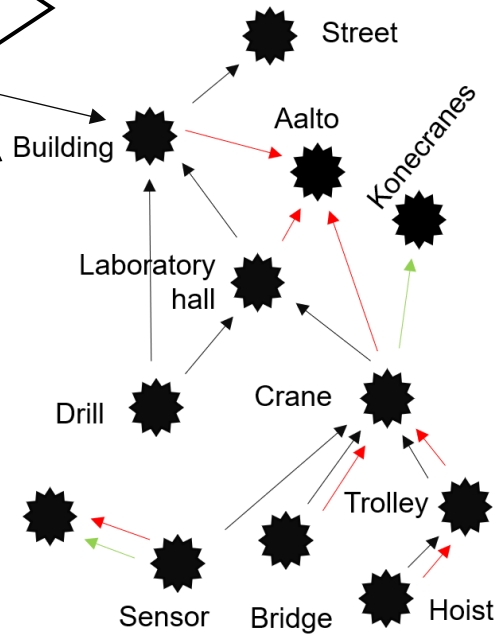
# Digital twin with Twinbase

**Almost any digital service can be a part of digital twin!**

**Twinbase links the parts together**

**... and makes twins talk to other twins**

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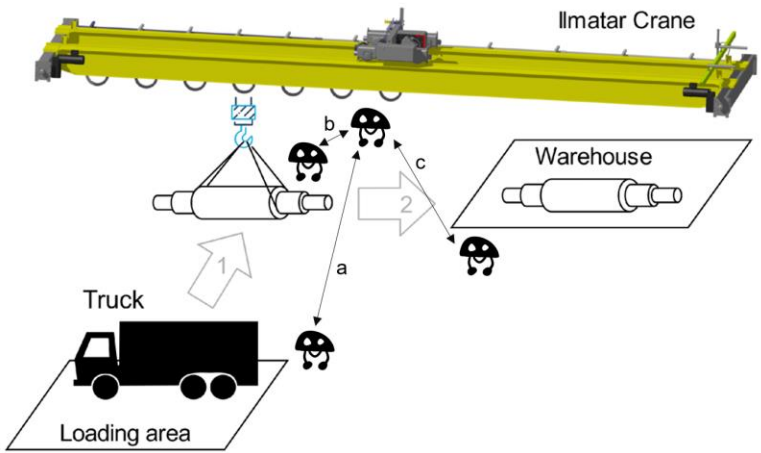
# Are there more use cases for Twinbase?

# More use cases for Twinbase

## Ad-hoc machine-to-machine communication




Mattila, Joel, Riku Ala-Laurinaho, Juuso Autiosalo, Pauli Salminen, and Kari Tammi. "**Using Digital Twin Documents to Control a Smart Factory: Simulation Approach with ROS, Gazebo, and Twinbase**." *Machines* 10, no. 4 (April 2022): 225. https://doi.org/10.3390/machines10040225.

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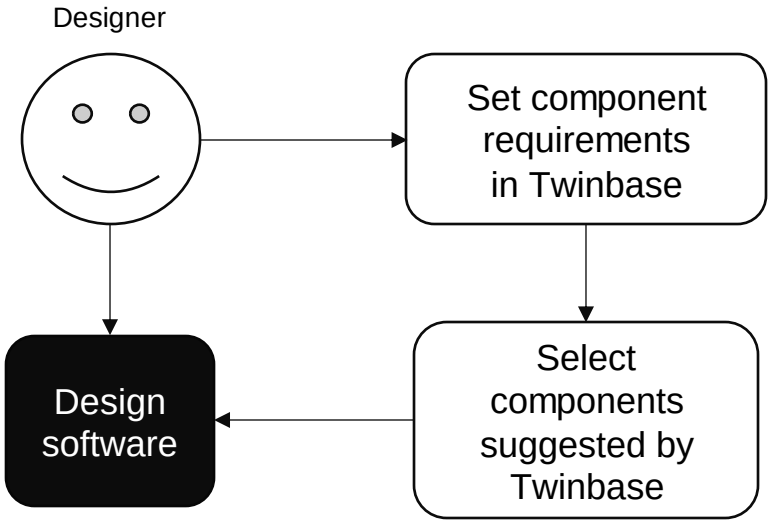
## Automated component discovery for system design




Related paper in review!

# More use cases for Twinbase

**Concrete use cases**

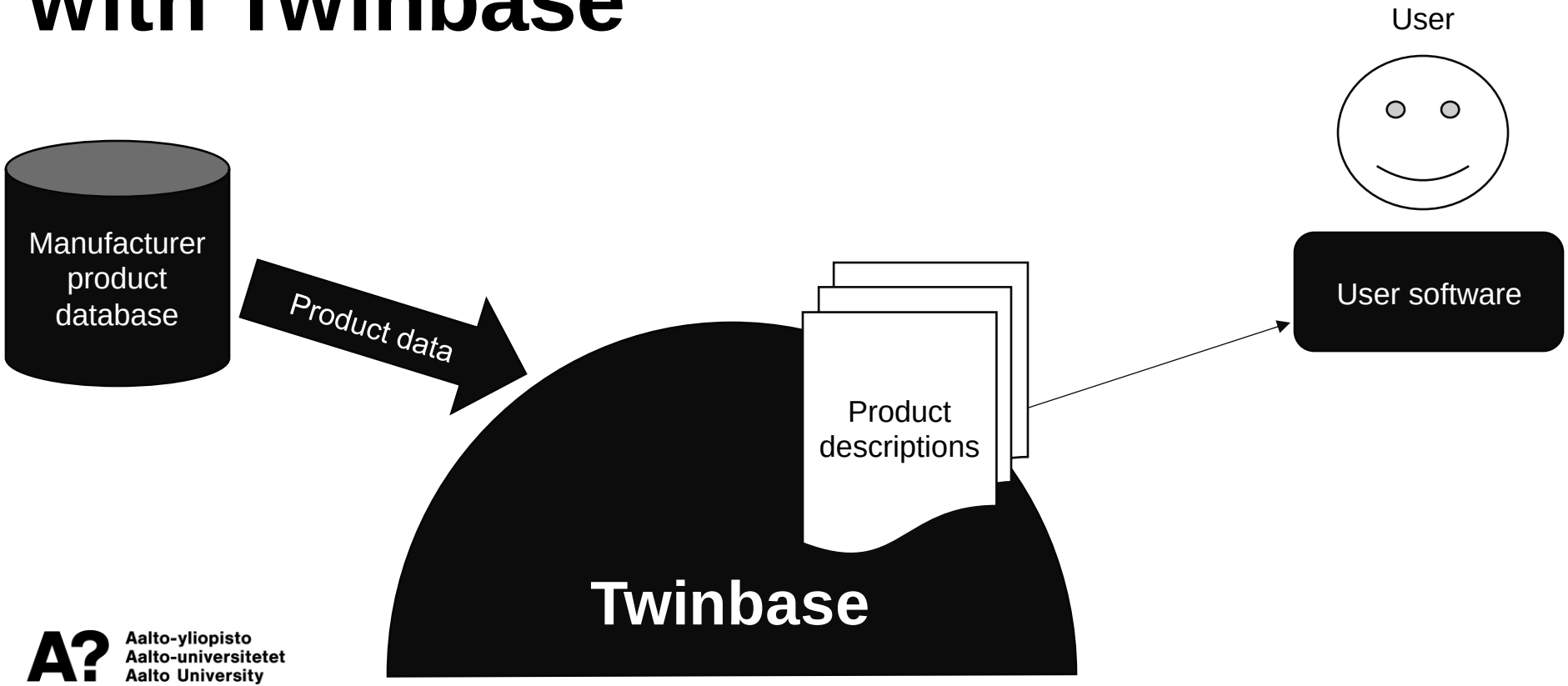
- **Initialization of mixed reality app**
  - Article published
- **Collaborative design**
  - Paper in review
- **Find data from a traffic radar**
  - Data discovery
  - Data catalog

**Higher level use cases**

- **Data market**
- **Data for AI**
- **Twin standardization**
- **Regulatory compliance**
- **Low code plugin**
- **Authentication management**
- **Data model mapping**
  - Vocabulary generator
  - Vocabulary mapping
- **Twin document generation**
- **Twin document updating**
- **System integration**
- **Inter-organizational master data management**

# How does Twinbase work?

# Standardizing product data with Twinbase



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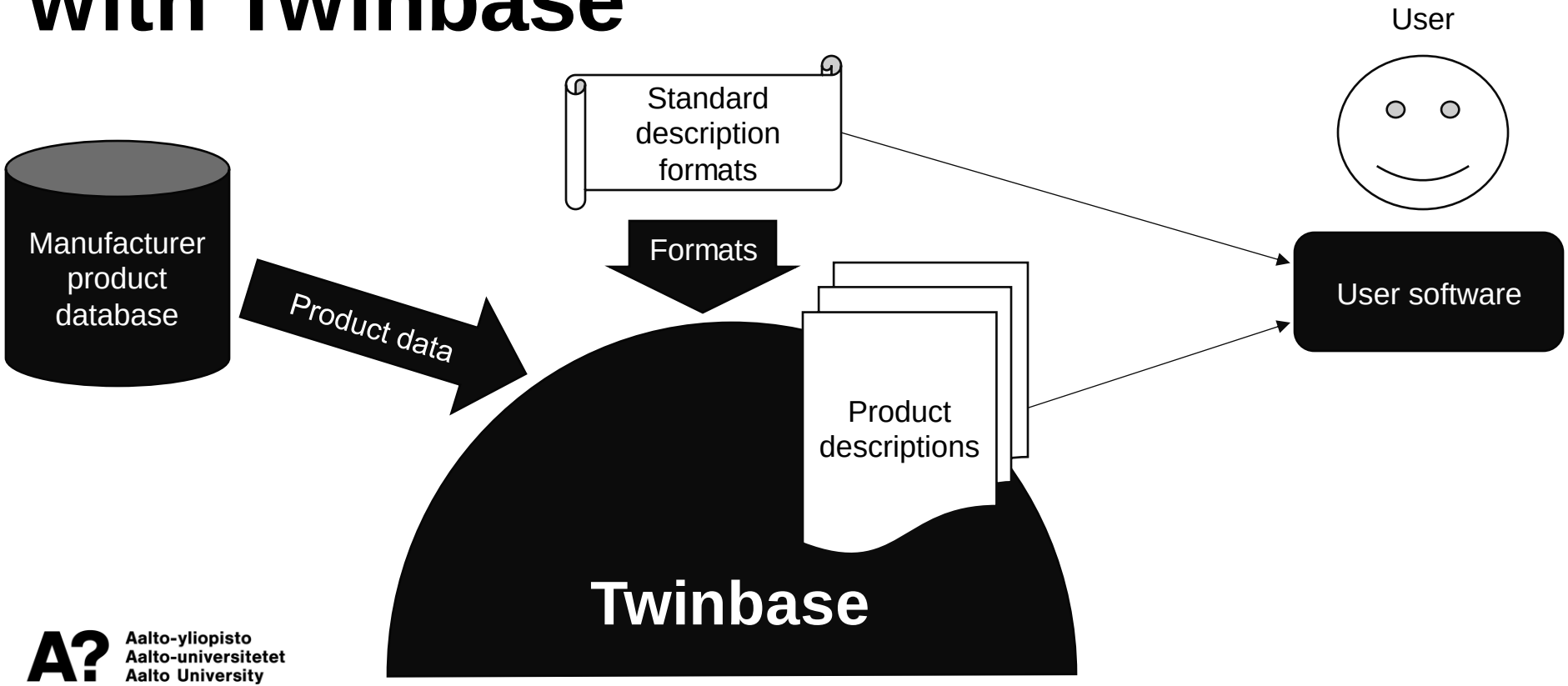

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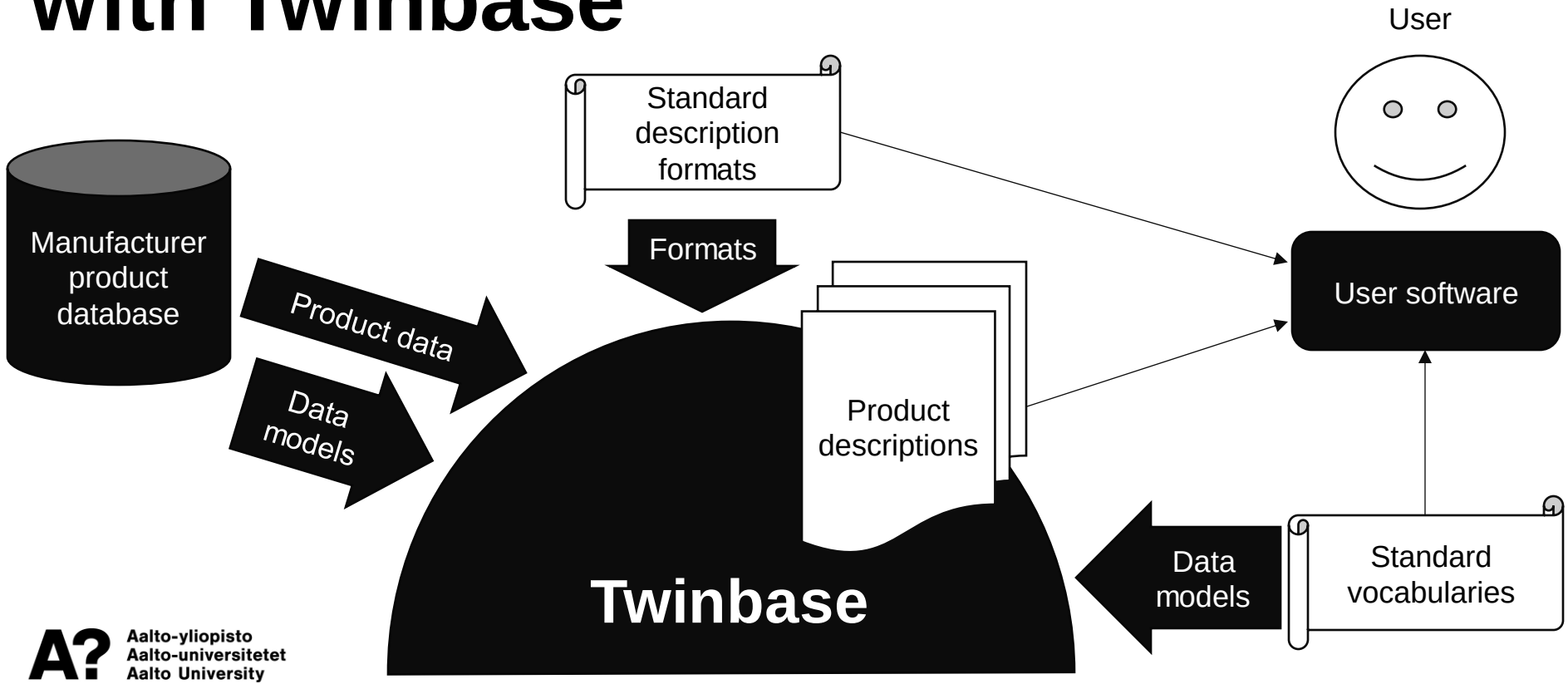


# Standards and technologies

## Linked data

- RDF
- OWL
- SHACL
- JSON-LD
- Schema.org

## Twin description formats

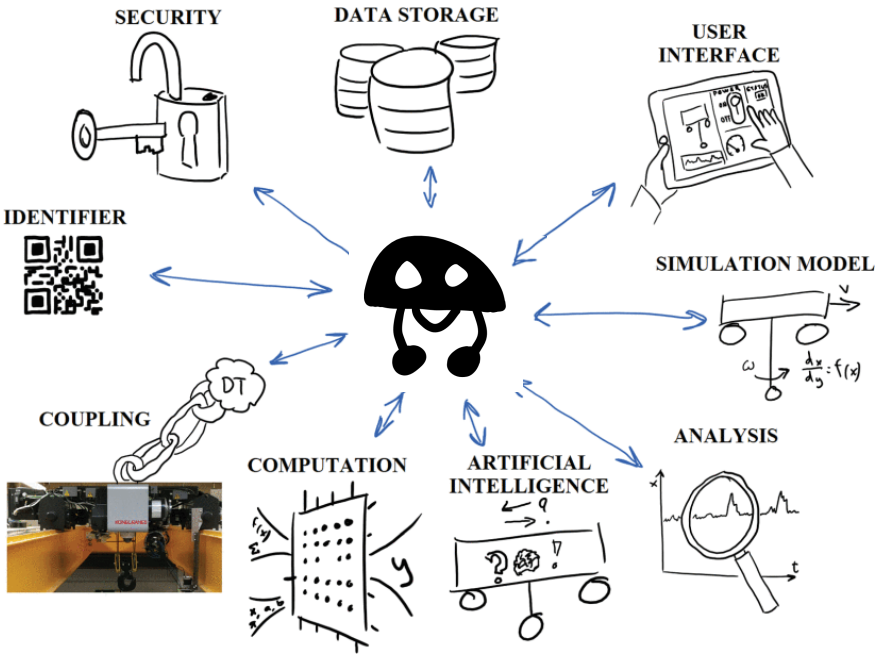
- AAS
- WoT TD
- DTDL
- NGSI-LD

## Data models

- AAS submodels
- ECLASS
- IEC CDD
- ETIM
- OPC UA companion specifications
- …

# Key takeaways

1. Twinbase connects digital services into one coherent digital twin
2. Twinbase enables digital twins to talk to each other
3. Standards and data models are crucially important



# Twinbase project info

# Twinbase Team

**Jani Hietala**
- Technical solutions

**Mirva Nevalainen**
- Business development advisor

**Juuso Autiosalo**
- Vision and architecture

**Kari Tammi**
- Principal Investigator

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**Junior Programmer**
- Plan to hire in Oct 2023

twinbase-bot

TWINBASE

# Project

**Planned timeline:**

- **January 2023 – June 2024**
  - Research to business (R2B) project at Aalto University
  - Budget: 564 449€
  - Funded by Business Finland
  - Paying customers not allowed
- **July 2024**
  - Start a startup

**Goals of R2B project:**

- Research: Twin document **methodology** is ready for commercial use
- Technology: Basic functions of Twinbase are **proven** (Proof of Concept)
- Business: Twinbase produces value for pilot **customers**

# Call for development partners

**Process:**

1. You express **interest**
2. Together we **ideate** a use case
3. Twinbase team **develops** Twinbase to support the case
4. We **build** the use case in the appropriate manner

**Target**: Five productive reference cases before Slush in November

**Join waitlist at twinbase.ai**

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**Contact: Juuso.Autiosalo@aalto.fi**

# Questions?

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# Publications

**Publications on Twinbase:**


Autiosalo, Juuso, Joshua Siegel, and Kari Tammi. "**Twinbase: Open-Source Server Software for the Digital Twin Web**." *IEEE Access* 9 (2021): 140779–98. https://doi.org/10.1109/ACCESS.2021.3119487.

Mattila, Joel, Riku Ala-Laurinaho, Juuso Autiosalo, Pauli Salminen, and Kari Tammi. "**Using Digital Twin Documents to Control a Smart Factory: Simulation Approach with ROS, Gazebo, and Twinbase**." *Machines* 10, no. 4 (April 2022): 225. https://doi.org/10.3390/machines10040225.

Tu, X. *et al.* (2023) "**TwinXR: Method for using digital twin descriptions in industrial eXtended reality applications**", *Frontiers in Virtual Reality*, 4. https://doi.org/10.3389/frvir.2023.1019080.

Autiosalo, Juuso. "**Discovering the Digital Twin Web - From Singular Applications to a Scalable Network**." Doctoral thesis, Aalto University, 2021. http://urn.fi/URN:ISBN:978-952-64-0621-3.


**Selected publications on digital twins:**


Autiosalo, Juuso, Jari Vepsäläinen, Raine Viitala, and Kari Tammi. "**A Feature-Based Framework for Structuring Industrial Digital Twins**." *IEEE Access* 8 (2020): 1193–1208. https://doi.org/10.1109/ACCESS.2019.2950507.

Autiosalo, Juuso, Riku Ala-Laurinaho, Joel Mattila, Miika Valtonen, Valtteri Peltoranta, and Kari Tammi. "**Towards Integrated Digital Twins for Industrial Products: Case Study on an Overhead Crane**." *Applied Sciences* 11, no. 2 (January 2021): 683. https://doi.org/10.3390/app11020683.

Ala-Laurinaho, R., J. Autiosalo, A. Nikander, J. Mattila, and K. Tammi. "**Data Link for the Creation of Digital Twins**." *IEEE Access* 8 (2020): 228675–84. https://doi.org/10.1109/ACCESS.2020.3045856.

Tu, Xinyi, Juuso Autiosalo, Adnane Jadid, Kari Tammi, and Gudrun Klinker. "**A Mixed Reality Interface for a Digital Twin Based Crane**." *Applied Sciences* 11, no. 20 (January 2021): 9480. https://doi.org/10.3390/app11209480.


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