Machinaide project summary 2019-2023

Case Aalto Smart Factory
–How to blend industrial machines with digital world

Finnish consortium and all WP´s & all partners

MACHINAIDE

19 partners

4 countries

ITEA 3 Call 5

Oct 2019 - Jun 2023

Smart industry

ITEA 3

Finland

Netherlands

Turkey

Rebublic of Korea

https://www.machinaide.eu

ITEA 3

BUSINESS FINLAND

IDEAL GRP

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

DP SYSTEMS

KONECRANES®

VTT

teknopar Endüstriyel Otomasyon

ETRI Electronics and Telecommunications Research Institute

REMION

CORDIS SUITE

Additive Industries

KE-works

RollResearch

ER METAL

Aalto University

DAKİK YAZILIM TEKNOLOJİLERİ

TNO

DOĞRU BİLGİ TEKNOLOJİLERİ

ERSTE

LELY

Work Packages and Goals

- **WP1: Use Cases, requirements and evaluation**
- **WP2: Interoperability between Digital Twin ecosystems**
- **WP3: Processing of multiple Digital Twin´s data**
- **WP4: Innovative Human Machine Interfaces for DT´s and services**
- WP5: Information usage across the machine **Life cycle**
- WP6: Business models
- WP7: Dissemination
- WP8: Project management

Use cases

Turkish Use case

- 1600T press line in Ermetal press factory
  - 1 press (800T) & 1 robot (fully automated) selected as project application area
  - Real-time data monitoring & collecting
  - Anomaly detection based collected data
  - Performing predictive maintenance simulations

Key Objectives

Increase in hours/failure rate
Decrease in maintenance costs

Dutch use cases

Agricultural use-case:

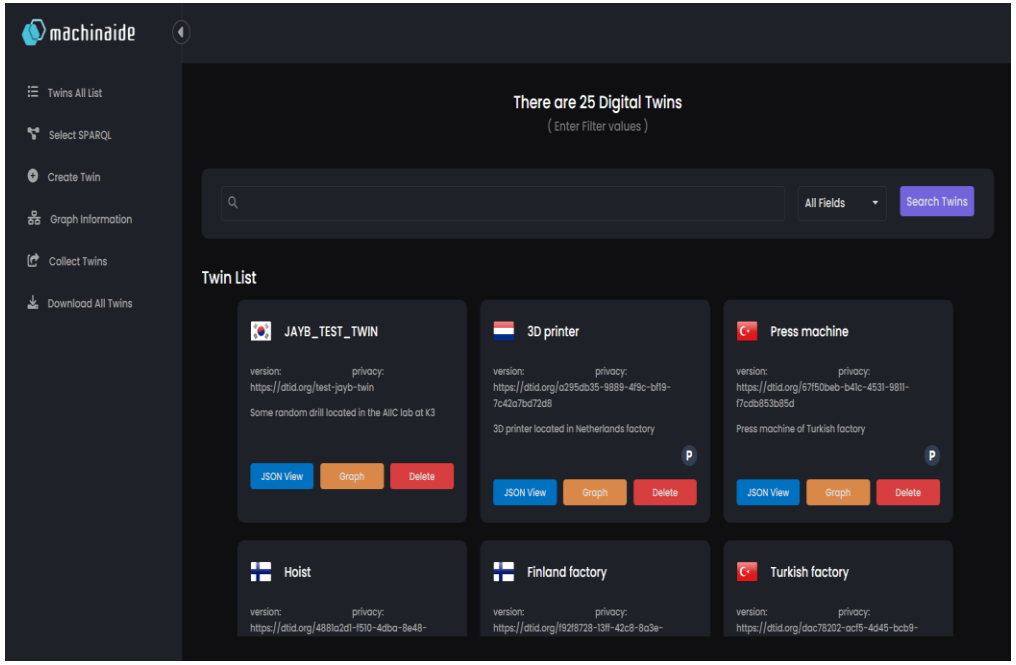
- Improving Lely Juno machine installation using KE-chain

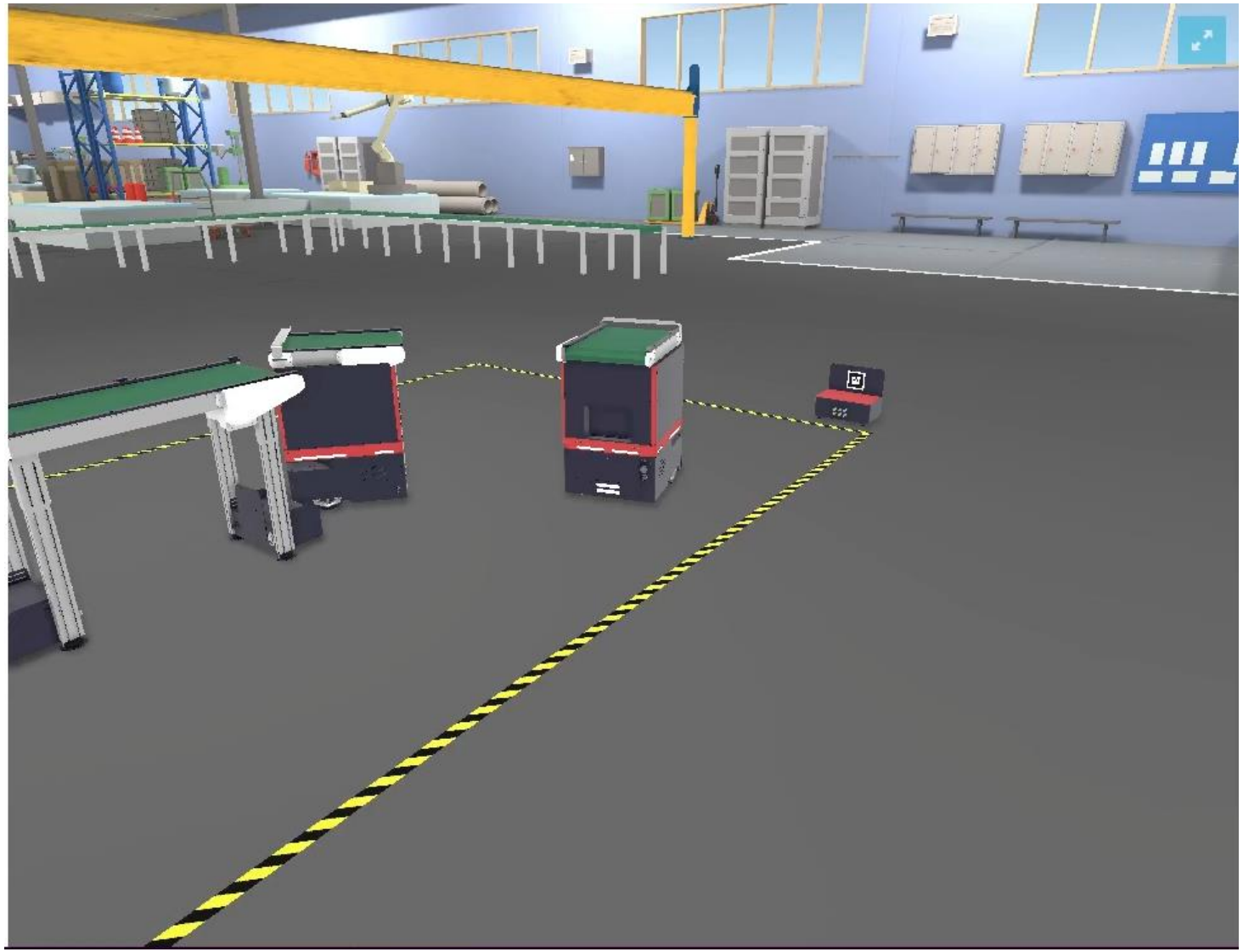
3D printing use case

- Data Collection & Data platform
- Software updates

Korean Use case

- Build a test bed for Autonomous Mobile Robots (AMRs) based material handling process
- KMAC Digital Twin Platform





Finnish partners

machinaide

Aalto University
School of Engineering

- Digital Twin Documents & Web, Connections , HMI, AIIC

VTT

- Business models

IDEAL GRP

- Smart Factory app & simulation, Worklist app

REMION

- Data management & processing

RollResearch

- Virtual Grinding machine

KONECRANES®

- Crane interface, APIs, HMI

From old machines to smart ecosystems

Old tech to new tech

Ecosystem

Enterprise Systems

ERP MES APS

Connectivity

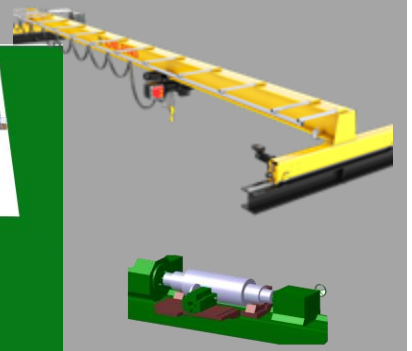
DTW

Smart Factory with Crane and Grinder

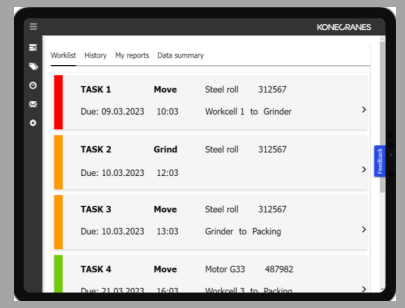
Physical

Virtual

Digital Twin based Smart Factory Simulations

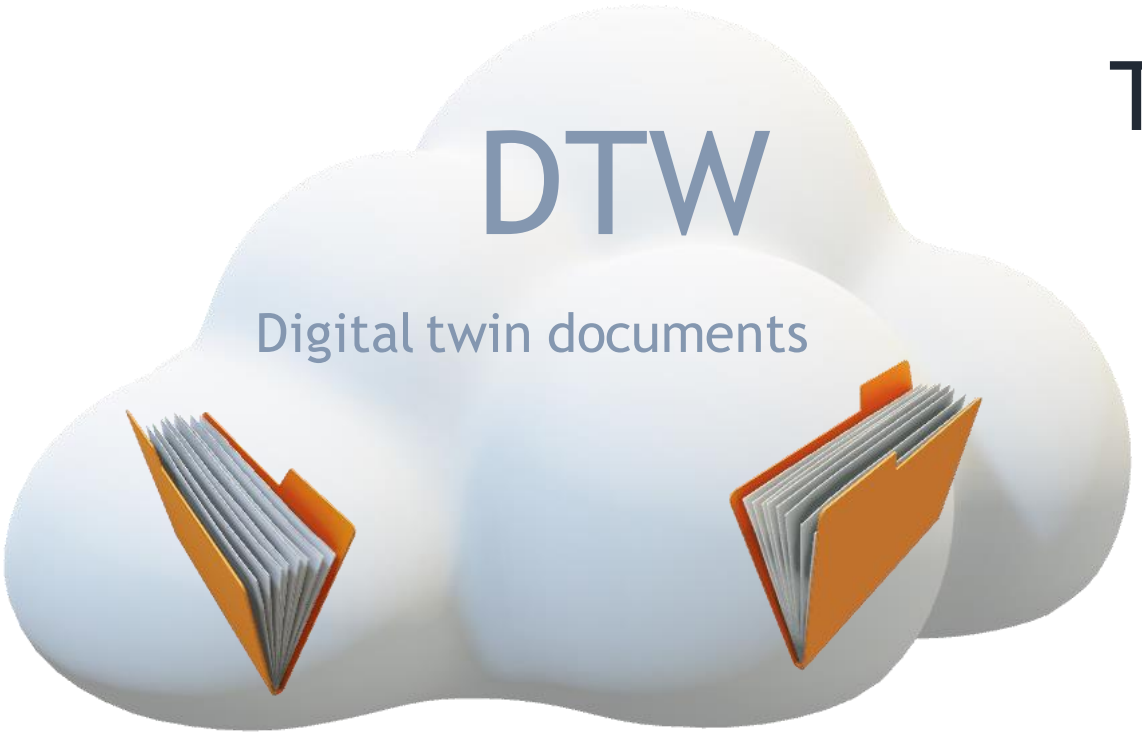


Smart Factory Control room with Analytics

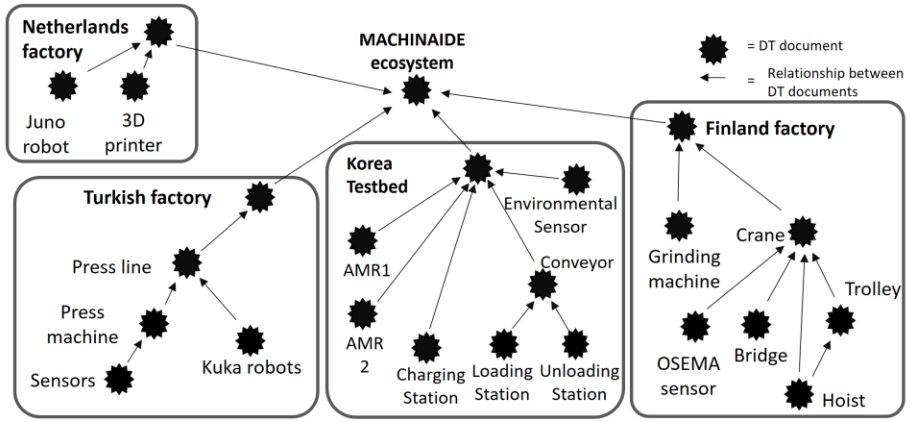


HMI

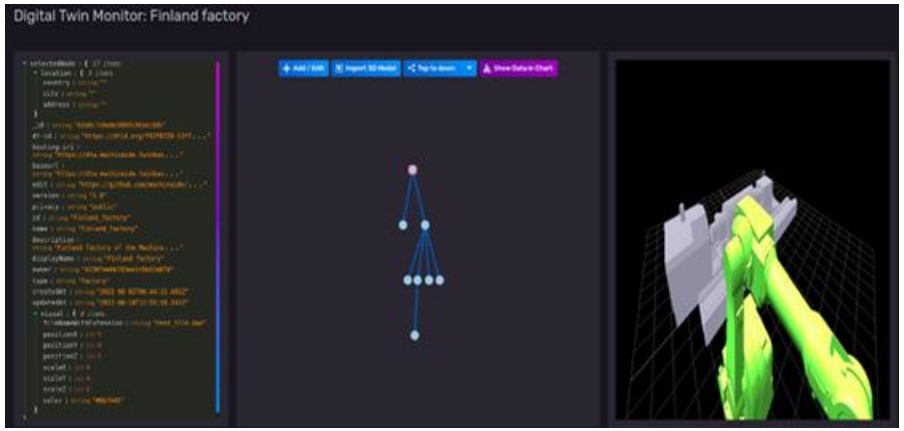
Digital Twin Document and Digital Twin Web (DTW)



Twinbase



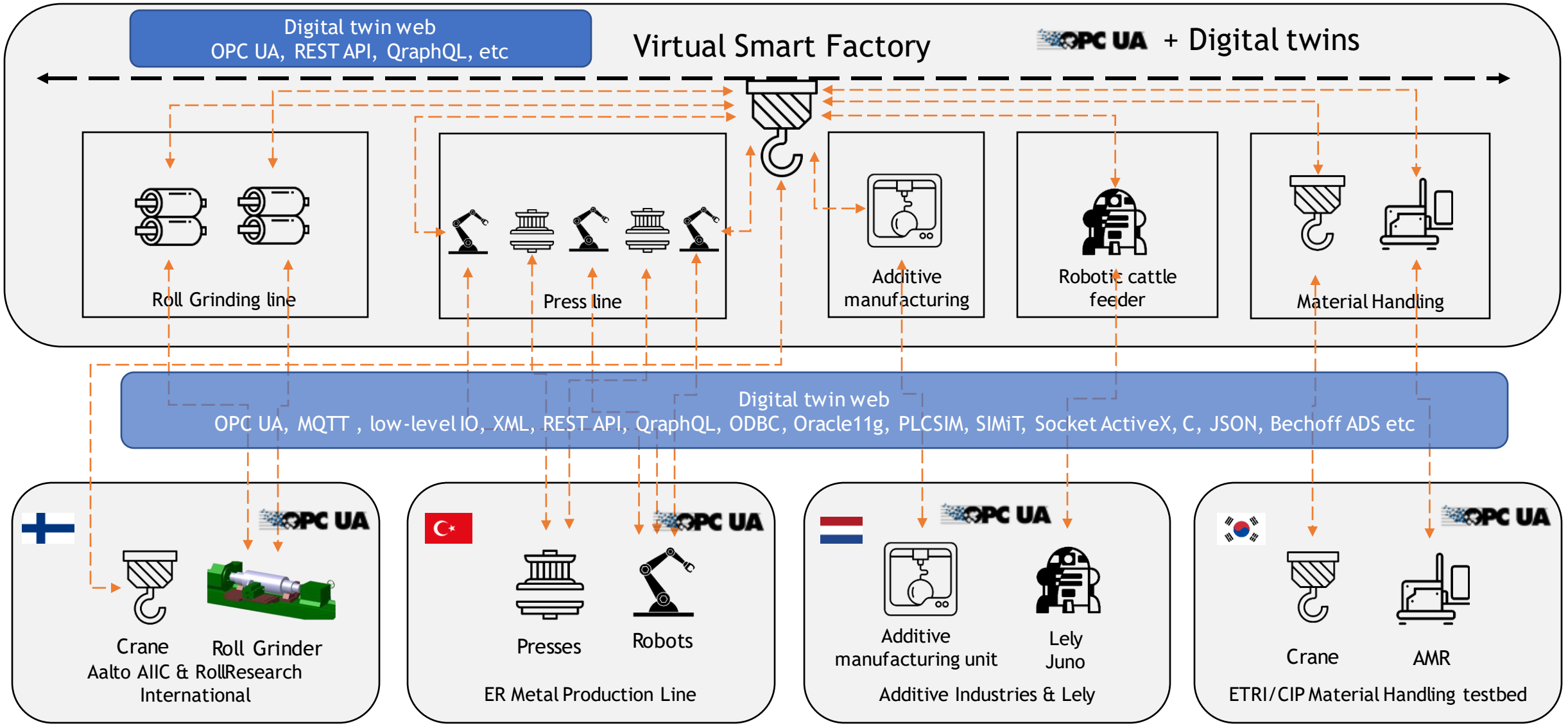
Twinaide



KMAC DT testbed

KE-chain

Workshop and Machine layer has a lot of interfaces & technologies



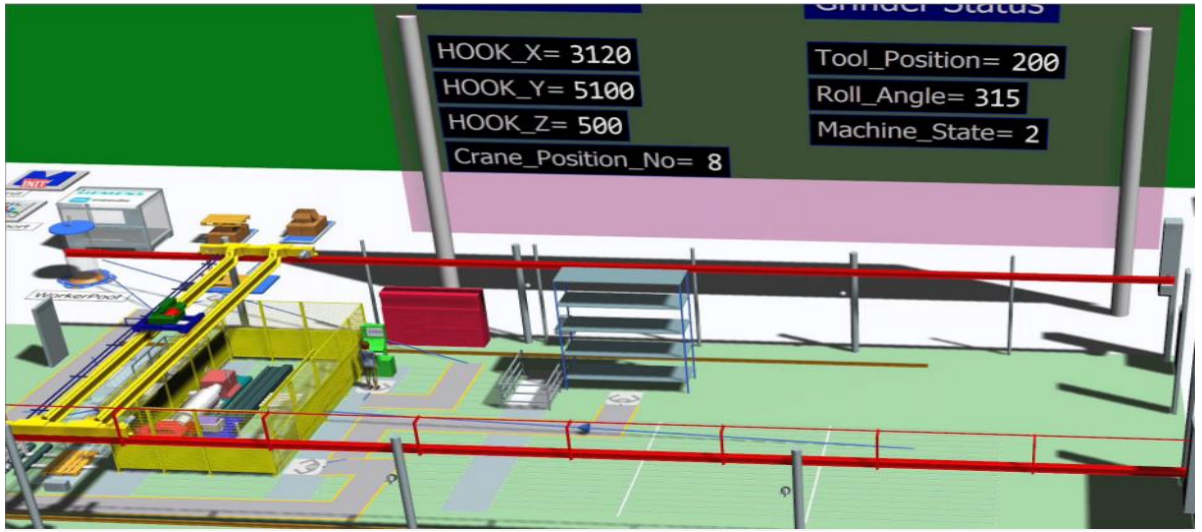
Developed virtual grinding machine

- Real CNC hardware (Siemens Sinumerik 840D sl) operating in simulation mode
  - Other studied option: Virtual CNC
- Communication over OPC UA with other DTs
- Information flow in both directions
  - Status information
  - Commands

Demonstration videos

- Ideal GRP, 3 min
- Remion, 2 min
- Crane domain (Aalto, RRI, KC), 5 min

Crane domain



Smart factory app

Anomaly detection on Regatta® platform

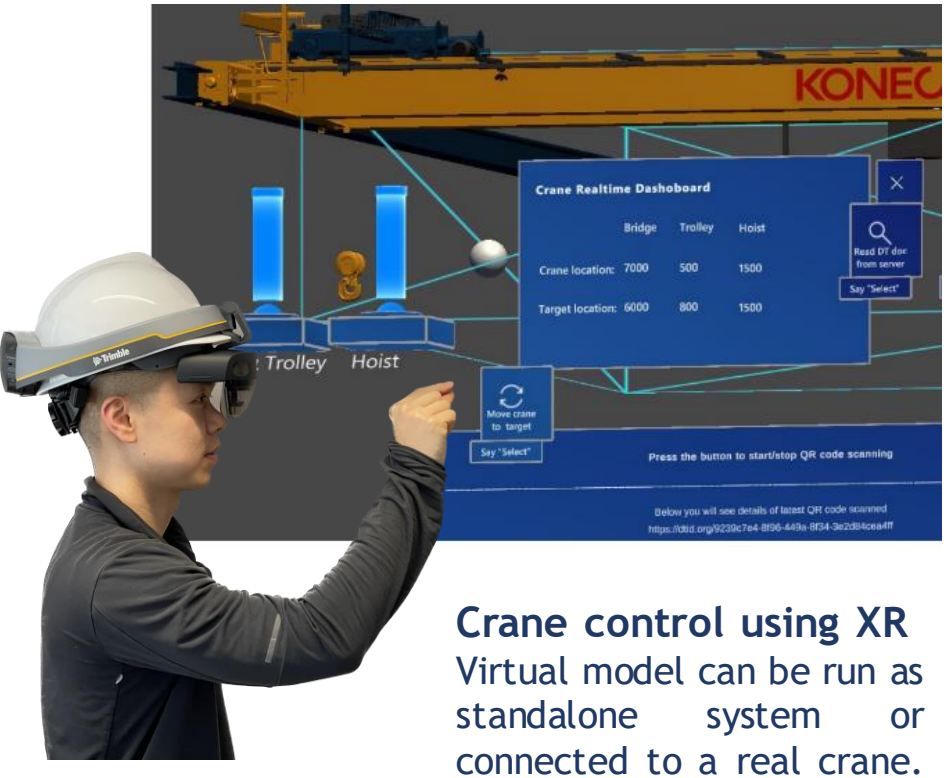
Machinaide Final ITEA Review

Markus Ranta – March 21, 2023

IDEAL GRP
an atos company

HMI prototypes

Hololens AR

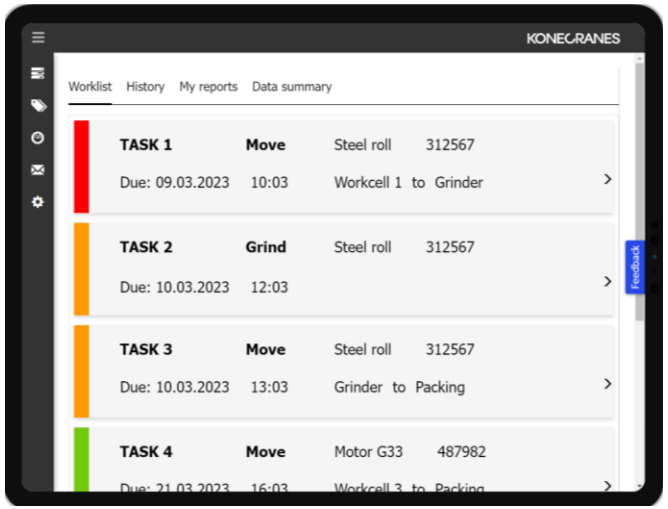


Crane control using XR
Virtual model can be run as standalone system or connected to a real crane. Both systems are connected to DT documents and DTW.

Varjo VR

Operator training in VR
Crane driving and smart features can be trained in realistic virtual environment.

Low code mobile app



Smart factory app
Material moves and machine operations as a Worklist for the operators.

Thesis works

Partner Name	Title	Degree	Author	Date
AALTO	Real-time two-way data transfer with a digital twin via web interface	MSc	Jani Hietala	5.2.2020
AALTO	IoT-based Smart Crane data-analysis and visualization	Bachelor	Joel Mattila	3.5.2020
AALTO	Communication between machines in smart factories	MSc	Joel Mattila	23.11.2021
AALTO	A Mixed Reality Interface for DigitalTwin Based Crane	MSc	Tu Xinyi	15.10.2021
AALTO	User Experience Challenges in Designing Industrial Internet of Things Applications	Bachelor	Anna Nikander	25.8.2020
AALTO	Multivariate fuzzy modelling of time-series data	MSc	Tuomas Keski-Heikkilä	24.07.2021
AALTO	API-based Digital Twins	PhD	Riku Ala-Laurinaho	10.12.2021
AALTO	Discovering the Digital Twin Web—From singular applications to a scalable network	PhD	Juuso Autiosalo	17.12.2021
AALTO	Framework for Virtual Reality digital ser-vices leveraging digital twin-based crane	MSc	Chao Yang	7.9.2021
AALTO	“Towards Industrial Metaverse: Combining Digital Twins and Extended Reality in Industry 5.0 Applications”	PhD	Tu Xinyi	Started 3/2021
AALTO	“Data-driven framework for digital applications leveraging digital twin-based Machine"	PhD	Chao Yang	Started 10/2021
AALTO	“Digital Twin Document for enabling self-organizing smart factories".”	PhD	Joel Mattila	Started 1/2022
REMION	Fuzzy modeling system for Regatta	BSc	Janne Saukkio	5/2022
RRI	Flexible human machine interface for roll machining automation,Aalto University, School of Electrical Engineering	MSc	Olli Raudaskoski	June 2022

Publications 1/2

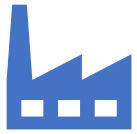
Partner Name	Journal / conference paper	URL	Submission date (D/M/Y)	Title/ Topic
AALTO	MDPI Journal of Sensor and Actuator Networks	https://doi.org/10.3390/jsan9020030	19.6.2020 (accepted)	Open sensor manager for IIoT, (Riku Ala-Laurinaho, Juuso Autiosalo, Kari Tammi)
AALTO	IEEE Access	https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=929875	18.12.2020	Data Link for creation of digital twins, (Riku Ala-Laurinaho et al.)
AALTO	Elsevier Computer standards and interfaces	https://acris.aalto.fi/ws/portalfiles/portal/83366076/computers_11_00065.pdf	1.5.2021 (published)	Comparison of REST and GraphQL interfaces for IIoT (Riku Ala-Laurinaho et al.)
AALTO	MDPI Applied Sciences	https://www.mdpi.com/2076-3417/11/2/683	12.1.2021	Towards integrated digital twins for industrial products: Case study on Ilmatar the overhead crane (Juuso Autiosalo et al.)
AALTO	MDPI Applied sciences	https://www.mdpi.com/2076-3417/11/20/9480	12.10.2021	A Mixed Reality Interface for a Digital Twin Based Crane (Xinyi Tu et al.)
AALTO	IEEE Access	https://ieeexplore.ieee.org/document/9568895	13.10.2021	Twinbase: Open-source server software for the Digital Twin Web (Juuso Autiosalo et al.)
AALTO	Frontiers in Virtual Reality, section Technologies for VR	https://www.frontiersin.org/articles/10.3389/frvir.2023.1019080/full	5.1.2023	TwinXR: Method for Using Digital Twin Descriptions in Industrial eXtended Reality Applications (Xinyi tu et. Al.)
AALTO REMION	--	--	Submitted in 2022	Multivariate fuzzy modeling (Riku Ala-Laurinaho, Juuso Autiosalo, Tuomas Keski-Heikkilä, Miika Valtonen, Kari Tammi)
AALTO	MDPI Machines	https://www.mdpi.com/2075-1702/10/4/225	Published 23.3.2022	Using Digital Twin Documents to Control a Smart Factory: Simulation Approach with ROS, Gazebo, and Twinbase (Joel Mattila et al.)
AALTO	MDPI applied sciences	https://doi.org/10.3390/app12126030	14.6.2022	Extended Reality Application Framework for a Digital-Twin-Based Smart Crane (Chao Yang et al.)

Publications 2/2

Partner Name	Journal / conference paper	URL	Submission date (D/M/Y)	Title/ Topic
VTT	17th International Research Symposium on Service Excellence in Management (QUIS17)	https://quis17vlc.blogs.upv.es/	. Full paper accepted 13.12.2021. Article presented on 13th January 2022	Hemilä, J., Salo, M, Petänen, P. (2022): "Utilization of Digital Twins in Industrial Service Supply Chains, The 17th International research symposium on service excellence in management (QUIS17), 12-15 January 2022 at Valencia Spain. Awarded as "Honorable Mention" at the conference.
VTT	12th SERVSIG Conference, 16-18.6.2022, Glasgow, Scotland	https://www.servsig2022.org/	Accepted abstract Presentation kept on 16th June 2022	Hemilä, J. (2022): Next Generation Industrial Services Based on the Digital Twins.
VTT	XXXIII ISPIM Innovation Conference, Copenhagen, Denmark	https://www.ispim-innovation.com/events	5.-8.6.2022 Paper presented 6th June 2022	Salo, M., Petänen, P. & Hemilä, J. (2022): "Creating value for the customers through new digital twin enabled service innovation", XXXIII ISPIM Innovation Conference, 5.-8.6.2022, Copenhagen, Denmark
VTT	IARIA Congress 2022, Nice, France, July 24-28, 2022	https://www.thinkmind.org/index.php?view=article&articleid=iaria_congress_2022_1_100_50075	Paper presented 25th July 2022	Hemilä, J. (2022): "Digital Twin Based Industrial Services - Just Hype or Real Business?". The Proceedings of IARIA Congress 2022. Nice, France, July 24-28, 2022. ISBN: 978-1-68558-017-9.
VTT	The 25th Excellence in Services International Conference (EISIC), Visby, Sweden, 25-26 August 2022	https://sites.les.univr.it/eisic/index.php/25th-eisic-visby-august-25-26-2022/	Paper presented 25th August 2022	Hemilä, J. (2022): "From Hype to Real Business by Utilizing Digital Twins in Industrial Services", The Proceedings of The 25th Excellence in Services International Conference (EISIC), Visby, Sweden, 25-26 August 2022
VTT	3rd International Conference on Innovative Intelligent Industrial Production and Logistics, 24.-26.10.2022, Valletta, Malta.	https://in4pl.scitevents.org/CallForPapers.aspx#A2	Abstract accepted. Presentation kept on 24th October 2022	Hemilä, J. (2022): "Business Benefits from Multiple Digital Twins in Machine Manufacturing Industries", The book of Abstracts of 3rd International Conference on Innovative Intelligent Industrial Production and Logistics, 24.-26.10.2022, Valletta, Malta.
VTT	ISPIM Connects Athens Conference - "The Role of innovation: Past, Present, Future", 28-30 November 2022. Athens, Greece.	https://www.ispim-innovation.com/events	Paper accepted Paper presented 30th November 2022	Petänen, P., Salo, M., Hemilä, J. & Silmukari, J., (2022), "Identifying customer value of digital twin-enabled service process", ISPIM Connects Athens Conference - "The Role of innovation: Past, Present, Future", 28-30 November 2022. Athens, Greece.
VTT	18th International Research Symposium on Service Excellence in Management (QUIS18), 20.-23rd June 2023, Hanoi, Vietnam	https://vinuni.edu.vn/quis18/	Abstract accepted. Full paper under construction	Hemilä J.: Machine-as-a-Service in Manufacturing Industries – Realism or Future Talk?

Summary & Conclusions

- Interoperability & Updates
  - Digital Twin Web
  - Device management & software updates
  - Machine interfaces & APIs



- Data prosessing
  - Factory data (ecosystem level) and Machine/asset level
  - System level modelling: Anomaly detection

- HMI
  - HMI development: Several AR/VR/XR devices
  - Smart factory app: Worklist feature

- Dissemination & future work
  - Plenty of publications and thesis works
  - Research to business project started and is ongoing

Any questions?

- Thank you!