DIMECC

NECOVERSE

Seppo Tikkanen

FIIF EVENT ON “INDUSTRIAL METAVERSE”

11.4.2024

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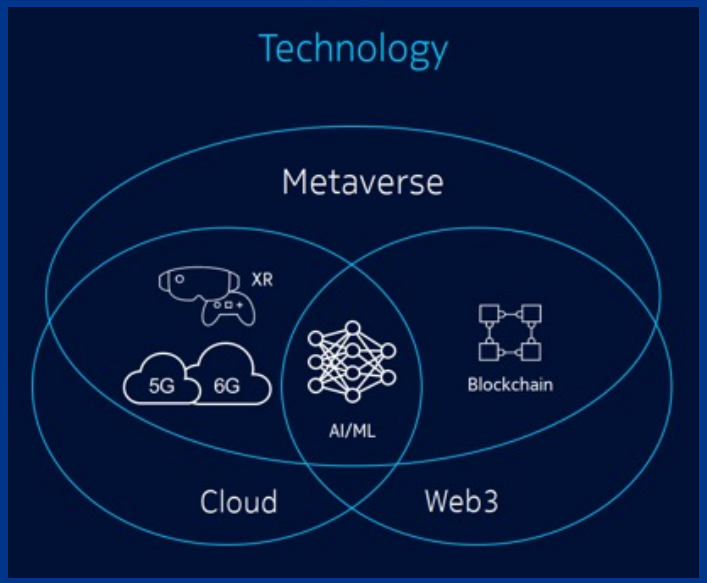

Content

General overview on the NECOVERSE-project.

Seppo Tikkanen, DIMECC

Next Generation Remote Inspections

Tuomas Suominen, KIWA

Industrial metaverse for human-centric industry processes

Chao Yang, Aalto University

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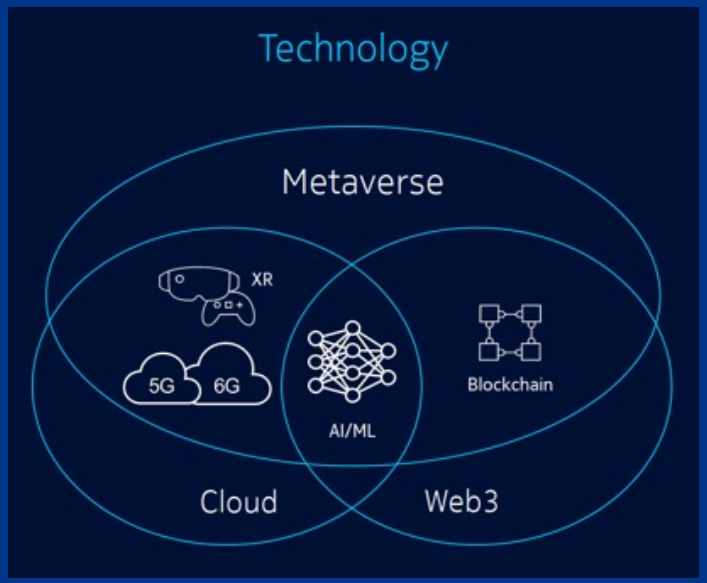


Next Generation Training, Design and Operation Environment Utilizing Industrial Metaverse

Utilizing Metaverse in industrial context, especially in shipbuilding.

Necoverse project develops new immersive and authentic collaborative tools aiming to improve productivity, safety and energy efficiency in training, design, commissioning, operations and maintenance.

NECOVERSE

Facts

Duration 2 years

7 Industrial partners
3 Research partners

Budget 5,5 M€

Project structure

WP's	Use case 1	Use case 2	Use case 3
01 Project Management	finpeda virtual space IMMERSIVE LEARNING EXPERIENCE	MEYER TURKU SHIPYARD 1737 HOLLINKI EXCELLENCE IN VIRTUAL SPACE	kiwa
02 Metaverse Technology	Lingsoft®		Aalto University
03 Metaverse Pilots	Education and training (people)	Architecture and design (ship)	Remote operations (shipyard)
04 Metaverse Impact	TURKU AMK TURKU UNIVERSITY OF APPLIED SCIENCES	dSign VTT	TURKU AMK TURKU UNIVERSITY OF APPLIED SCIENCES
05 Dissemination and Exploitation	VTT Aalto University	Aalto University TURKU AMK TURKU UNIVERSITY OF APPLIED SCIENCES	VTT

Use Case 1

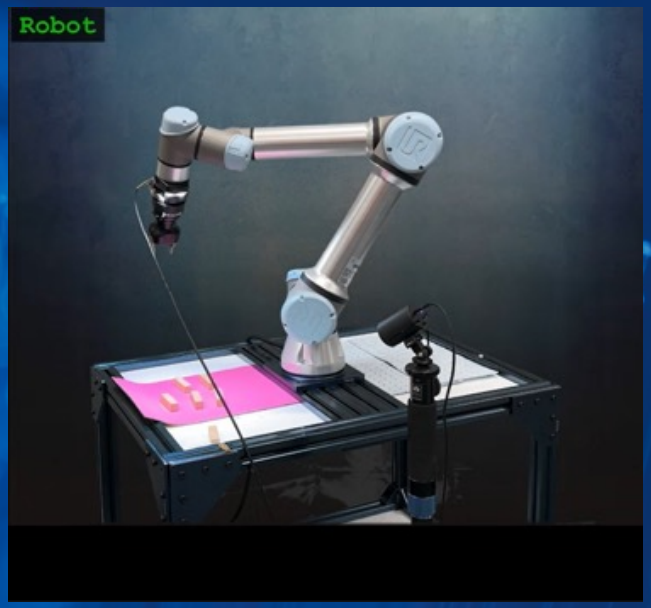
Education and training

Bringing training and education to real world context utilizing both VR and AR solutions.

The use of metaverse technologies in education and training can provide several benefits, including:

- **Improved retention and recall of information**: Immersive and interactive training experiences can facilitate the acquisition of new knowledge and skills and can improve the retention and recall of this information over time.
- **Enhanced collaboration and communication**: The metaverse can enable learners to interact and collaborate with each other and with instructors in real-time, fostering a sense of community and enabling more effective learning.
- **Increased convenience and flexibility**: The metaverse can provide learners with the ability to access training content from any location and on any device, enabling flexible and convenient learning.

Education and training pilot case



Robot programming training

Training of robot operations and programming for welding remotely by using metaverse technology. Learning basic commands, programming and welding procedures in multiuser metaverse environment prior to conducting operations with physical robot.

Cooperation: Finpeda, Lingsoft, VTT, TUAS
Location: Machine Technology Centre, Turku
Pilot timeline: during 2024

Use Case 2

Architecture and design

Metaverse will enable collaborative design environment for various stakeholders. The use of metaverse technologies in ship architecture and design can provide several benefits, including:

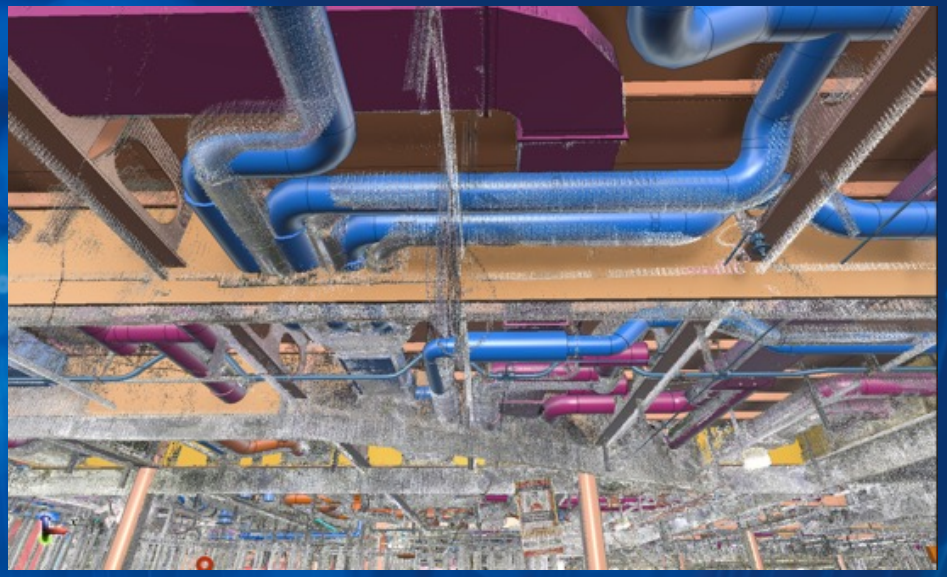
- **Improved accuracy and realism of simulations**: AI-enhanced simulations can improve the accuracy and realism of simulations, enabling designers and engineers to assess the performance and behavior of ship systems and structures with greater confidence.
- **Enhanced communication and collaboration**: The metaverse can enable designers and engineers to interact and collaborate with each other and with other stakeholders in real-time, fostering a sense of community and enabling more effective decision-making.
- **Increased efficiency and productivity**: Collaborative design environments can reduce the need for physical meetings and enable more efficient and productive workflows, saving time and reducing costs

Architecture and design pilot cases

Magical interactive immersive spaces

Customized industrial multiuser metaverse environment for architecture and design where feel and look of a design and quality of virtual spaces are in focus. Immersive collaborative environment for architects, designers, engineers, clients and end-users. Utilization of metaverse technology and augmented reality technology.

Cooperation: dSign, Hollinki, Turku UAS, VTT
Location: Turku UAS FIT Lab, Turku and VTT, Espoo
Pilot timeline: during 2024



Change management at ship construction phase

Customized industrial multiuser metaverse environment by comparing collected point cloud data with 2D/3D CAD data and with the built environment. Implementing a collaborative and tangible environment where data from various sources and next phases of construction can be visualized. Utilizing point cloud scanning to mitigate late implemented production changes in prototype vessels and ensure the updated information is corrected into design data for next vessels in serie.

Cooperation: Shipbuilding Completion, Tuteka, Turku UAS, VTT
Location: Turku UAS FIT Lab, Turku and VTT, Espoo
Pilot timeline: during 2024

Use Case 3

Remote operations

Metaverse will enable remote inspections and remote evaluation techniques. The use of metaverse technologies in remote operation can provide several benefits, including:

- **Improved efficiency and productivity**: Remote operation can enable operators to monitor and control systems and processes from a distance, reducing the need for physical presence and enabling more efficient and productive workflows.
- **Enhanced communication and collaboration**: The metaverse can enable operators to interact and collaborate with each other and with other stakeholders in real-time, fostering a sense of community and enabling more effective decision-making.
- **Increased safety and convenience**: Remote operation can reduce the need for operators to be physically present in potentially hazardous or inconvenient environments, enhancing safety and convenience.

Remote operations use cases

Crane inspection

Konecranes Ilmatar crane inspection done remotely using metaverse technology. Onsite collaboration with inspector, maintenance or client with augmented reality glasses and software.

Cooperation: Aalto, VTT, Kiwa
Location: Aalto Research Lab, Espoo
Pilot timeline: during 2024

Elevator inspection

Kone elevator inspection done remotely using metaverse technology. Onsite collaboration with inspector, maintenance, client or manufacturer with augmented reality glasses and software.

Cooperation: Aalto, VTT, Kiwa
Location: Aalto Research Lab, Espoo
Pilot timeline: during 2024

Visual NDT inspection

Visual pipe weld inspection done remotely using metaverse technology. Onsite collaboration with inspector, maintenance or client with augmented reality glasses and software.

Cooperation: TUAS, VTT
Location: Machine Technology Centre, Turku
Pilot timeline: during 2024

Necoverse

Next Generation Remote Inspections

Kiwa Inspecta

Tuomas Suominen, Business Development Manager, Kiwa Growth and Innovation Team, Finland

Public

Trust
Quality
Progress

Kiwa in a Nutshell

A global company

Founded in Netherlands 1948

Operation in 40 countries

Part of SHV Group

1 B€ turnover

10 000+ employees

Testing

Inspection

Certification

Training, competence

Technical consulting

Digital services

Quality

Safety

Health

Sustainability

Products

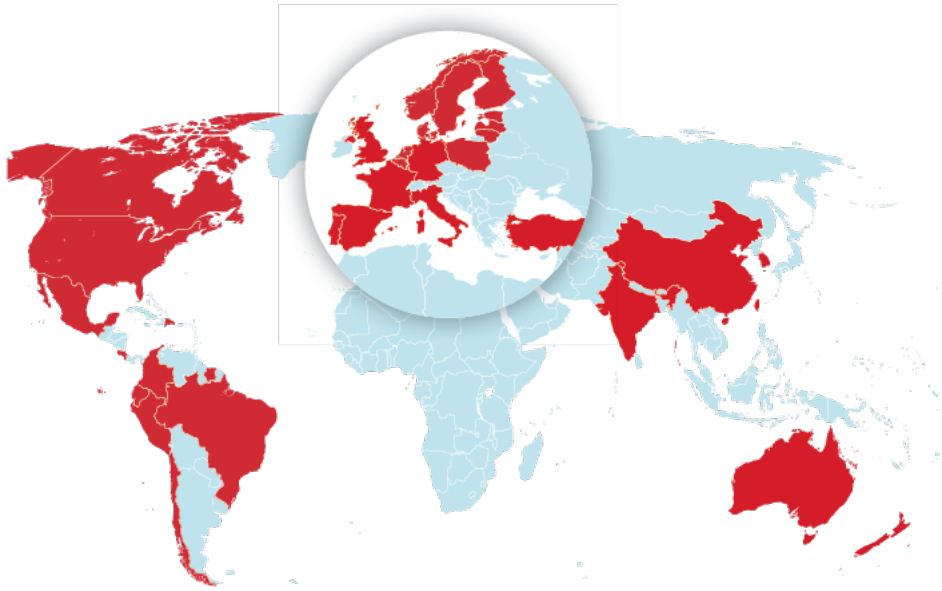
Services

Processes

Organisation

Systems

People



The Kiwa family

Necoverse Project Structure – 3 Sub-projects

Dock and ship **training and learning** in the metaverse	Dock and ship **architecture and design** in the metaverse	Dock and ship **remote operations** in the metaverse

finpeda
Innovations in education

DSIGN
VERTTI KIVI & CO

kiwa

Solutions will apply to assembly, inspection, asset monitoring, maintenance and logistics.

Case: the current state and future of inspection

- **Inspections, testing and certifications have traditionally required a lot of planning, travel and on-site work interruptions.** In addition, the necessary expertise may not have been available in the target country. The data needed to prepare for the inspections have been scattered throughout the organization.

- **Inspections and equipment monitoring can be done partly or completely remotely in the future.** Booking the remote inspector's working time will be quick and flexible. The work will be cheaper and more ecological when traveling will be reduced. Competent inspectors can be used from anywhere in the world. Digital twins and related databases will provide information and inspections can be performed even for hidden structures and devices.

Benefits of remote inspection

- Remote inspections would make inspections **more cost-effective, higher quality, minimize errors** and be **more flexible** for customers.
- Well-functioning, reliable remote inspections would significantly increase **the cost-effectiveness of operations** and **reduce labor intensity.**
- They would allow one inspector to perform **a significantly larger number of inspections during the working day** than with traditional inspection methods.
- Because there is a shortage of experts, **increasing efficiency** and **reducing labor intensity would increase turnover** and **lower costs.**
- Services **can be provided worldwide** as inspections in remote areas or more distant locations can be provided at a reasonable cost.
- Increasing digitization and reducing the human factor in inspections **would reduce errors.**
- **Continuously collected and analyzed device data would** also support the inspector in the manual parts of testing and inspection.

Kiwa vision

Kiwa vision

Kiwa will be an international forerunner in remote testing, inspections, evaluations and equipment monitoring offered in industrial metaverses. Inspections will move from point-in-time inspections to real time monitored inspection data and thus increase safety.

Project goals

Consortium partners research workable solutions for remote testing, inspections, auditing and continuous monitoring.

Research pilots

Crane: Virtual Reality Enhanced Remote Inspection

- **Participants**
  - Aalto, Konecranes, Kiwa
- **Pilot**
  - In VR environment, the remote inspector can interact with the crane to check the kinematic features.
  - Additionally, the operational data of the crane, video and audio streaming data, accelerator sensors can be perceived in the field level for the remote inspector to check.
- **Technologies**
  - Virtual reality, remotely controlled device, IoT data transmission, video transmission.

Image: Aalto

Crane: Robot Enhanced Inspection

- **Participants**
  - Aalto, Konecranes, Kiwa
- **Pilot**
  - During a production stop, the scheduler assigns tasks to the mobile robot and the crane for hook checking. The mobile robot arrives at the target position to take pictures and videos of the hook, through computer vision, the quality of hook can be evaluated and inspected.
- **Technologies**
  - Robot navigation, autonomous robot control, computer vision, model-based system engineering.

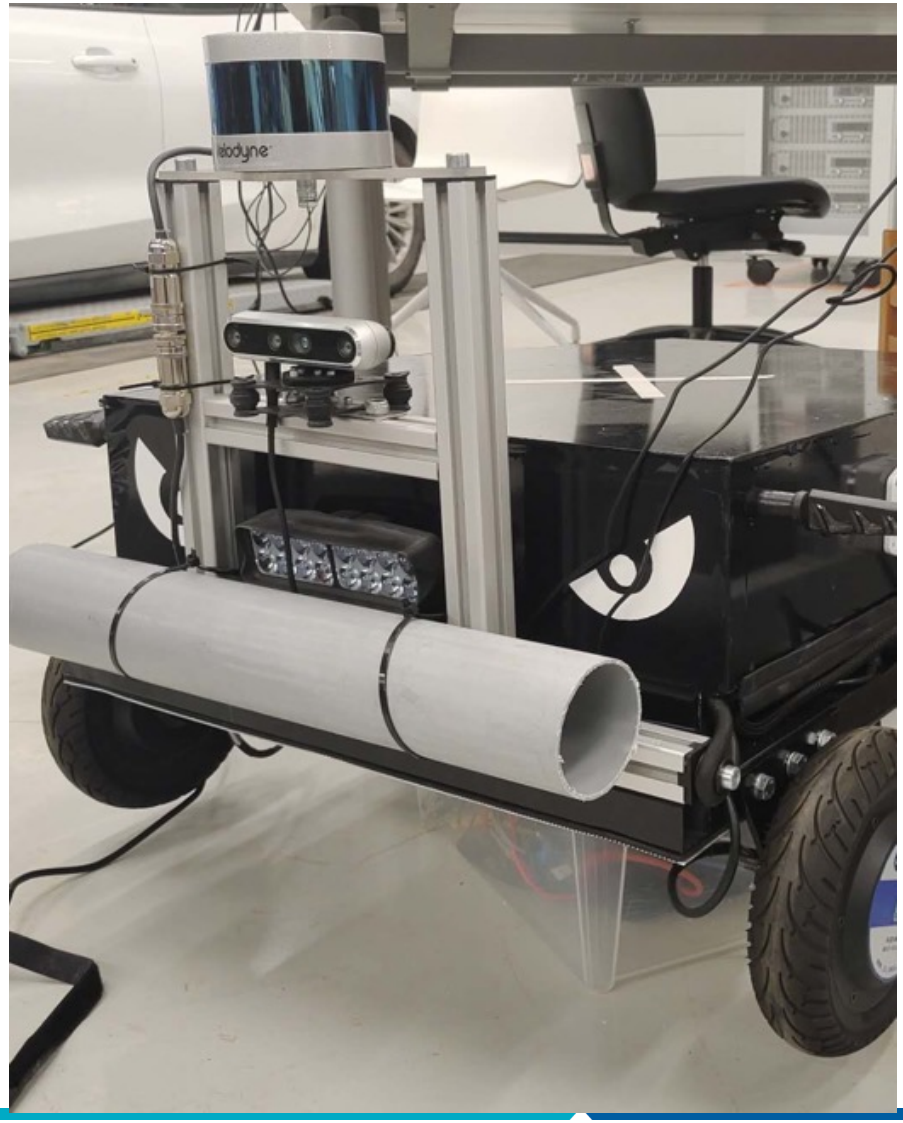


Image: Aalto

Elevator: Technology and Remote Collaboration Powered Inspections

- **Participants**
  - Aalto, Kone, Kiwa
- **Pilot**
  - Research what phases of elevator inspection processes could be done with the assistance of metaverse technology and remote collaboration with maintenance.
- **Technologies**
  - Cameras, sensors, lidars, AR/VR wearables, inspection robots, computer vision.

Fire Safety Equipment: AR Enhanced Collaboration With Stakeholders During Inspection

- **Participants**
  - VTT, Kiwa
- **Pilot**
  - During a fire safety inspection, the inspector wears an augmented reality headset to collaborate with colleagues, customer and other stakeholders so remotely connected parties do not need to travel to the site. The collaborators can pinpoint locations and 2D material in the AR environment for the inspector to see.
- **Technology**
  - AR smart glasses and software, live video between participants (WebRTC), remote site annotations using 2D image (ZeroMQ, ProtoBuffers, Datachannel)

Image: Magic Leap 2
www.magicleap.com

Metal structure monitoring – welded steel structure condition monitoring

- **Participants**
  - Turku University of Applied Sciences, Kiwa
- **Pilot**
  - A small drone is set on a customer site with inspection tech (possibly laser scanner or phased ultrasound scanner). A remote inspector operates and teaches the drone and inspects stainless steel bridge welds. After the inspection the drone repeats the inspection time after time for some years and monitors the bridge structures. The data is gathered in a system and AI evaluates possible changes over time.
- **Technology**
  - Drone with steel weld inspection capabilities, AI powered software to operate and teach the drone to inspect streel structures. Data gathering methods and AI analysis software.

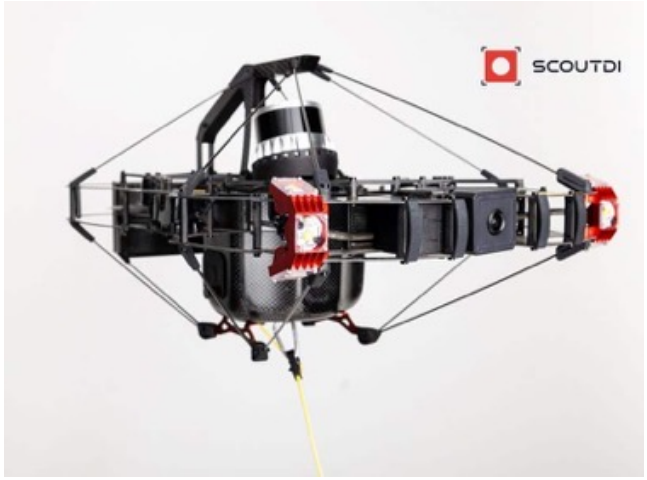


Image: ScoutDI, www.scoutdi.com

Wind turbine walkdown inspections with small drone

- **Participants**
  - Kiwa
- **Pilot**
  - Inspect inside wind turbine with small drone.
  - Faster, safer and better results in walkdown inspections.
  - Inside wind blade – hollow structure and support structure
  - Ladders
  - Elevator wires
  - Hard to reach places
- **Technology**
  - Small video drone with smart glasses.

Image: DJI Avata, www.dji.com

Audits and trainings in virtual space

- **Participants**
  - Kiwa
- **Pilot**
  - Find solution how to do system certification audits and trainings in virtual space. If possible, set up a virtual office for staff.
- **Technology**
  - Microsoft Mesh or similar technology.

Customer participating in inspection remotely

- **Participants**
  - Kiwa, hardware provider, software provider
- **Pilot**
  - Find solution how to visit customer factory remotely.
- **Technology**
  - Wearable camera and suitable software for inspector, such as Realwear

Image: Realwear, www.realwear.com

Thank you, lets connect in LinkedIn!

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Necoverse Project - Aalto

Industrial metaverse for human-centric industry processes

Aalto-yliopisto
Aalto-universitetet
Aalto University

Presenter: Chao Yang

11/04/2024

Opportunity, challenge, objective

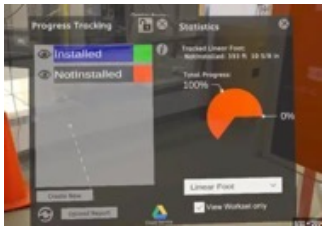
Why?

Facing **mass customization and personalization** production, the industrial processes become more complicated and dynamic. Particularly for **human-centric industrial operations**, like **inspection, maintenance, complex assembly, diagnostic, and logistics**. We need provide more in-time and comprehensive information to operators for correct **decision-making**.

What?

The industrial metaverse combines physical-digital fusion and human augmentation for industrial applications, and contains **digital representations of physical industrial environments**, systems, assets and spaces that people can control, communicate and interact with.
(From Nokia.com)

Industrial metaverse = Digital Twin + Extended Reality + Human involvement/interactivity

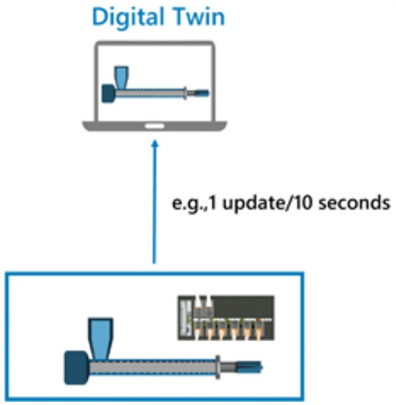




Opportunity, challenge, objective

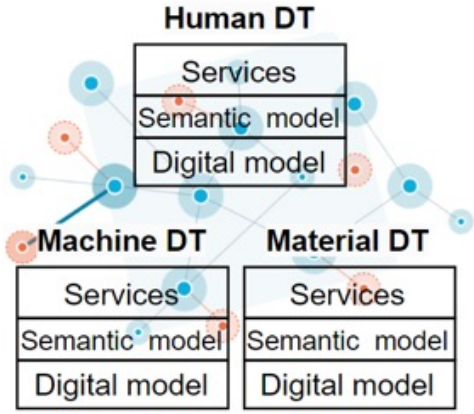
Traditional DT

- Case-by-case twins
- Internal data models
- Focus on individual machine behaviors
- Machine-readable data
- Runs locally



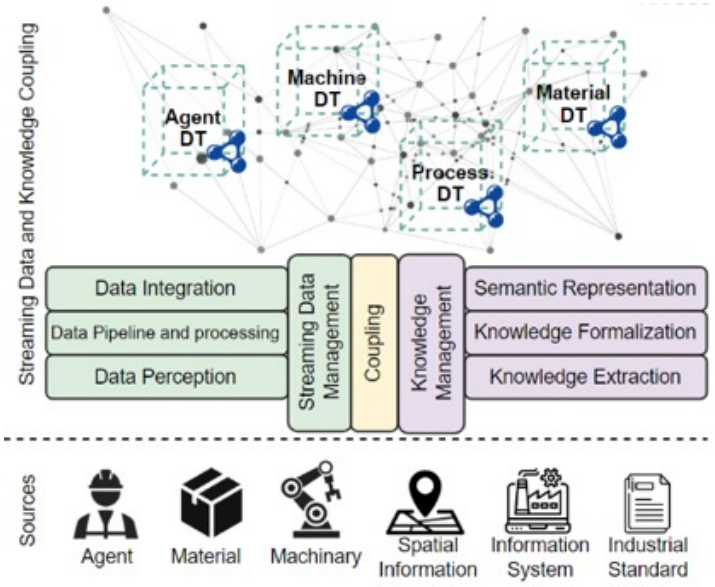
Future Industrial Metaverse

- Twins as infrastructure
- Standard data models
- System integration
- Human-in-the-loop
- Digitalized service



Solution – Knowledge and streaming data integration

The integration of knowledge model and streaming data
to interconnect individual DTs



Information retrieval for the industrial processes

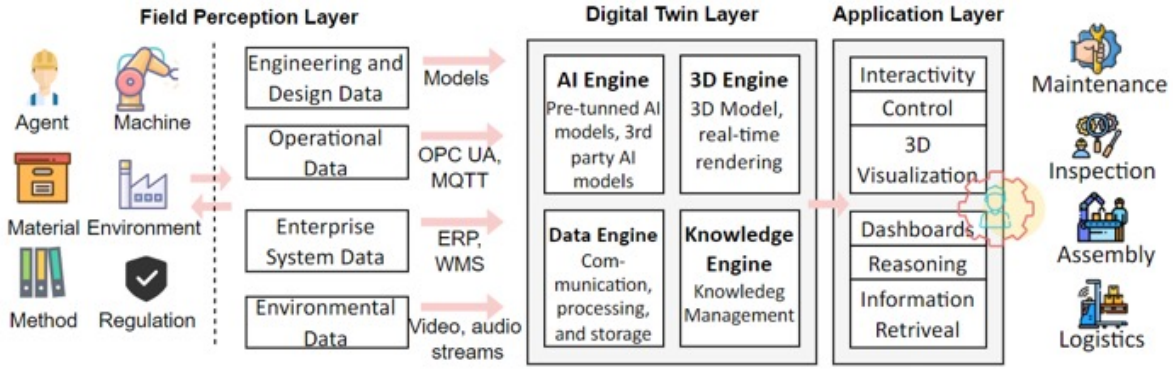
Questions	Results
1) What's the machine's ID and its position for task "T101-1"?	"AGV112", "100, 80"
2) What's the material's ID and height by task "T101-2?	"M11-1", "70cm"
3) What's the machine's ID of "T101-2" and its hook's height?	"Crane100", "80cm"

Streaming data

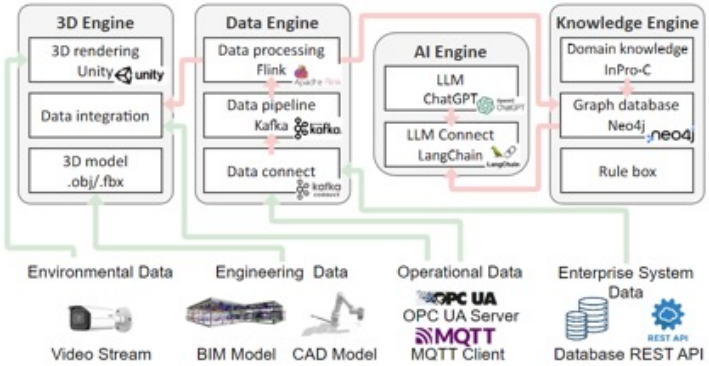
Specification data

Solution – Architecture design

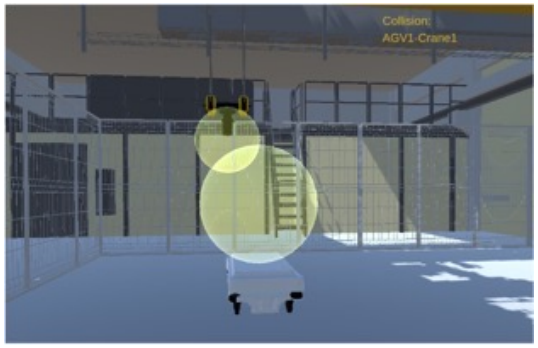
Industrial Metaverse Conceptual Architecture



System Implementation



Collision Detection



Natural language-based information retrieval

#Instance 1
Query: 'Which machine required for T001? Is that machine working?'
Generated Cypher: MATCH (ot:OperationalTask {name: 'T001'})
-[:hasMachine]→(machine:Machine)
OPTIONAL MATCH (machine)-[:hasStatus]→(status:Status)
RETURN machine.name AS Machine, status.value AS Status
Full Context: {'Machine': 'M001', 'Status': 'Working'}
Result: 'The machine required for T001 is M001 and yes,
it is currently working.'

Testbed for Proof Of Concept

Aalto Industrial Internet Campus

Aalto University Industrial Internet Campus (AIIC) is a platform for students, researchers, and companies to innovate and co-create smart, connected products and services. Industrial Internet Campus enables multidisciplinary research, education and innovation together with industrial partners. We welcome companies from start-ups to global leaders to co-innovate with us. We offer experimentation facilities in industrial internet, IoT and AI.

- Point cloud data and BIM model
- Research-based Elevator from KONE
- Overhead crane from Konecranes (with OPC UA, Restful, MQTT communication)
- Robot kits (TurtleBot, DBot)
- Virtual Environment (ROS Gazebo, Unity)
- Indoor Positioning system
- 5G network

Thanks for your attention.
Questions/Comments/Wishes...?

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