Human-Driven Industrial Metaverse

VTT initiative on Finnish industrial action

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Agenda

1. Future of industrial work and the Human-Driven Industrial Metaverse

2. Project portfolio and examples

3. Example project preparation: Common Cockpit for remote operation of autonomous fleets

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Future of industrial work and Human-Driven Industrial Metaverse

Aging population, lack of appeal among youth
- we are running out of labor in REAL work

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Road transport & broader mobile work machines

Bus and coach drivers' shortage grew 54% in 2023, IRU calculates. 80% of operators face difficulties filling positions

Europe's bus and coach driver shortage widens 54%, according to IRU. 105,000 driver positions are missing, 10 percent of the total professional driver population. Over 80% of bus and coach operating companies face severe difficulties to fill driver positions. And driver shortages are forecast to more than double in five years, reaching 275,000. The above-mentioned [...]

Seafarer Labor Shortage Reaches 17-Year High Reports Drewry
Maritime

Aviation

A shortage of qualified staff could put aviation safety under pressure this summer, warns the European Union's Aviation Safety Agency (EASA) in a safety bulletin.

The industry lost many employees during the Covid-19 pandemic. Too few staff were then available to manage the flow of passengers when demand for international air travel increased rapidly last year. Airlines, airports, air traffic controllers and maintenance companies are still struggling to find enough qualified staff this year, notes EASA.

We Can't Find Enough Skilled Workers: Can Automation Fill The Gaps?
Manufacturing and supply chains

By 2030, it's likely than more than 85 million jobs could go unfilled globally because there aren't enough skilled people to take them, according to a recent Korn Ferry analysis. "Signs are already emerging that within two years there won't be enough talent to go around. In countries with low unemployment and booming manufacturing production, a labor shortage has already accelerated automation and increased use of robotics—not to replace people, but because there aren't enough of them to fill the factories."

The iconic American hard hat job that has the highest level of open positions ever recorded
Construction

- The construction industry in America is facing an extreme labor shortage, roughly 650,000 workers, slowing completion of construction projects from residential homes to infrastructure to hospitals.

- The shortage of construction workers has many causes: the pandemic, and shifts in American cultural values and workforce demographics.

- The solution, according to experts, is a balance between immigration policy, greater use of technology, and efforts to raise the profile of construction as a career path.

Disruptions driving opportunities for Industrial Metaverse

- A storm of Artificial Intelligence in different forms is dramatically changing how people will work

- Sustainable Development Goals driving wellbeing, decent work, sustainable cities and climate action

- Gig economy expanding into industrial work - Gen Z and beyond expecting location/time flexibility and variety in their employment. Desire for meaningful work

- Convergence of consumer and professional end user experiences into extended reality headsets, replacing phone screens with affordable & sleek branded form factors
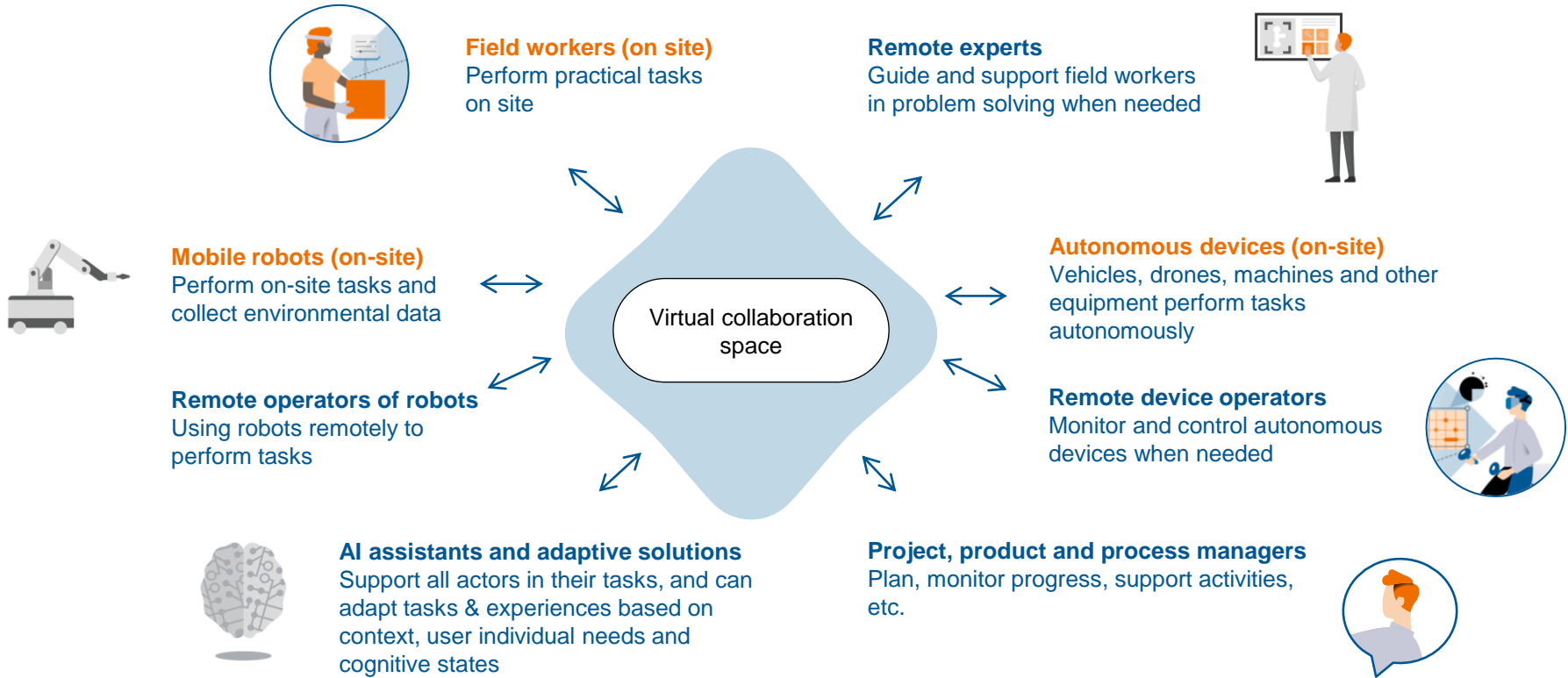
Key statistics on gig workers

86% Eighty-six percent of freelancers think that the best days for freelancers are yet to come

80% Eighty percent of large corporations plan to increase their use of flexible workers in the coming years

# Collaboration in a shared workspace, uniting physical and virtual, digital twin not always mandatory

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Field workers (on site)
Perform practical tasks on site

Remote experts
Guide and support field workers in problem solving when needed

Mobile robots (on-site)
Perform on-site tasks and collect environmental data

Virtual collaboration space

Autonomous devices (on-site)
Vehicles, drones, machines and other equipment perform tasks autonomously

Remote operators of robots
Using robots remotely to perform tasks

Remote device operators
Monitor and control autonomous devices when needed

AI assistants and adaptive solutions
Support all actors in their tasks, and can adapt tasks & experiences based on context, user individual needs and cognitive states

Project, product and process managers
Plan, monitor progress, support activities, etc.

Human driven considerations when working in industrial metaverse - immersiveness and photorealism not always desirable

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Working in virtual environment
- Physical and cognitive ergonomics (e.g., simulator sickness, comfort, mental load)
- Tools and means of manipulation
- Smooth transfer between virtual and physical tasks

Complex systems
- Managing human-technology-AI teams working together in hybrid environments

worker

team

organisation(s)
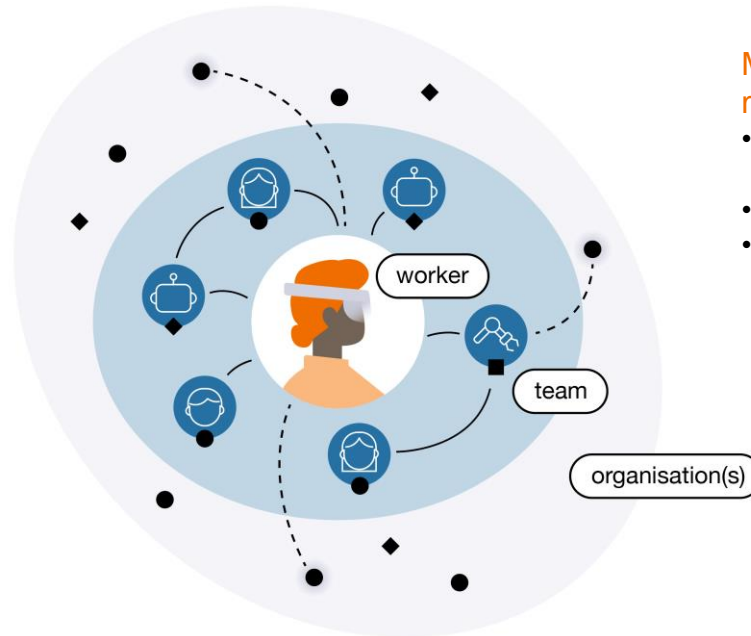
Motivation and feeling of meaningfulness
- Working based on employees' values
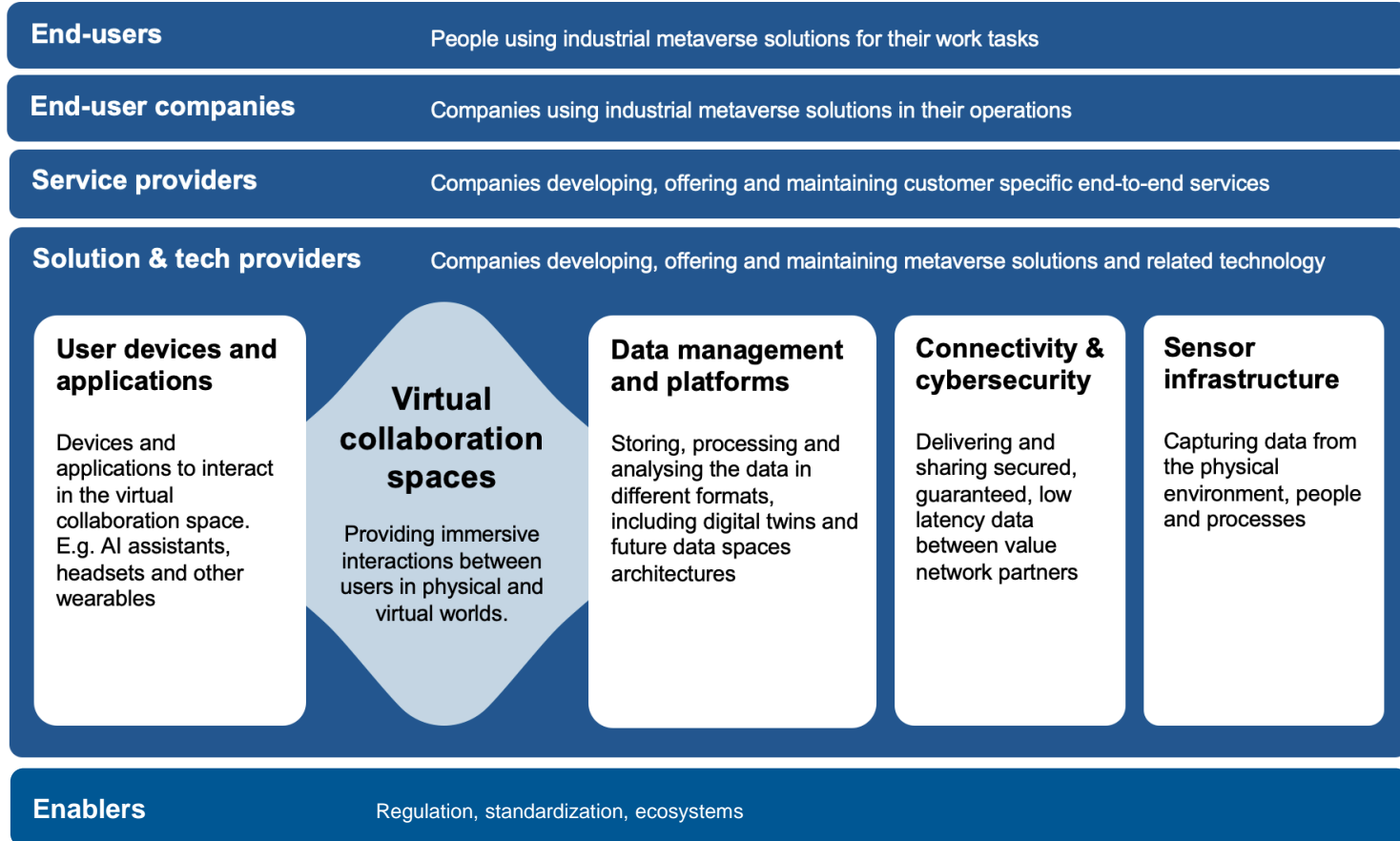- Work-life balance
- Being part of the work community

Safety and ethics
- Safe workways and ensured privacy
- Inclusiveness

▶ Mobile robotics

▶ Emotionally adaptive technologies - artificial emotional intelligence
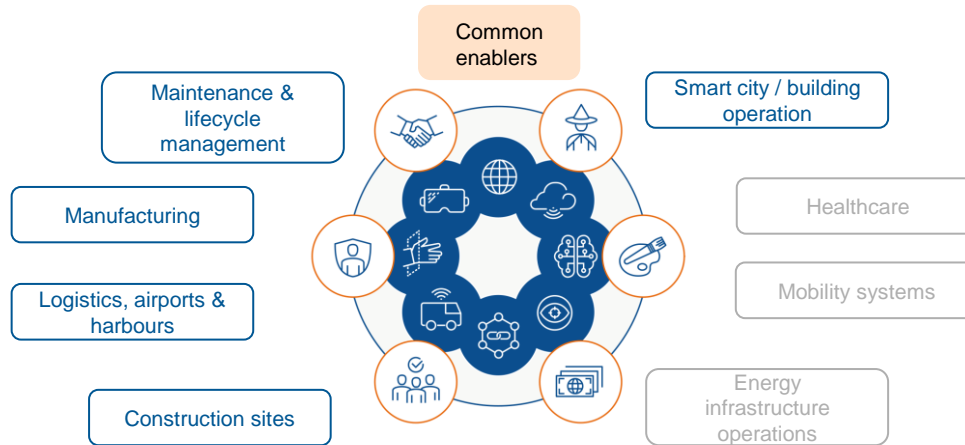
Value network of industrial metaverse

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| End-users | People using industrial metaverse solutions for their work tasks |

| End-user companies | Companies using industrial metaverse solutions in their operations |

| Service providers | Companies developing, offering and maintaining customer specific end-to-end services |

Solution & tech providers — Companies developing, offering and maintaining metaverse solutions and related technology

User devices and applications

Devices and applications to interact in the virtual collaboration space. E.g. AI assistants, headsets and other wearables

Virtual collaboration spaces

Providing immersive interactions between users in physical and virtual worlds.

Data management and platforms

Storing, processing and analysing the data in different formats, including digital twins and future data spaces architectures

Connectivity & cybersecurity

Delivering and sharing secured, guaranteed, low latency data between value network partners

Sensor infrastructure

Capturing data from the physical environment, people and processes

Enablers — Regulation, standardization, ecosystems

Vision for Finland, 203X

- Appealing and productive careers in location independent industrial work in all human-centric verticals from manufacturing, maintenance, construction to logistics and mobility systems

- Living Lab, leading Europe as the best place for R&D in metaverse solutions

- Attract people to work for Finnish companies either globally or moving to Finland to enjoy the metaverse, merger of physical and virtual worlds where life and work converge

Project portfolio and examples

# Humiverse project 2022-2023 for cross industry opportunity identification

Autonomous creation of immersive 3D spaces with multi-user interaction

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Telia

Autonomous 5G mobile robot - enabled autonomous scanning. Keeping the digital always up-to-date and avoiding tedious and time-consuming manual scanning work.

Visualization of the factory, multimodal data and immersive multi-user environment can be used e.g. for product design, manufacturing cell and processes planning, and trainings.
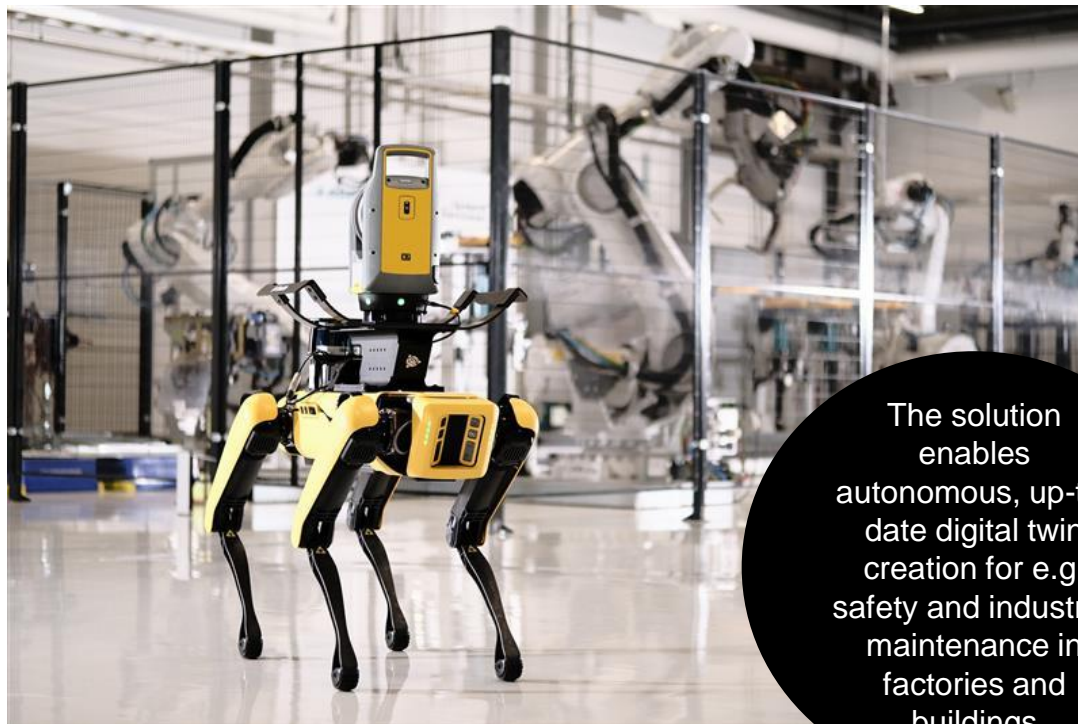
The solution enables autonomous, up-to-date digital twin creation for e.g. safety and industrial maintenance in factories and buildings

Industrial metaverse through the eyes of a robot (youtube.com)

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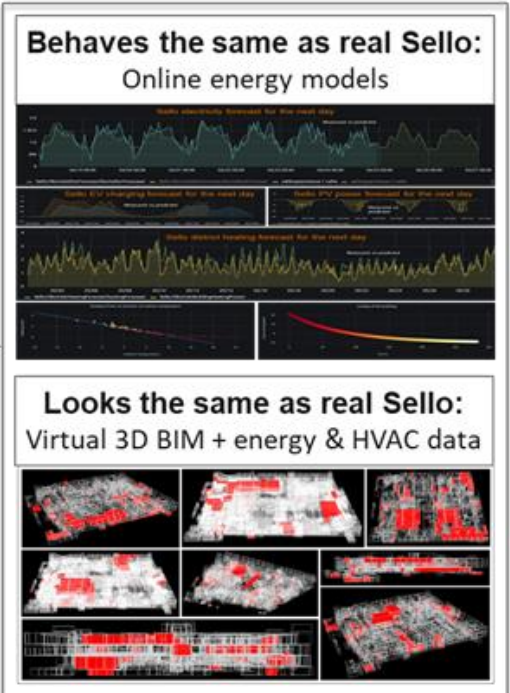# Self-learning real-time operative digital twin of a building

Digital Twin of a real asset (e.g. a building) behaves and looks the same way as a real one. This is enabled by using AI,
online simulators, smart algorithms, big data and 3D BIM models.

Not a shadow of real asset but a real operative digital twins can be used for e.g. energy optimizing, HVAC fault detection and predictive maintenance.

Real building:
Sello shopping center

3D BIM model
Energy & HVAC measurements
Background picture source Siemens

Online

Virtual Twin: case energy

Behaves the same as real Sello:
Online energy models

Looks the same as real Sello:
Virtual 3D BIM + energy & HVAC data

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eXtended Reality prototype for the remote operation concept of a reach stacker

Kalmar

KALMAR plans to enhance its current reach stackers by adding remote operation capabilities. The remote operation system has been meticulously designed and evaluated in a virtual harbour metaverse. Users have been able to thoroughly test the system and provide valuable feedback before its actual implementation.

The XR-enhanced remote operation concept is set to be implemented in 2025, promising advancements in efficiency and functionality.

https://youtu.be/Xu8Qz2fv47A?si=HAL7KQGJkHR8L8BL

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Sharing real-time 3D data for better situational awareness and seamless collaboration between teams

Target
Enhancing collaboration of design and construction teams

Solution
Sharing BIM design and related data in real time between stakeholders. Team communication in virtual 3D environments

Benefits
Transparency of design process reduces unneeded work and enables better end results

Real-Time-Collaboration

Technologies: Cloud-based Shared BIM Objects & data, Collaborative Demand-driven Sharing, Collaborative Communication, Built Environment Metaverse

Business Finland project partners: VTT, Tampere University, Trimble, AFRY, Gravicon, Senate Properties
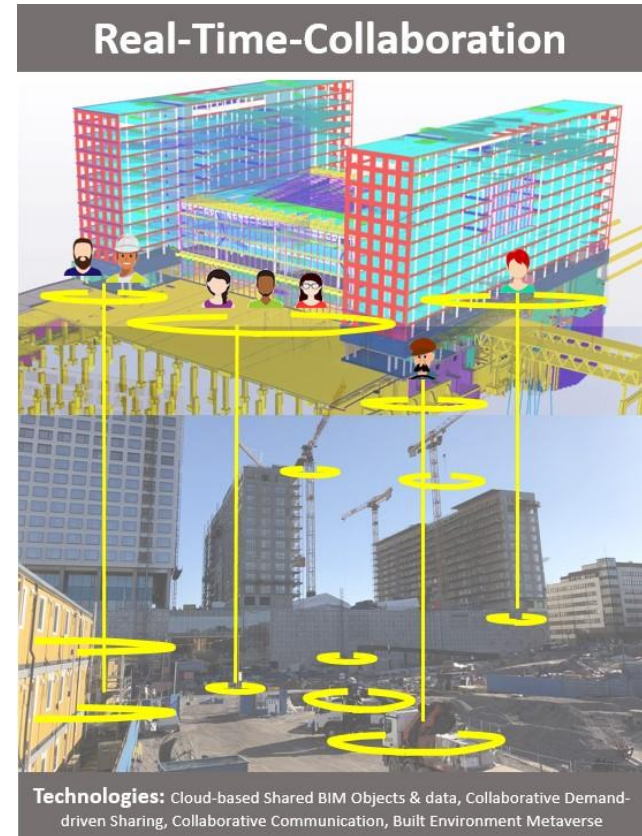
Contact: Markku Kiviniemi, VTT

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Participative and immersive planning of intensive care and monitoring unit (EVICURES)

Research questions
Used Evidence Based Design (EBD) + Virtual Reality (VR) + end users to real plan and construction process. Project carried out 2014-2016.

Methods
VR used Widely for mixed user groups.
Questionnaire offered 106 statements on nine different topics, including entrances and courtyards, architecture, indoor conditions, durability, functionality, safety, comfort, accessibility and usability

Results
The EVICURES project developed a new user-friendly design model for intensive and intermediate care facilities. In addition the real ICU was planned and functionally built.

Collaboration
EPSHP, SeAMK, Granlund, Sait Gobain, Ecophon, Jääskeläinen Arkkitehdit

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A user-oriented, evidence-based design project of the first Finnish single room ICU

Results of EVICURES project

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MetaBEE (Tampere) project vision: Shared Reality and Crowdsourcing to enable real life digital twins in the built environment metaverse

WHAT IF…

All people become sensors - **citizens** moving around and **professionals** working in the built environment - in addition to experiencing augmented data on the surroundings, are willing **to share the data captured** with their multi sensored **Shared Reality (SR)** headsets

This **crowdsourced data** is used, along with data captured by fixed/mobile mounted sensors to **update the digital twin of the environment in real time** to make it a **powerful tool for work**. AI will detect anomalies and make real life twin available for professionals for situational awareness, operation and maintenance

Experiencing and interacting with the digital twin with a headset replacing the phone screen
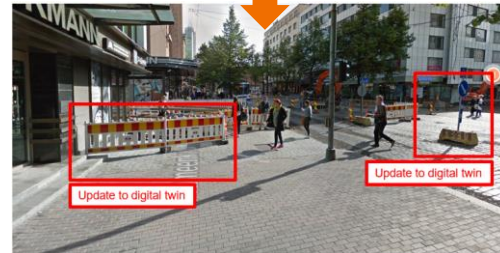
Sharing the reality to update the digital twin, getting paid for it

Value generation: A metaverse service provider maintains the digital twin, offers its content to various stakeholders, collects data from people, offers headsets and service free of charge to consumers as an incentive to enable crowdsourcing

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Future project vision: Employing local labour to reduce expert travel in industrial work

WHAT IF…

Building infra from elevators and HVAC all the way to access control, copy machines and coffee makers can be fixed by **local janitors**;

Factory or construction site audits can be performed locally with basic skills **monitored by the responsible auditor off site**;

Basic maintenance & checks of **remote built infrastructure** (transport, telecom, energy) by local inhabitants, farmers or fishermen;

…using **SR headsets** & immersive workspaces, supported by location independent experts and generative AI based remote assistants.

… with spare parts and tools delivered by **multimodal autonomous supply chains**.

Business potential: Local employment, attractive secondary jobs, rapid response and short downtime, reduced travel/commuting related time and OPEX

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Common Cockpit by VTT

Human Driven Industrial Metaverse for situational awareness and remote operation of autonomous fleets

Business Finland co-innovation project preparation

Vision of a future workflow in remote operation of autonomous fleets

Real-time data is collected from all devices and equipment, and their surroundings using **sensor fusion**. If **a problem** occurs, ...

... **artificial intelligence** suggest actions based on the data. It explains why we are in this situation and what could be possible solutions for solving the problem.

... meanwhile, **situational awareness** is established and shared with humans selected by AI as a virtual team from a **global pool of certified experts, both remote and on-site**.

Each task is assigned to a person who has the necessary skills, sufficient cognitive state, and the needed equipment available, e.g. haptics, XR, software, etc.

Images: Dall-E

203X vision - future value network
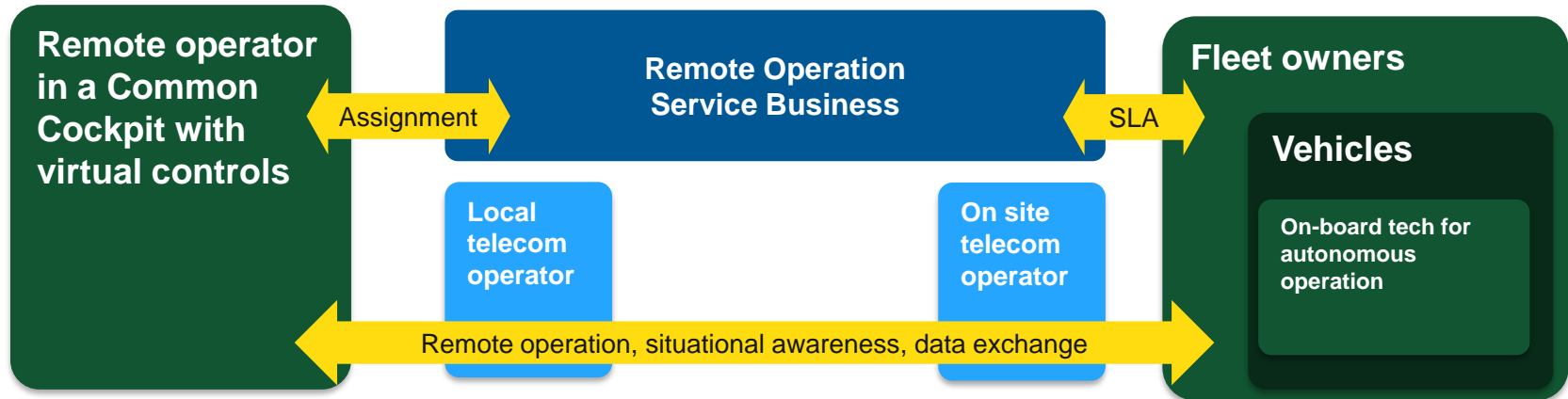
CoCOne project & evolution towards 203X vision
(BF co-innovation under preparation)

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CoCOne project scope

Common concept and pilot for selected domains combining land, sea and air, including:

- **Human-AI situational awareness**

- **Trusted wide area connectivity**

- **Data Spaces sharing architecture & interoperability**

- **Business viability**

Additional domains with higher complexity (land, sea, air, rail)

Dynamic remote team assignment towards Remote Operation as Service Business, CoCo platform as a service

Novel user interface technologies (Shared Reality, virtual controls/haptics, cognitive load based adaptation)

Prescriptive situational awareness

Low latency distributed edge AI and cybersecurity

CoCOne 2025-2026

Future projects 2027 onwards