



Twin Transition for The Timber Industry

2024 Manufacturing Partnership Day

Muhammad Mahtab Alam (TalTech) 07.05.2024

Brussels, Belgium

AGENDA

1. Project Overview
2. Selective Usecases from Wood Value Chain



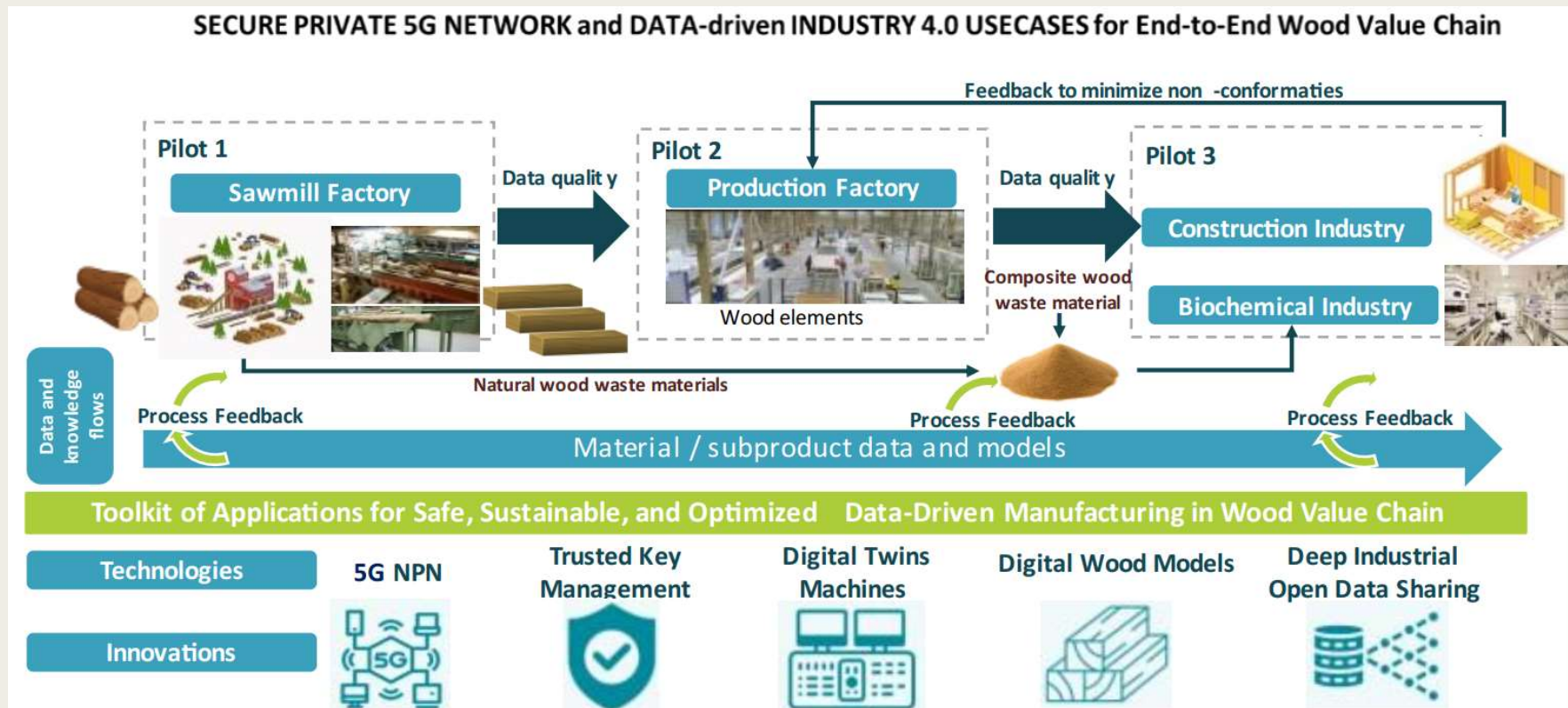
5G-TIMBER Concept in Nutshell

5G-enabled UCs and field trials for different small and medium-sized manufacturing industries

Pilot 1: Small-volume machinery

Pilot 2: hand-assembled elements production

Pilot 3: construction focusing on the wood value chain (WVC)



UC Category 1

Data driven sawmill and woodworking machine setup

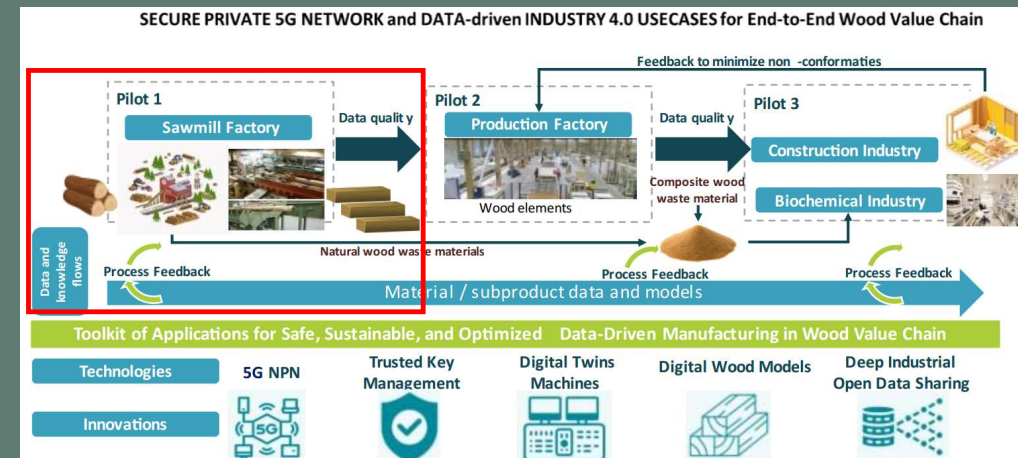


First part of the WVC after forestry: starts from cutting the logs to their processing in sawmills to obtain lumber.

Focus: equipment used in sawmills, the development, modernisation, setup, monitoring, remote operation and maintenance.

UC Category 1 comprises three UCs:

- UC1.1 Data and material models driven lumber production and handling;
- UC1.2 DTs assisted assembly, remote operation and servicing for woodworking machinery;
- UC1.3 Data and Artificial Intelligence (AI) driven industrial machines' fault prediction and design support.



Usecase Overview

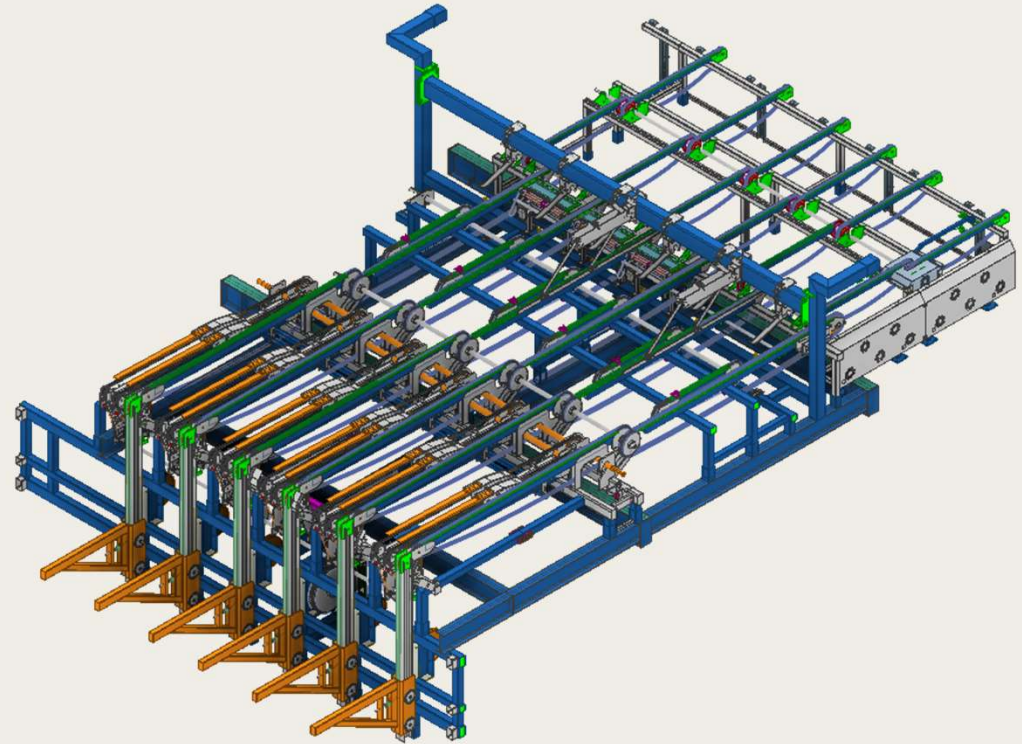
DTs assisted assembly, remote operation and servicing of woodworking machinery

The objective of UC1.2 is to support the operation and control of the timber packing machine, leveraging a Digital Twin (DT) of the machine and Machine Learning (ML) models to process data acquired in the operating environment.

A digital twin of the machine is being developed to:

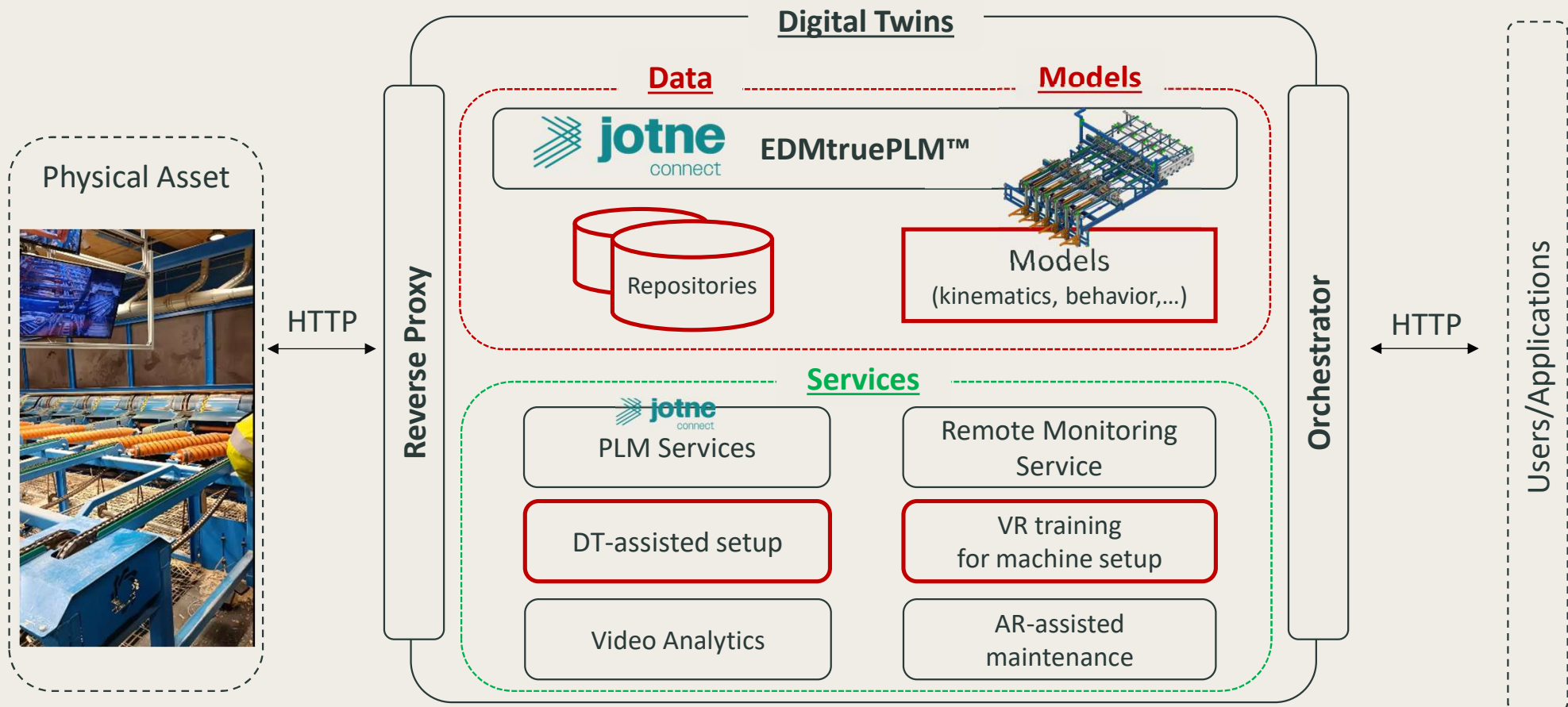
1. support for the setup/maintenance of the machine
2. monitor the machine and support the detection of blockages (remote operation)
3. train the operators to solve jams and common issues on the machine

The DT will integrate the ML models, algorithms and it'll support VR/AR visualization. The data sharing will rely on ISO 10303 and enabled by the PLM tools.



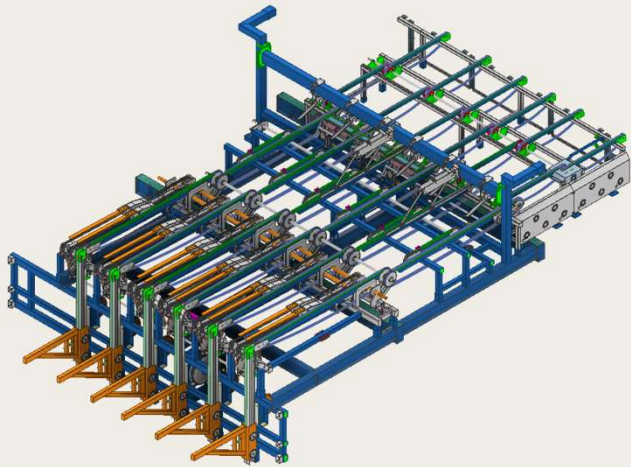
The packing machine is an automatic machine that collects, moves, and packs sawn timbers. It is designed, manufactured and assembled by Hekotek and delivered to the customers that will operate it.

Digital Twin: Architecture



Digital Twin: Models

3D Geometrical Models



Geometric data and product breakdown structure

(Based on information and material provided by Hekotek)

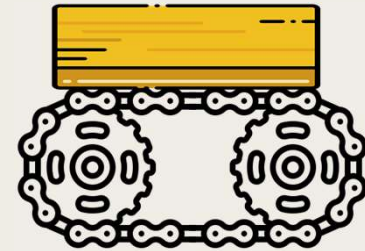
Kinematic Model



Models the behavior of the machine (actuators, chains, etc.)

(Based on the information and material provided by Hekotek and the data collected by Octavic to get a real-time update of the model)

Dynamic Model



Captures the interactions between the machine component and the sawn timber

UC Category 2

Modular Wood-house Factory

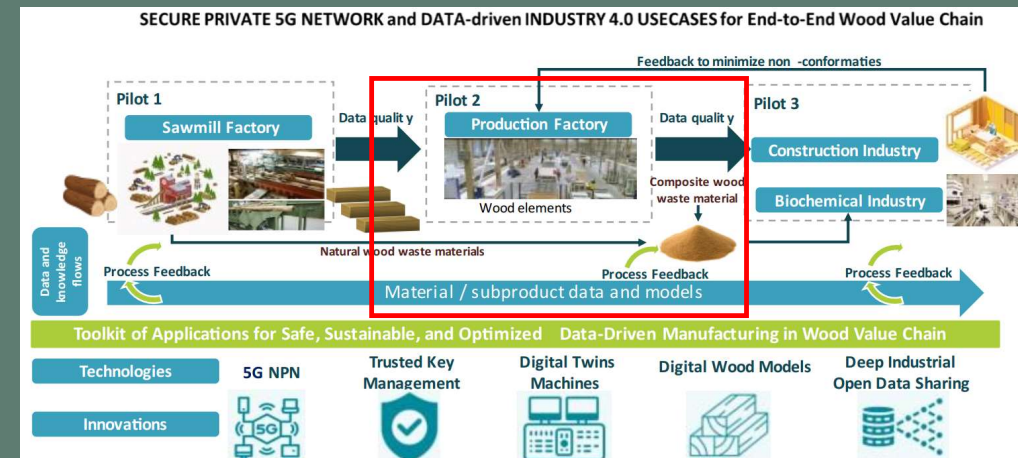


Focus on the manufacturing process of the wooden house module: from when the lumbers arrive at the woodhouse factory to when the modules leave the factory for the construction site.

Addresses deploying a 5G private network within a production environment and how it can support integrating different applications and tools.

UC Category 2 comprises three UCs:

- UC2.1 Precise localization for production processes optimization and human safety
- UC2.2 DT, AR and Industry 5.0 UX assisted production supported by ZSM 5G data exchange
- UC2.3 Data driven design to production cycle optimization



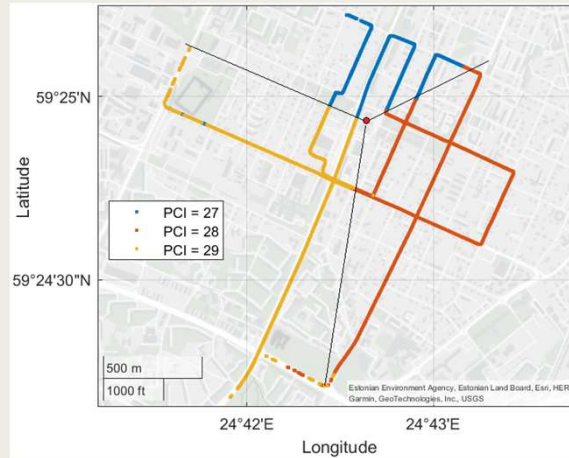
Usecase Overview

- **Goal:** Demonstrate benefits of microwave 5G NPN and sensor fusion based precise localization methods for indoor logistics and human safety.
- **Description:** UC2.1 focus on 5G (ToF + AoD + imaging) based localization testing to optimize material and human movement trajectories: increase production efficiency and improve safety, in GDPR compliant way.
- **Key Challenges:** Implementation of 5G localization infrastructures based on recent 3GPP releases, algorithmic complexity for indoor localization.
- **WVC relevance:** Broad manufacturing relevance.
- **Expected Benefits:** Wooden elements assembly work efficiency improvement by 10%, improved safety of workers during 2D to 3D assembly processes. Forklifts operational efficiency improvement of 20% in pilot.
- **Roles of participants:** Athonet and Accelleran – 5G infrastructure (RAN, core) preparation. THA AIS – 5G module, Tallinn University of Technology – positioning software implementation, on-site installation support. Harmet – pilot site owner. [POLIMI, TIETOFI – video-based positioning](#).

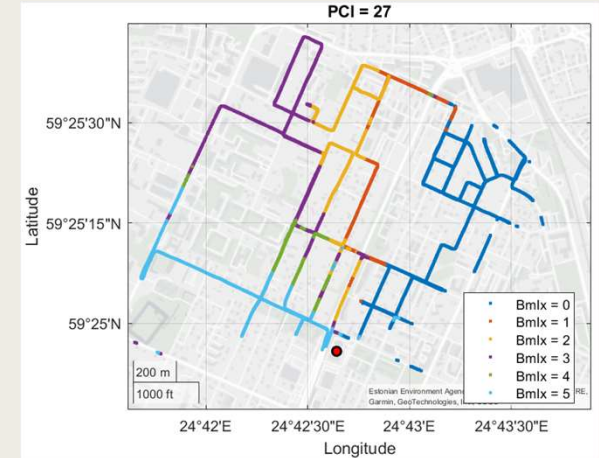
5G-based DL-AoD positioning



R&S TSME6 5G scanner for beam measurements.



Sectors of single gNB



Beams in single sector

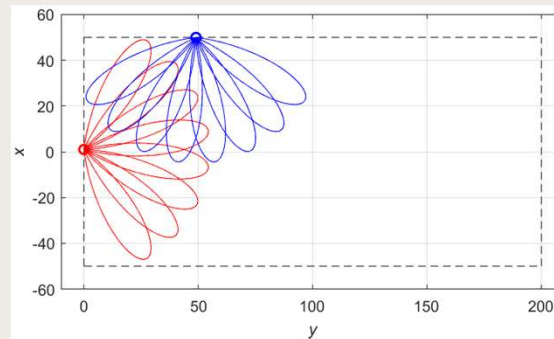
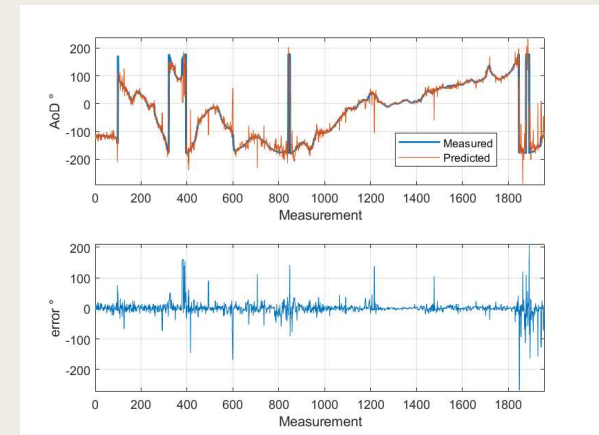
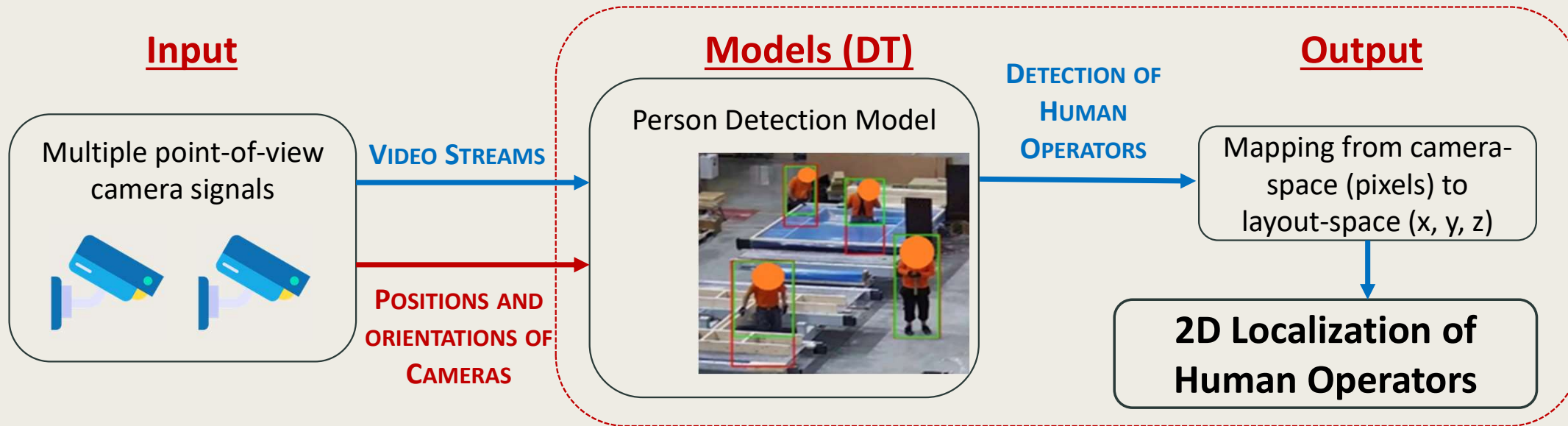


Illustration of beams orientation for indoor positioning.



AoD estimation with ML 10

Vision-based Localisation



The objective is **to assess the position of human operators on the shop floor (xy coords)**.

The following assumptions apply:

- cameras are installed, providing a view of the movements and activities of the human operators; the position and orientation of the cameras on the shop floor are known.
- the characteristics of the cameras are available (parameters of the lens, etc.).
- it is hypothesised that the human operators to be localised are just walking on the floor (not flying, jumping on different levels, etc.)

UC Category 3

Construction and renovation with wooden elements, valorisation of composite waste



Addresses aspects of the lifecycle of wooden elements:

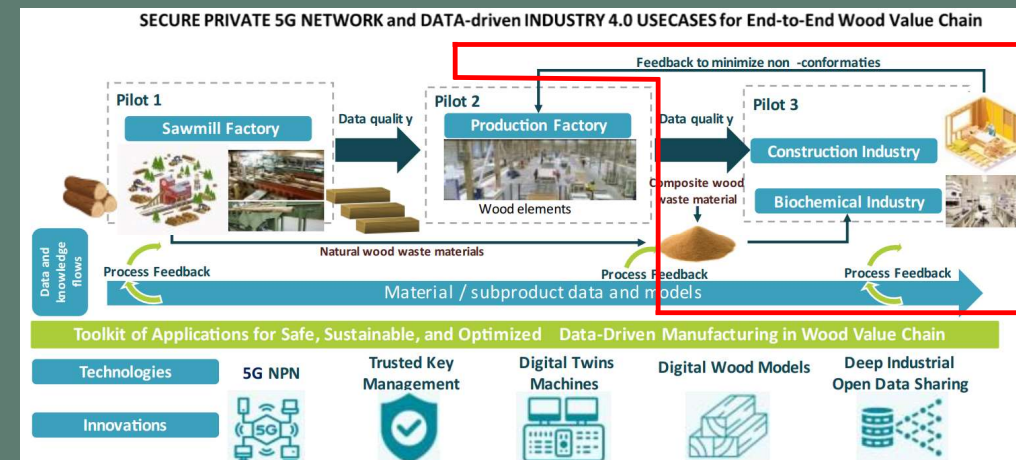
Construction phase: from when the wooden houses leave the factory to when the building modules are assembled at the on-site location.

Use phase: use of 5G IoT devices, tools and methodologies for monitoring and maintenance of wooden houses.

Analysis of alternative wooden composite materials for the wooden house: aim to improve waste recycling the production process.

UC Category 3 comprises three UCs:

- UC3.1 AR and Industry 5.0 UX assisted assembly and renovation of green buildings
- UC3.2 Long term SHM of wooden constructions using IoT and embedded AI
- UC3.3 Wooden composites waste recycling



Usecase Overview

- **Goal:** Validation of 5G IoT SHM data acquisition solutions for long preservation and reuse of wooden elements..
- **Description:** Long term carbon conservation into wooden construction elements requires their reuse. **Reuse is enabled by elements condition monitoring** over their life cycle (factory, on-site installation). Pilots the use of energy efficient 5G-NB based IoT with edge & AI capabilities to trace **how modules** are **transported, assembled, and used over time** to assess how the module parts can be further renovated or reused as parts for new houses. Data used also for further design improvements.
- **Key Challenges:** Enable and validate the feasibility of reuse of wooden construction elements targeting temporary house UCs



Others

Vibrations acceleration during transportation and assembly - commissioning and implementation integrity

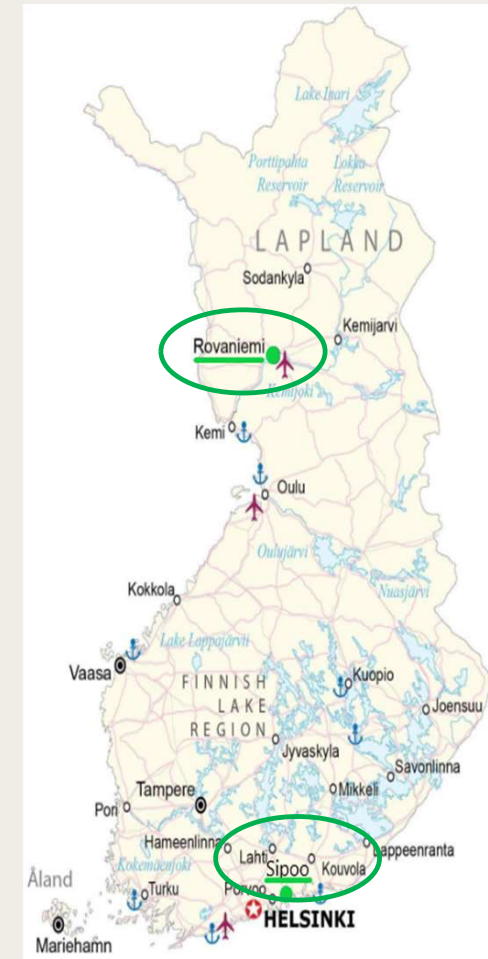
Loading during use of elements

Acceptable vibration levels on houses – Human perception (1-80 Hz)

Acoustic emission for cracks identification

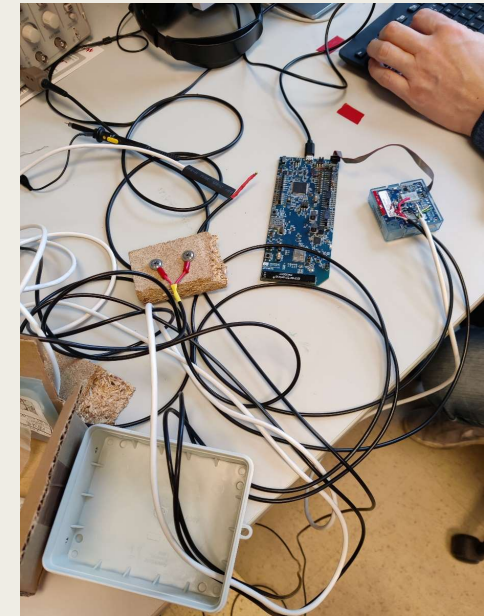
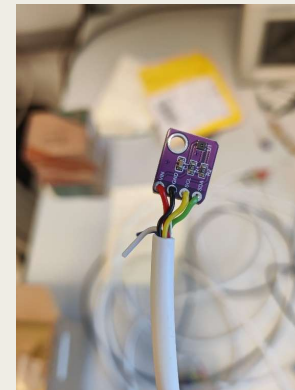
Cellular IoT device for SHM DAQ and communication

- Currently sensors installed into 2 test houses in Finland (Rovaniemi and Sipoo)
- Both modular buildings are of same type, buildings owned by company Adapteo AB
- Sensors to Rovaniemi installed IV qtr 2022, sensors to Sipoo I qtr 2023 – Sipoo is a follow-up to Rovaniemi

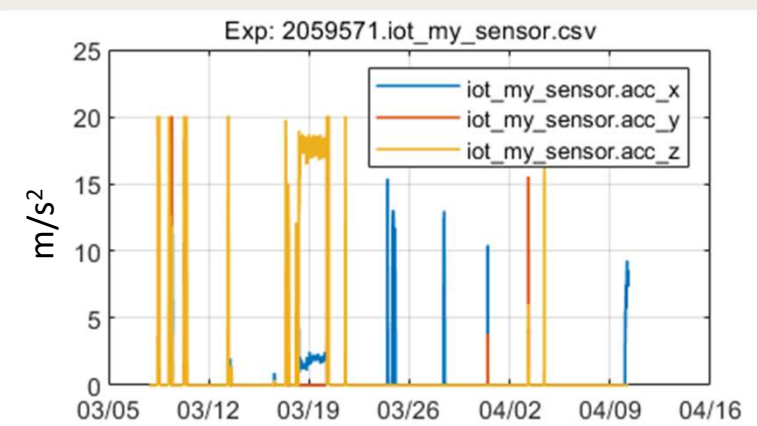
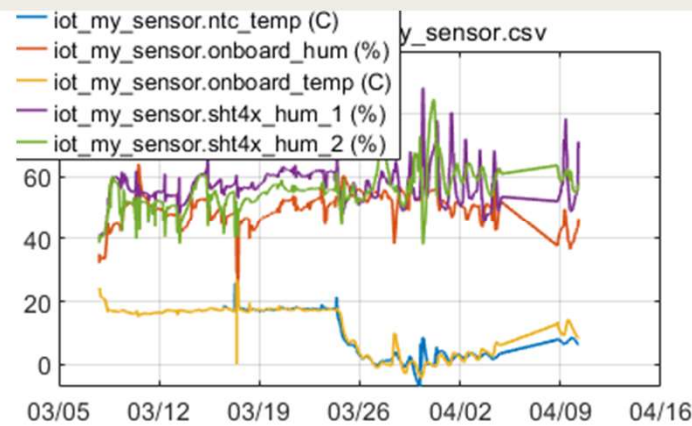
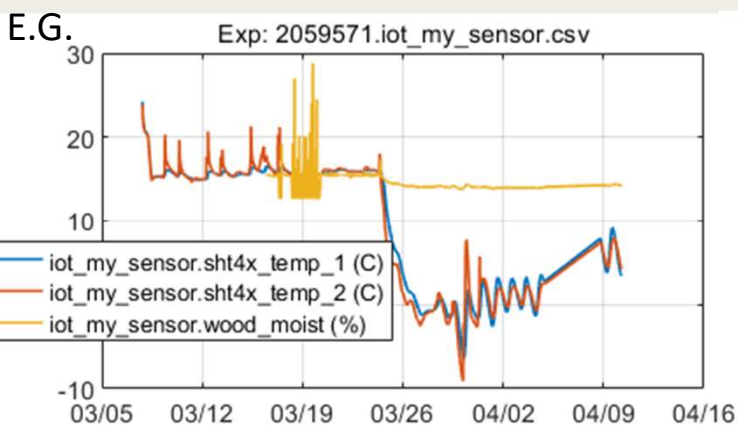


UC3.2 Cellular IoT device for SHM DAQ and communication

- Cellular IoT sensor device prototype development for long term SHM of modular houses: during manufacturing, transportation (avg current consumption 20uA) and 25+ years of operation
 - Environmental conditions (temp + RH)
 - Material moisture (air humidity + conductivity)
 - Mechanical impacts
- Currently regular cell connectivity --> to be supporting 5G DECT NR



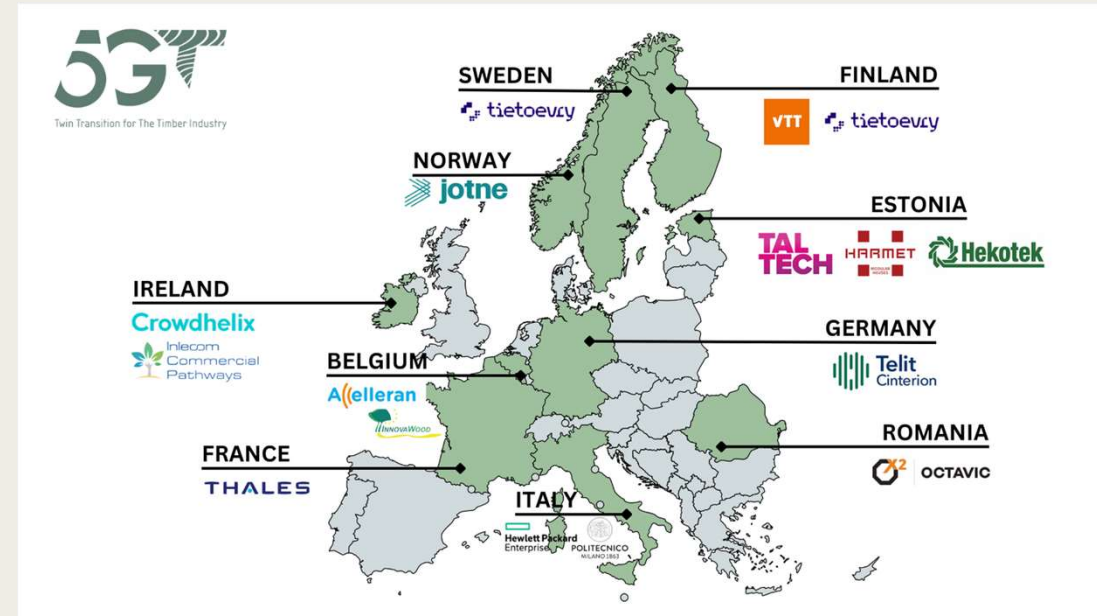
15



Horizon Europe “5G-TIMBER: Secure 5G-Enabled Twin Transition for Europe's TIMBER Industry Sector”



5G-TIMBER



- Successful technical and mid-term reviews
- All Deliverables submitted are approved to date 😊

Thank you for listening!

See you at our Project Exhibition
Stand 25 😊