

# Digital twin for freight handling in intermodal chain

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Achim Klukas, 19.10.2022

# The Fraunhofer-Gesellschaft and Fraunhofer IML

Sales figures and number of employees 2021

**30.000**  
employees

**76 institutes**  
and research  
institutions

**2,9 billion**  
research volume



**Fraunhofer IML, Dortmund**

**380**  
employees

**30.1 million**  
turnover, 42% of which from  
industry and commerce

# Fraunhofer IML

## Department of Transportation Logistics

### Fields of Work

Transportation Logistics is an independent body for projects and the creation of innovative logistic concepts. Our target is to strengthen our clients' competitiveness in the long-term and prepare them for the challenges that lie ahead. We assist our clients in the areas of transport, traffic and logistics with great commitment and an experienced team.

### Facts and Figures 2021

- Founded 1989
- 29 employees plus students and trainees
- Computer Science, Industrial Engineering, Logistics, Spatial Planning, Mechanical Engineering, Business Administration and Mathematics
- Annual turnover > 2,5 Mio. € with > 40% by industry
- International activities in Europe, USA, China and India



# Fraunhofer IML

Department of Transportation – Our topics



**Multimodal  
Logistics**

**Electromobility and  
urban logistics**

**Logistics Network  
Design**

**Telematics and  
information management**

# Definitions

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A digital twin is a virtual representation of a real-world physical system or product (a physical twin) that serves as the indistinguishable digital counterpart of it for practical purposes, such as system simulation, integration, testing, monitoring, and maintenance

(Wikipedia)

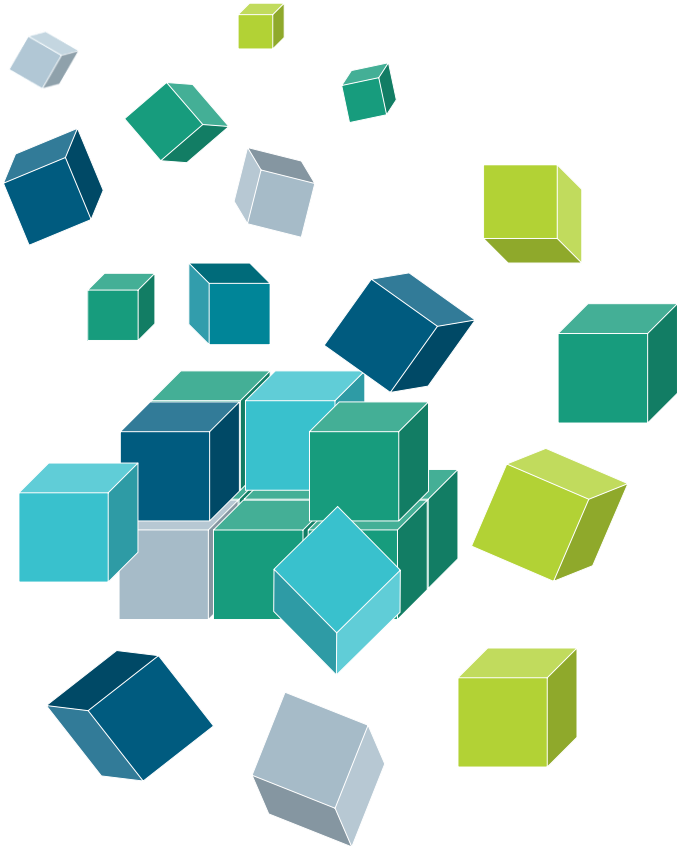
The term "digital twin" refers to a concept used to model products as well as machines and their components using digital tools, including all geometry, kinematics and logic data.

(Fraunhofer IOSB)

A digital twin is a virtual model of a process, a product or a service, for the creation of which real-time data obtained with sensors is processed by artificial intelligence and software analysis in the Internet of Things (Industry 4.0).

(twi-global)

# Maturity level of digital twins



**01** Level 1 (representative): There is no communication between physical object and virtual representation

**02** Level 2 (Simulator): Communication is unidirectional (from physical object to virtual representation)

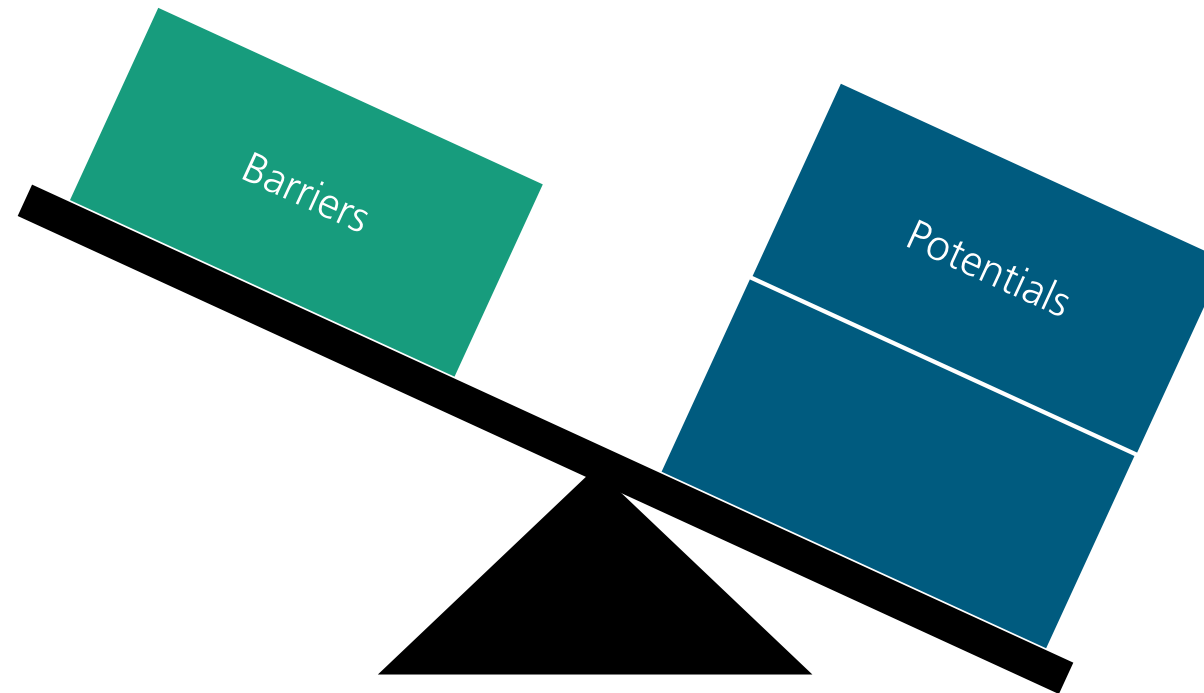
**03** Level 3 (Monitor): Communication is for monitoring the physical object and is from the object to the virtual representation, visualization is primarily sensor data

**04** Level 4 (Smart Monitor): Represents an extension of the third stage and involves linking received data and enriching it to gain and visualize insights

**05** Level 5 (Digital Twin): Here, there is additional communication from the virtual representation to the physical object. Thus, an interaction with the virtual model has a direct effect on the physical object

# Barriers and potentials

- Unclear ecosystem and lack of understanding of the system
- Data availability and data sovereignty
- Security



- Resource optimization
- Cost reduction in the transport as well for test beds
- Reducing downtimes and less waiting times
- Identification of optimization potentials

# Typical actual application areas of the digital Twin

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- Typical areas of application include production and logistics planning or product/plant development
- Digital Twin can be used to shorten the development/introduction period for products and processes, as restructuring or new designs can be tested in the digital environment
- Monitoring of processes using real-time data enables early identification of machine downtimes so that preventive maintenance measures can be carried out
- In the long term the combination of transparent information with simulation/analysis tools makes the digital twin a promising instrument for tapping new potential and thus an immediate growth driver



# Rail Transport

## Digital Twin of trains

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- The digital twin of trains is the key to more reliable vehicles and more capacity on the rails
  - With digital twins, it will be possible to send trains to the maintenance when it becomes necessary (less disruptions)
  - The data obtained from these systems could be used by artificial intelligence to simulate the vehicle's functions (also its physical behavior)
- ➔ Rail traffic becomes more punctual and more attractive; this supports the climate-friendly mobility transition



Image Source: Â©littlewolf1989@adobe.stock

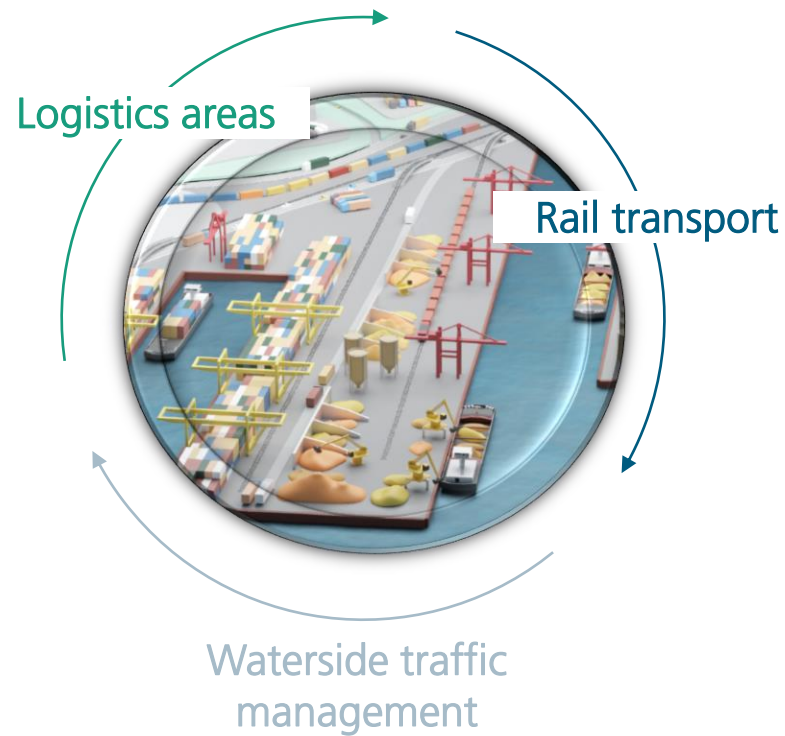
# Inland Ports

Example from the TOLKIEN project



## Logistics area

- Digital recording of a logistics area and monitoring of emissions
- Optimization of handlings in Combined Transport Terminals



## Rail Transport

- Digital traffic recording of the port railroad transport
- AI based optimization of the shunting processes



## Waterside traffic Management

- Optimisation of the handling schedules based on ETA and resource capacities
- Information processing and transmission

# Inland Waterway Transport

## Example from the CRISTAL project



### ITALY

- Simulation the impact of extreme events on goods transportation along Po River
- Evaluate the possibility to modal shift from road in Po River region.
- Develop Decision Support System to enhance the overall management of Po River IWW

### POLAND

- Simulate the transport chains in the inland waterway network under permanent bad navigation conditions
- Process the data generated by new IoT technology in real environment based on own buoys system

### FRANCE

- Water level simulation
- Establish predictive models that support help decision-making
- Tools for predictive infrastructure maintenance

# Intermodal Transport Chain

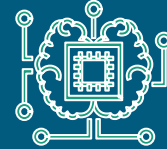
Example from the MultiRELOAD project

Aim of the project



MultiRELOAD will work towards realizing the Physical Internet along two major European TEN-T corridors by demonstrating innovative multimodal freight solutions & services

Description of the "Digital Twin" business scenario



- Transparency and visibility of port services to all the freight transport nodes within a corridor
- Integrates functionalities like real time track & trace of the transport as well as ETA for multimodal transport
- AI based smart scheduling and routing on expected arrivals times to nodes/terminals
- Connecting stakeholders along the transport chain

Main Benefit



- Enhanced operational efficiency and reduced operational costs in the long run
- Better Integration of inland ports into supply chain
- Increased resilience through real-time data and information exchange between freight transport nodes



**The digital twin offers an alternative to previous conventional solutions, in that the seamless connection between the real and digital worlds enables an increase in flexibility and efficiency across different areas of the transport chain**

# Contact

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