



Fraunhofer Institute for Material
Flow and Logistics IML



Technical University Dresden 2023

Towards a digital continuum

IMHRC Research Colloquium 2023 · Michael ten Hompel

Fraunhofer IML · TU Dortmund · Lamarr Institute for Machine Learning and Artificial Intelligence



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> 50 Mio. €

Budget 2023

> 700

Employees¹ (12/2022)

> 200 Companies

2022

~ 30%

of the budget with industrial partners

~ 850.000 h

on behalf of logistics research (2022)

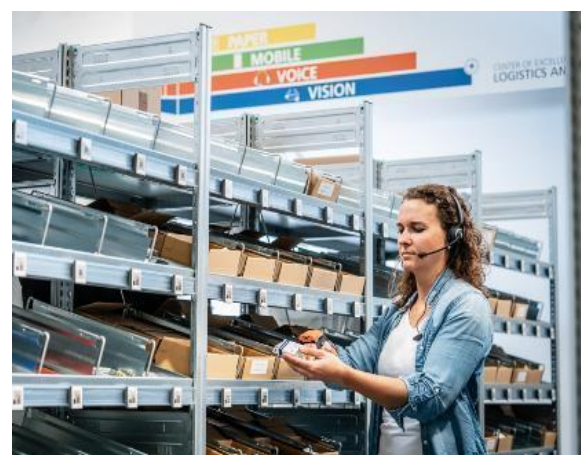
~ 10% Growth

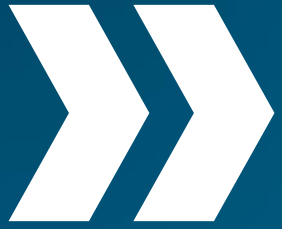
Rate²⁰²³





100% Logistics



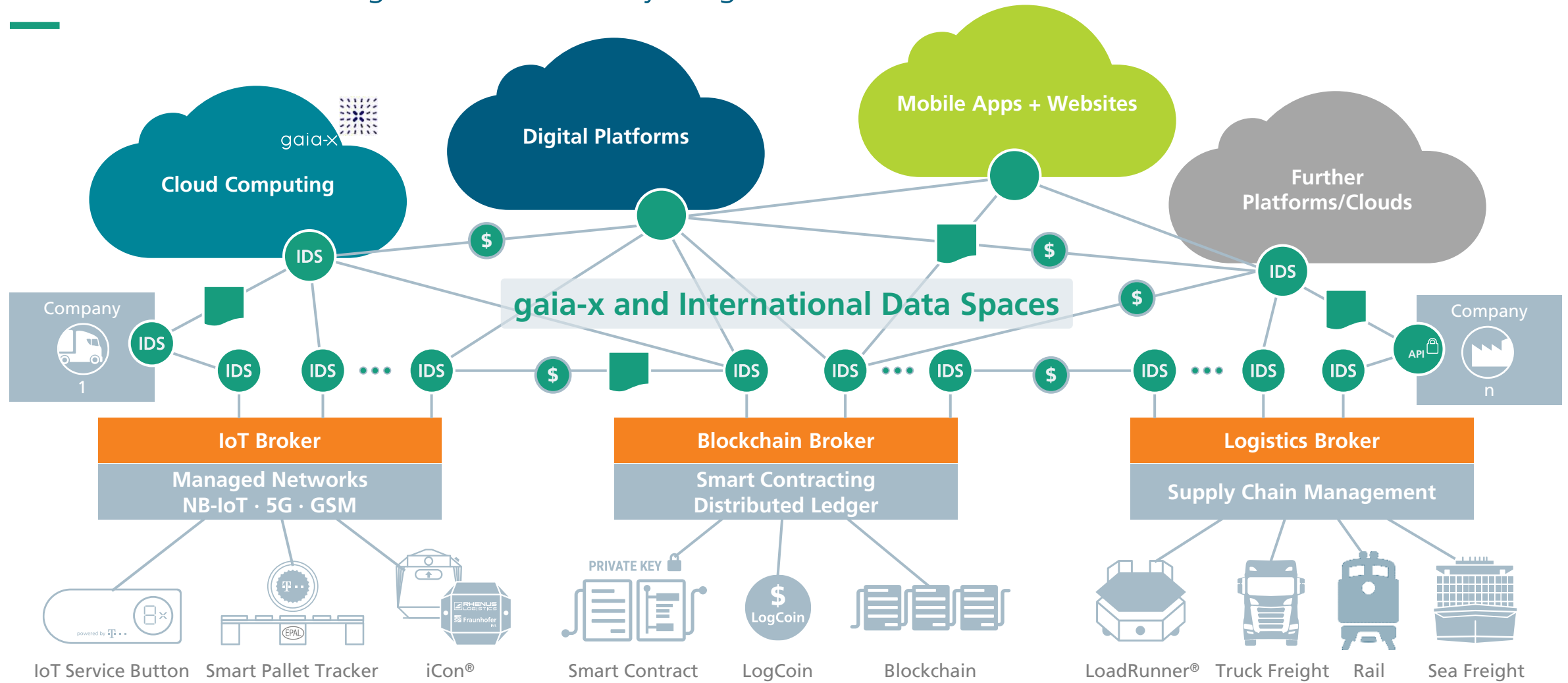


**With the digitization of everything and
Artificial Intelligence in everything,
everything will change for everyone.**

Michael ten Hompel · Deutscher Logistikkongress 2019

Silicon Economy – The Digital Ecosystem

It is not about something – it is about everything



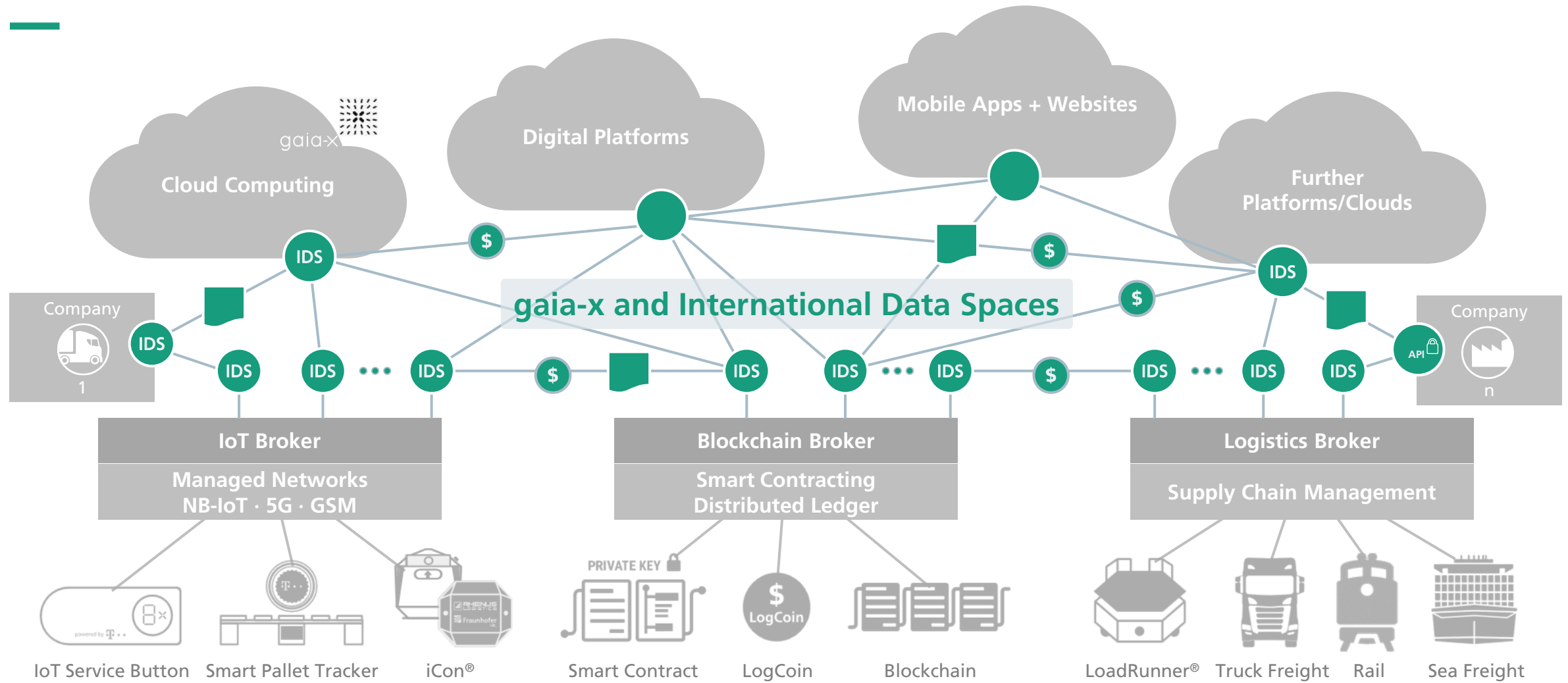
Silicon Economy Logistics Ecosystem is funded by:



Offen



Silicon Economy – The Digital Ecosystem



Silicon Economy Logistics Ecosystem is funded by:

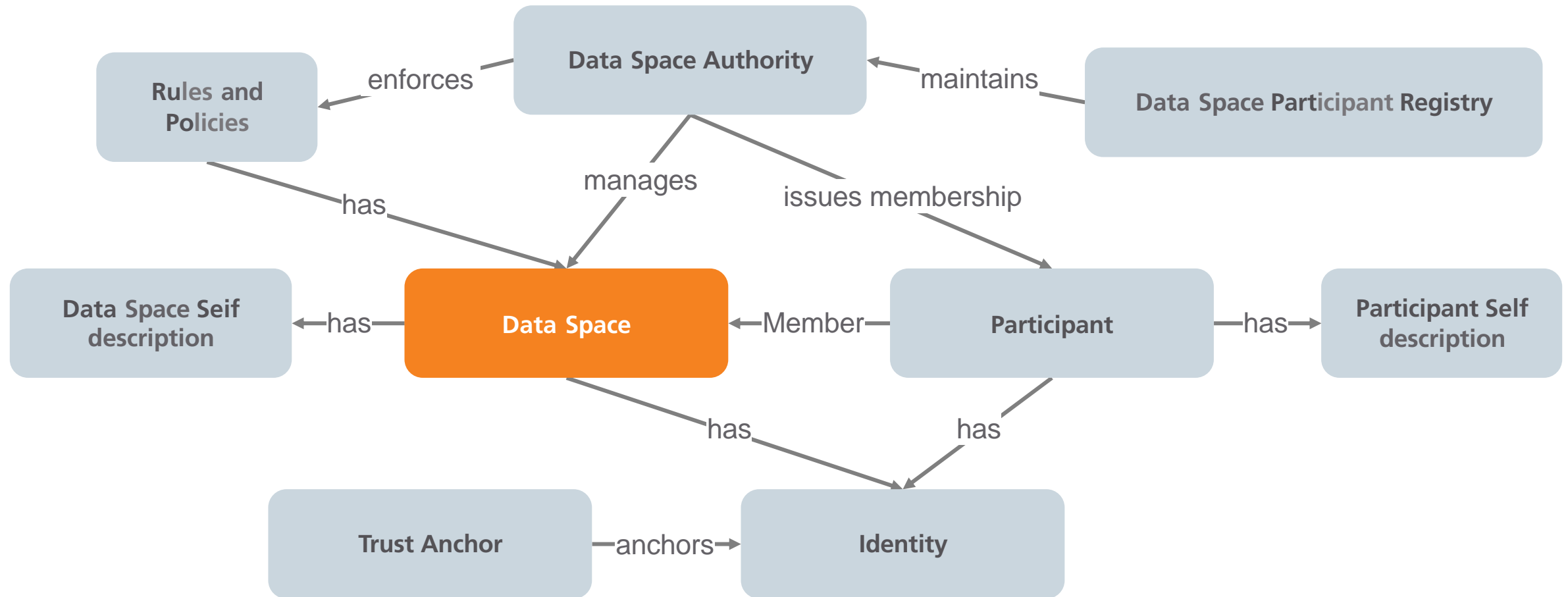


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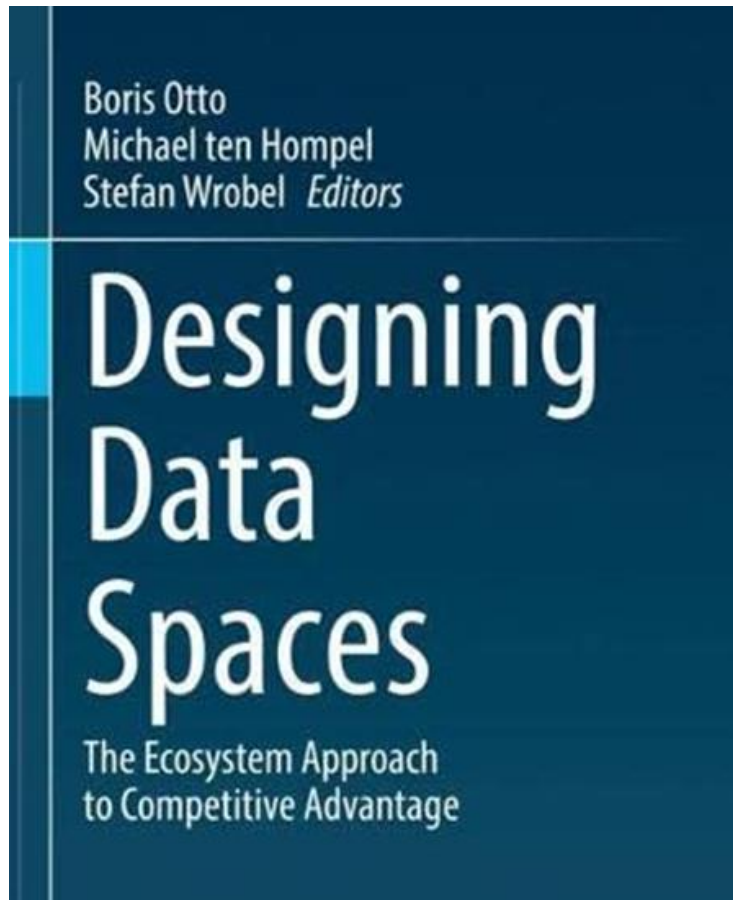


International Data Spaces - Architecture

www.internationaldataspaces.org



Designing Data Spaces: The Ecosystem Approach to Competitive Advantage

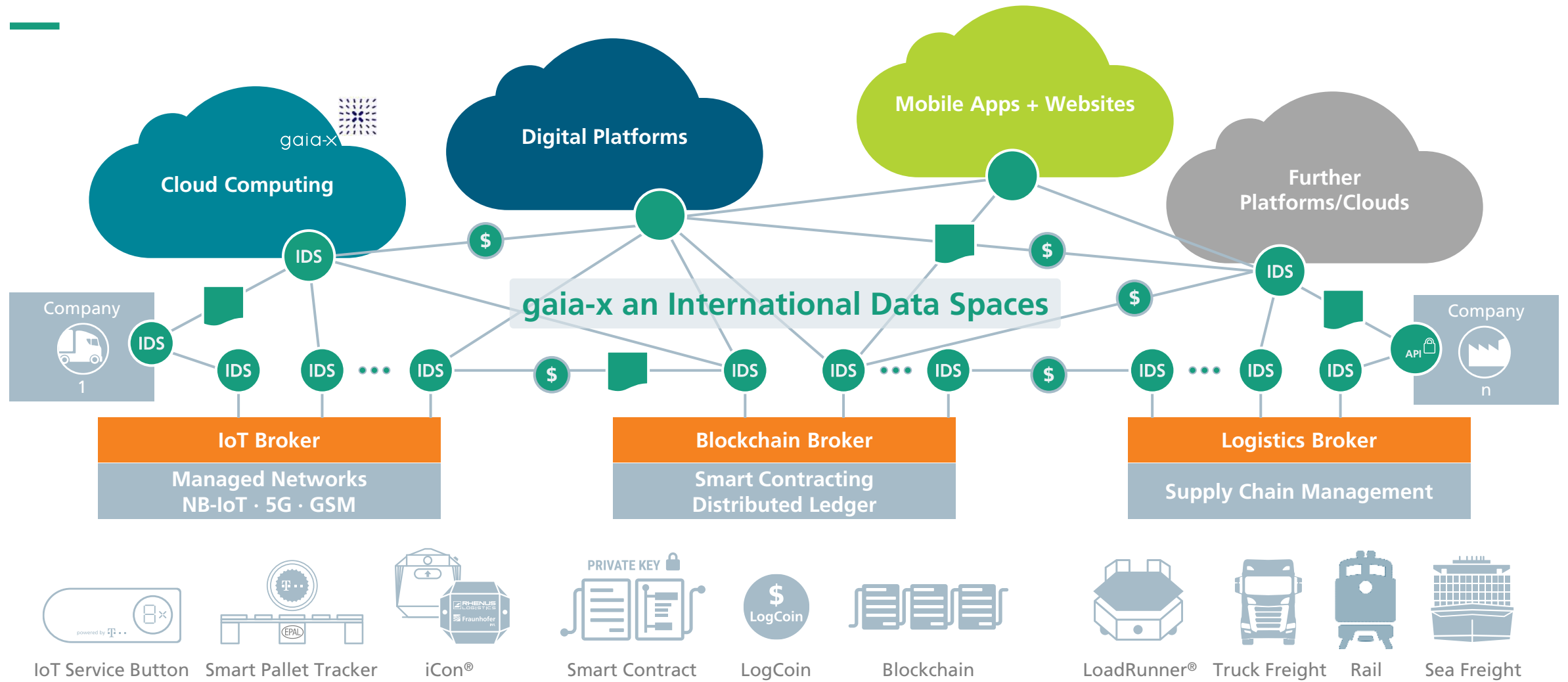


This open access book provides a comprehensive view on data ecosystems and platform economics from methodical and technological foundations up to reports from practical

Overall, the book provides professionals in industry with an encompassing overview of the technological and economic aspects of data spaces, based on the current EU-funded GAIA-X project. It presents implementations and business cases and gives an outlook to future developments. In doing so, it aims at proliferating the vision of a social data market economy based on data spaces which embrace trust and data sovereignty.

Otto, B., ten Hompel, M., Wrobel, S., (Hrsg.), Springer 2022
<https://link.springer.com/book/9783030939748>

Silicon Economy – The Digital Ecosystem



Silicon Economy Logistics Ecosystem is funded by:



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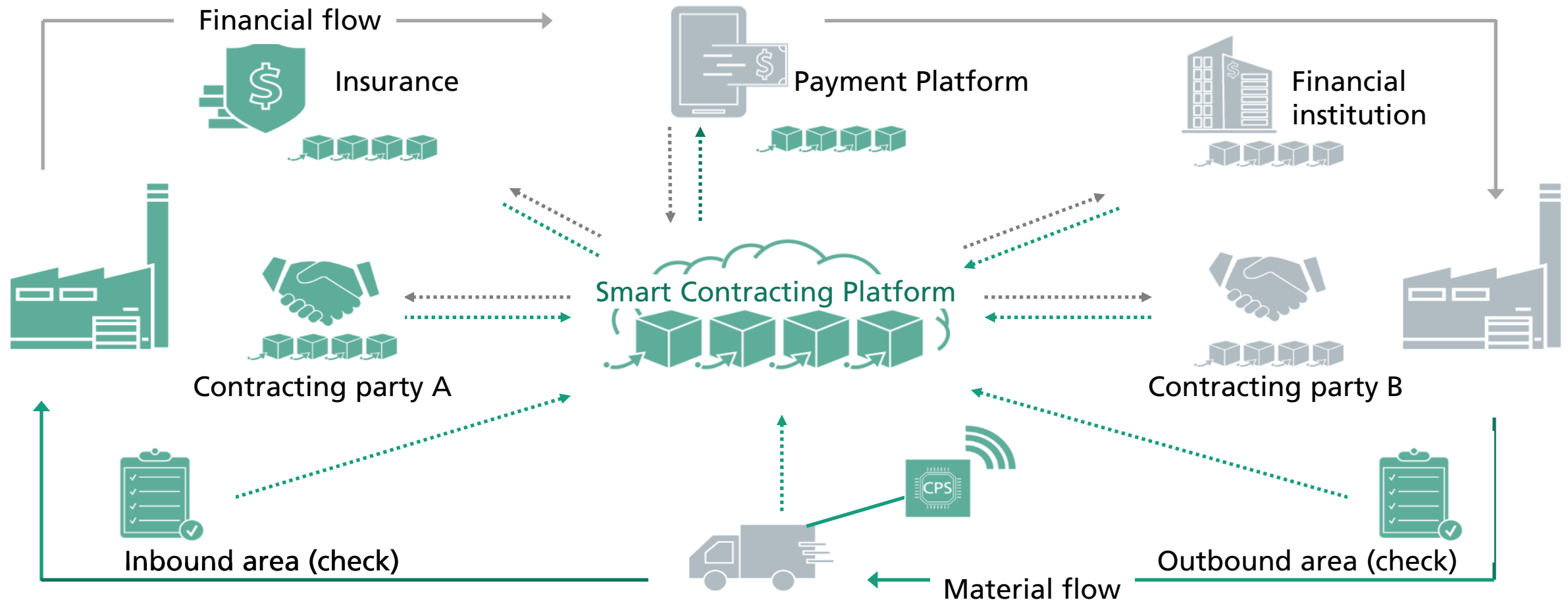


»No blockchain - no business«

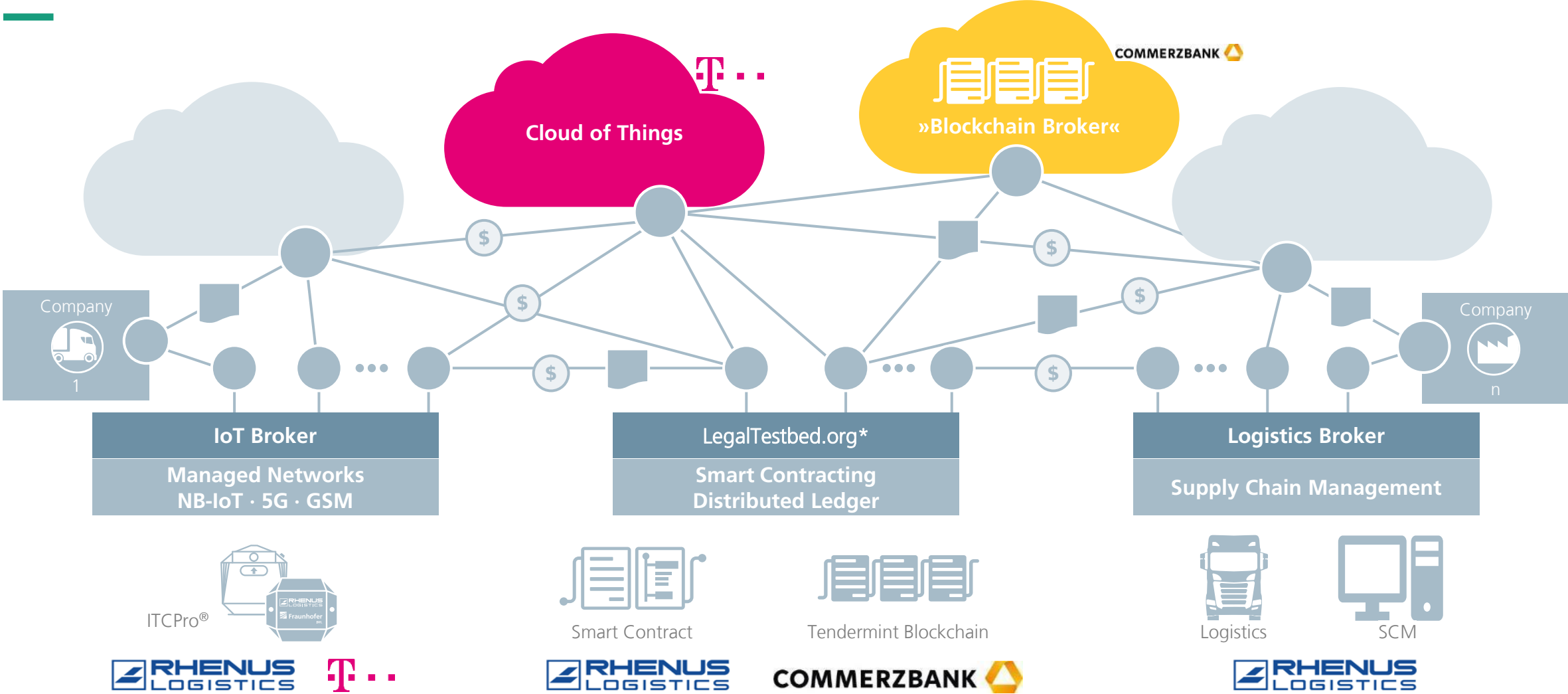
—

Logistics on the way to Silicon Economy

The future: Blockchain-based supply chain management



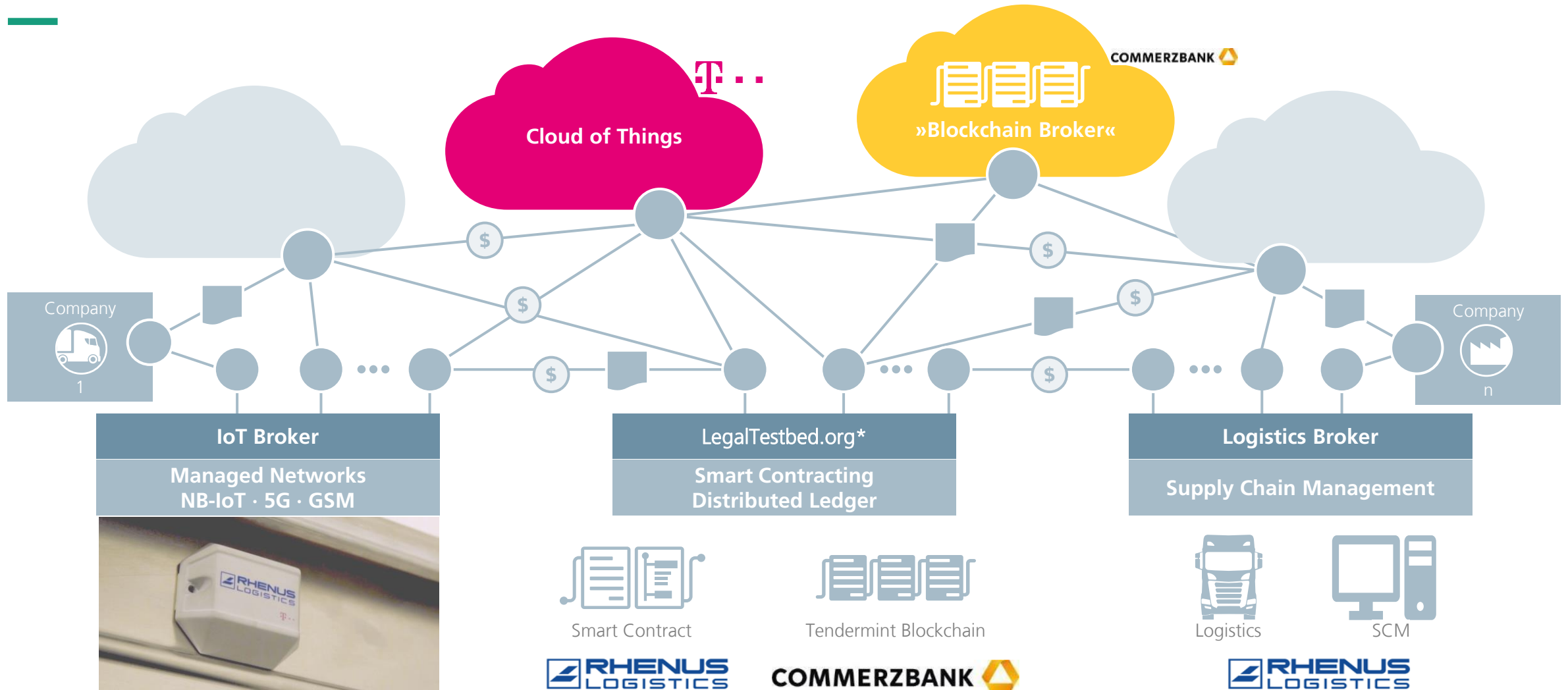
Towards a digital continuum: Rhenus ITCPro®



ITCPro is a registered trademark of Rhenus SE & Co. KG
 Developed within Rhenus and Commerzbank »Enterprise Labs« at Fraunhofer IML
 Slide 18 19.07.2023 © Fraunhofer IML

Offen

Towards a digital continuum: Rhenus ITCPro®



Silicon Economy – The Sensing Puck

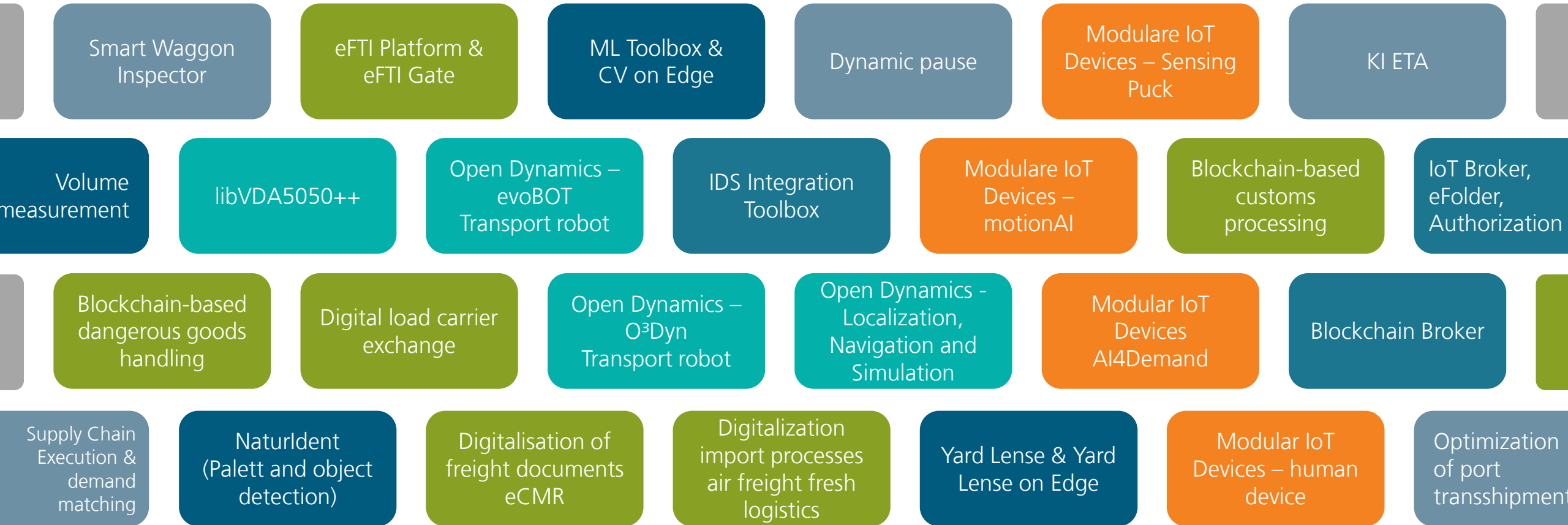
Open Source → Open Logistics Foundation Repository

Seamless monitoring of transports | Recording of positions, temperatures and process steps | Ultra-low-power technology | Can be used worldwide



Silicon Economy

Building blocks of an AI-based, open and federated platform economy.



Silicon Economy Logistics Ecosystem is funded by:



Federal Ministry
for Digital
and Transport

Data space components

Mobile robotics

AI-based platform services

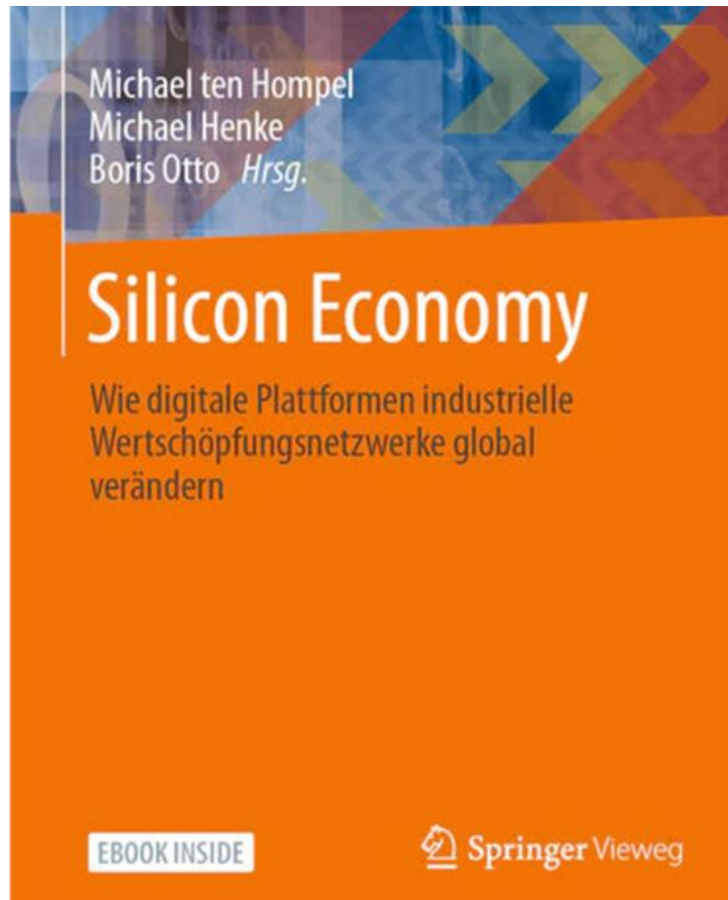
IoT hardware and software

Digital freight information

AI-based vision



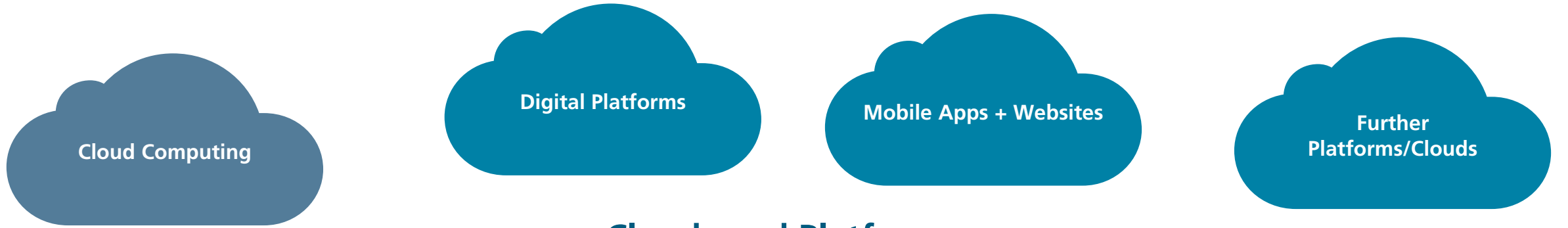
Silicon Economy (German)



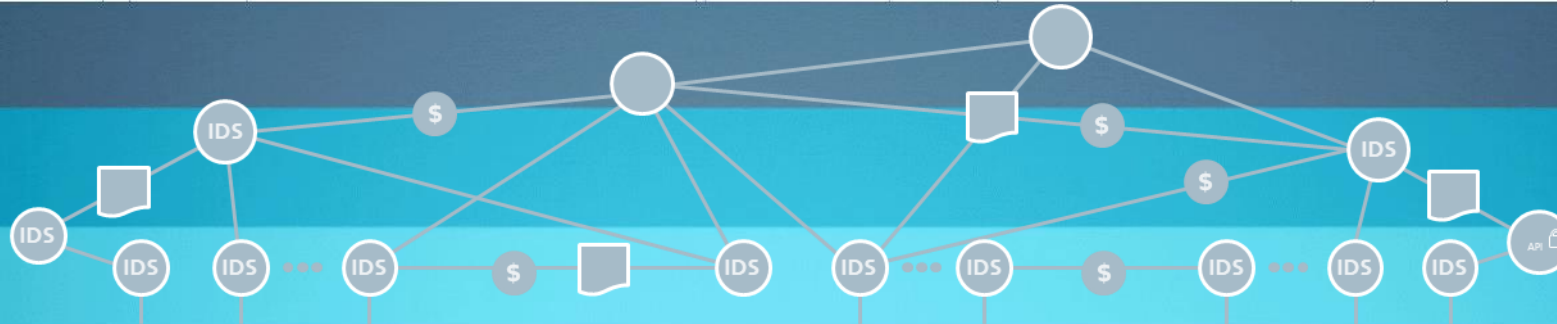
Die Silicon Economy ist das Synonym für eine digitale Infrastruktur, die auf der automatisierten Verhandlung, Disposition und Kontrolle von Warenströmen beruht und neue, digitale Geschäftsmodelle (nicht nur) für die Logistik ermöglicht. Diese Infrastruktur erfordert und ermöglicht das Handeln von Daten, ohne die Souveränität über die Daten zu verlieren.

Dieses Buch richtet sich an Menschen und Unternehmen, die eine offenes und föderales Ecosystem für die Logistik und für das Supply Chain Management benötigen, Produkte entwickeln, Lösungen in Soft- und Hardware einbringen oder die Silicon Economy bereits nutzen und sich an der Open Logistics Foundation beteiligen wollen.

ten Hompel, M., Henke, M., Otto, B. (Hrsg.), Springer 2022
eBook : <https://link.springer.com/book/9783662639559>



Clouds and Platforms



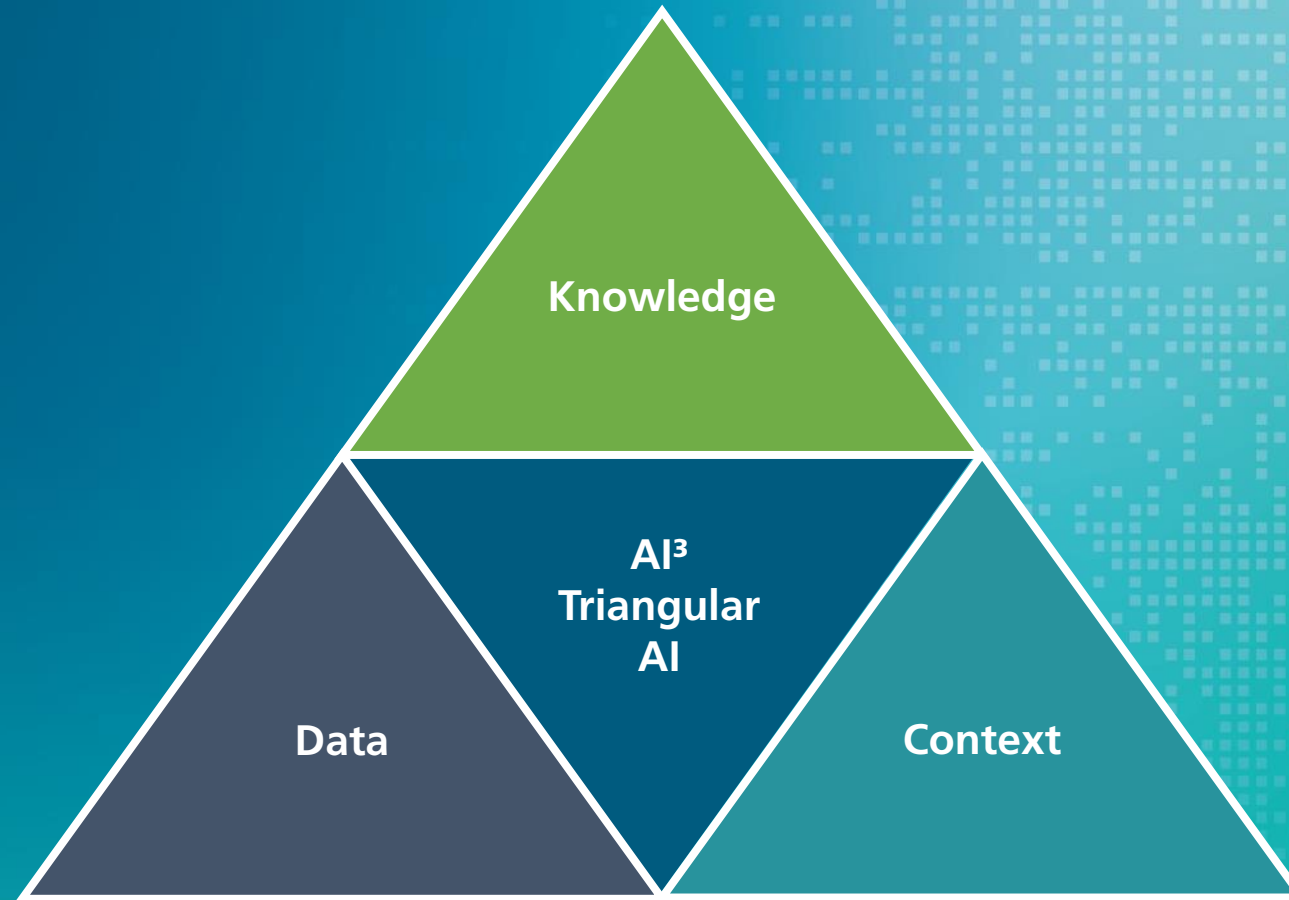
Internet of Thing and Operational Level



Digitales Kontinuum – es gibt kein unten und oben mehr

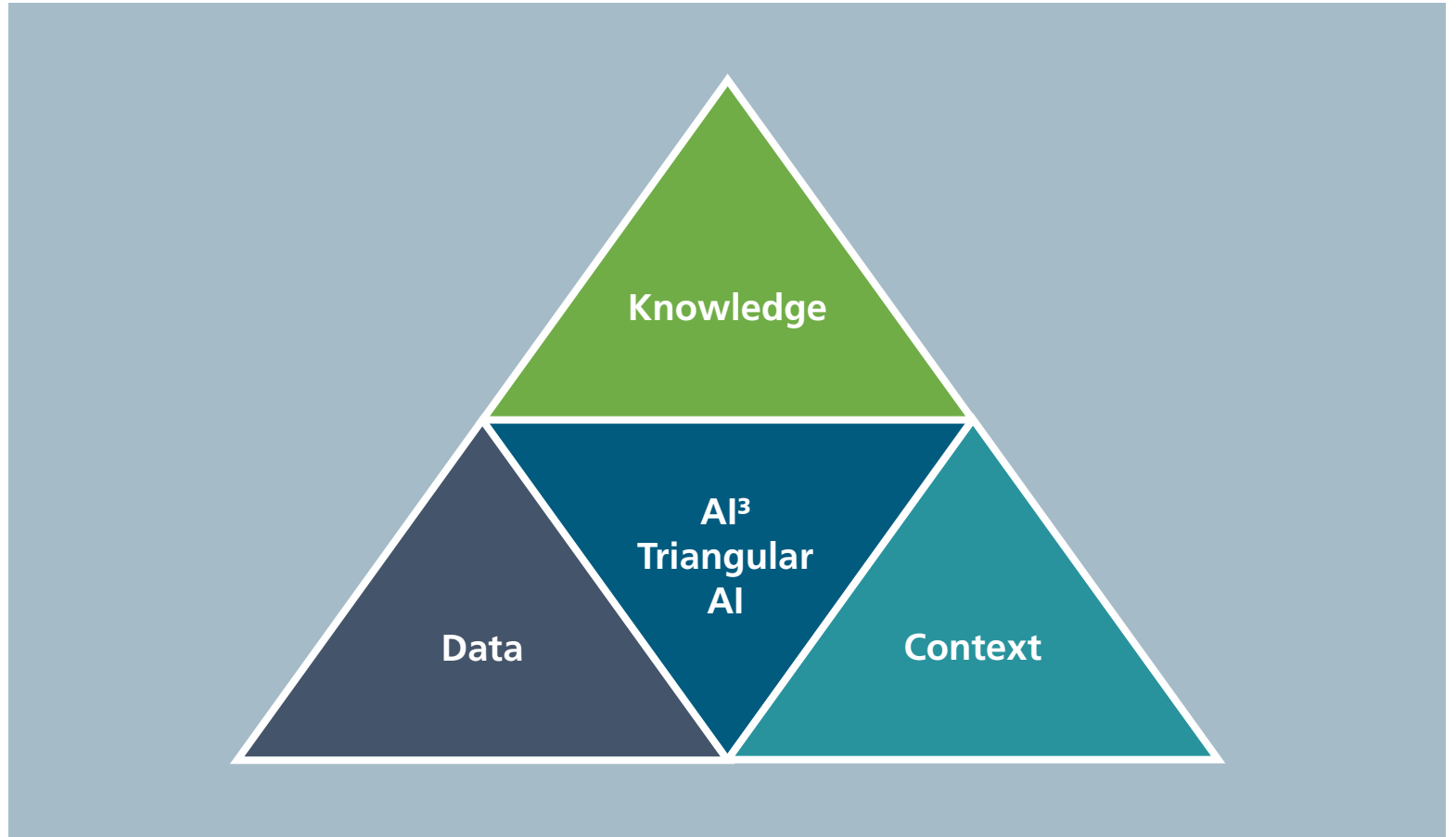


Triangular AI³ – AI of a third Generation



Lamarr Institute for Machine Learning and Artificial Intelligence

www.lamarr-institute.org



Part of the German government's AI strategy - funded by:



Ministerium für Kultur und Wissenschaft des Landes Nordrhein-Westfalen



tu technische universität dortmund



Fraunhofer IAIS

Fraunhofer IML

ChatGPT-3.5 → ChatGPT-4

Generative Pre-trained Transformer · OpenAI

GPT-3 has been trained with 175 billion parameters, making it the largest language model ever created. In comparison, GPT-4 is said to have been trained with more than 1 trillion parameters (the figure of 100 trillion parameters has been denied by OpenAI).

GPT-4 accepts both text and image input.

GPT-4 is better at processing significantly more complex instructions.

**GPT-4 is said to be in the top 10% percent of graduates on the "bar test" (GPT-3.5 was still in the bottom 10%).
[Heise/OpenAI]**



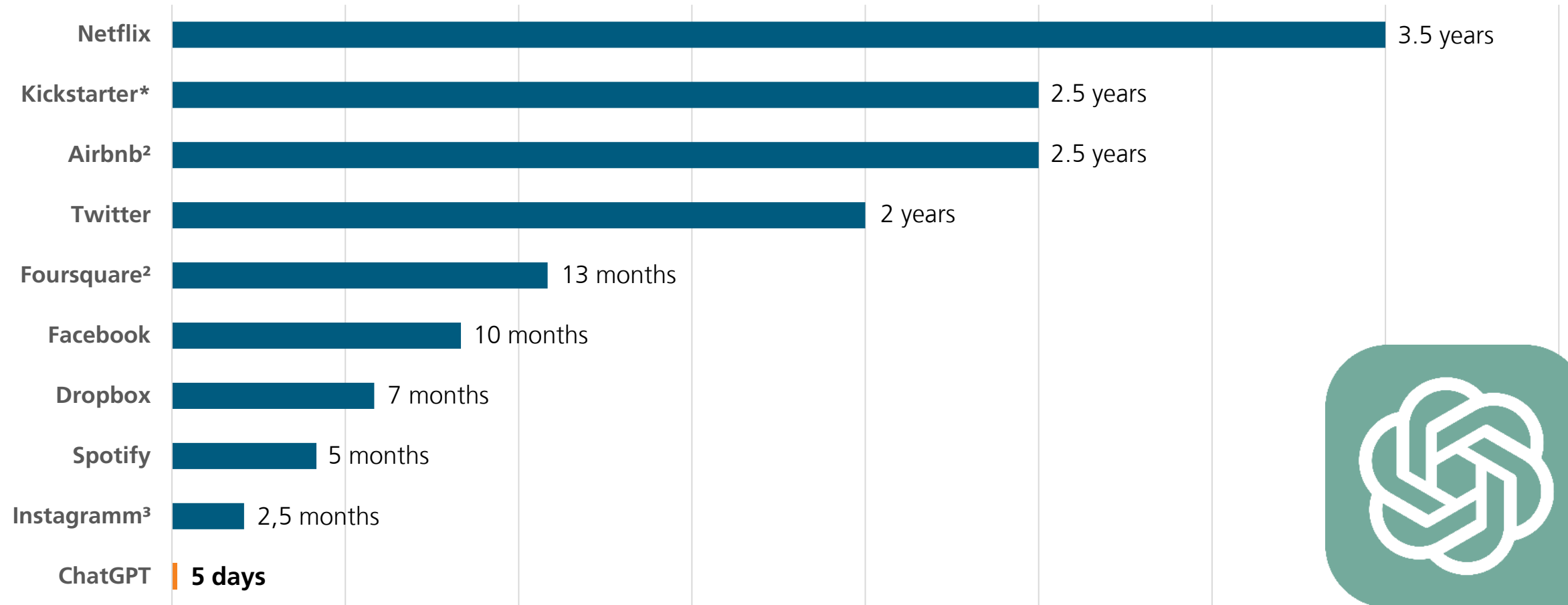
The "Bar Test" is a standardized examination administered by the NCBE. The exam is designed to test the skills and knowledge that each lawyer needs to be admitted to practice law in a U.S. state.

Pic.: Pixabay.com · Tumisu

Offen

ChatGPT sprints to 1 million users

Time it took for selected online services to reach 1 million users



*one mio. backers · ²1 mio. nights booked · ³1 mio. downloads

Source: Company announcements via Business Insider and LinkedIn · statista



Artificial intelligence and the digital continuum are turning the world upside down. The race will be won by the company that thinks all the new technologies together.

Digital Twin

Object Recognition



Pic.: Dachser · Dachser Enterprise Lab at Fraunhofer IML · Dachser DCs at Unterschleissheim & Öhringen

Dachser @ILO: 400-600 camera-based scanners under the hall ceiling

Locating and measuring pallets in real time



Identify



Measure



Localize

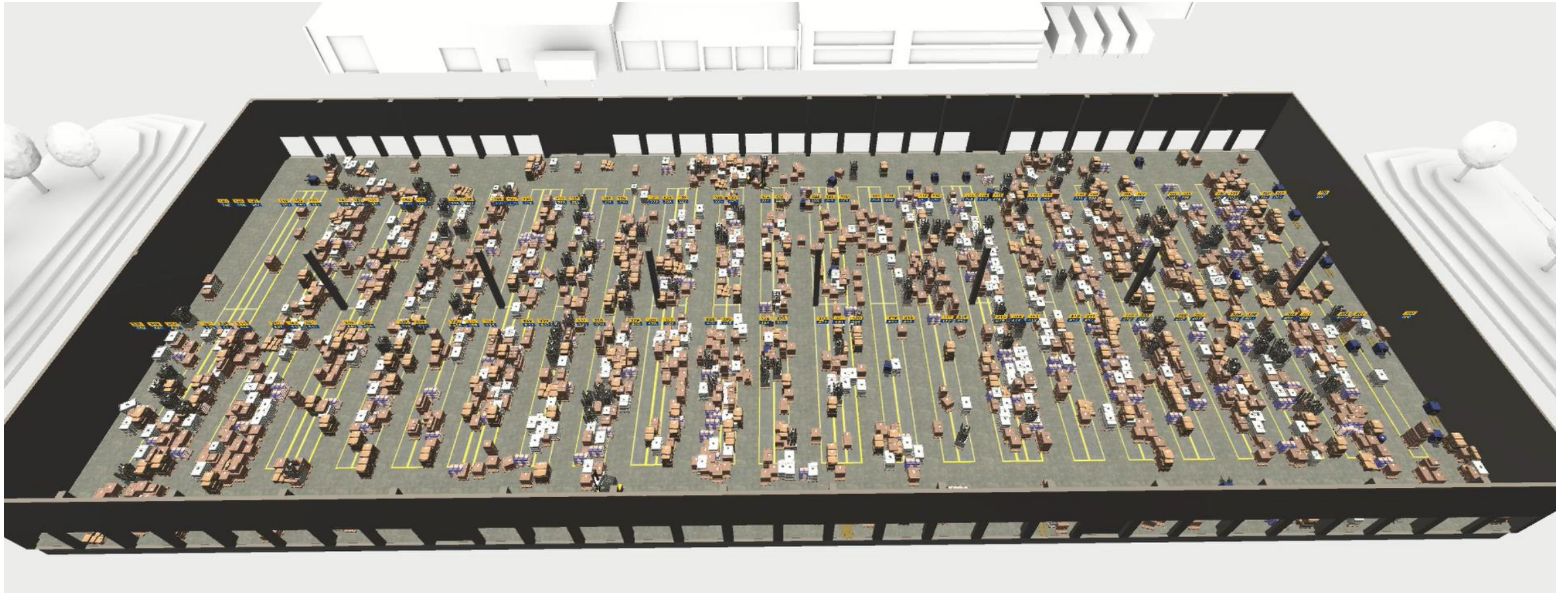


Visualisieren

Dachser Enterprise Lab at Fraunhofer IML · Dachser DCs at Unterschleissheim & Öhringen

Dachser @ILO: 400-600 camera-based scanners under the hall ceiling

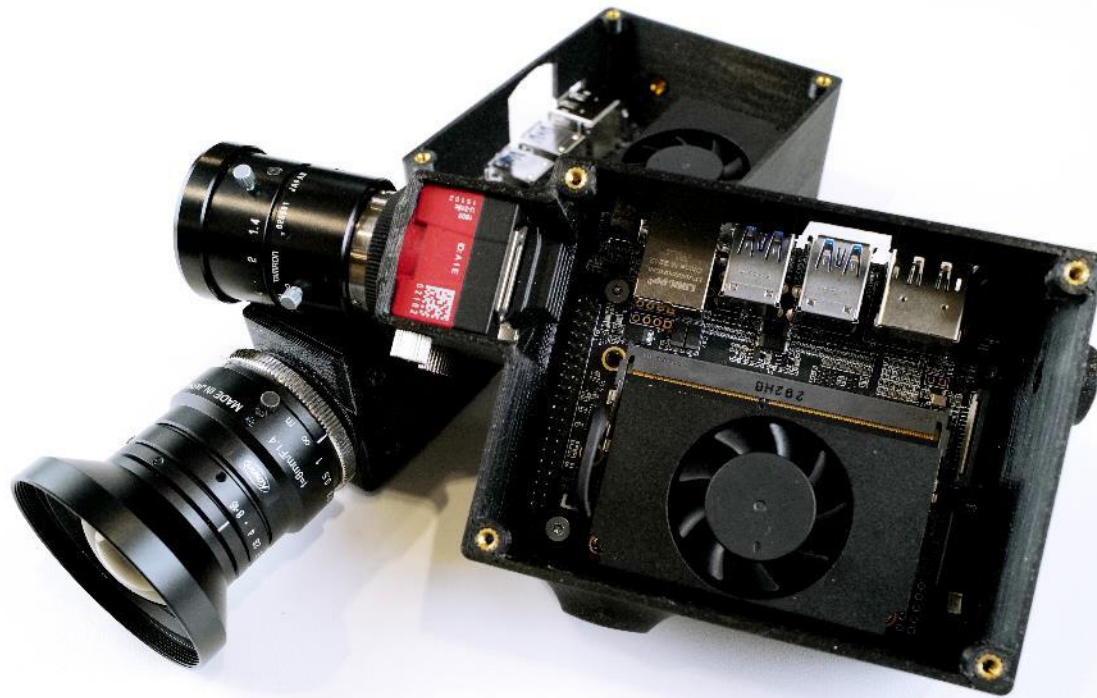
Locating and measuring pallets in real time



Dachser Enterprise Lab at Fraunhofer IML · Dachser DCs at Unterschleissheim & Öhringen

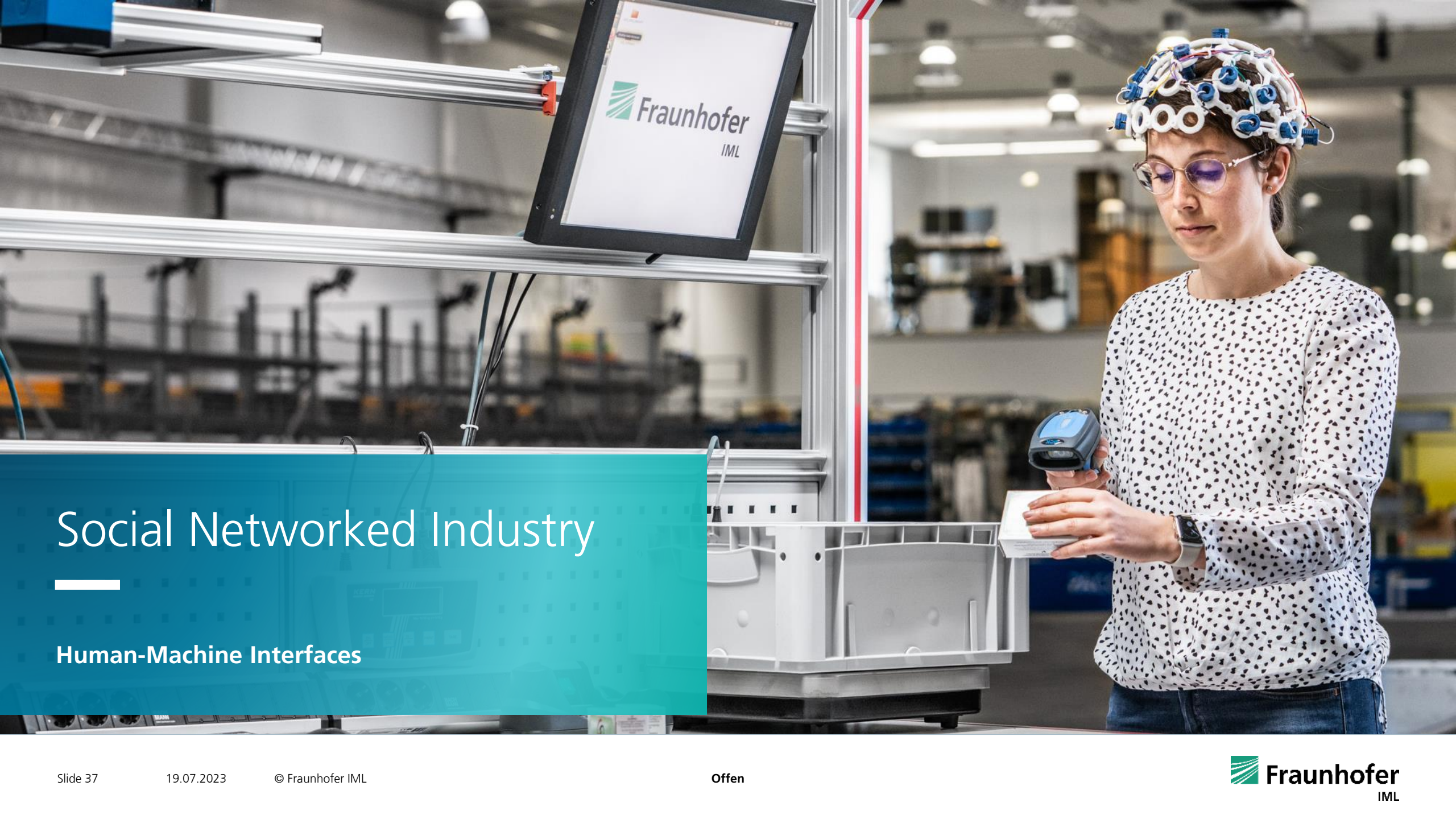
Silicon Economy Projekt »CV on Edge«

Software and hardware for AI-based image processing



Intelligent camera: AI-based image processing at the point of capture.

Guided Training: Guided training of AI models also for non-experts

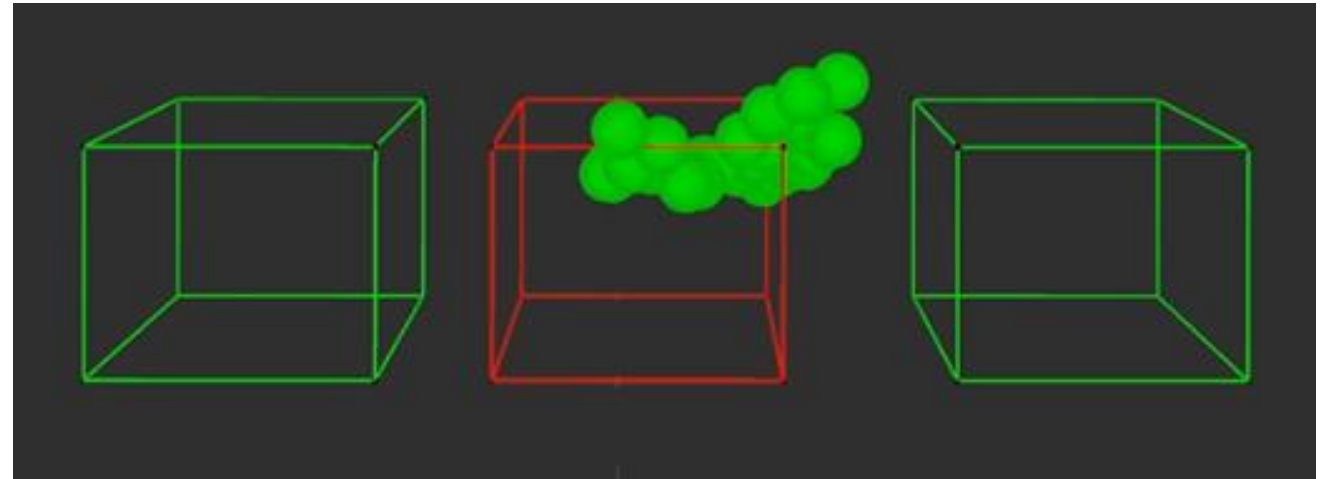


Social Networked Industry

Human-Machine Interfaces

Social Networked Industry - Automated booking using AI and computer vision

Example: Pick&Pack-Process



In cooperation with:



© Fraunhofer IML

Offen



Social Networked Industry

Humans and AI work in partnership in social networks



Pic.: Montage · Fraunhofer IML

Explorative study of a BCI for order picking

Thought control for the reduction of mental stress



EEITFF

Explorative study of a BCI for order picking

Test execution

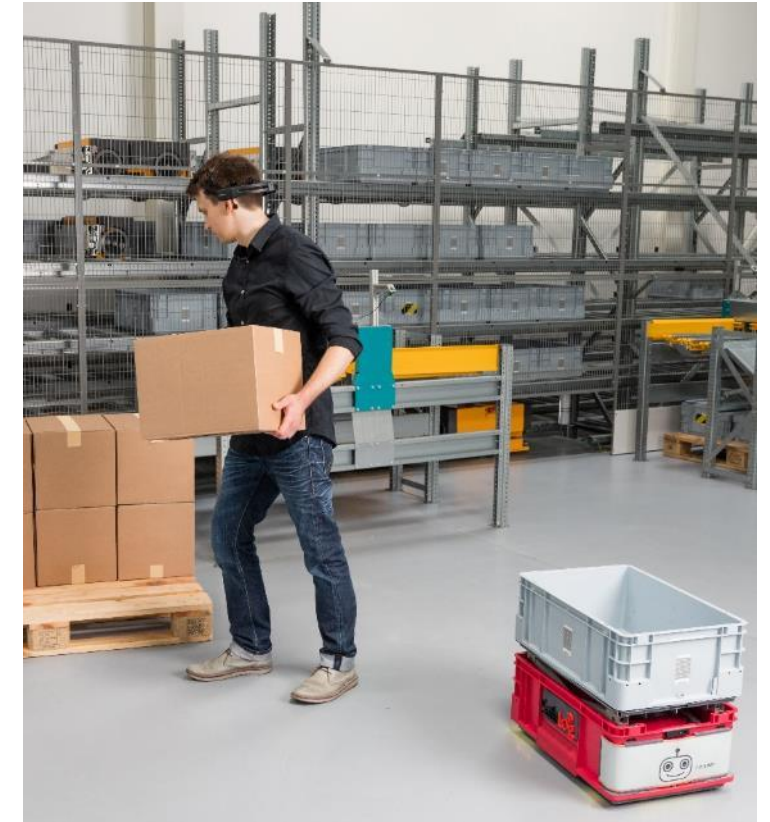
Control AMR via BCI



Picking goods



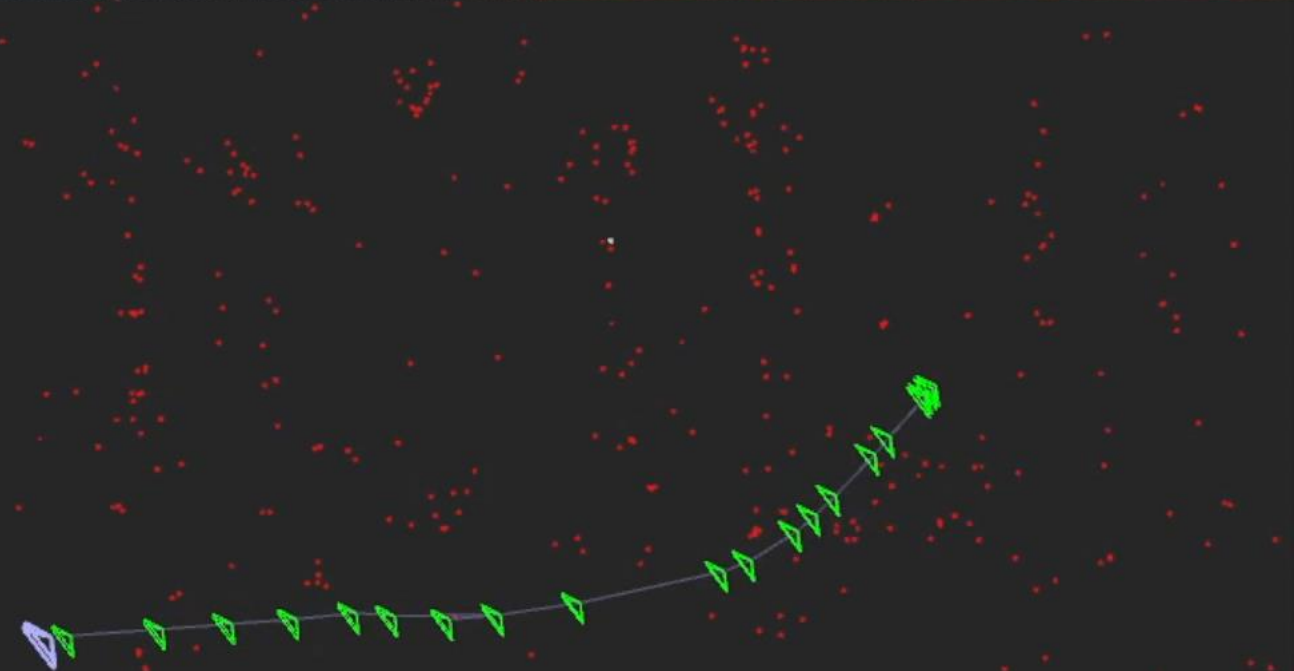
Send AMR away via BCI



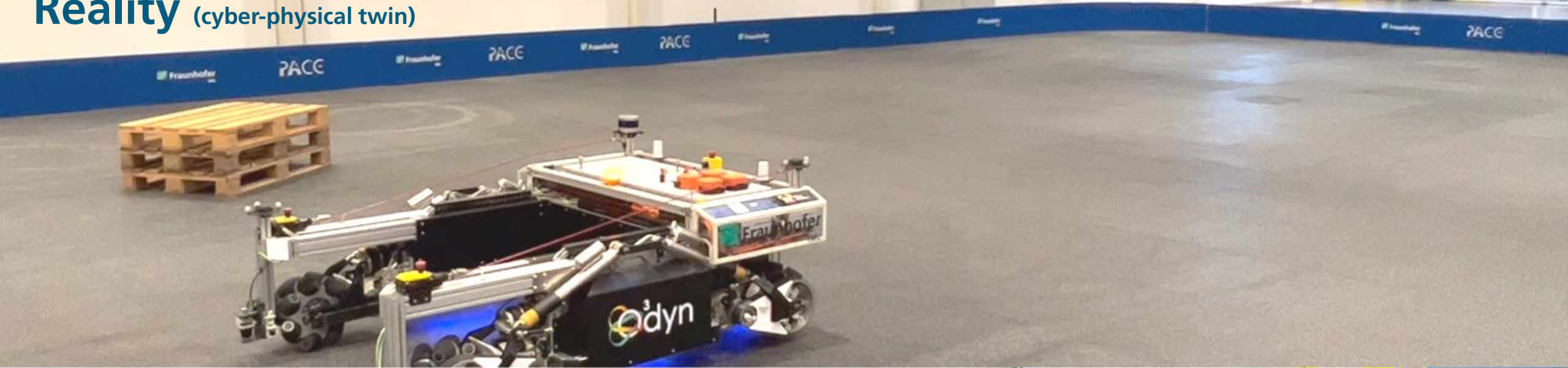


Remote AI & 360° V-SLAM

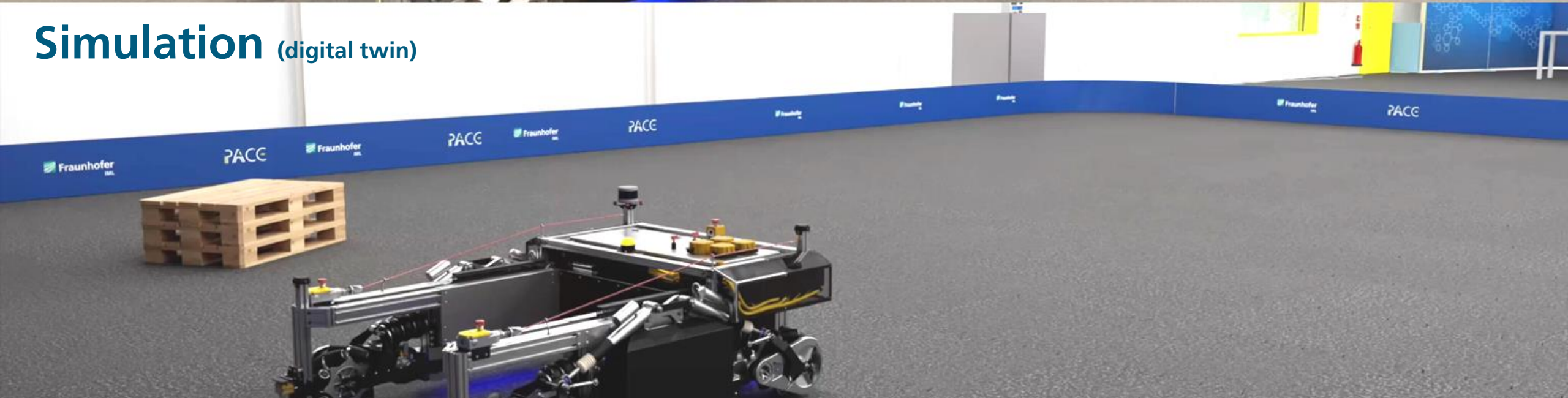
Digital Reality and physical Reality are converging



Reality (cyber-physical twin)



Simulation (digital twin)



Pic.: Fraunhofer IML · Simulator: NVIDIA ASAAC · Animation: Omniverse · funded by:

Simulation-based AI

Paradigm shift "Holistic simulation" in (faster than) real time

1

Actuators

Physical quasi-correct modeling of motors and actuators

2

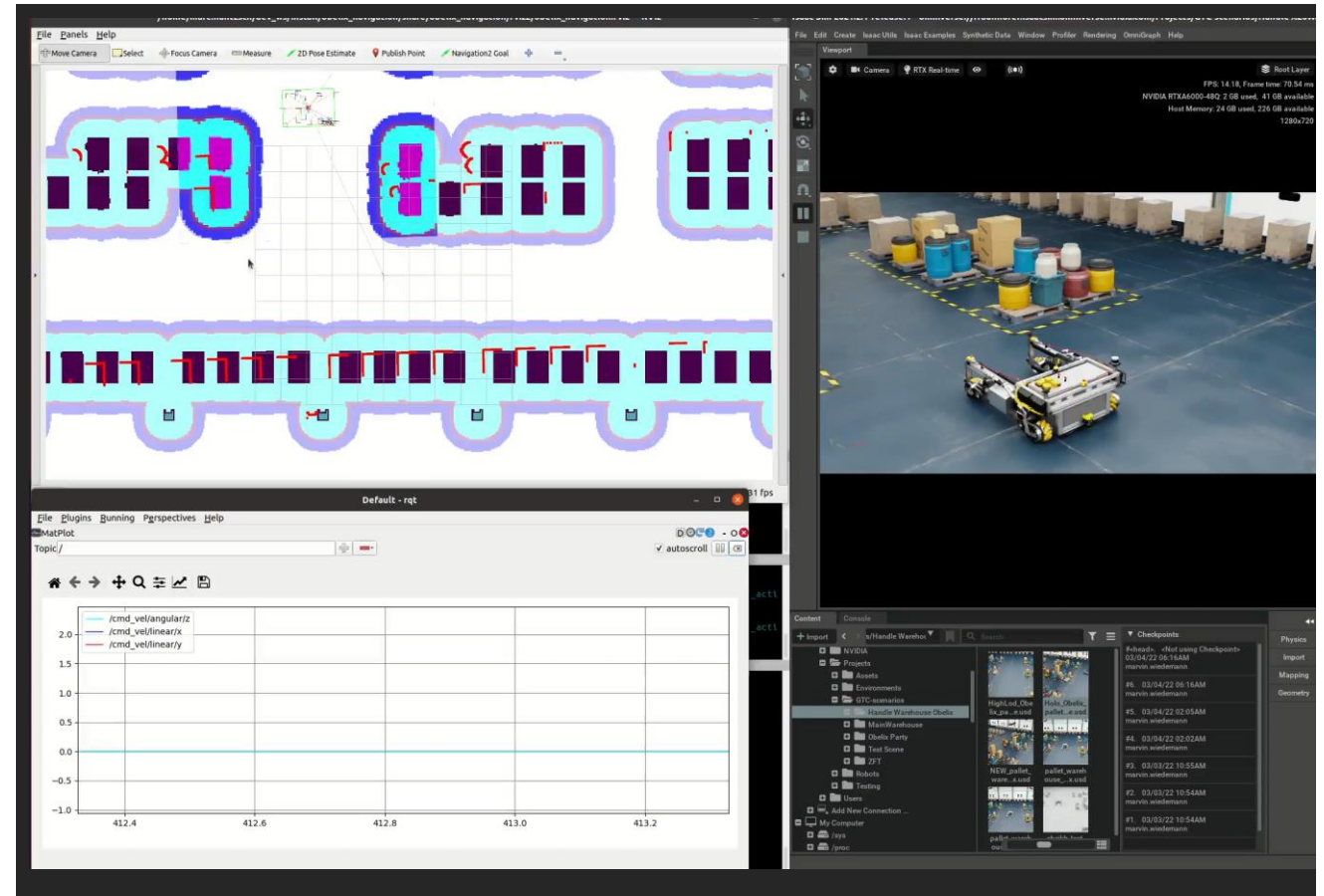
Sensors

Ray tracing based mapping of (optical) sensors

3

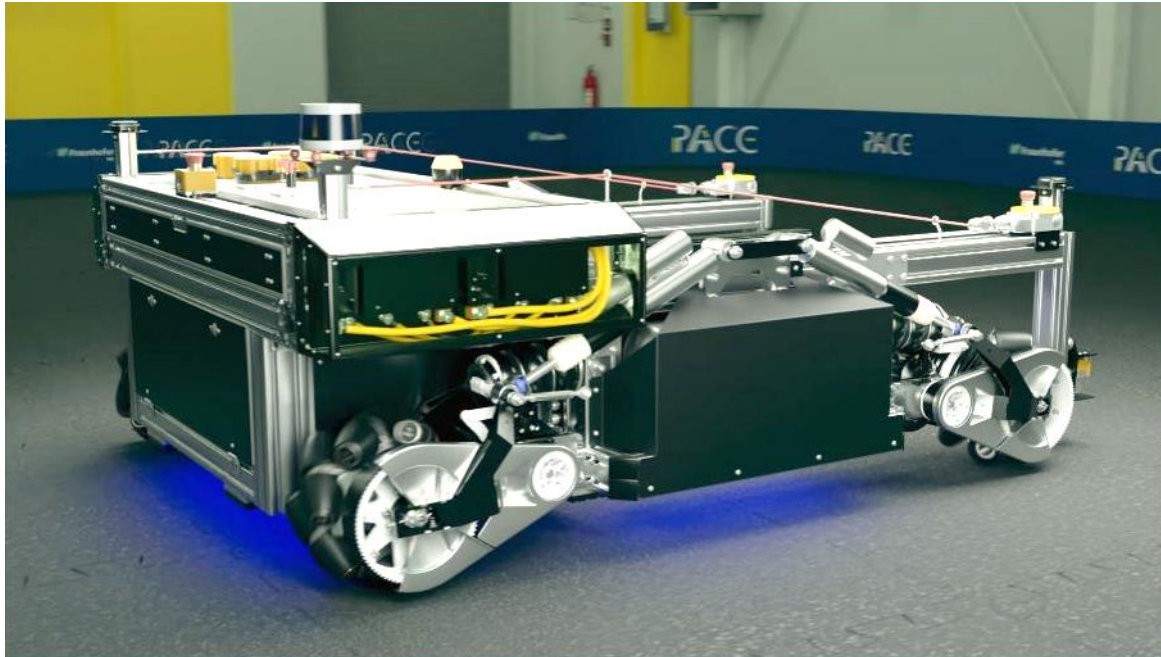
Communication

Modeling on physical as well as protocol level



O³dyn - Simulation Model ist Open Source

<https://git.openlogisticsfoundation.org>



Name	Last commit	Last update
Materials	Initial commit	6 months ago
Parts	Initial commit	6 months ago
documentation	changed order of the topics	2 months ago
.gitignore	Initial commit	6 months ago
LICENSE	Initial commit	6 months ago
README.md	Initial commit	6 months ago
o3dyn.usd	Initial commit	6 months ago
o3dyn_ros1.usd	Fix missing ROS integration when using L...	3 months ago
o3dyn_ros2.usd	Update ROS2 model to fix bug with new ...	3 weeks ago

O³dyn on your Nucleus

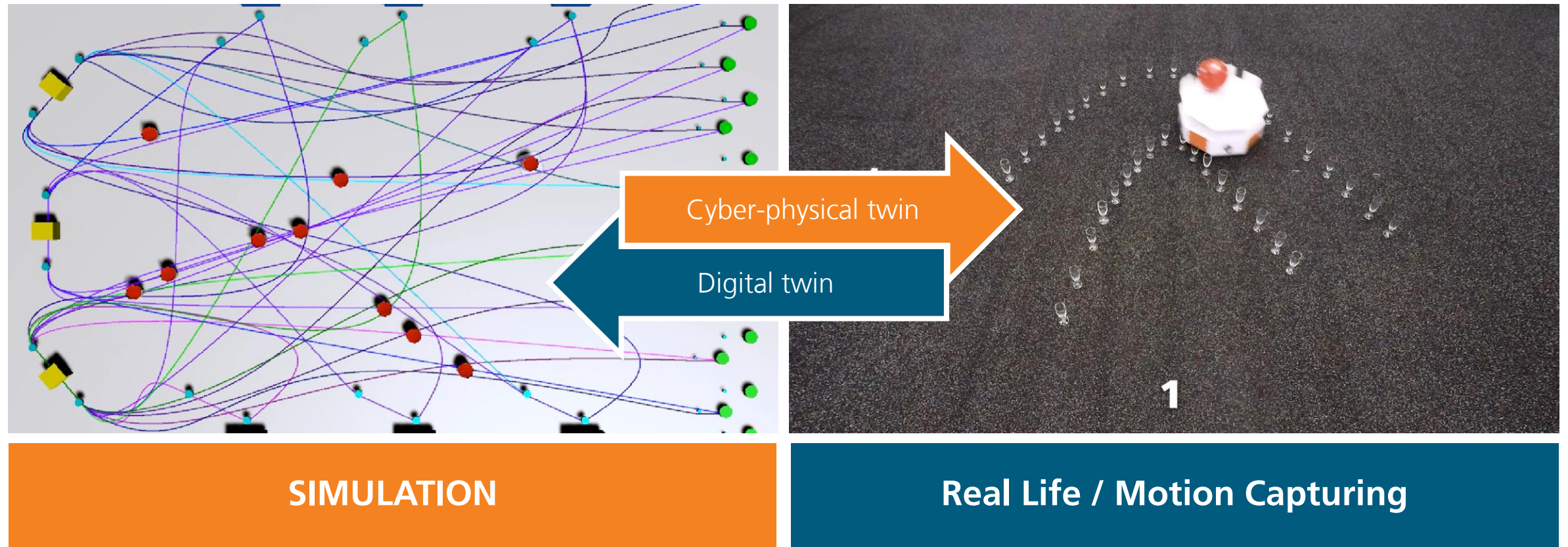
`omniverse://localhost/NVIDIA/Assets/Isaac/2022.2.0/Isaac/Robots/O3dyn`

Open source release @ Open Logistics Foundation

<https://git.openlogisticsfoundation.org/silicon-economy/simulation-model/o3dynsimmodel>

LoadRunner®

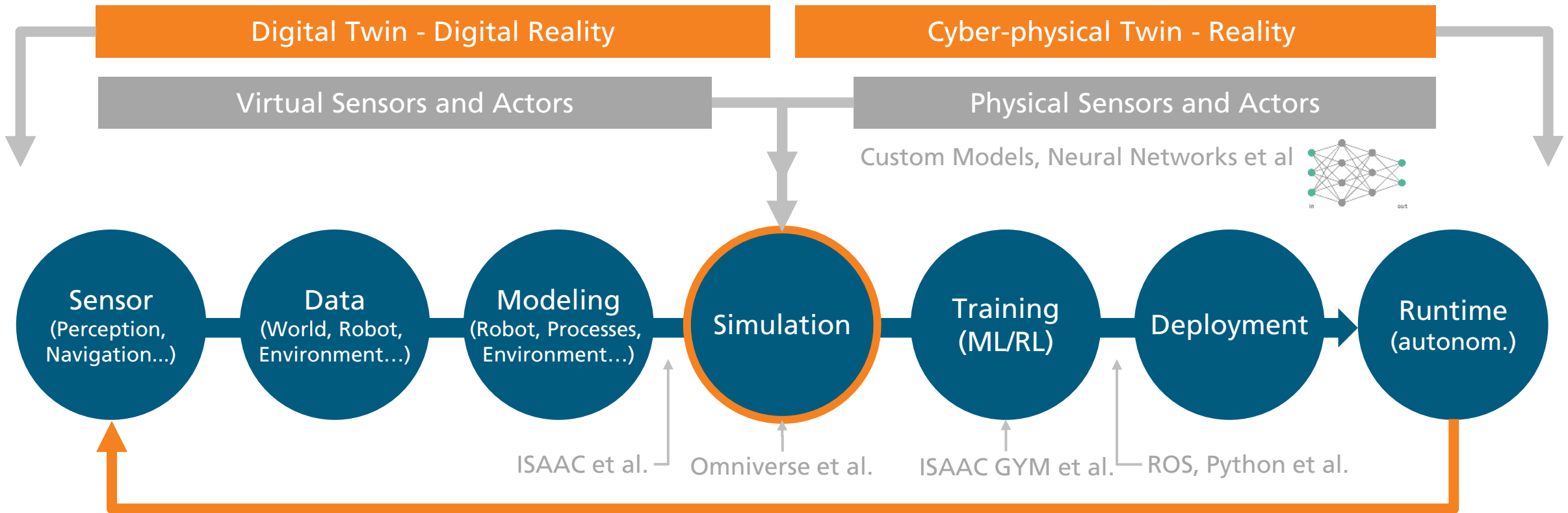
Sim2Real Adjustment · Rotationsinvariant motion capturing wth 400 frames/s



LoadRunner® is a project of the KION Enterprise Labs

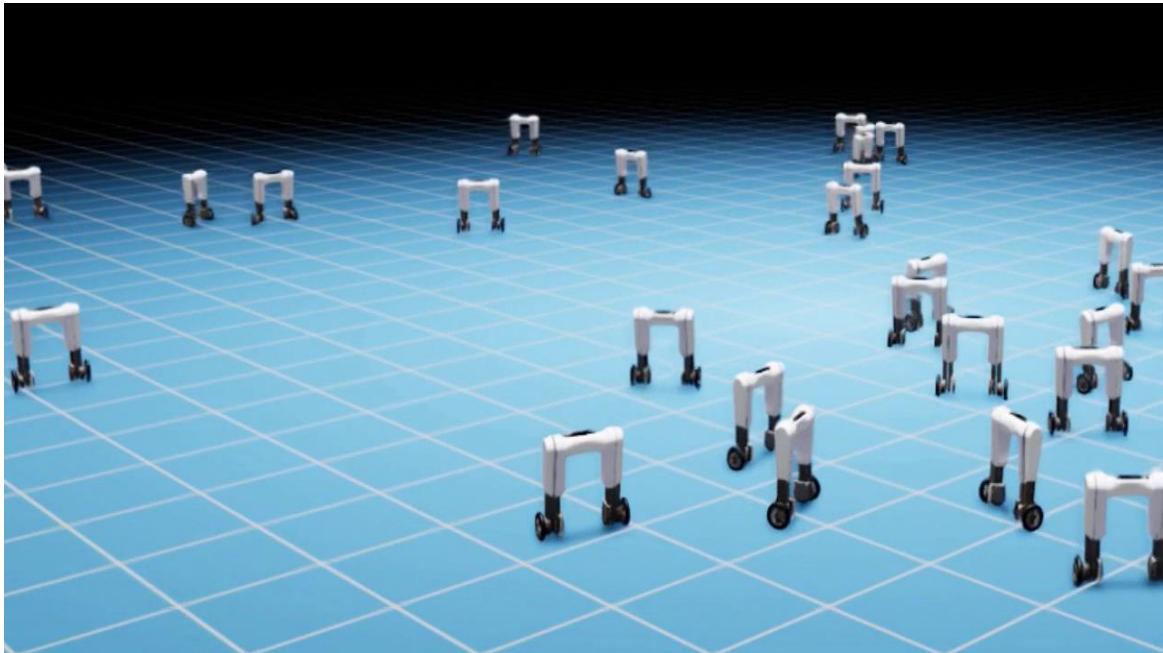
The Robotics Continuum

... not just for Robots!



evoBot

Speed: 10m/s · Charge typ. 30kg · Single-shift operation with one battery charge



SIMULATION



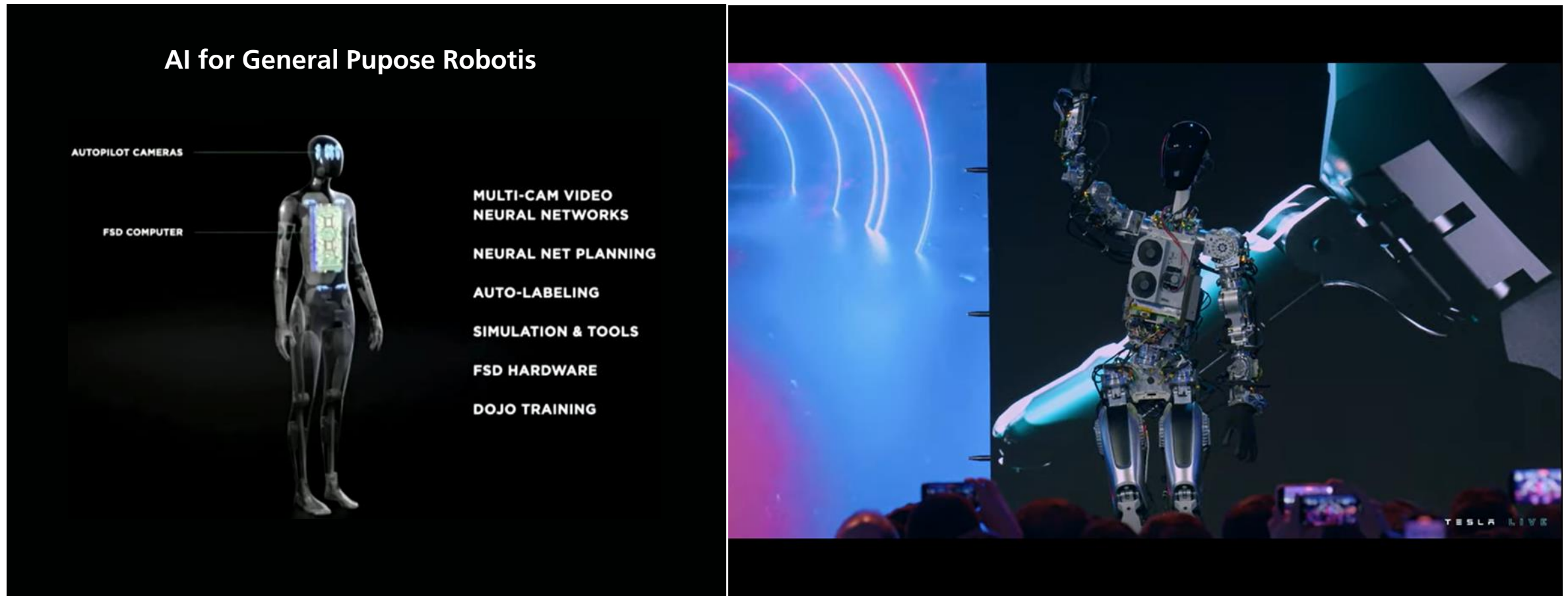
Real Life

(Video: manual / semi-autonomous control)



The development goes in the direction of humanoid robots

Elon Musk announces working prototype of »Optimus« (Tesla AI Day on September 2022).



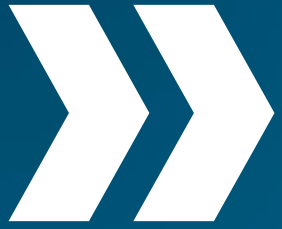
Pic.: Tesla Optimus presentation by Elon Musk on 30.9.2022 (Youtube.com)

OpenAI Co-Founder & CEO Sam Altman



**»AI will probably most likely lead
to the end of the world,
but in the meantime,
there'll be great companies.«**

Pic.: Wikipedia, Sam Altman TechCrunch SF 2019 Day 2 Oct 3 (cropped).jpg



No logistics institute or research organization has sufficient resources to develop the Digital Continuum on its own.

Open Logistics Foundation

www.openlogisticsfoundation.org

The screenshot shows the homepage of the Open Logistics Foundation website. The browser's address bar displays "openlogisticsfoundation.org". The website features a blue header with the logo on the left and navigation links for "Repository" and "Info Hub" on the right. Below the header is a white navigation bar with links for "About", "Projects", "Community", and "Services", along with a search icon. The main content area has a blue background with a blurred image of people. The primary headline reads "The future of logistics is open source." followed by the subtext "Away from silo thinking and media discontinuity, and towards common, cross-industry standards – what open source can do for". A yellow circular callout box on the right contains the text "We're hiring!" and lists two job openings: "Open Source Program Manager" and "Communications and Marketing Manager". A "LEARN MORE" button is located at the bottom of this callout. On the far right, there are three circular icons representing a mobile phone, an envelope, and a GitHub logo.



Never Walk Alone

It's no use standing on the sidelines

Open Logistics Foundation 2023