

WORKSHOP #54:

3D Perception as a Key Enabler for AI-Based Robotics

Stavanger 2026-03-25



roboception

„If we were only able to provide the visual capabilities of a 2-year old, robots would quickly get a lot better.“

Rodney Brooks (2015)

Organization

3D Perception as a Key Enabler for AI-Based Robotics

Vision of the workshop:

3D perception turns robots from blind manipulators into adaptive, data-driven collaborators in production and logistics. It enables safe interaction, robust autonomy, and scalable AI-driven services across entire value chains.

What we will focus on today

- AI-based perception of **known** objects and **unknown** objects
- From pixels and point clouds to actionable knowledge: detection, pose estimation, scene understanding, and uncertainty handling for real-world deployments.
- Integrating 3D perception with federated data ecosystems to connect edge devices, cloud services, and enterprise IT, enabling new applications and data-based business models.

Format of the workshop

- Short impulse presentations from industry and research on current capabilities and deployment experiences.
- Interactive polling and discussion of challenges, user needs, and expectations.
- Panel session on how AI-based 3D perception and federated data ecosystems unlock new services, partnerships, and revenue streams in robotics

Agenda

3D Perception as a Key Enabler for AI-Based Robotics

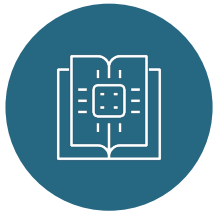
- 11:20 **Introduction and Definition of Key Statements / Questions**
Dr. Michael Suppa, Roboception GmbH, Germany
- 11:25 **Insights on Pose Estimation and Grasp Prediction of Unknown Objects**
Maximilian Durner, DLR, Germany
- 11:35 **Industrial-Grade Bin Picking: Real-World Deployment and Performance for Known Objects**
Dr. Nicolas Alt, Siemens AG, Germany
- 11:45 **Shiny, reflective, thin – approaches and challenges for 3D perception in sheet metal**
Dr. Ralph Lange, Trumpf, Germany
- 11:55 **The Data space: Introduction to a new way of sharing and using data collectively**
Dr. Lukas Solbach, VDMA, Germany
- 12:05 **AI-based Perception of Seen and Unseen Objects**
Dr. Michael Suppa, Roboception GmbH, Germany
- 12:15 **Interactive Poll Session / Round Table Discussion with the Audience**
- 12:35 **Closing Remarks and Take Home Messages**

Key Questions

3D Perception as a Key Enabler for AI-Based Robotics



How does 3D perception enable robust AI-based robotic skills for handling known and unknown objects, while unlocking greater flexibility, autonomy, and economic value in dynamic production and logistics environments?



What are the key technical challenges and solution approaches for deploying 3D perception in real-world robotic applications such as bin-picking, kitting, and assembly?



How can federated data ecosystems improve the development, sharing, and scalability of AI perception models across different robots, factories, and applications?

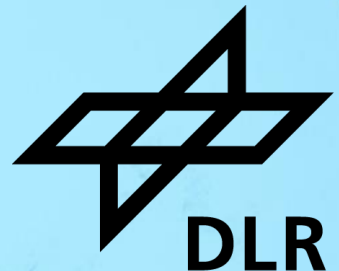


Would a federated data space increase your willingness to share and jointly use data?
If not, why not?

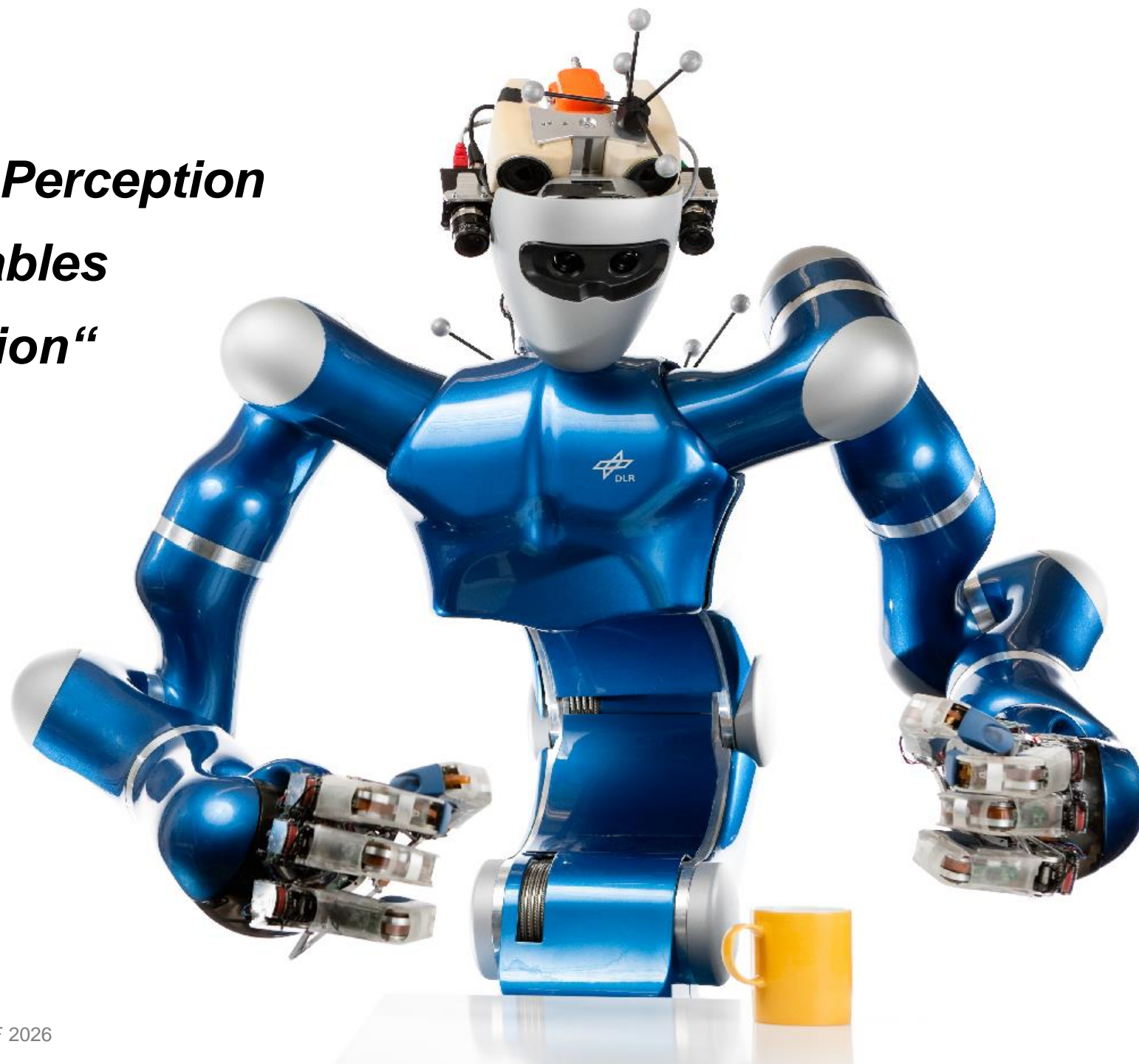
INSIGHTS ON POSE ESTIMATION AND GRASP PREDICTION OF UNKNOWN OBJECTS

Maximilian Durner

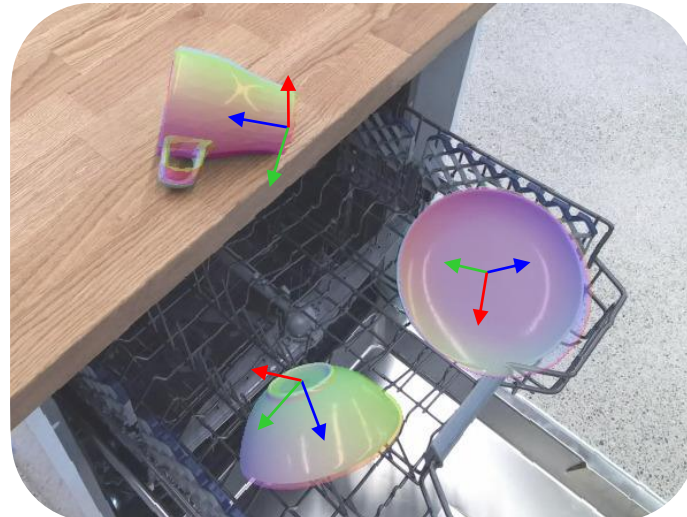
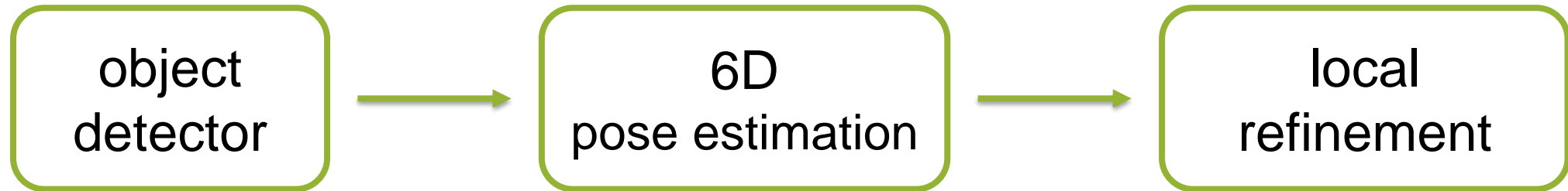
WS#54 3D Perception as a Key Enabler for AI-Based Robotics



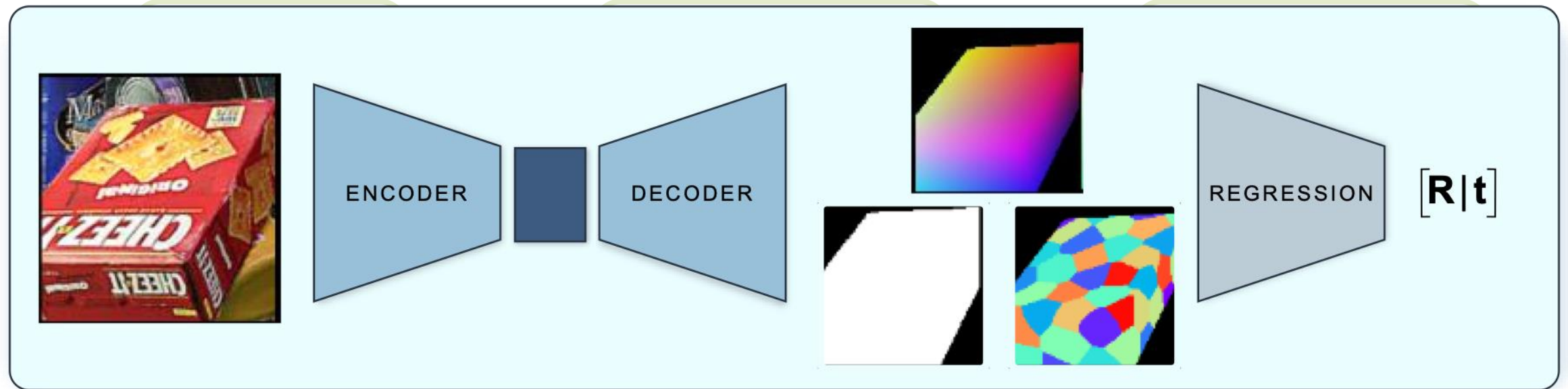
***„Visual Perception
that enables
Interaction“***



Perception system



Perception system



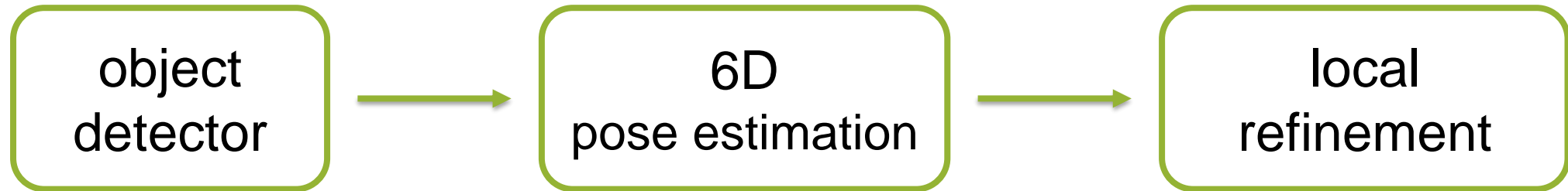
[Ulmer et al., IROS 2023]

Perception system

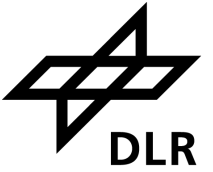
Object Information



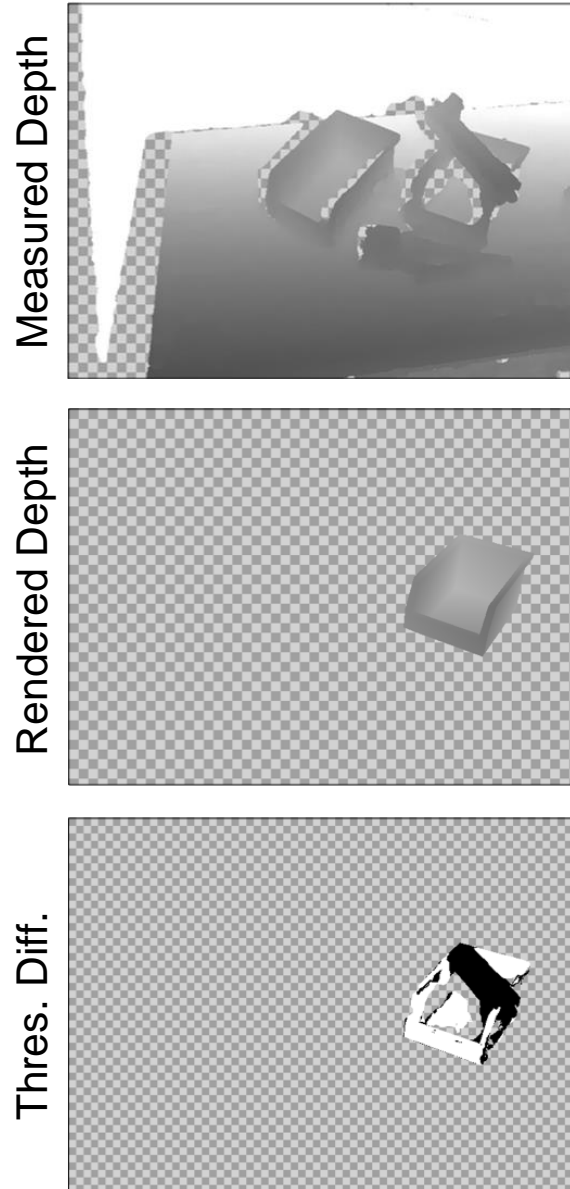
Set-up Time



6D Pose estimation: Dense Correspondences



Pose Plausibility



INVERSE

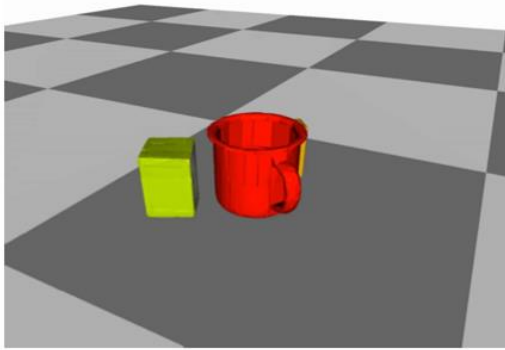


Plausibility score:

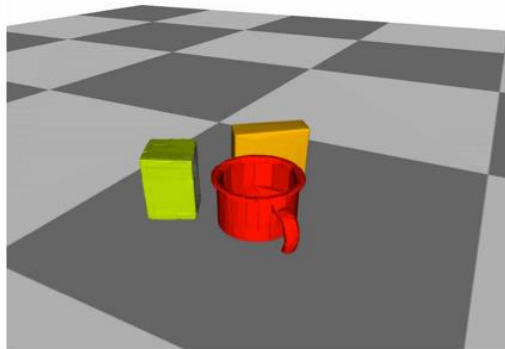
- Visual Information

Pose Plausibility

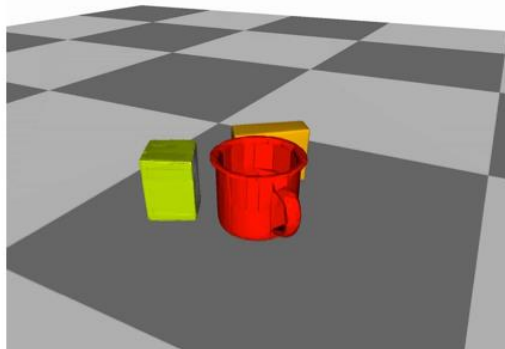
Floating
→ Implausible



Intersecting
→ Implausible



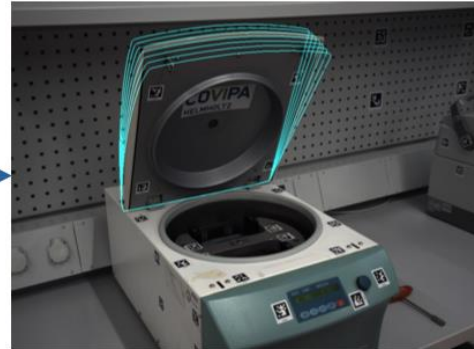
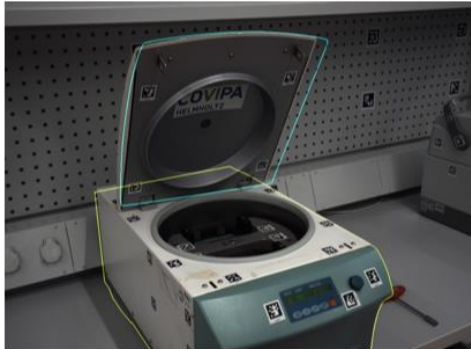
Stable
→ Plausible



Plausibility score:

- Visual Information
- Physics

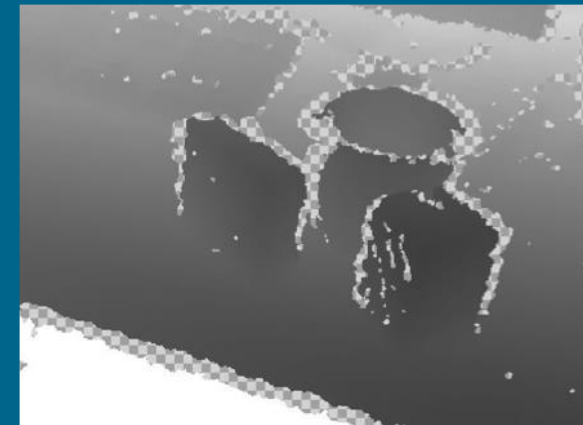
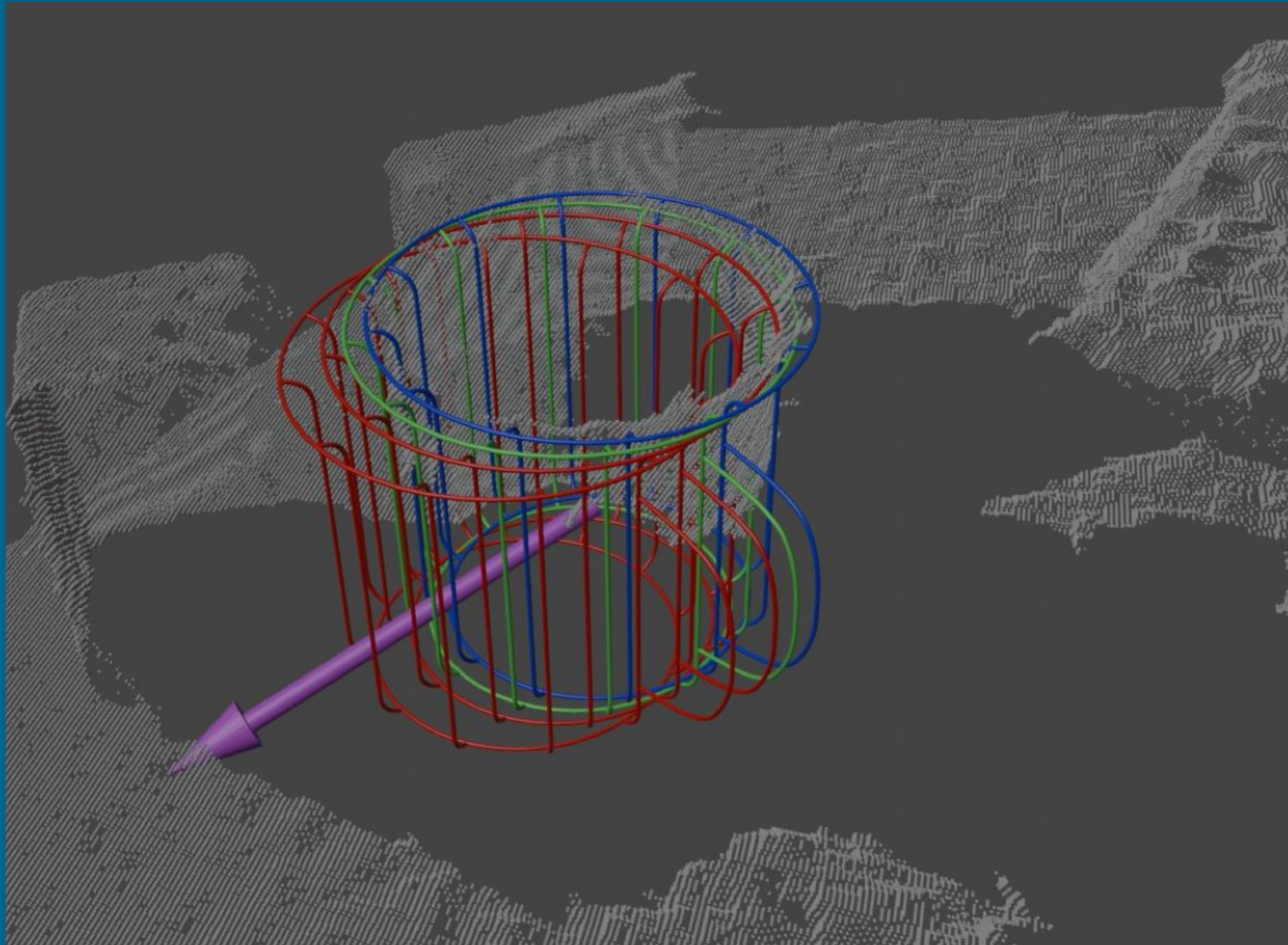
Pose Plausibility



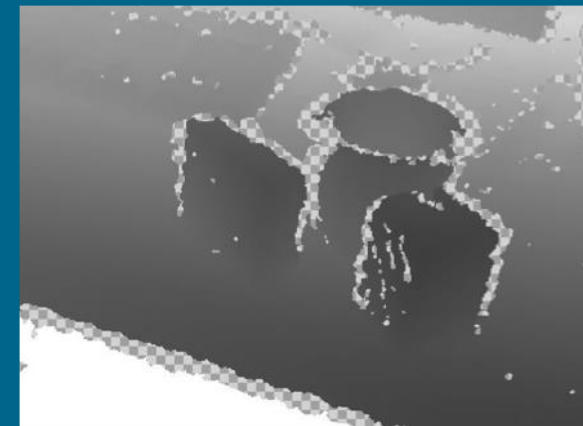
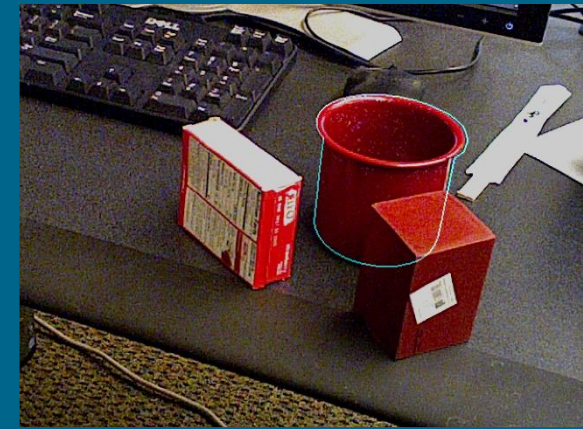
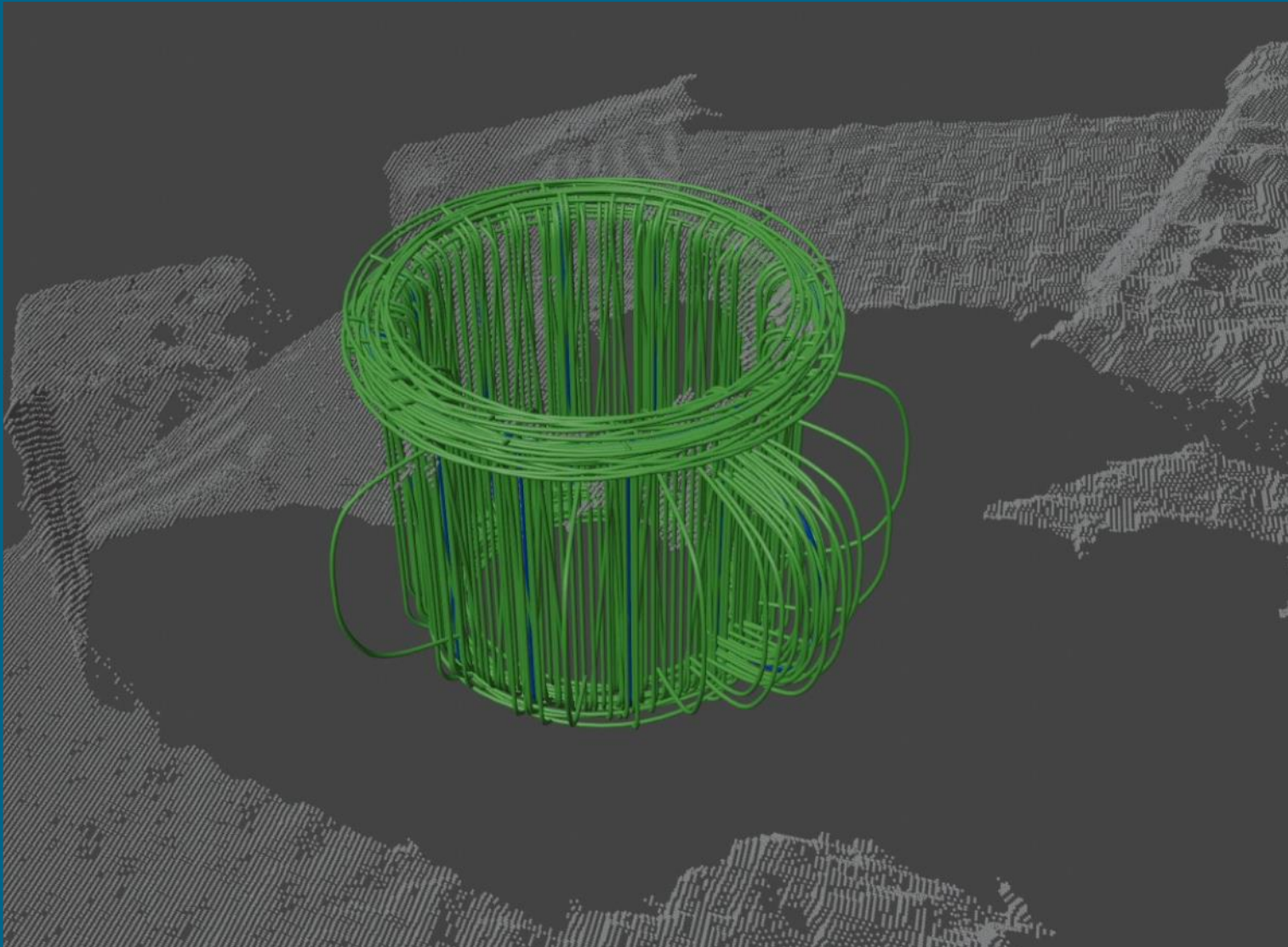
Plausibility score:

- Visual Information
- Physics
- Prior Knowledge

Pose Plausibility

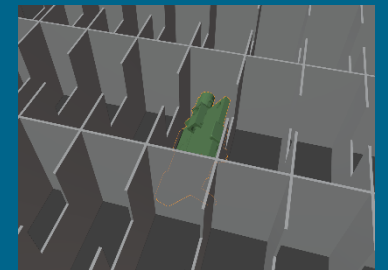
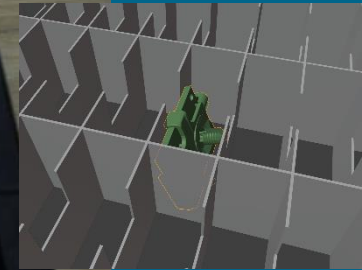
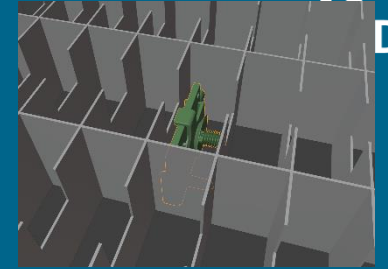
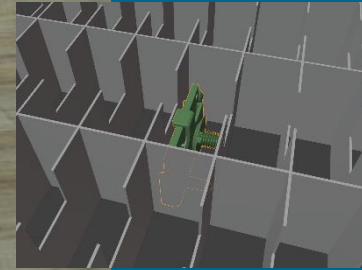


Pose Plausibility

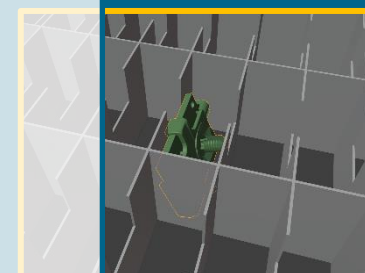
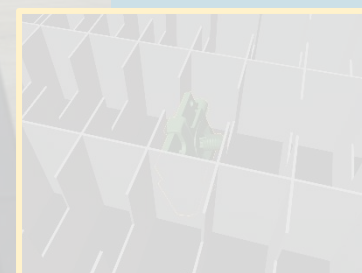
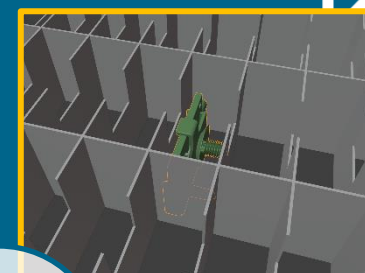
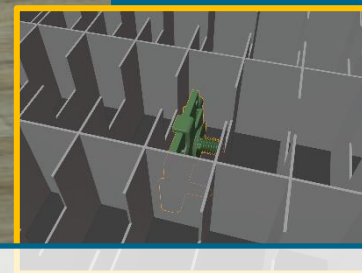




DLR



- Check estimated pose
- Refine pose
- Estimate other possible poses
- Estimate Poses

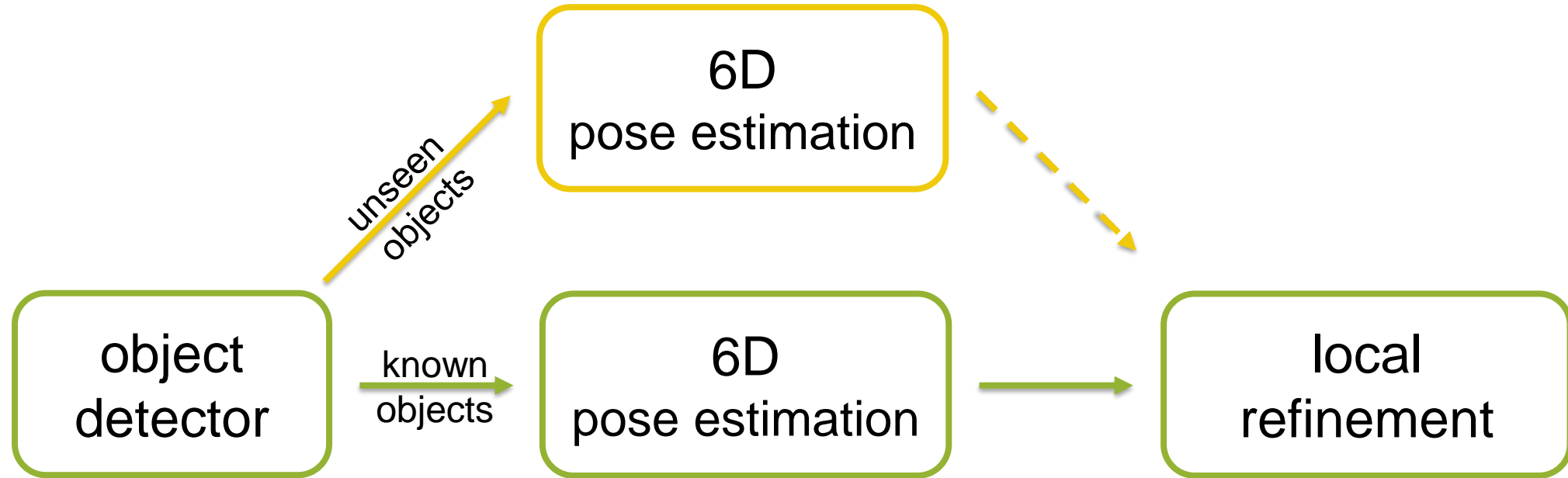
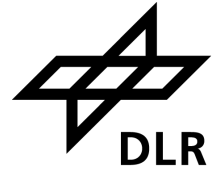


Perception system

Object Information



Set-up Time



Model-based Unseen Object Detection: OC-DiT



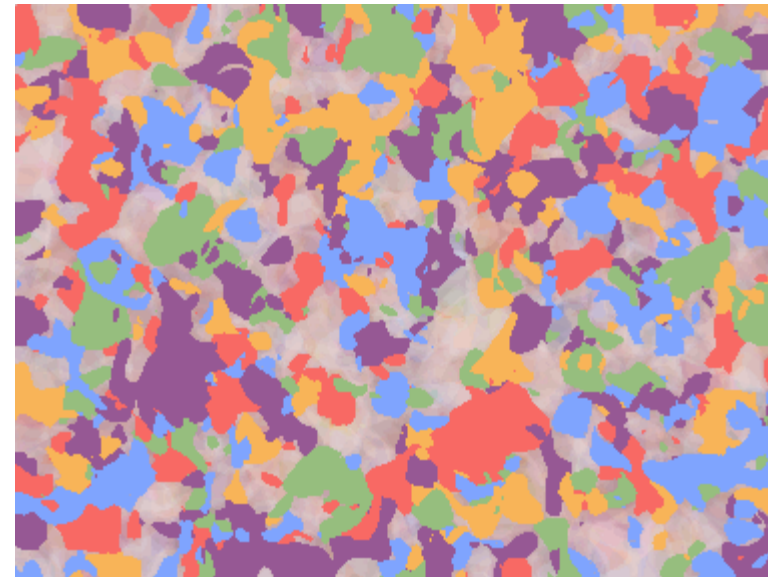
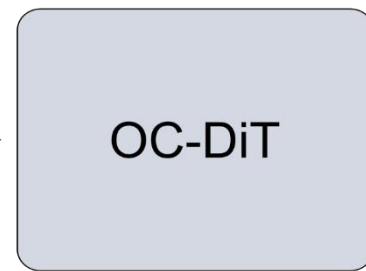
Object Conditions



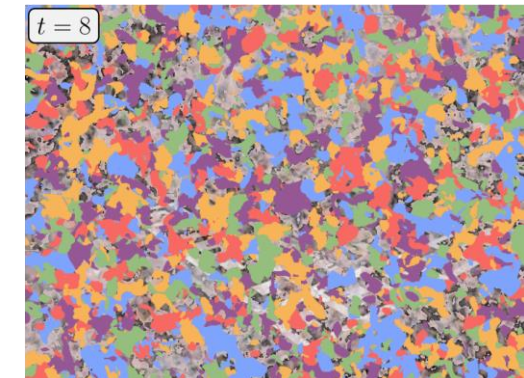
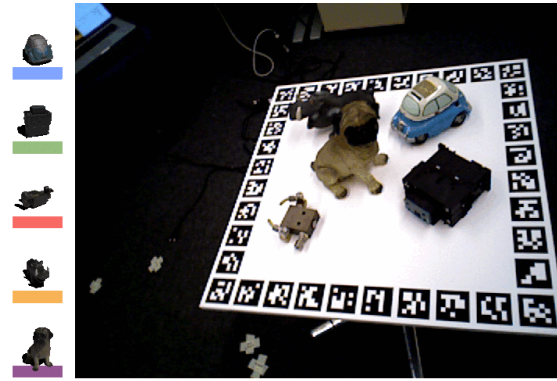
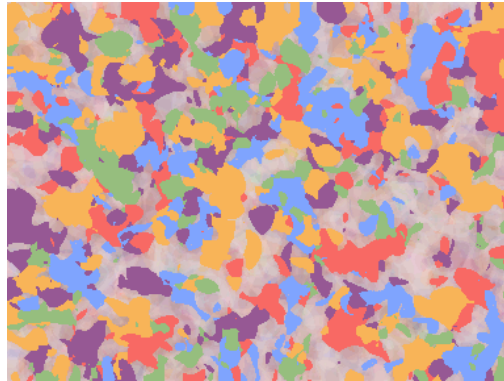
Input Image

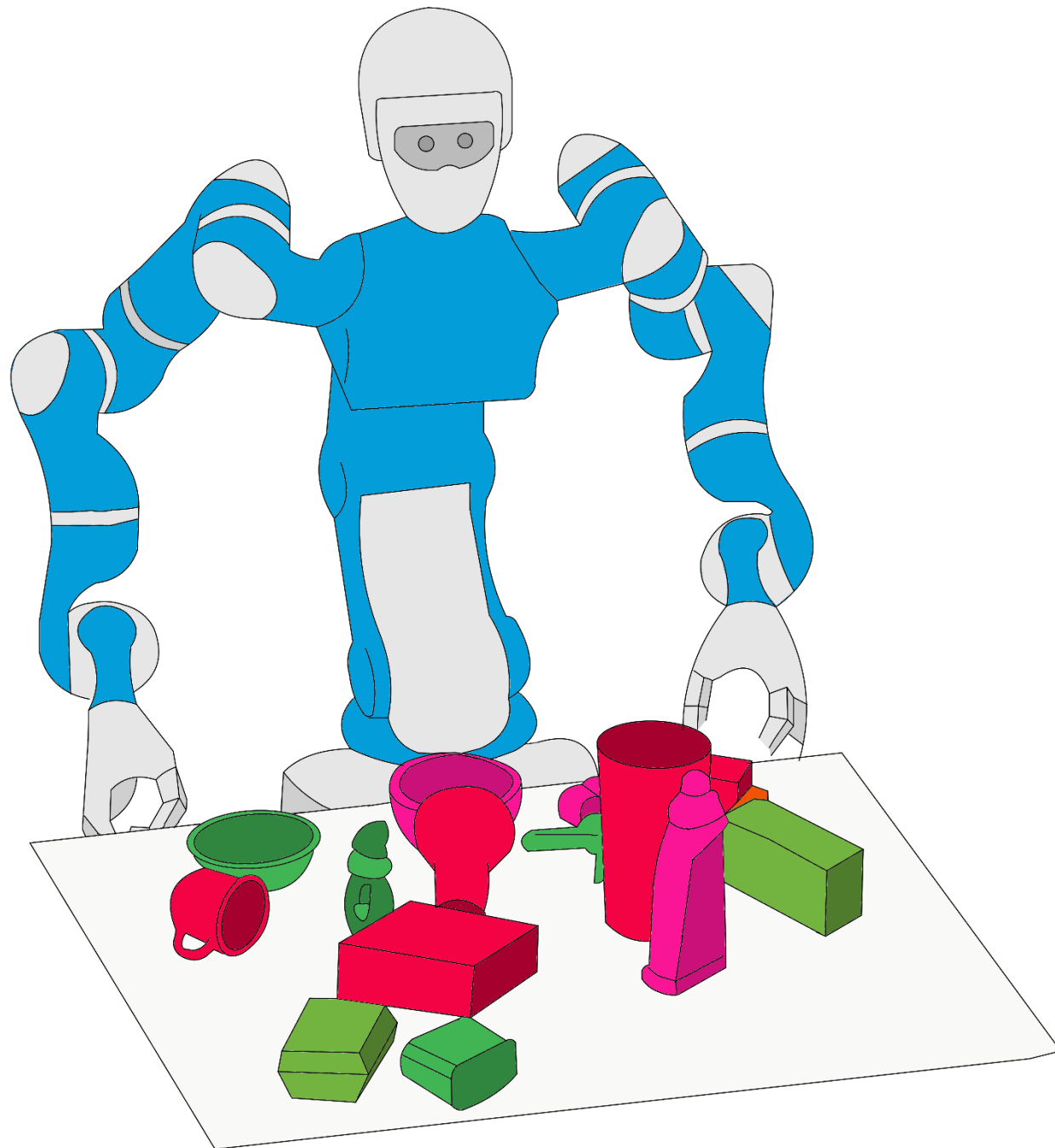
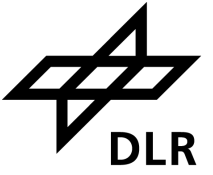


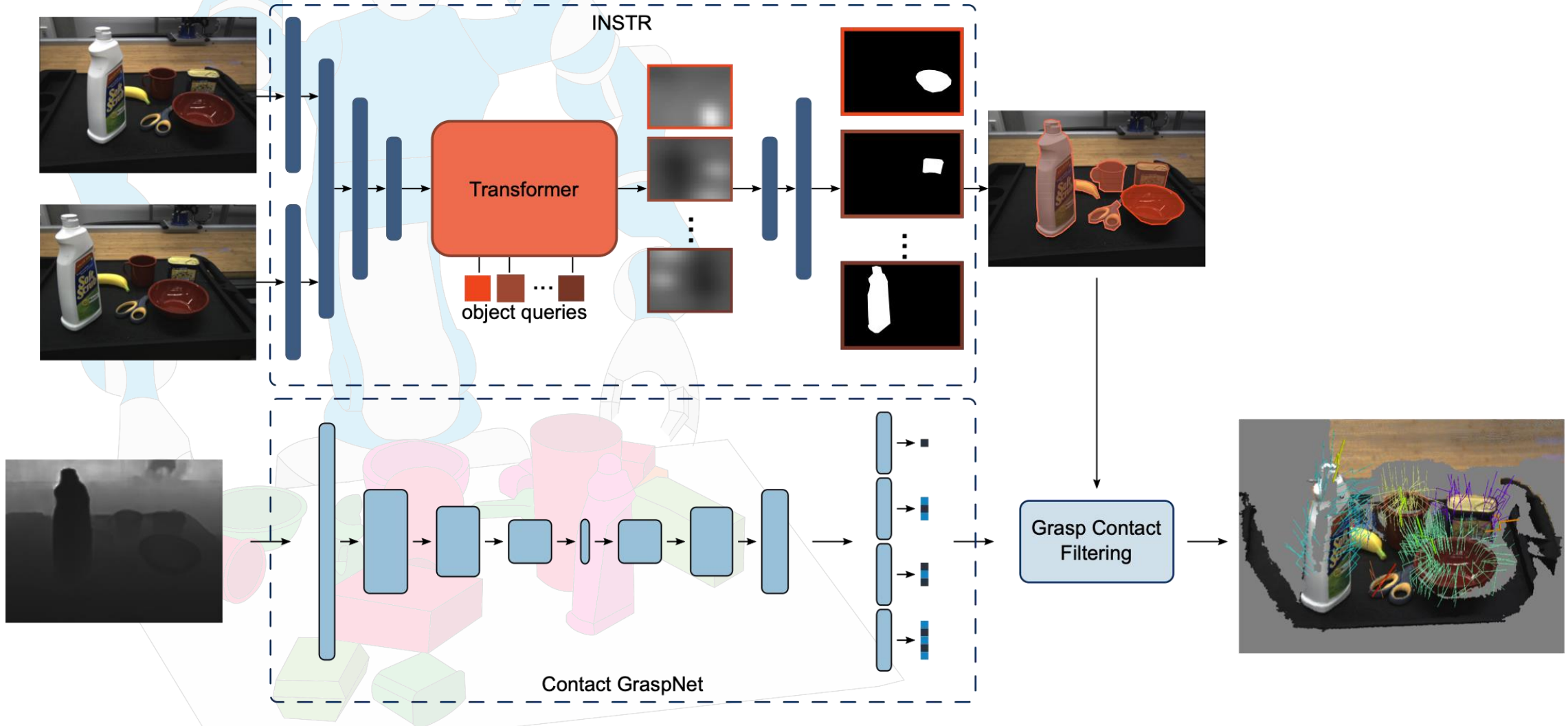
Noise



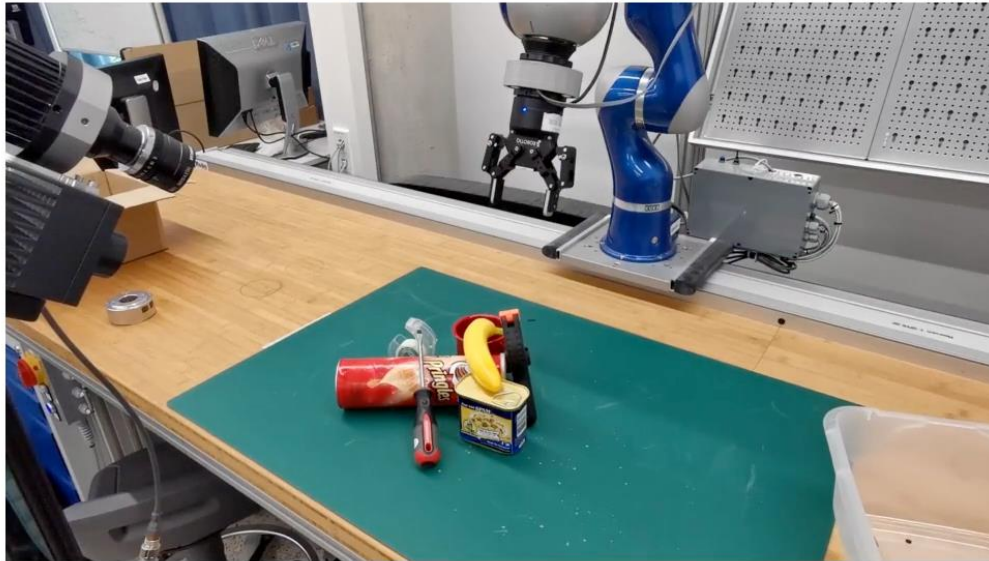
Model-based Unseen Object Detection: OC-DiT



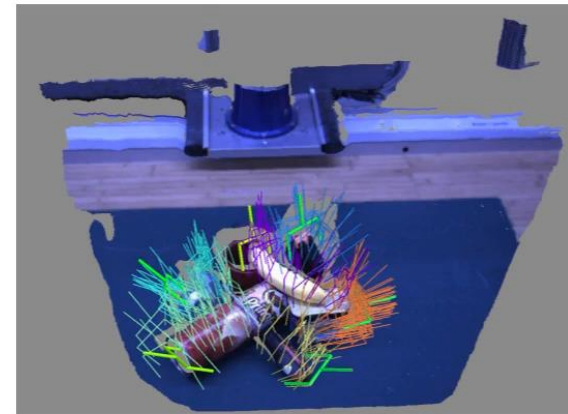




Perception pipeline

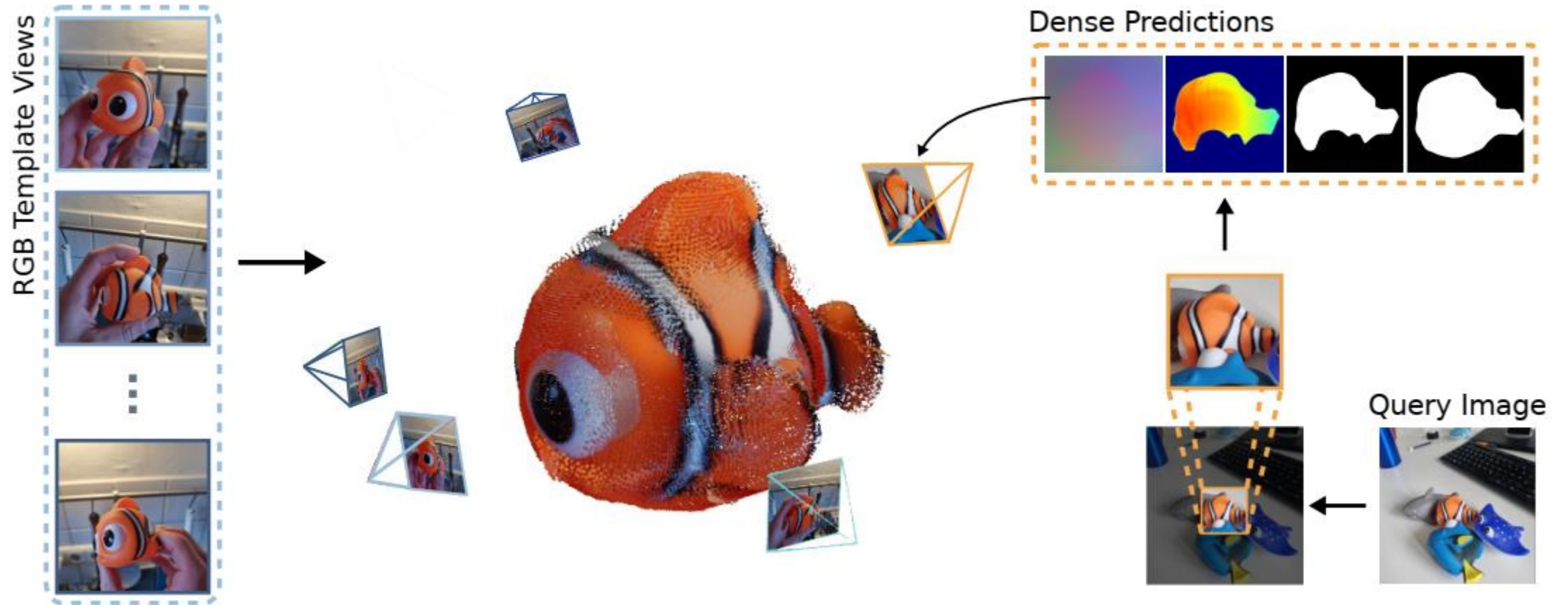


instance masks



6D grasp estimation

Object Perception

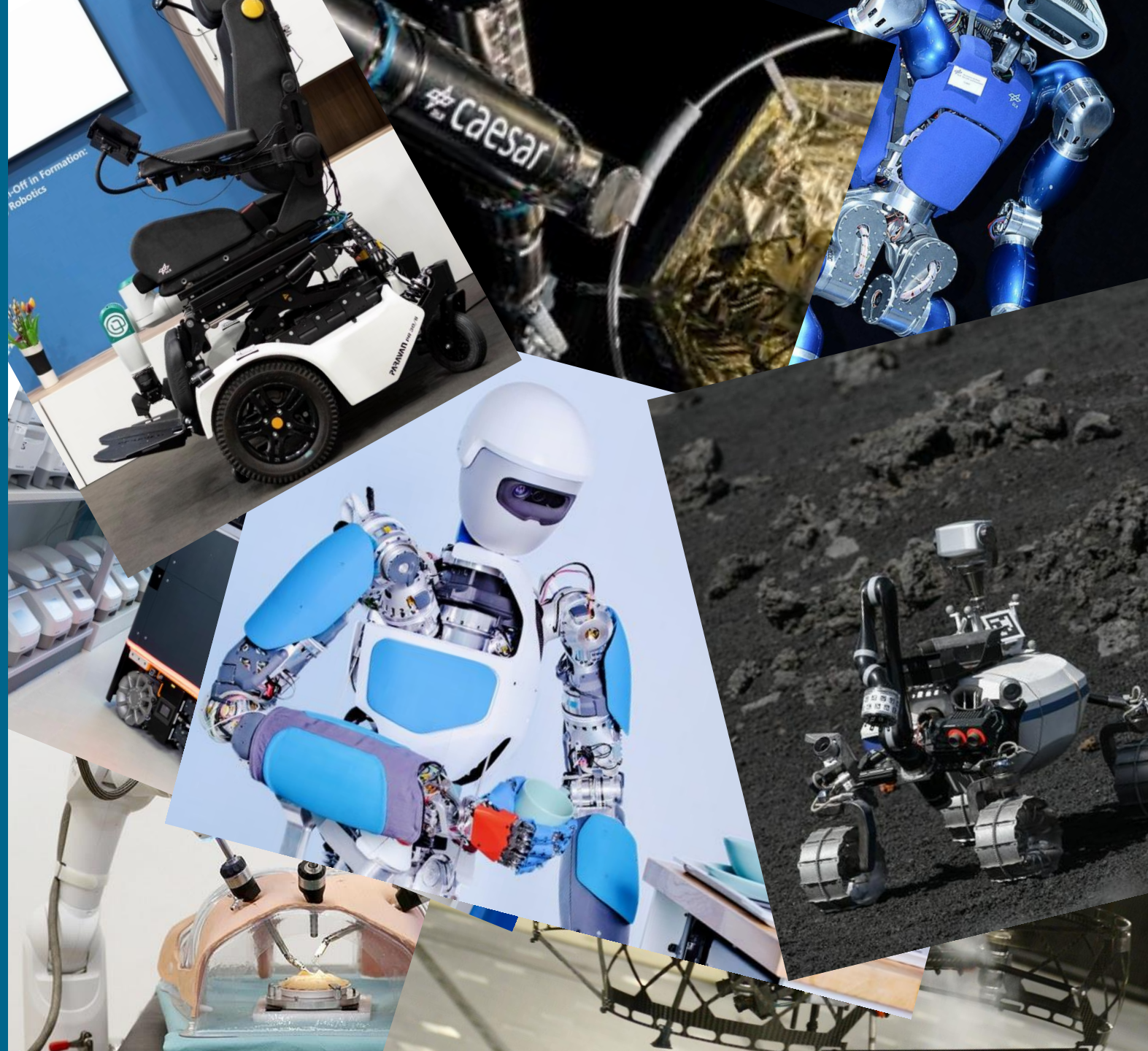


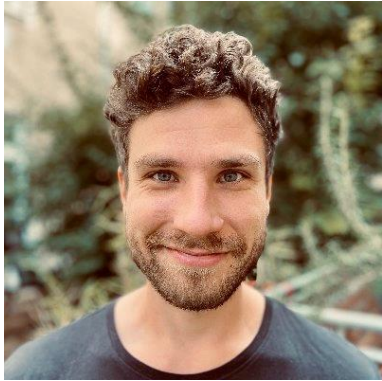
Take Aways

- Qualitative synthetic data
- Exploit Robotic Perception
- Precision vs. Flexibility

Outlook

- Articulated, Deformable Objects
- Category- / Semantic-Level
- Multi-Modality





Max Ulmer



Anne Reichert



Marcus Müller



David Risch



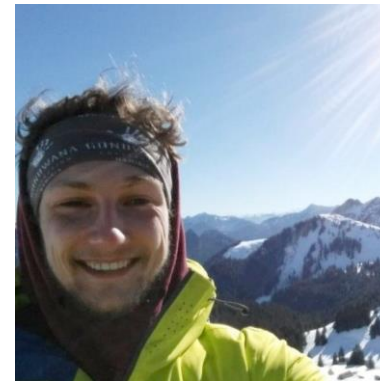
Felix Schiel



Wout Boerdijk



Leonard Klüpfel



Sebastian Jung

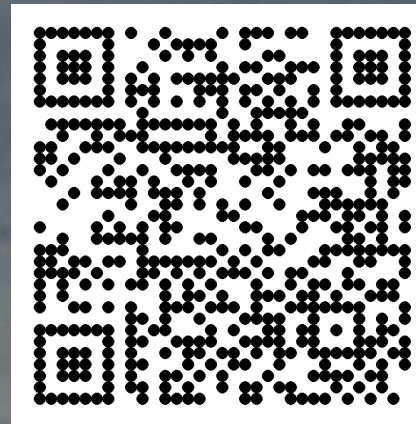


Rudolph Triebel

Maximilian Durner

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Perception and Cognition, DLR-RMC

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ERF 2026 – Workshop #54: 3D Perception as a Key Enabler for AI-Based Robotics

Shiny, reflective, thin – approaches and challenges for 3D perception in sheet metal

Ralph Lange, Head of Robotics at TRUMPF Machine Tools



TRUMPF Machine Tools

Portfolio Overview



Machines for laser cutting



Punching and punch laser processing



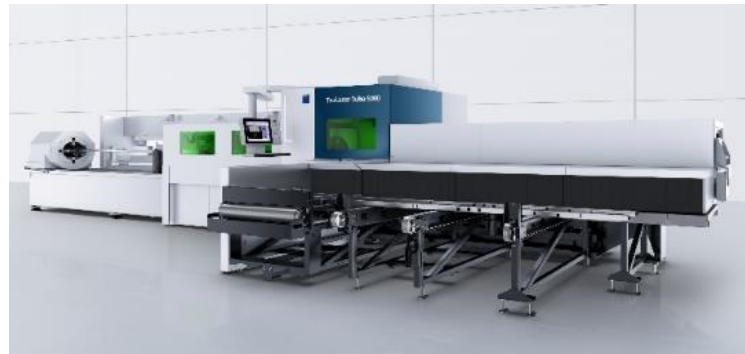
Machines for bending



Machines for laser welding



Machines for tube processing

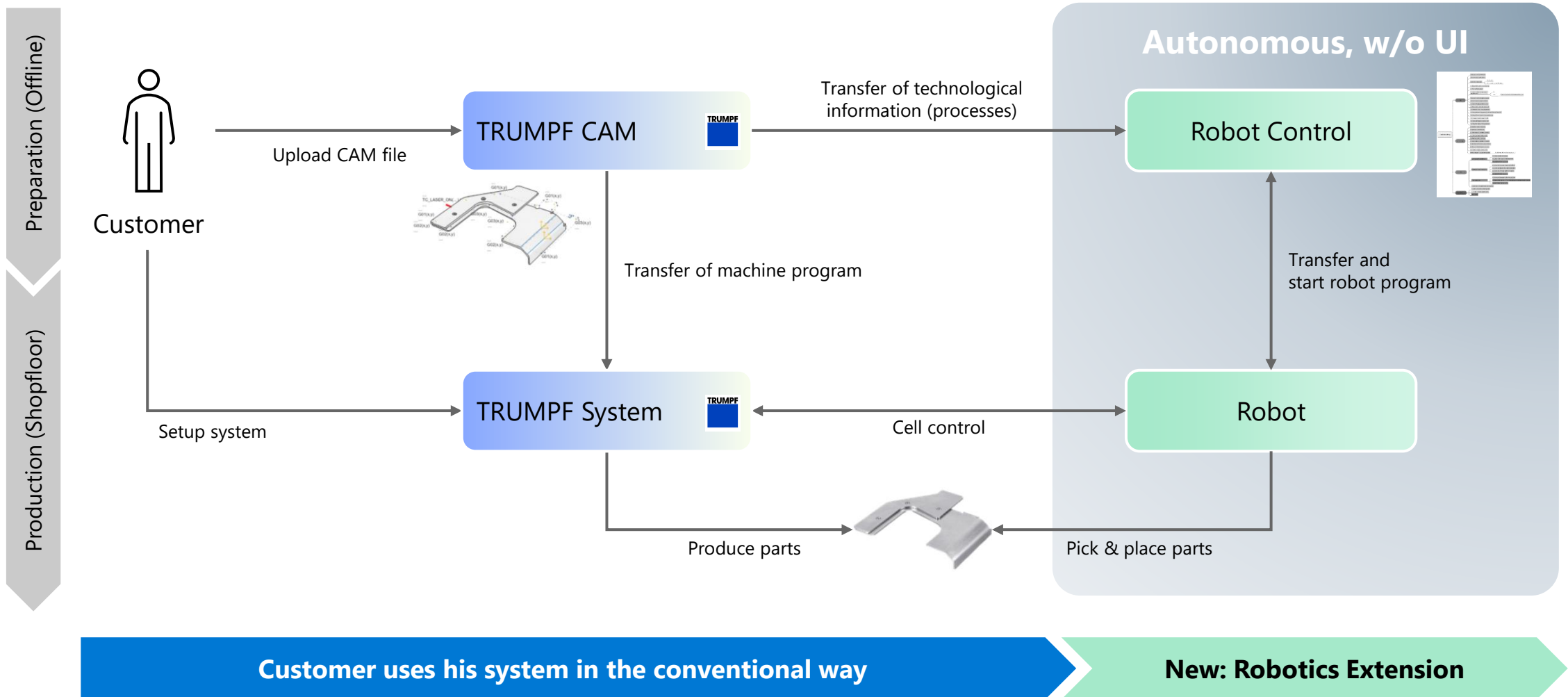


Solutions for a networked production



Autonomous, AI-based Robotics as Enabler for Automation at SMEs

High-level approach



TRUMPF



SortMaster Station and SortMaster Vision

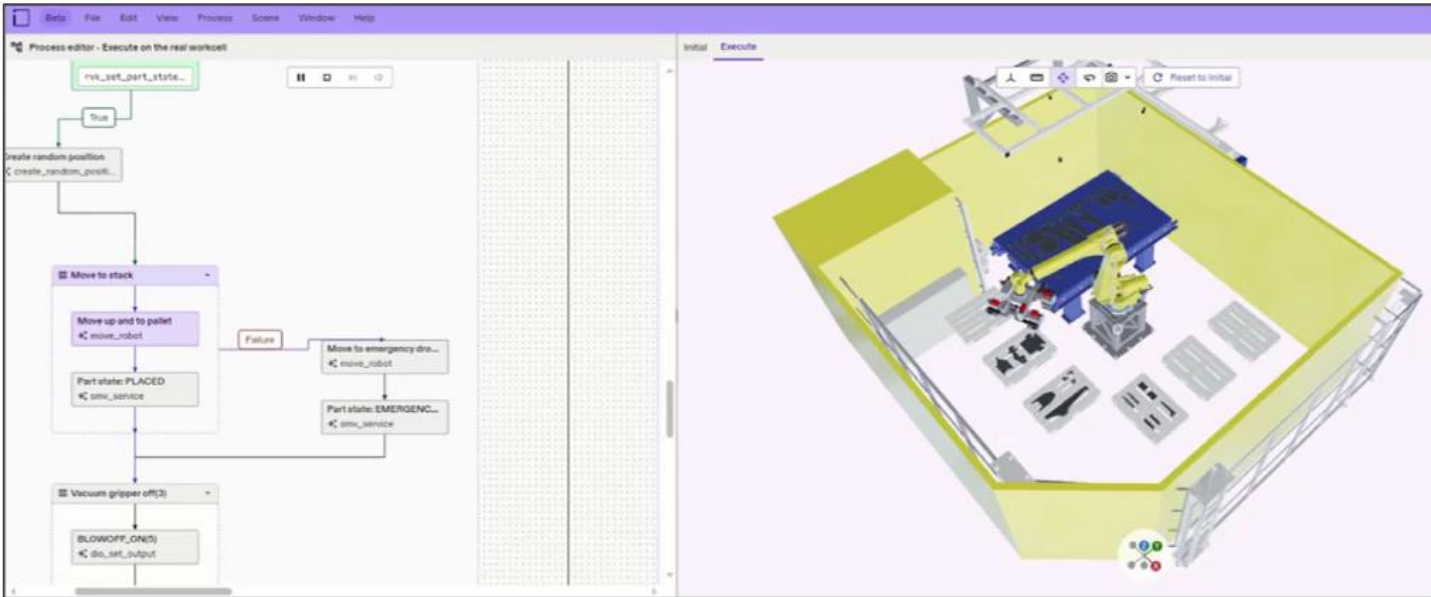
Reliable separation,
autonomous sorting!



https://www.trumpf.com/en_INT/products/machines-systems/automation/separating-and-sorting/sorting/

SortMaster Vision

Consistent use of digital twin with Intrinsic Flowstate



“Skill”-based: Organize the complexity of robotic actions into reusable SW modules

Dynamic motion planning: Real-time motion planning and collision avoidance w/o any adaptations

Transferable: Implement own skills and the know-how into the robot process

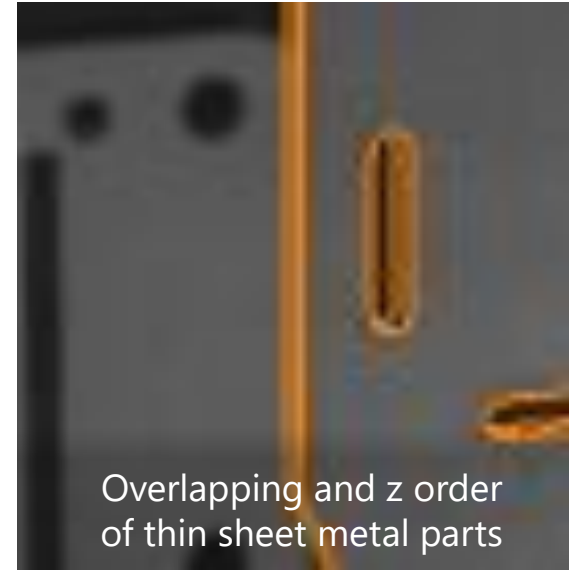
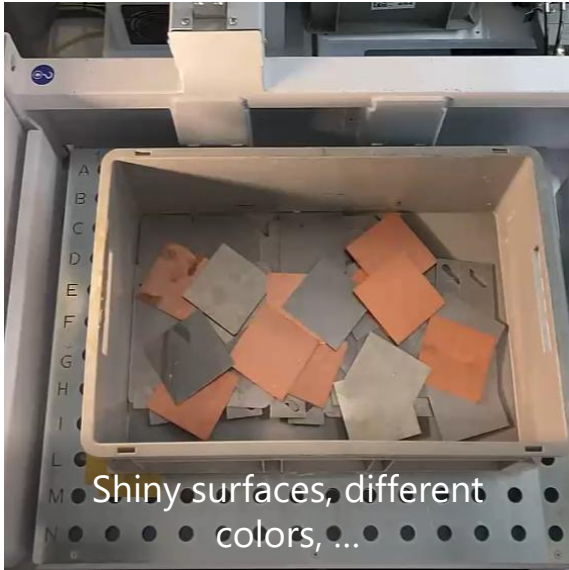
Robot-agnostic control: Intuitive control, independent of the robot OEM

Digital Twin: Test and visualize the mission in simulation, in advance before deployment

Perception: Latest AI vision technology based on foundation models to detect and identify parts

Challenge 1: Robust Perception in Sheet Metal

... at affordable cost



➔ Very good progress on perception in sheet metal with our partner Intrinsic

Open issues:

- How to reduce size and computational complexity of models?
- Combine different aspects (identification, pose estimation, overlapping, slug piece detection) into one model or better keep them separated (maybe with shared backbone)?
- How to handle incremental updates in scene efficiently?

Challenge 2: Holistic Scene Understanding

Key for long-term autonomous operation



- Detecting unusual situations (= contingencies)
- Input for decision making about recovery procedures

Problems:

- Interior of cells may be customized
 - ... even between batches or orders
- Little reference data available
- Decisions must be explainable

Idea: Include operators in maintenance of the digital twin!

Ralph Lange

TW500

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www.trumpf.com

The data space: Introduction to a new way of sharing and using data collectively

Data Sharing

Data Sharing – Cross-Company And Cross-Industry

- Data sharing involves transferring data to other companies or receiving data from them in order to cultivate and use it jointly.
- The greatest potential of data can be realised when combining different sources.
- However, in this day and age, it is virtually impossible for a single actor to have all the data required for comprehensive analyses at their disposal.

58 %

Benefits of data
transfer unclear

47 %

Benefits of data
reception unclear

61 %

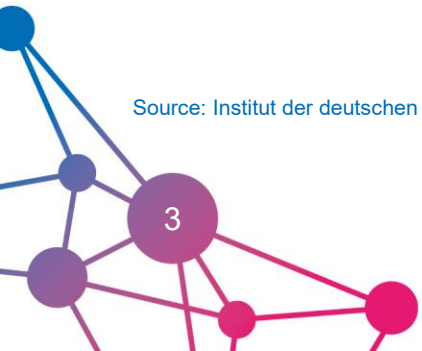
Risk is greater
than the benefit

74 %

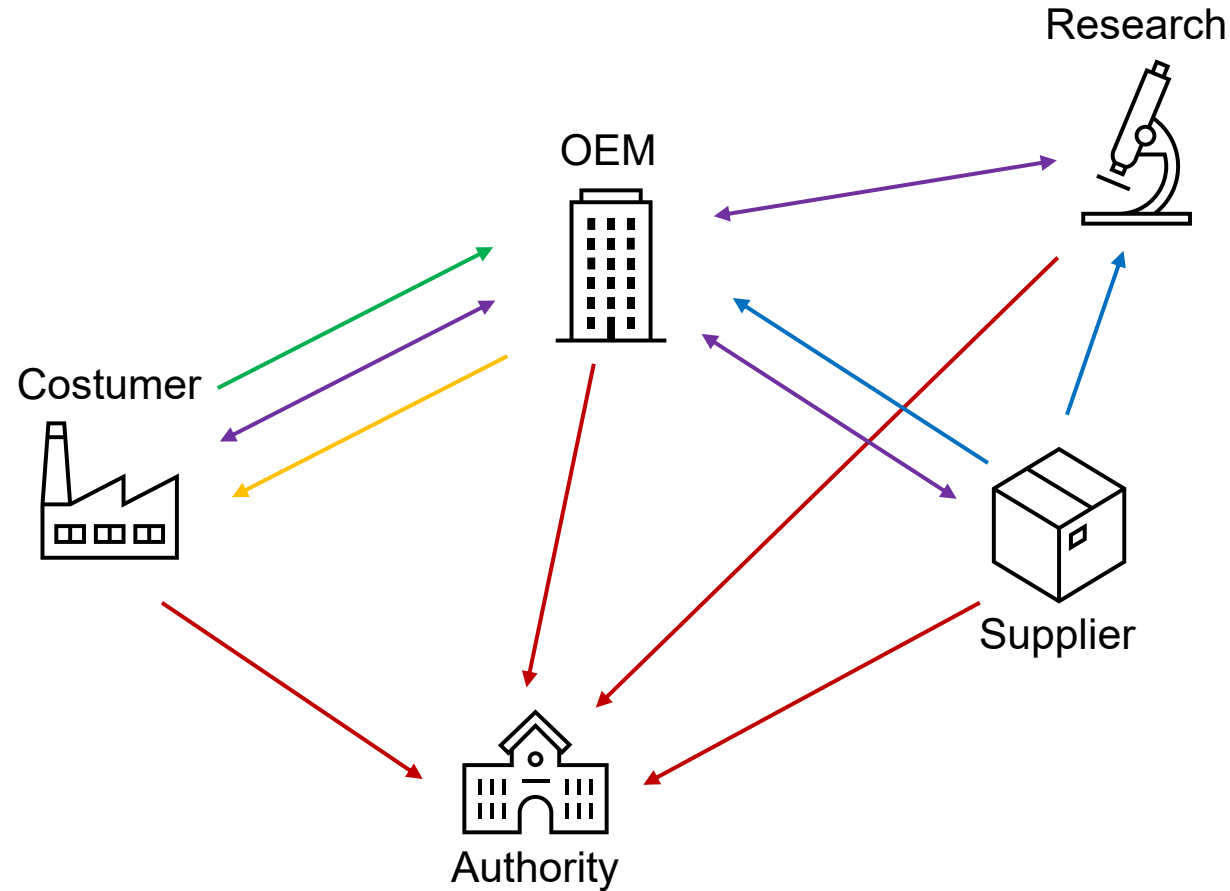
All data
available

N=1051, companies from industry and industry-related service providers in Germany 2023

Source: Institut der deutschen Wirtschaft, Fraunhofer-Institut für Software- und Systemtechnik ISST



Data Sharing – Which Data to Share?

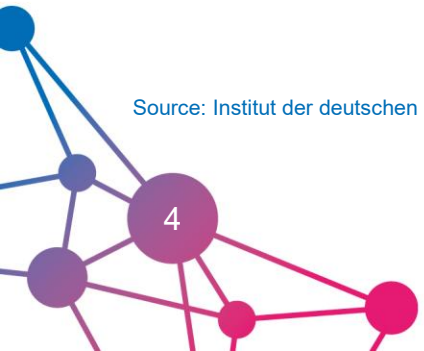


- Product data
- Production data
- Customer usage data
- Supplier data
- Research and development data
- Financial and regulatory data

↑ Most shared
58 %
Financial data

↑ Least shared
33 %
Research and development data

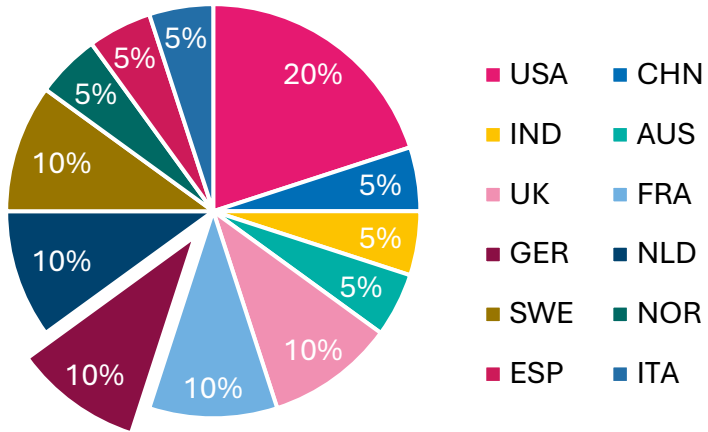
Source: Institut der deutschen Wirtschaft



Data Sharing – Business Benefits

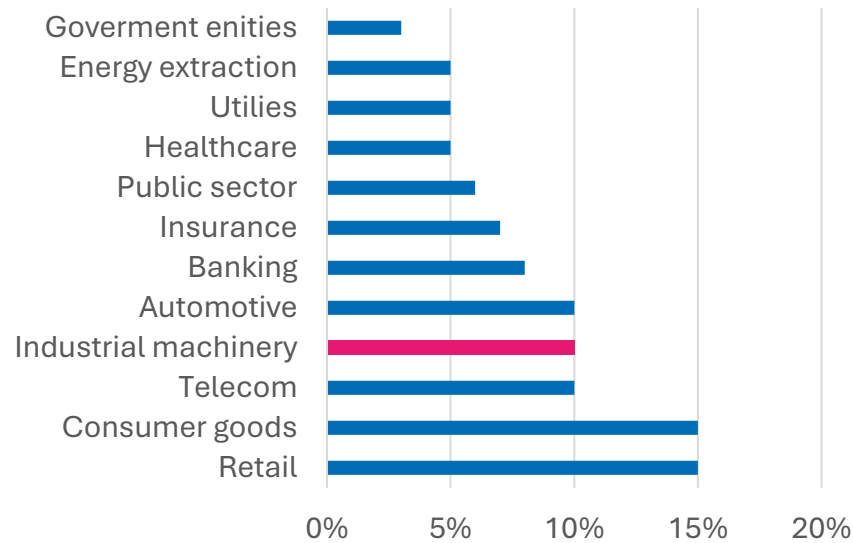
Investigated Countries

N=750



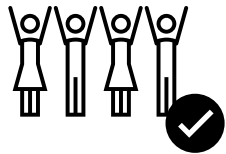
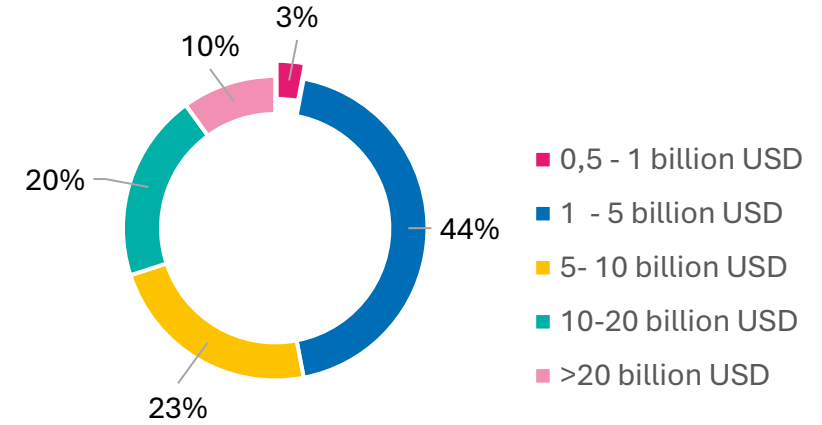
Investigated Sectors

N=750



Global revenue/budgets

N=750



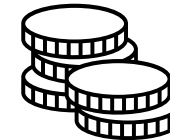
+15 %*

Customer satisfaction



+14 %*

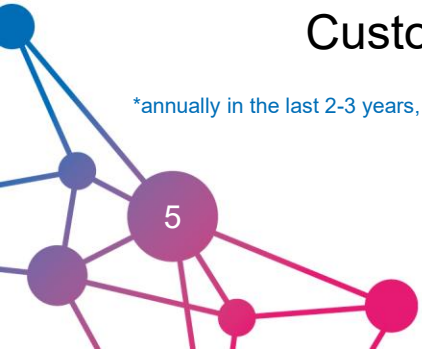
Productivity/efficiency



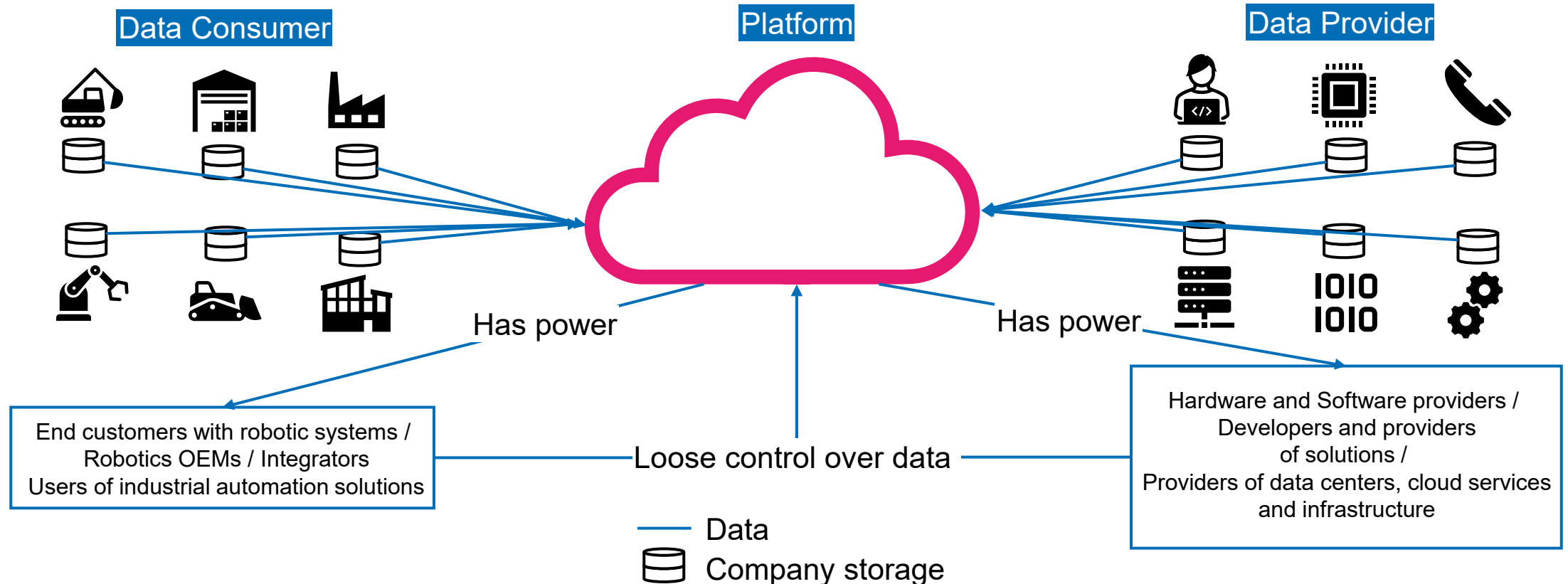
-11 %*

Costs

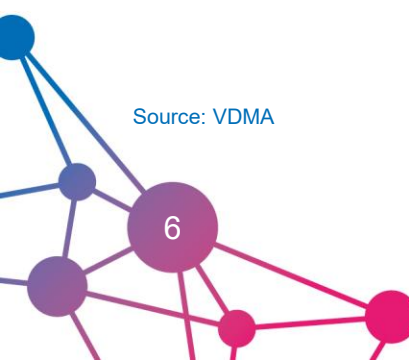
*annually in the last 2-3 years, Source: Capgemini 2021



Data Sharing – Data platforms promise integration but deliver silos, dependencies and monopolization



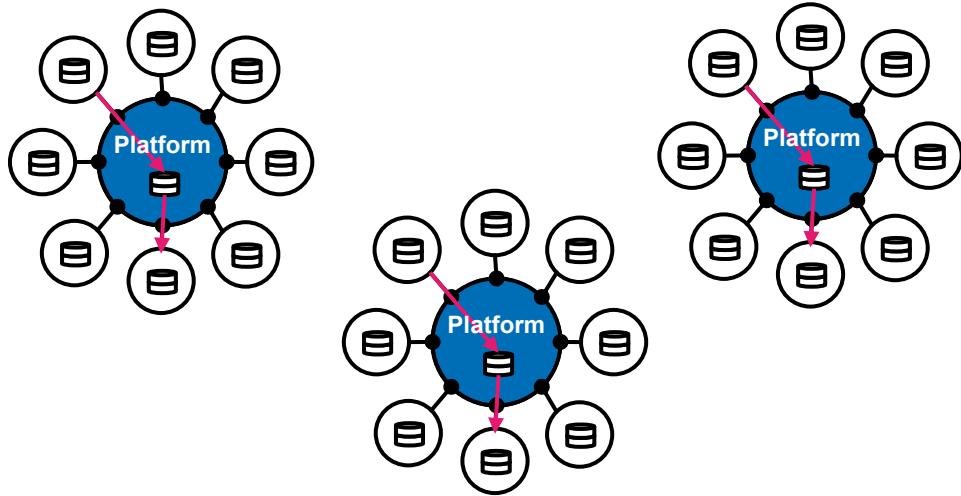
Source: VDMA



Data Spaces And Digital Ecosystems

Data Spaces And Digital Ecosystems – Improving Digital Collaboration

Platform or manufacturer orientated



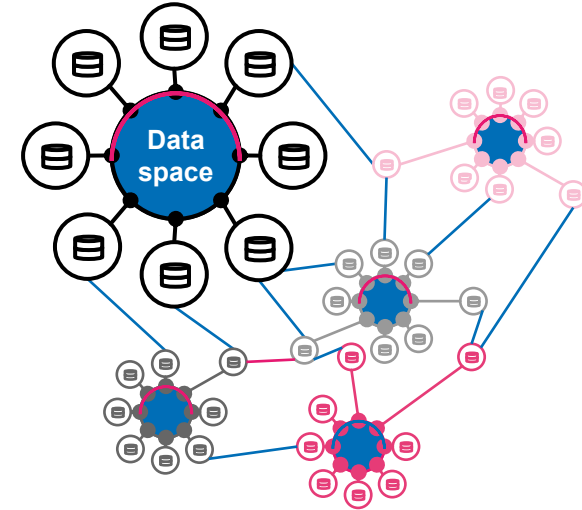
Central architecture

Central data storage

Silos, Lock-In, no trust, monopolies

VS.

User orientated or interoperable



Decentral and federated structure

No central data storage , control

Interoperability, sovereignty, trust

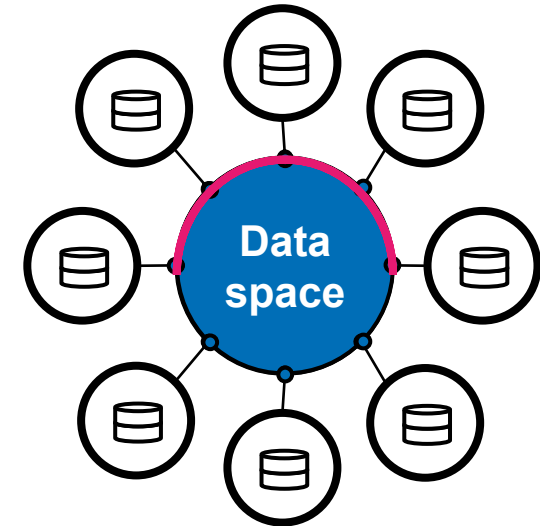
Source: VDMA

Data Spaces And Digital Ecosystems – Scalable peer-to-peer connections

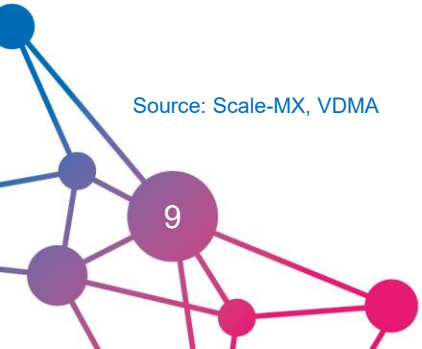
A **data space** is a **trusted framework** in which **cross-industry and cross-company information** can be exchanged **automatically** and **sovereignly** in order to increase **efficiency** and **enable new value creation**.

A **clean interface** between companies through:

- 👉 Decentralisation
- 👉 Interoperability
- 👉 Market access for all companies
- 👉 Data sovereignty
- 👉 Shared infrastructure



Source: Scale-MX, VDMA

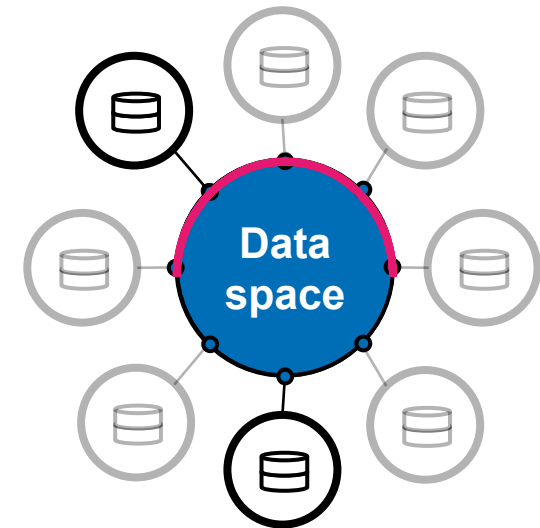


Data Spaces And Digital Ecosystems – Scalable peer-to-peer connections

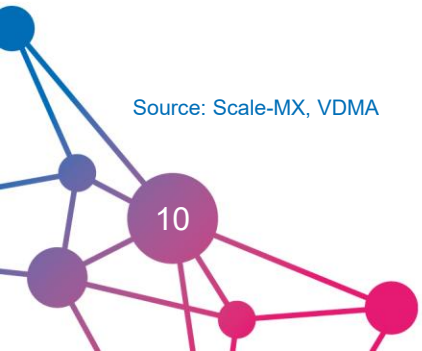
A **data space** is a **trusted framework** in which **cross-industry and cross-company information** can be exchanged **automatically** and **sovereignly** in order to increase **efficiency** and **enable new value creation**.

A **clean interface** between companies through:

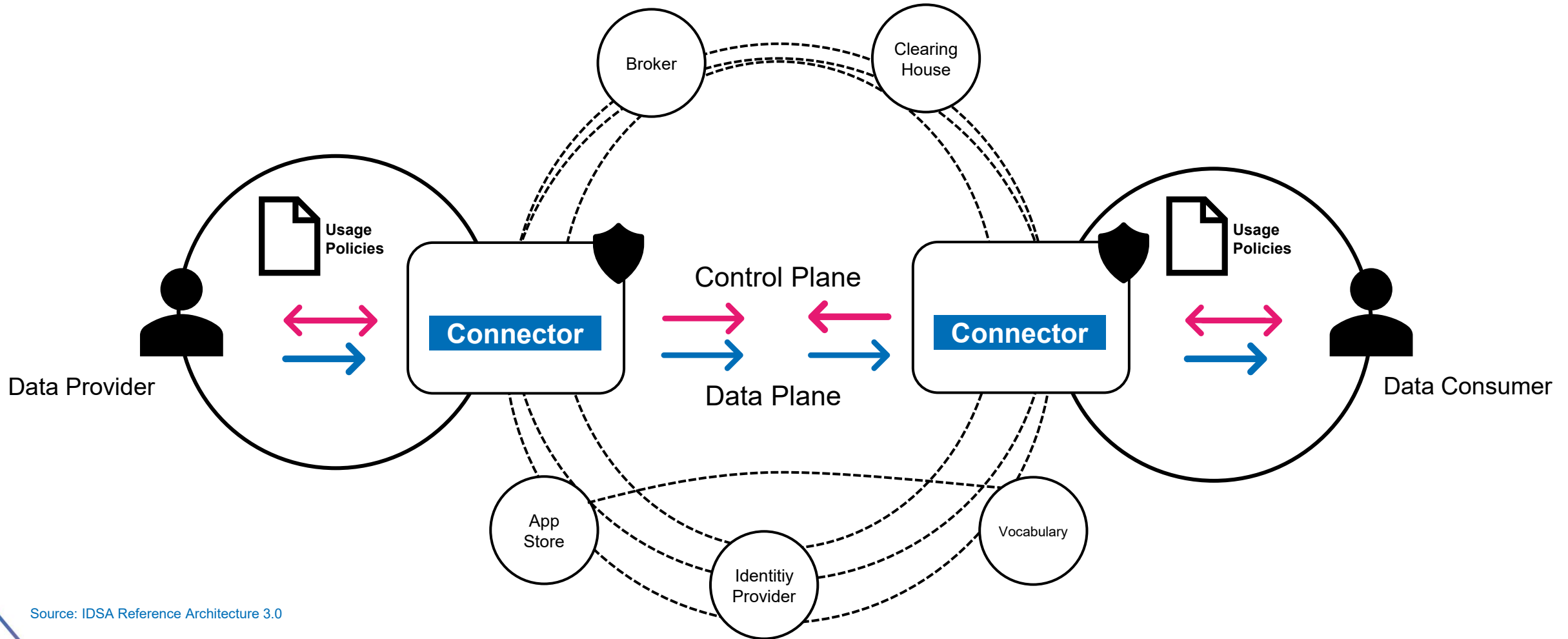
- 👉 Decentralisation
- 👉 Interoperability
- 👉 Market access for all companies
- 👉 Data sovereignty
- 👉 Shared infrastructure



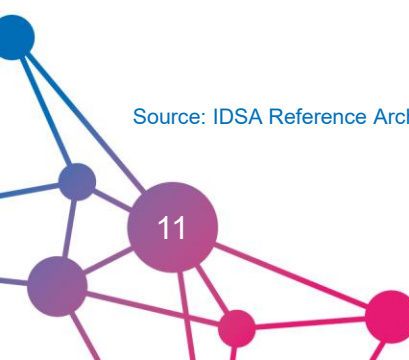
Source: Scale-MX, VDMA



Data Spaces And Digital Ecosystems – Architecture



Source: IDSA Reference Architecture 3.0



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AI-based Perception of Seen and Unseen Objects

Dr. Michael Suppa

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Robots Need 3D Vision
WHY IMPLEMENT ROBOT VISION?



Today's robotic systems cannot handle unorganized items.



Many existing processes are labor-intensive.



Some tasks are impossible to automate.



Pre-organization and standardization need (down)time, space, money.

Three Major Trends in Robotics

#1

**GOOD DATA
INSTEAD OF
BIG DATA**

- Generation of detection templates based on CAD data
- Simulations create realistic training data using model-knowledge

**IMPLEMENTATION
WITH MINIMUM
EFFORT**

#2

**PLUG-AND-
PRODUCE**

- Integrators and end users can add modules on the same platform
- Smart sensors enable distribution of computing resources

**SCALABLE
MACHINE
LEARNING
PLATFORM**

#3

EASE-OF-USE

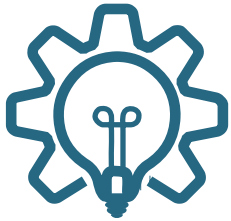
- AI reduces parameterization effort for the user
- Web interfaces with wizards enable non-expert use

**EASE-OF-USE FOR
VISION-NEWBIES**

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Challenge: Automation of Complex Tasks
REQUIRES CONSIDERATION OF VARIATIONS

Environment



Lighting conditions
Perspective

Objects



Material varies from
shiny and transparent
to translucent and black
Different sizes and distances

Application

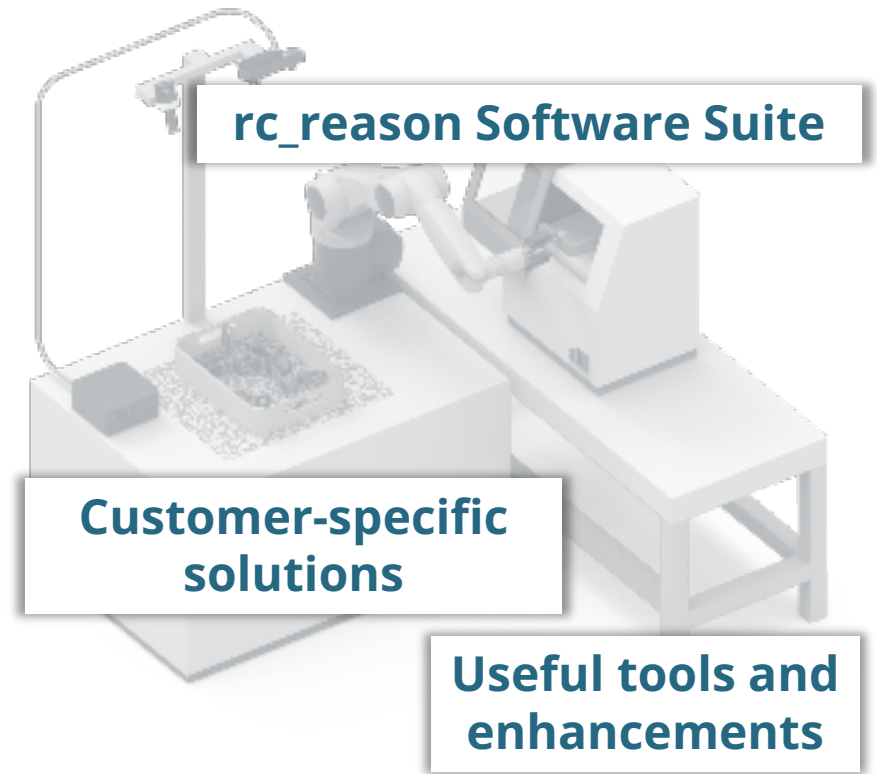
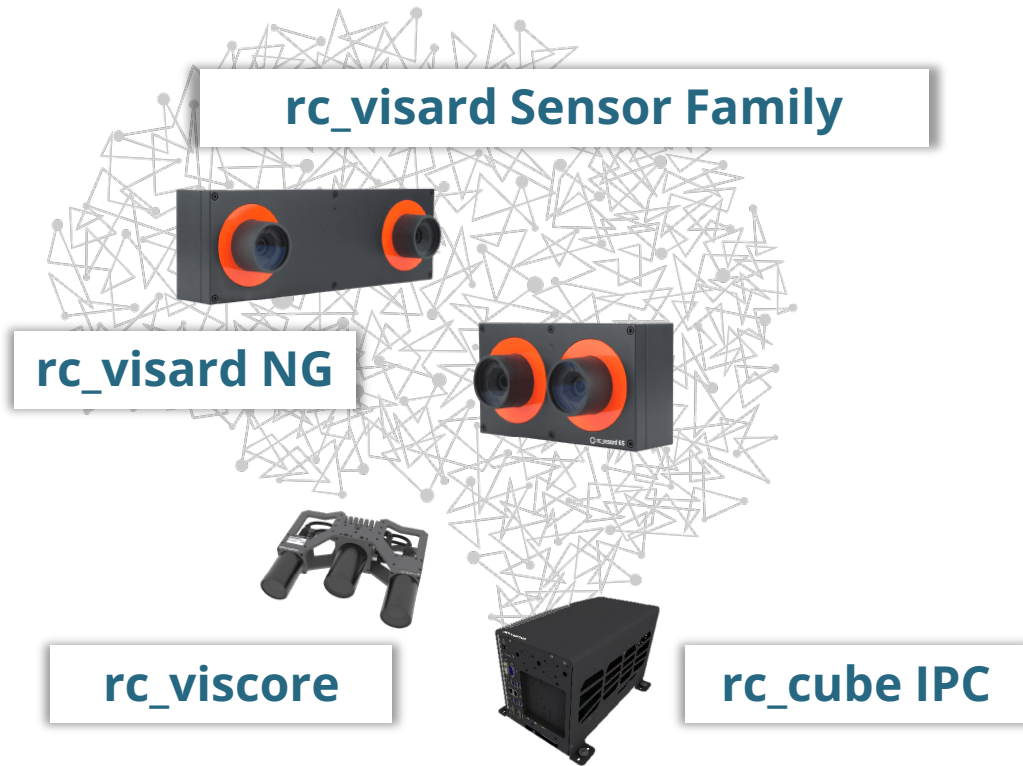


Parameterization requires
expertise
Test & implementation time
>97% availability
(successful picks)

Data must cover all variations: Hard (impossible) to achieve with real data/ human input.

3D Stereo Vision for Your Robot

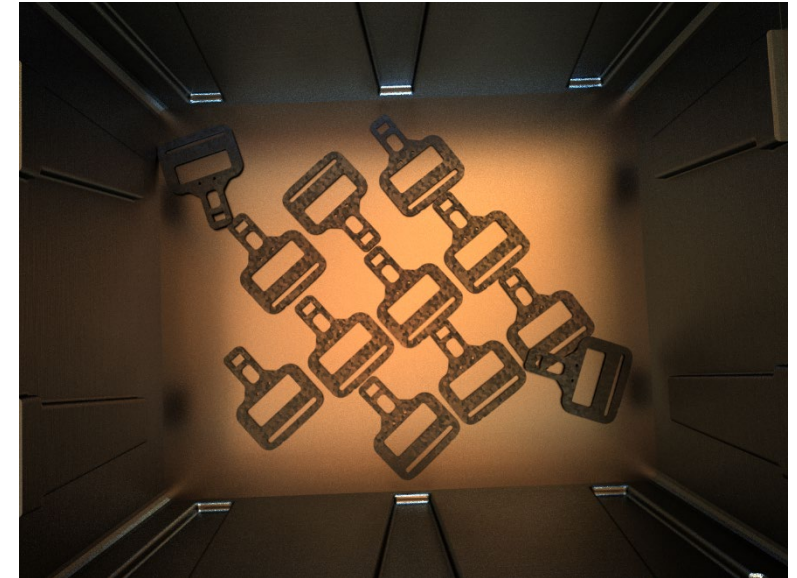
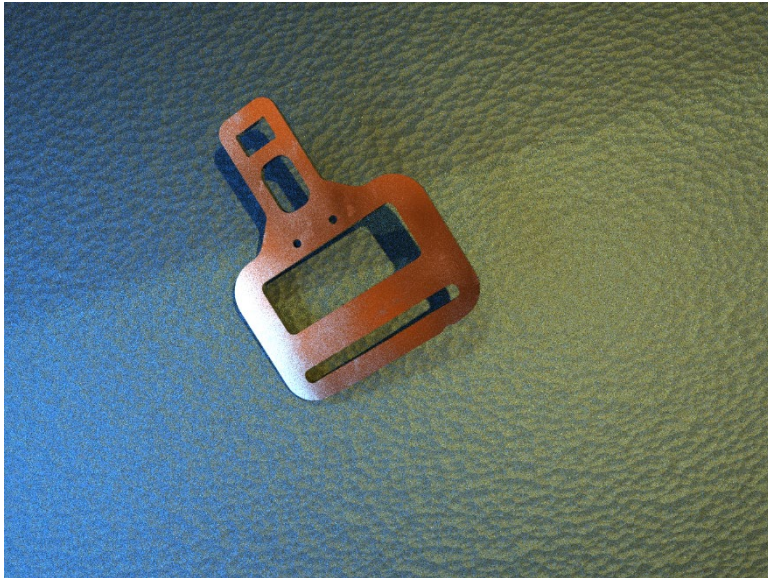
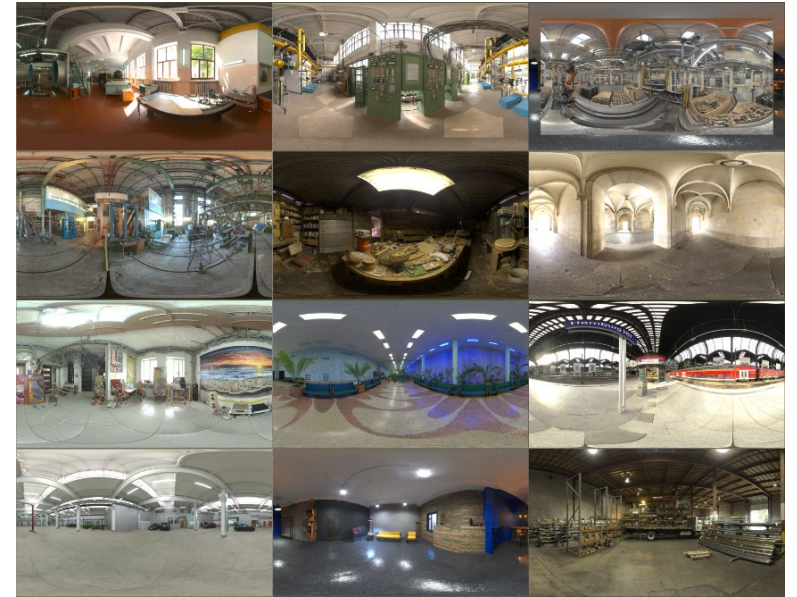
Advanced AppliedAI Software



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AI-Based Detection of Known Items TRAINING WITH SYNTHETIC DATA

- Training data from a photorealistic simulation environment
- Material library, lighting simulation, CAD-models
- Support for various applications and parts
- Automated creation of templates as a cloud service



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The Magic AI Ingredient: Synthetic Data



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AI-based Detection of Unseen Items TRAINING WITH SYNTHETIC DATA

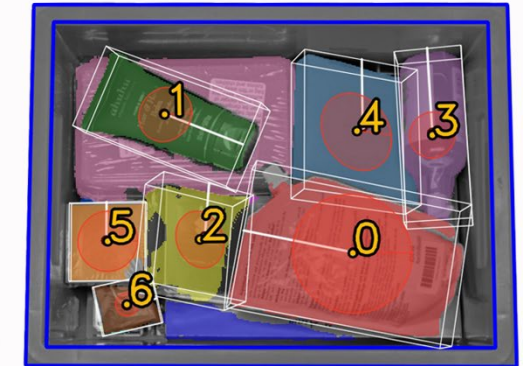
- Training data from a photorealistic simulation environment
- Material, texture, lighting simulation
- Neural network per object category trained on dataset and refined with synthetic data
- Object categories allow for data and quality control



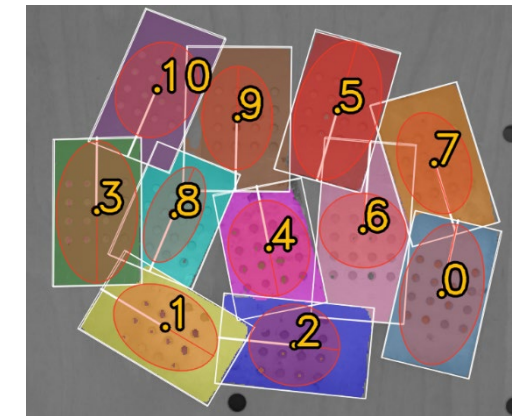
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rc_reason ItemPickAI
OBJECT CATEGORIES

- Neural networks enable robust segmentation to ensure the grasp point is centered and the object's orientation is determined for proper placement
- Training is based on object categories with large image datasets
- Currently supported categories:
 - **Bag:** various volumes and fill levels
 - **Consumer Goods:** Wide range of packaged everyday items
 - **Sheet Metal:** flat metal parts of various shapes and surface qualities
- Additional categories coming soon



Object Category: Consumer Goods

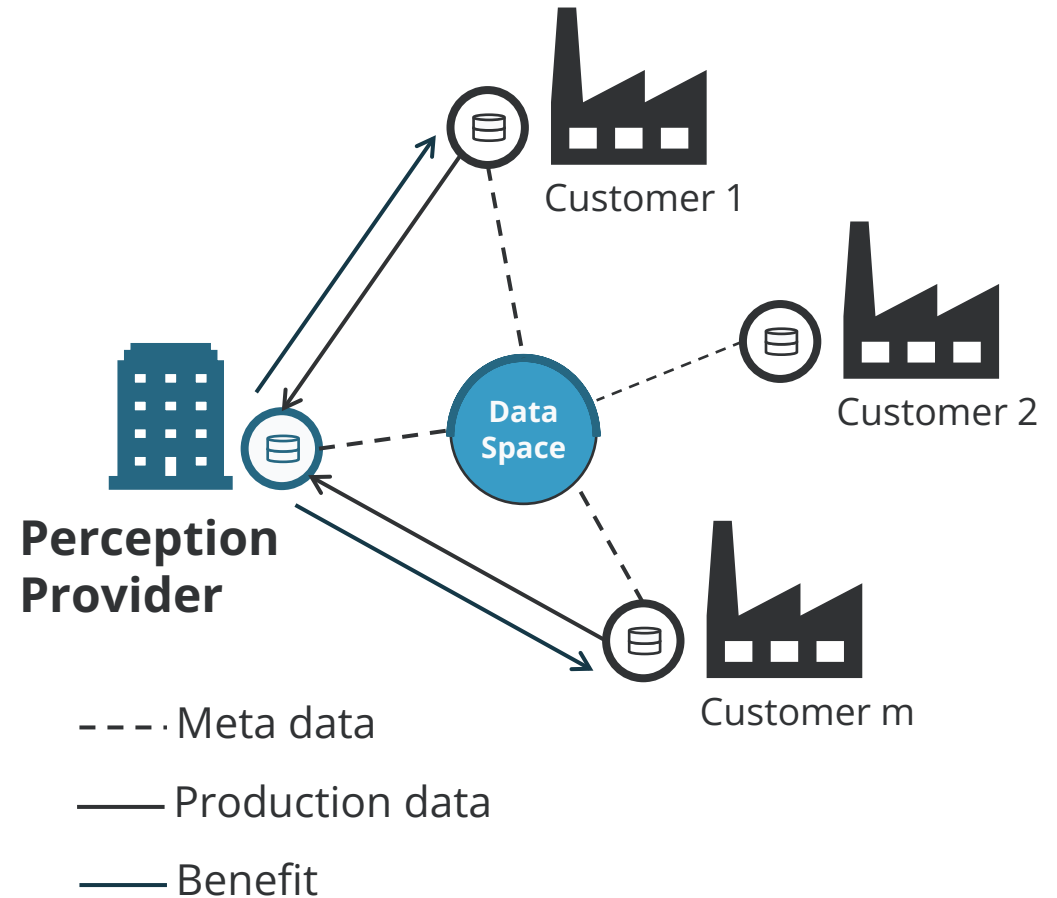


Object Category: Sheet Metal

 Data Pooling

- Customers are free to decide whether to make data from their systems available to improve perception modules or AI models in general.
- The provider of the perception module has the option to reward users for providing data
- All customers get the improved model

Possibility to manage and further develop software modules over the entire life cycle via one interface with individual access rights



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Round Table Discussion



Dr. Nicolas Alt
Siemens AG



Maximilian Durner
DLR



Dr. Ralph Lange
Trumpf



Dr. Lukas Solbach
VDMA



Dr. Michael Suppa
Roboception

Closing

Slides will be published on the website:

<https://roboception.com/join-our-workshop-at-the-european-robotics-forum-erf-2026-in-stavanger-norway/>



Enabling AI Robotics

Join the TG Perception: <https://www.robotics-portal.eu>