

# Digital Ecosystem for AI-based Robotics

Get Together for Robotics 2025

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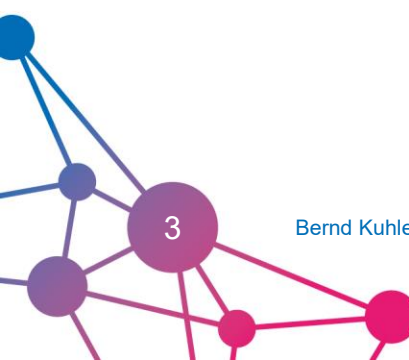
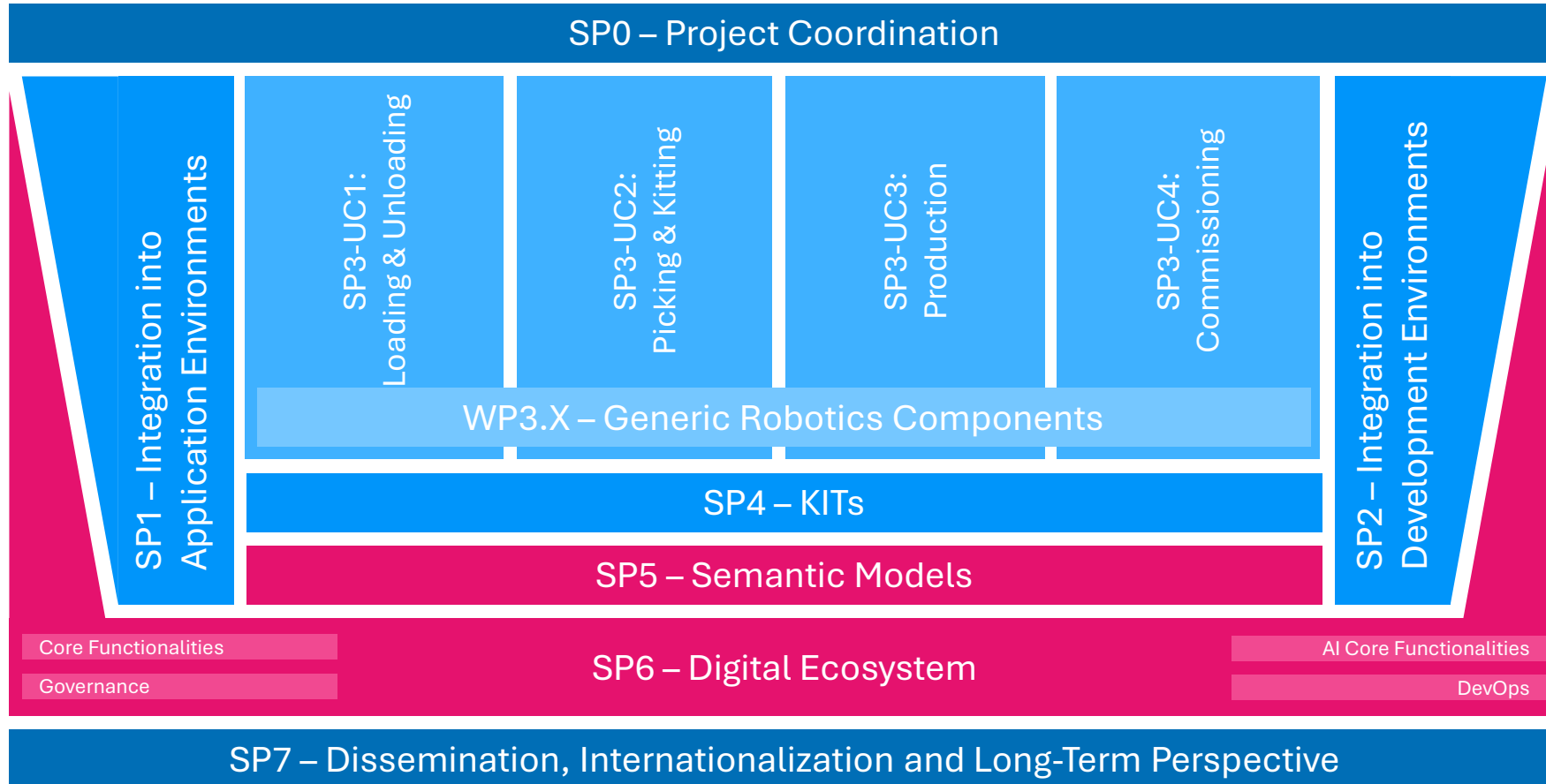
**ROX**  
Enabling AI Robotics

# Digital Ecosystem for AI-based Robotics – Overview

- RoX promotes the use of advanced AI in practically relevant robotic solutions
  - **Increasing the flexibility of robotic solutions.**
  - **Broadening the range of applications for robotic solutions.**
- Digital ecosystems **foster close cooperation/collaboration between e.g. users, system integrators, IT vendors and manufacturers of robotic components.** They also provide the opportunity to realize innovative value-added services
  - Accelerating the design and commissioning of robotic solutions
  - Unlocking new market potential through value added digital services – e.g. predictive maintenance.



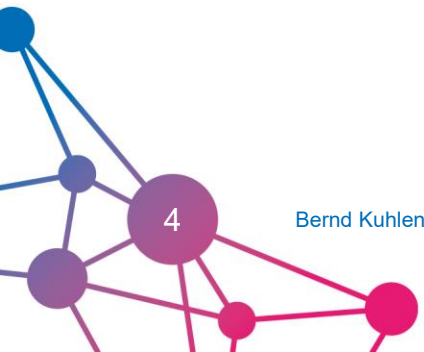
# Digital Ecosystem for AI-based Robotics – Fields of Action



# Digital Ecosystem for AI-based Robotics – Partner

## - Partner (\*= Coordination):

- ABB\*
- Boehringer Ingelheim
- DLR\*
- DFKI
- Dürr Systems
- Fraunhofer Gesellschaft\*
- Gluth Systemtechnik
- RIF Institut
- Intrinsic
- INVITE
- Mercedes-Benz
- Rheinmetall
- Roboception
- Robomotion
- SAFELOG
- SCHUNK
- Siemens\*
- SOTEC
- T-Systems
- VDMA
- Wacker Chemie
- Würth
- Yardstick Robotics



# Details – SP3-UC1 Loading & Unloading



## Loading and unloading pallets on trucks

- With **autonomous mobile robots (AMR) or autonomous forklifts**
- Challenges: moving pallets in very confined workspaces requires force-feedback control; ensuring personal safety

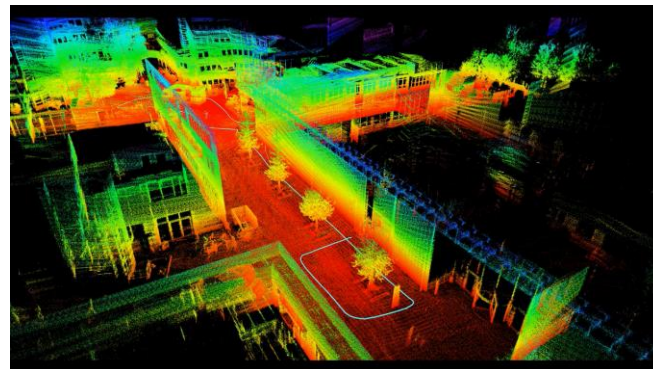
## Pallet handling in warehouses and production with autonomous forklifts

- Transportation, storage and stacking of pallets in warehouses and production sites



## Autonomous outdoor transport in factory traffic

- **Seamless outdoor and indoor operation by 3D mapping** (no GNSS, no markers)
- Challenges: generalization capabilities of perception and navigation in unstructured or non-standardized and open environments



# Details – SP3-UC2 Picking, Packing, Palletizing in Warehouses ...

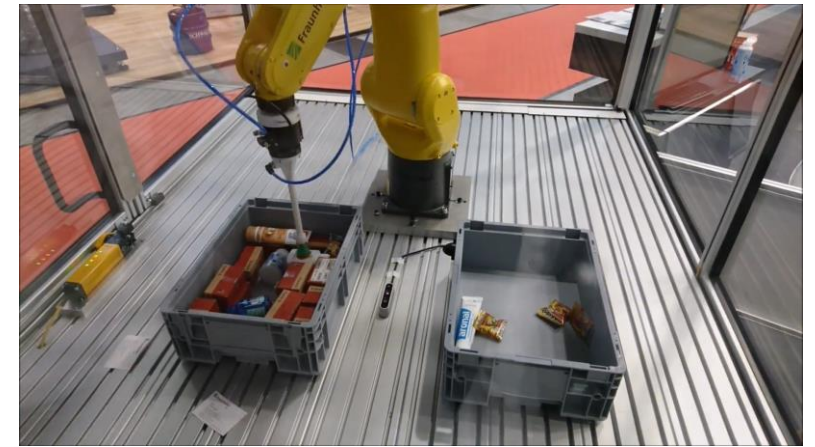


## Mixed palletizing at distribution centers

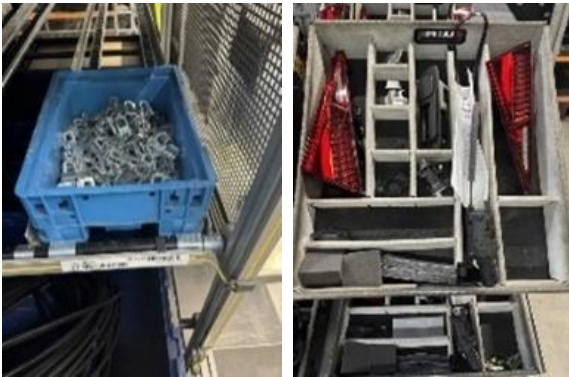
- Depalletizing of homogeneous pallets and creating mixed pallets e.g. for retail stores
- Goal: compact, mobile picking solutions to supplement large-scale systems
- **Challenges: goods and package variety, package identification and pose estimation, grasp planning, planning of a stable and compact packing pattern**

## Order fulfillment in warehouses and for end-of-line packaging

- Model-free pick&pack process for order fulfillment in retail or end-of-line packaging in production
- Goal: single item picking from e.g. totes of an automated storage and retrieval systems (AS/RS) and packing into shipping carton for delivery
- **Challenges:**
  - **Perception, gripper technology and corresponding grasp and packing planning for the extreme variety of goods**
  - **Short cycle times, missing master data, undefined delivery sequences**



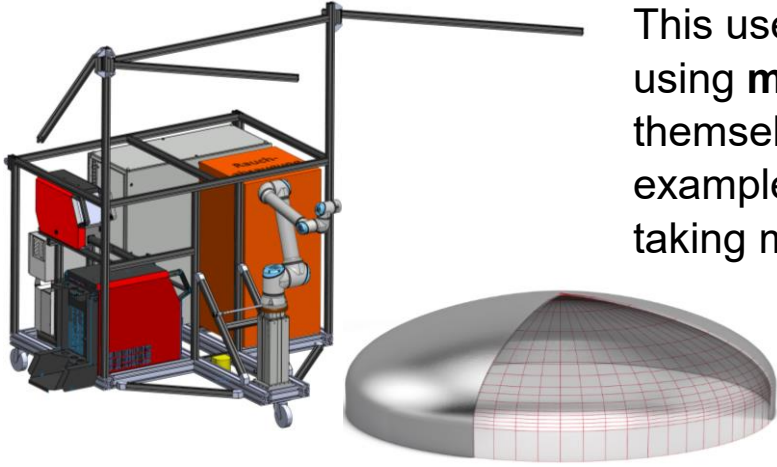
# Details – SP3-UC2 ... Kitting in Production



## Kitting in production

- Assembly pre-picking: required parts for an assembly step are compiled from the industrial warehouse
- **Goal: establish a generic robotic picking solution for the broad range of parts**
- Challenges
  - Exceptional generalization requirements for perception and gripping capabilities
  - **Extreme variety of components and their delivery states, including packaging materials**
  - Short cycle times for fulfilment
  - Simple setup or model-free operation required

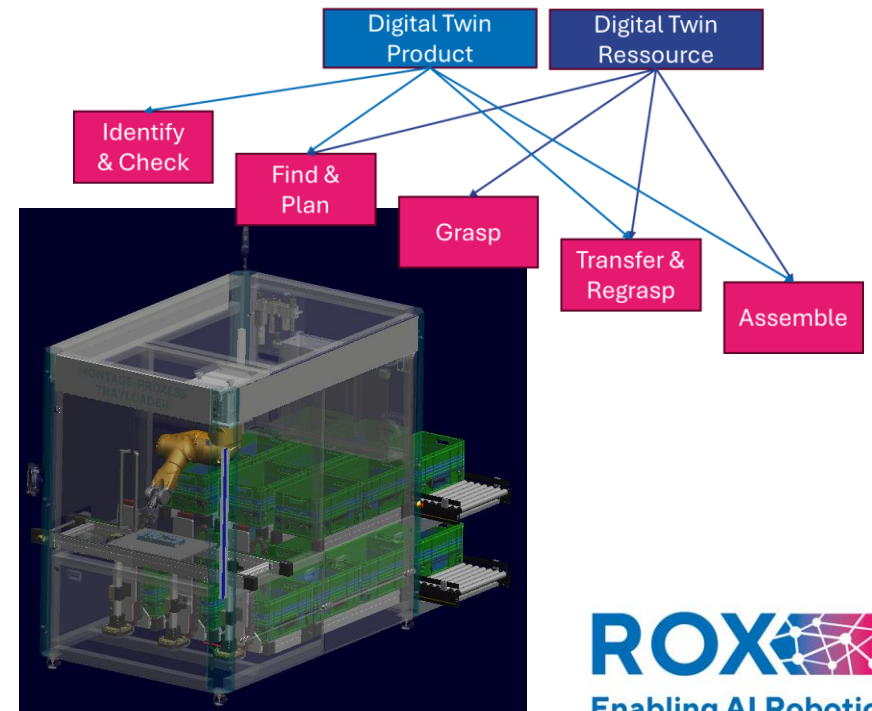
# Details – SP3-UC3 Production Automation (1/2)



This use case addresses the **automation of (high-mix, low-volume) production** using **multifunctional robot assistants and robot cells** that can learn new tasks themselves without programming or are instructed by natural interaction, for example. By providing sufficiently intelligent and generic basic robot functions and taking meta-tasks into account, these **robot solutions can be used flexibly and economically** in previously non-automatable fields of application (e.g. disassembly), even in existing systems.

## Multifunctional robot cells for precision assembly and for welding processes

- Development and application of generic robot skills for complex assembly and welding processes
- Sensor-guided intelligent robot behaviors and simple instructing
- Challenges: modelling, generalization and provision of the specific process knowledge; robot capabilities such as sensor guidance, control via force-torque feedback, force teaching or sensor-supported welding tasks in batch size 1



# Details – SP3-UC3 Production Automation (2/2)

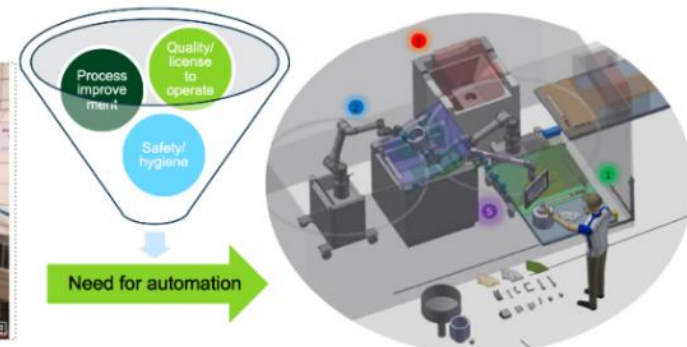


## Multifunctional robots for handling tasks in industrial and logistics processes

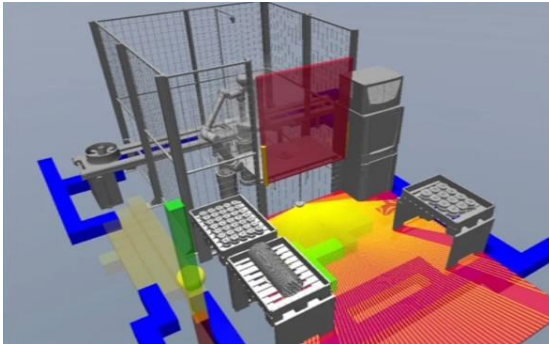
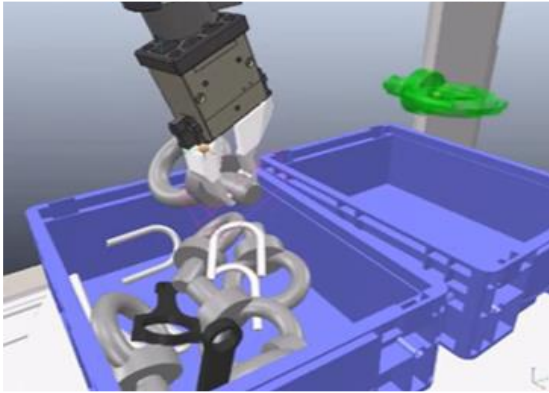
- Universally applicable robot solutions for various logistics tasks in different settings, such as
  - Universal logistics robot for **transportation tasks**
  - Flexible handling robot for **machine tending** in production
  - Multifunctional robot for handling and operation in **laboratory environments**
- Challenges: universal task comprehension, world and process modelling; adequate perception, gripping, handling and placing skills

## Robot system for cleaning production equipment in the pharmaceutical industry

- Automation of the periodical cleaning of pharmaceutical production parts by universal handling and cleaning solutions



# Details – SP3-UC4 Commissioning



In this application aspect, the focus is on using **AI to speed up and reduce costs during the commissioning or reconfiguration of robotic systems and applications**, which is what makes **variant-flexible** and **economical automation** possible in the first place. Depending on the application, the process also includes the commissioning of automatic tool changers, human/robot collaboration (HRC) or robot/robot interaction (RRI).

## AI-supported design and commissioning: system configuration and safety

- **AI-based assistants for simplifying and accelerating solution design, programming, commissioning, safety design and validation, and documentation of robotic solutions**

## Commissioning/teaching new use cases for production & logistics

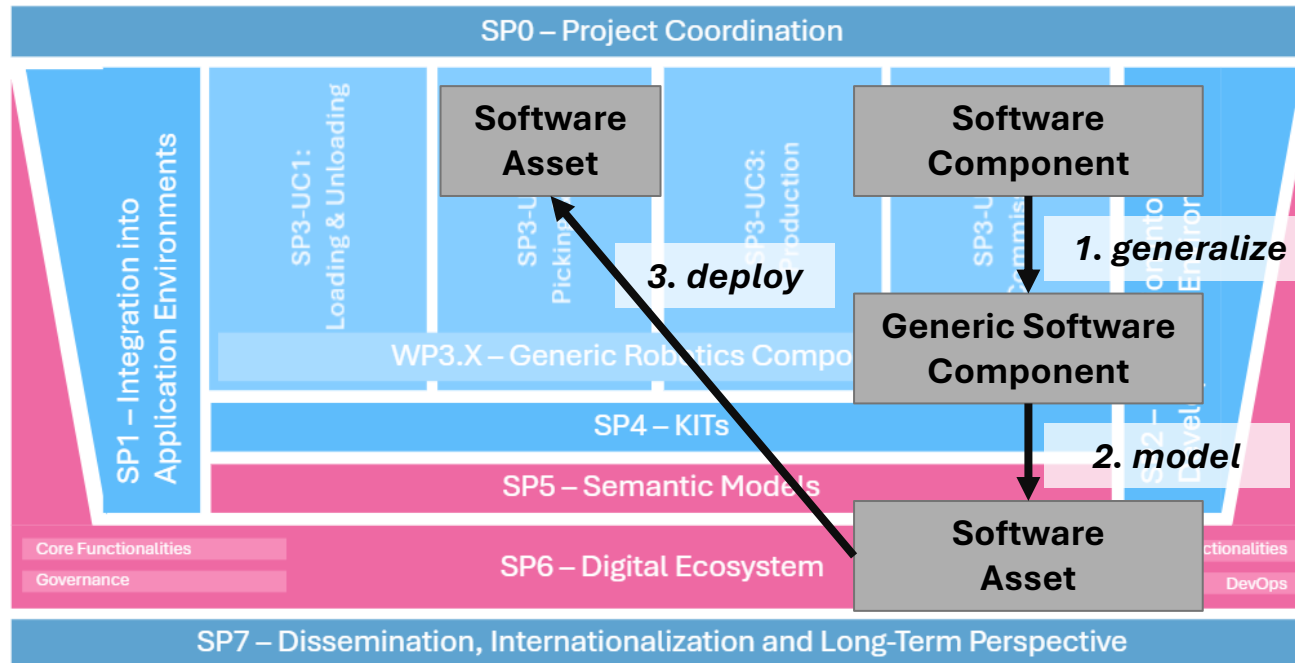
- **Techniques like simulation, imitation learning, transfer learning and foundation models for swift and simple setup or adaptation of novel applications**

## Commissioning and optimization of motion processes in static multi-robot systems

- **Tools and methods for efficient search and transfer of previous solutions to novel multi robot setups, e.g. for painting robot lines**

# SP3.X - Generic Software Components for Robotics

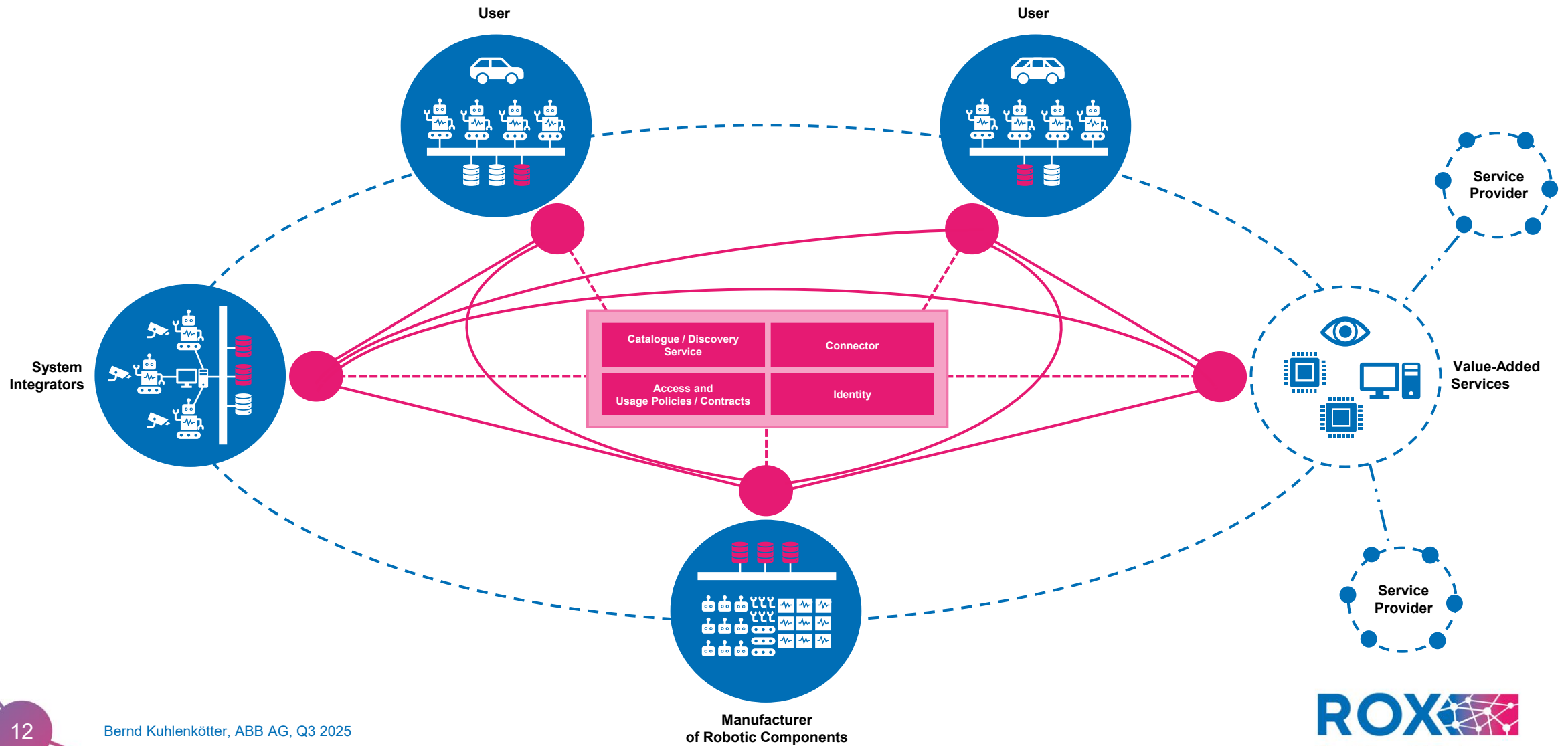
**Aim:** Identify and generalize software components in the use cases in SP3 (step 1 below), so that these components can be made available through the RoX ecosystem in SP4/5/6 (step 2/3 below)



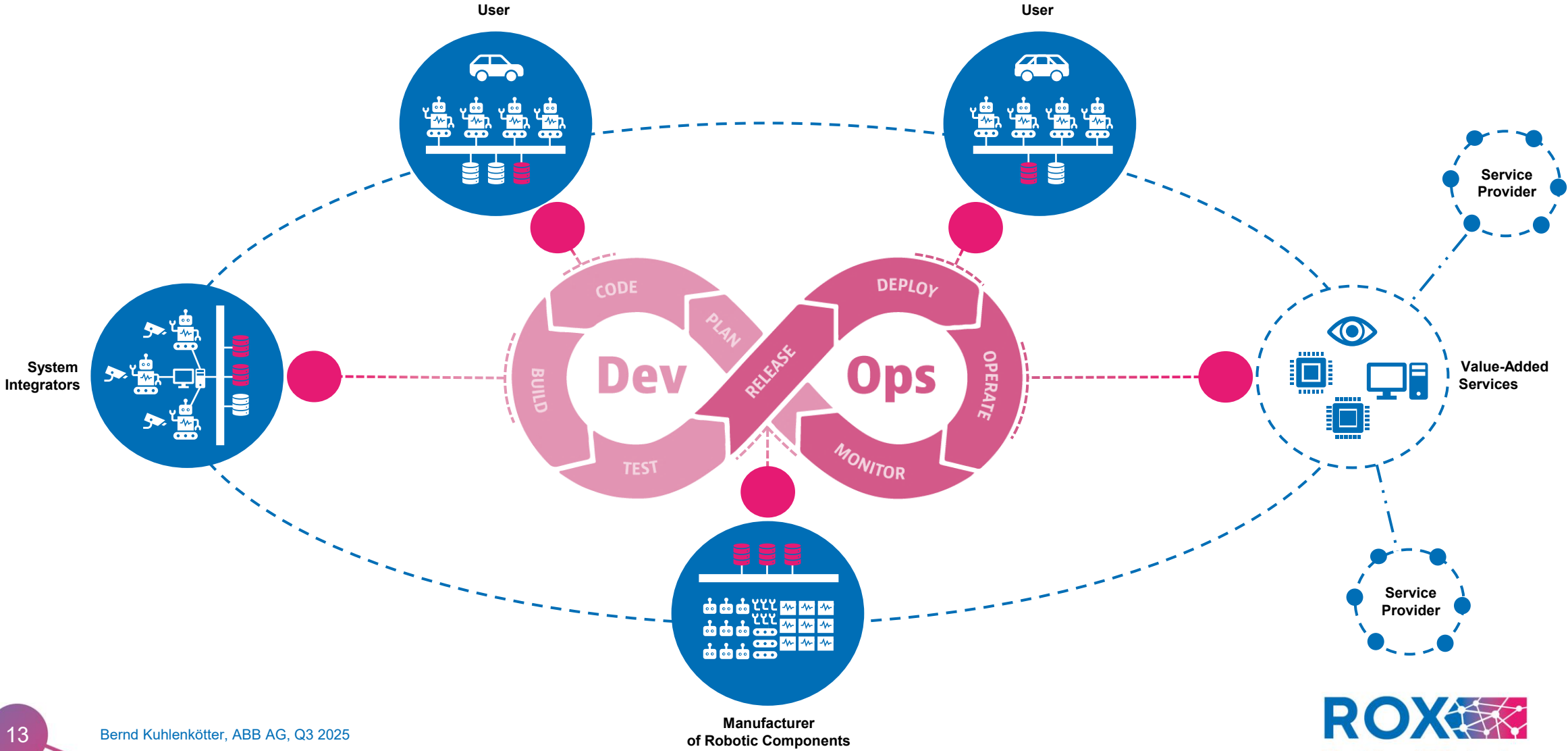
## Main Software Classes

Hardware wrappers	SP3.X.1
Perception	SP3.X.2
Manipulation and grasping	SP3.X.3
Processes and Planning	SP3.X.4
Human-Robot Interaction	SP3.X.5
AI Foundation Models	SP3.X.6

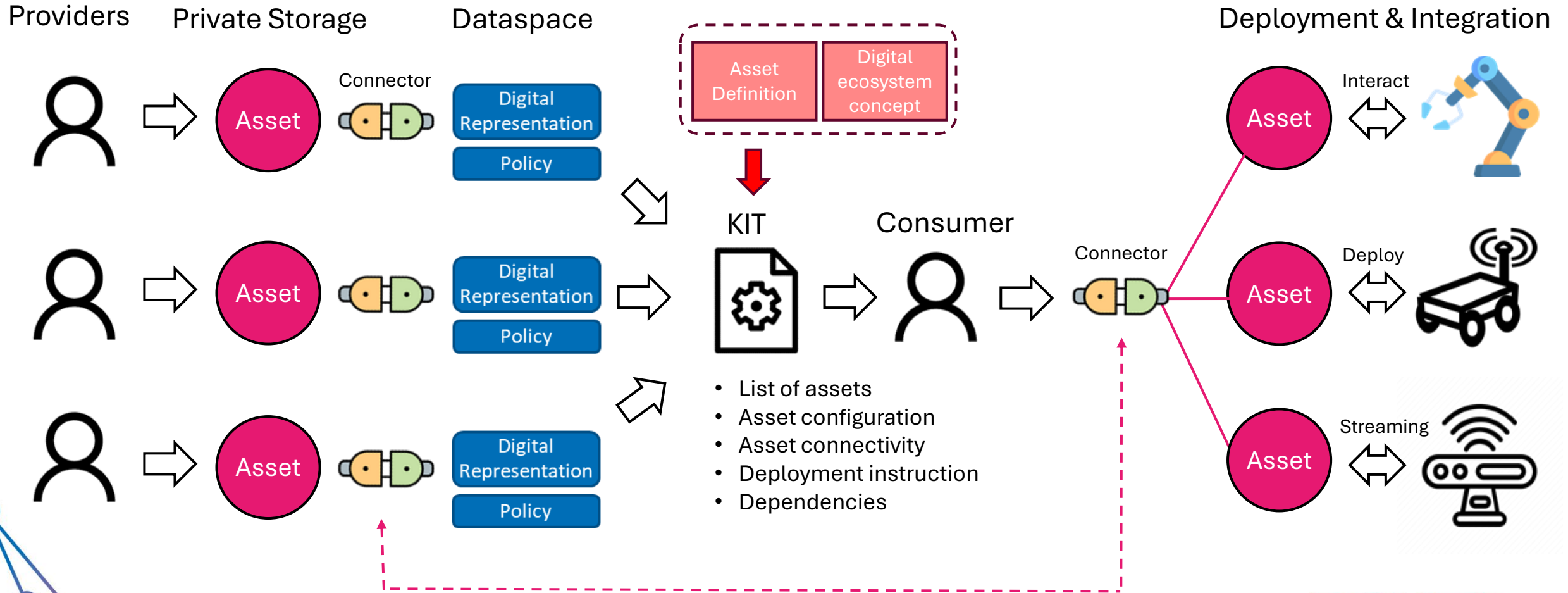
# Digital Ecosystem for AI-based Robotics – Focus on Ecosystem



# Digital Ecosystem for AI-based Robotics – Focus on Ecosystem Use-Case



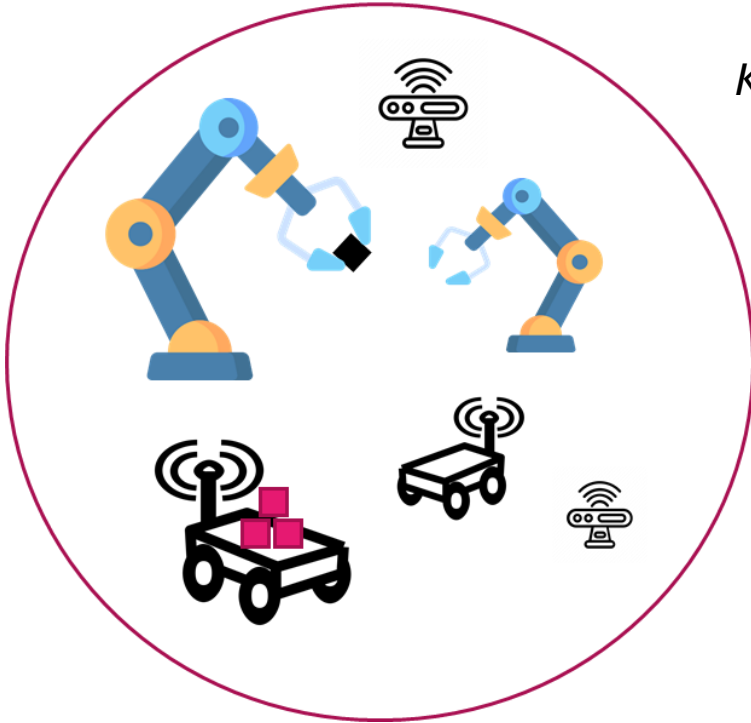
# SP 4 – KIT: Concept overview



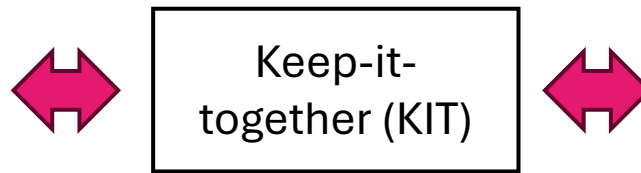
Contracts for asset sharing aligned with governance policies

# SP 4 – KIT

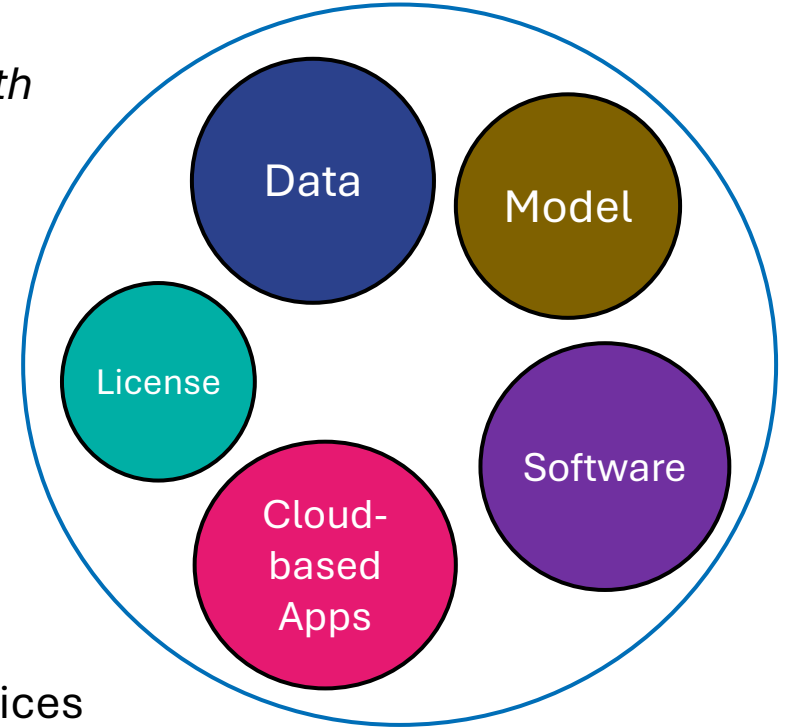
Robot Application



*KIT is the interface for robots interact with the assets in the dataspace*



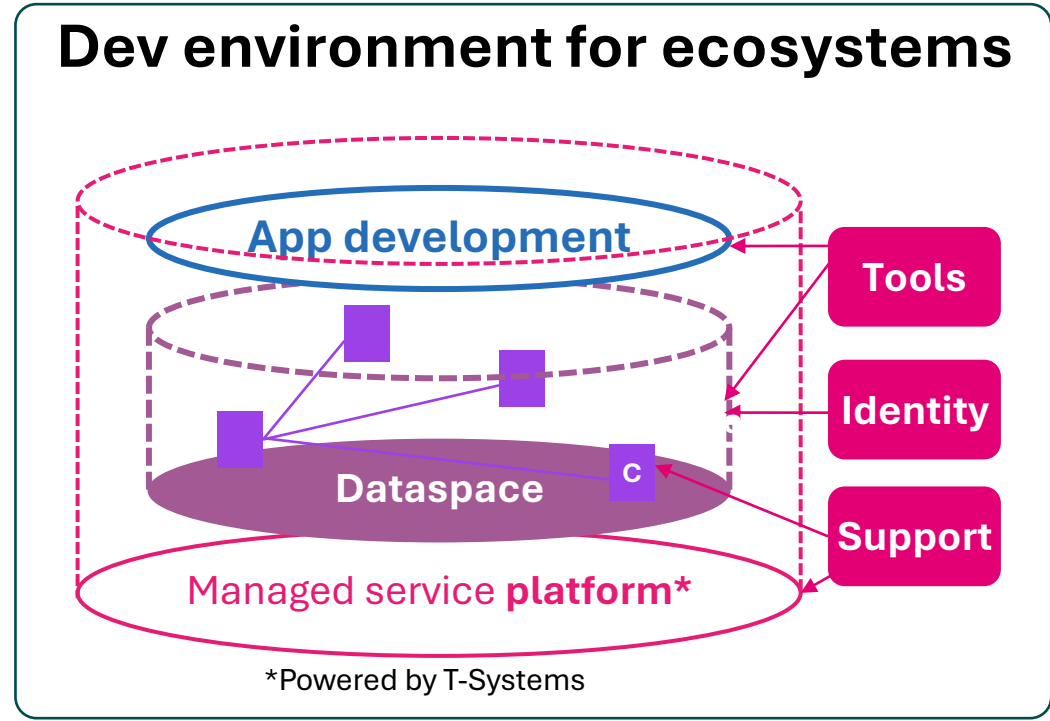
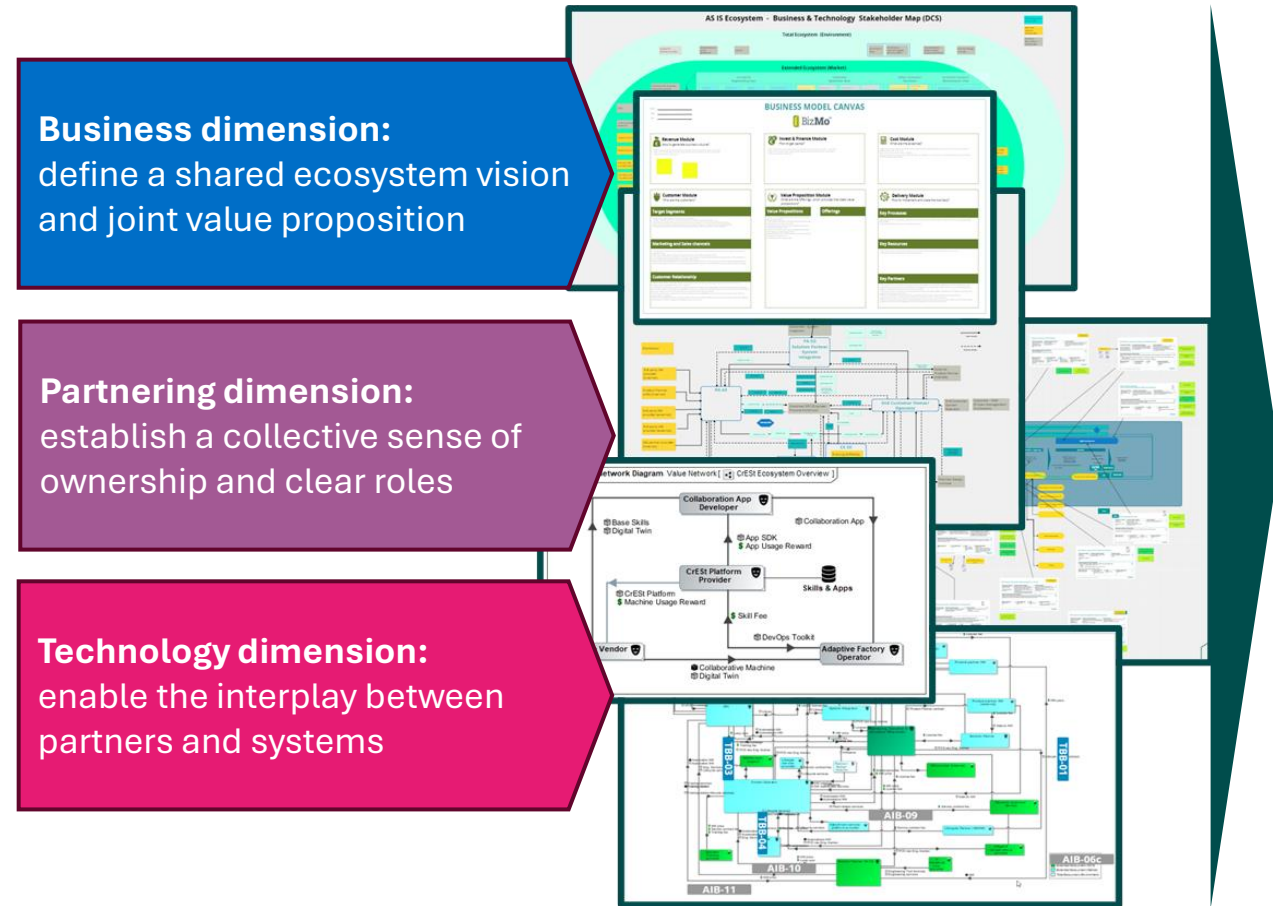
Dataspace



- KIT utilizes dataspace to enable:
- Manage and share **data**
  - Download/upload AI **models**
  - Deploy **software** on the edge devices
  - Monitor (live)data via cloud-based **apps**
  - Enable MLOps life cycle using a dataspace
  - Governance and ownership of digital assets

# SP 6 - Digital robotics ecosystem: Overview

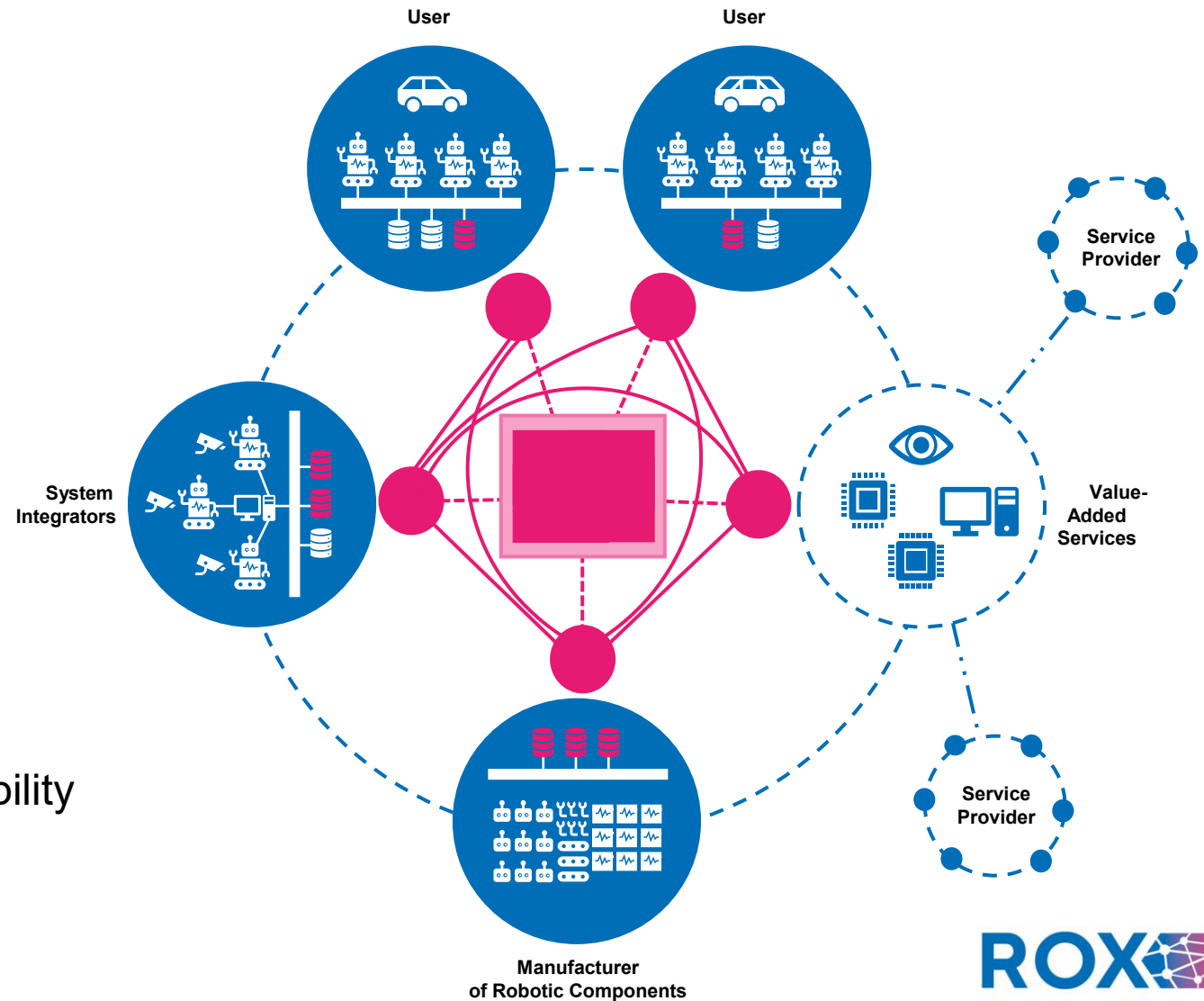
Target: Design and orchestration of the digital AI-based robotics ecosystem on three dimensions.



- **Modernize and create new apps** ready for data ecosystems
- Benefit from built-in **data governance and sovereignty**
- Easy, **browser-based UI** provided as managed service

# Digital Ecosystem for AI-based Robotics – Focus on Ecosystem

- RoX's digital ecosystem is based on European values
  - ultimate authenticity and trust
  - data protection in line with European standards
  - high level of sovereignty and self-determination
  - transparency
  - openness and modularity
  - interoperability
  - usability
- RoX is striving for an international visibility and impact



# Digital Ecosystem for AI-based Robotics – Connected to IPCEI-CIS

- An important step from the perspective of the ecosystem development is the realization of a cloud/edge continuum (i.e. the seamless integration of edge and cloud computing, as well as the tactile use of associated resources and services), in order to enable significant added value in the emerging field of AI-based robotics
  - improved performance
  - more efficient implementation of data-driven/data-centric services
  - novel opportunities for cooperation and collaboration
  - enhanced security and robustness
  - improved overall user experience (UX)
- In addition to IT-related challenges, other areas such as data protection/security, operational safety, and robustness/resilience are also being addressed.
- RoX works closely with IPCEI-CIS in this area! (CIS = Cloud Infrastructure and Services)



The IPCEI-CIS is the central initiative for Europe (more than 100 companies/institutions from 12 EU member states) to build the world's first 'Multi-Provider Cloud/Edge Continuum'

# Thanks for your attention

## Contact

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