

Agent-based Control for Material Handling Systems in In-House Logistics

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Agenda

- Challenges for in-house logistics systems
- State-of-the-art in controlling in-house logistics systems
- Cyber-physical systems
- Agent-based architecture for controlling in-house logistics systems
- Implementation of an agent-based architecture for dynamic and robust in-house logistics
- Evaluation of an agent-based in-house logistics systems
- Outlook

Challenges for in-house logistics systems

- Increasing complexity of automation technology for in-house logistics
- Rising dynamic requirements for in-house logistics
- Efficient processing of one-off items
- Horizontal and vertical integration of IT systems (to rise the efficiency and productivity of logistics systems)

State-of-the-art in controlling in-house logistics systems

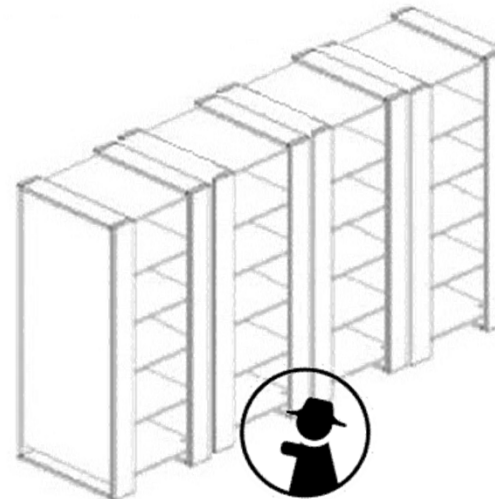
- Big material handling systems with centralized control units
- Addressing the challenges in state-of-the-art in-house logistics systems by modularization of system components regarding the basic functions, such as
 - Unloading
 - Hauling
 - Storing
 - Conveying
 - Loading

Cyber-physical systems

- Cyber-physical-systems (CPS) enable *smart factories*
- Machines, storage systems and components
 - exchange information autonomously
 - trigger actions and
 - control each other independently.
- Consolidation of physical objects and the cyber world
- MAS can be applied for the implementation of the data processing and decision making units of represented objects

Multi-Agent Systems

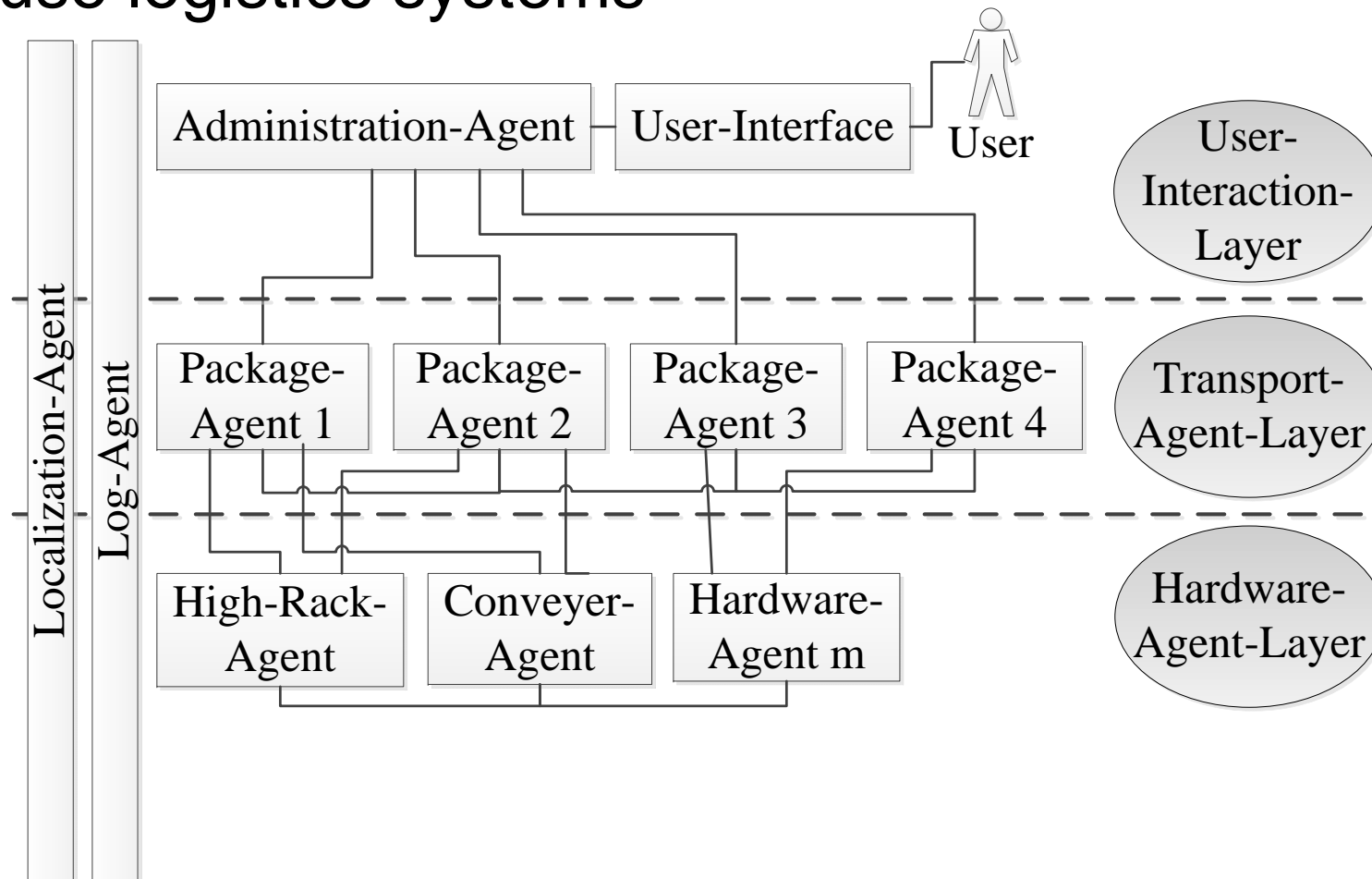
- **Multi-Agent systems (MAS)** consist of individual agents representing physical objects and making decisions for this objects autonomously
- Agents' decisions are based on its goals and sensed environmental conditions
- Agents reduce the system's complexity by acting locally; representing a module of a big complex system
- Advantages of a MAS are:
 - Flexibility
 - Adaptability
 - Scalability
 - Robustness



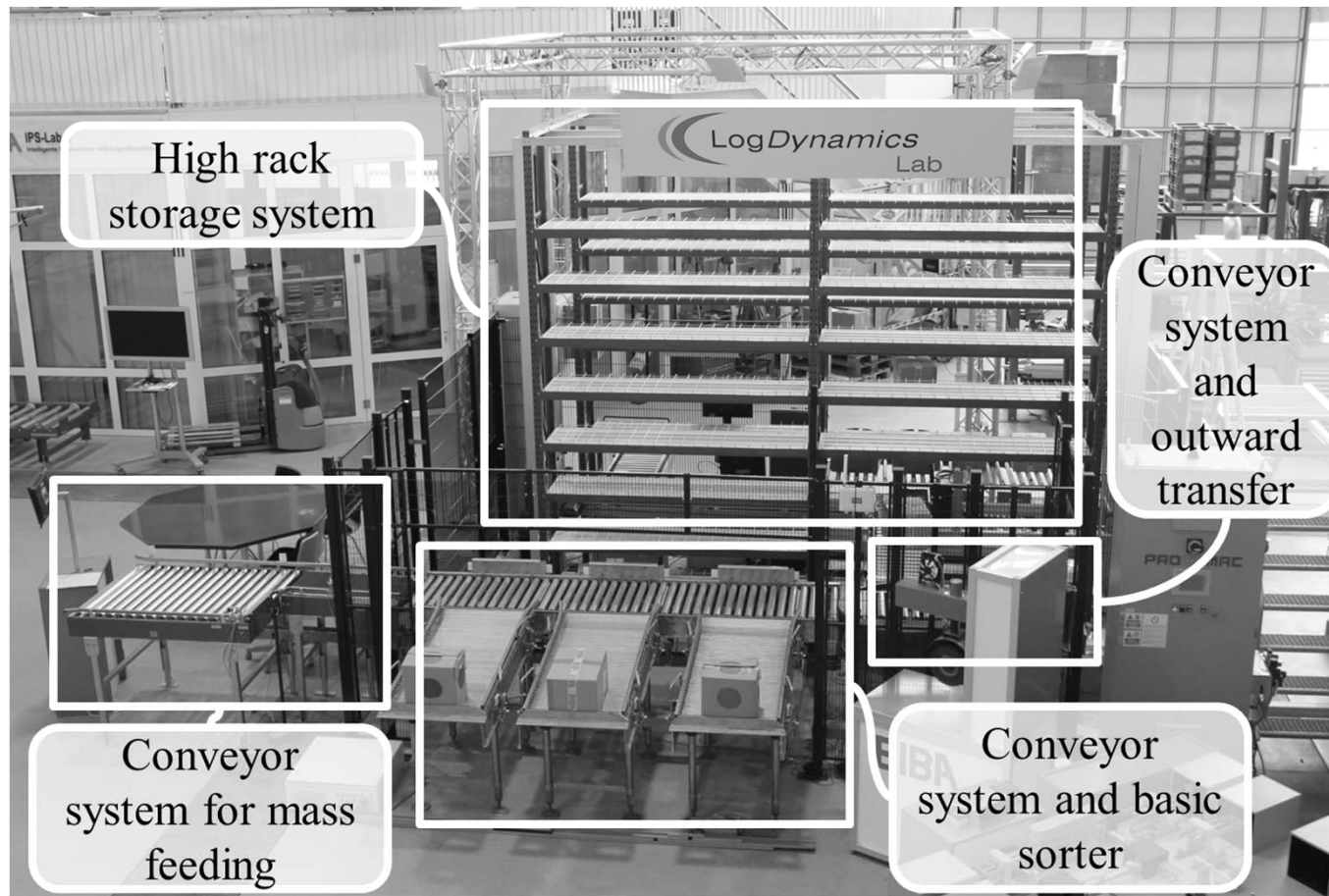
Advantages of MAS and CPS in in-house logistics

- Reduction of the overall complexity (by decomposition of the central problem to decentralized smaller problems)
- Robust and adaptive system behavior in dynamic environments
- Improved scalability of the logistics system
- Integrating manual work

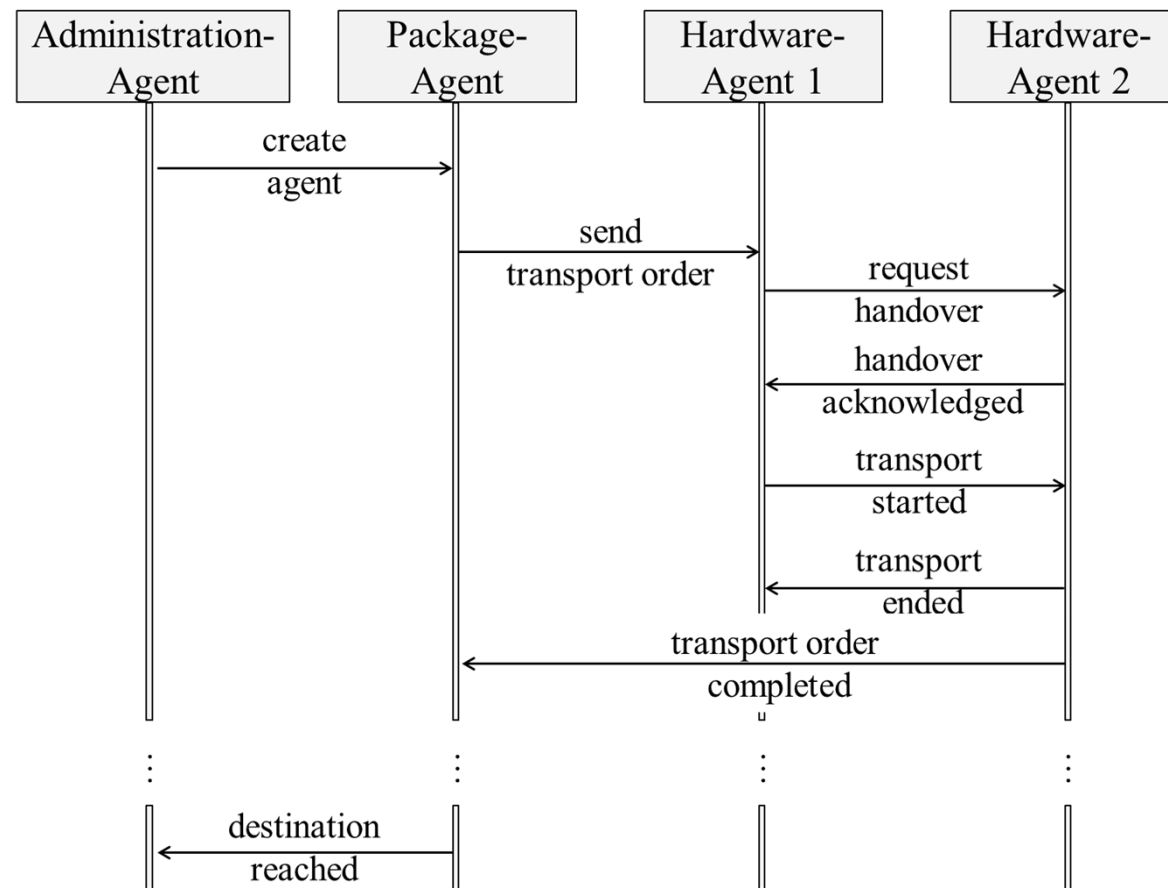
Agent-based architecture for controlling in-house logistics systems



Implementation of an agent-based architecture for dynamic and robust in-house logistics



Implementation of an agent-based architecture for dynamic and robust in-house logistics



Evaluation of an agent-based architecture for controlling in-house logistics systems

- MASs in combination with small PLC programs reduce the complexity
- High level communication between agents controls the overall system behavior (horizontal integration)
- Agents control and access the SPS of its represented low-level components (vertical integration)
- Improved scalability (adding new components / machines)
- Consideration of individual properties and demands of stored goods
- JADE is feasible in real world environments for the implementation of CPS

Outlook

- Integration of further material handling equipment to investigate the scalability
- Adding an Electronic Product Code Information System (EPCIS)
- Implementation and application of localization systems (e.g., via RFID and MOJIX)
- Analysis and identification of limitations

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