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**UNIMORE**  
UNIVERSITÀ DEGLI STUDI DI  
MODENA E REGGIO EMILIA

# Intelligents Agents supporting Digital Factories

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EU H2020 “vF Interoperation supporting buSiness innovaTion” (FIRST Project Grant No. 734599)



20<sup>TH</sup> WORKSHOP “FROM OBJECTS TO AGENTS”

# Agenda

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- Motivation of the work
- Overview of digital factories in the context of Industry 4.0
- Agent-based architectures for digital factories
- Discussion on pros and cons of agent based methodologies for digital factories

# Motivation

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- Digital Factory is a key core concept for enabling next generation of factory of the future
- Evaluation of agent methodologies (MAS) to enable key tasks of digital factories

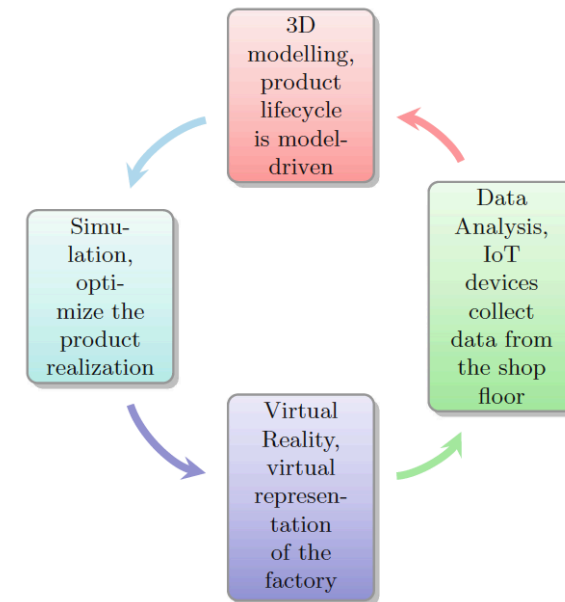
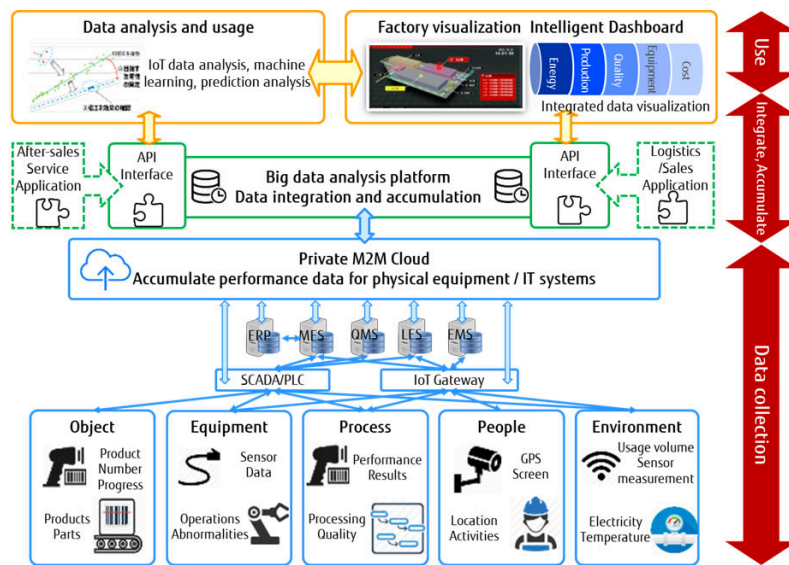
# Digital Factory

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- *A digital factory refers to a new type of manufacturing production organization that simulates, evaluates and optimizes production processes and systems*
- It covers the entire product lifecycle through:
  - Collaborative design based on models
  - Simulations of virtual plant representing the real factory
- Digital Twin model:
  - Create virtual models of physical assets
  - Optimize the production process by simulations
  - Establish a two-way connectivity between the real and the virtual factory

# Digital Factory

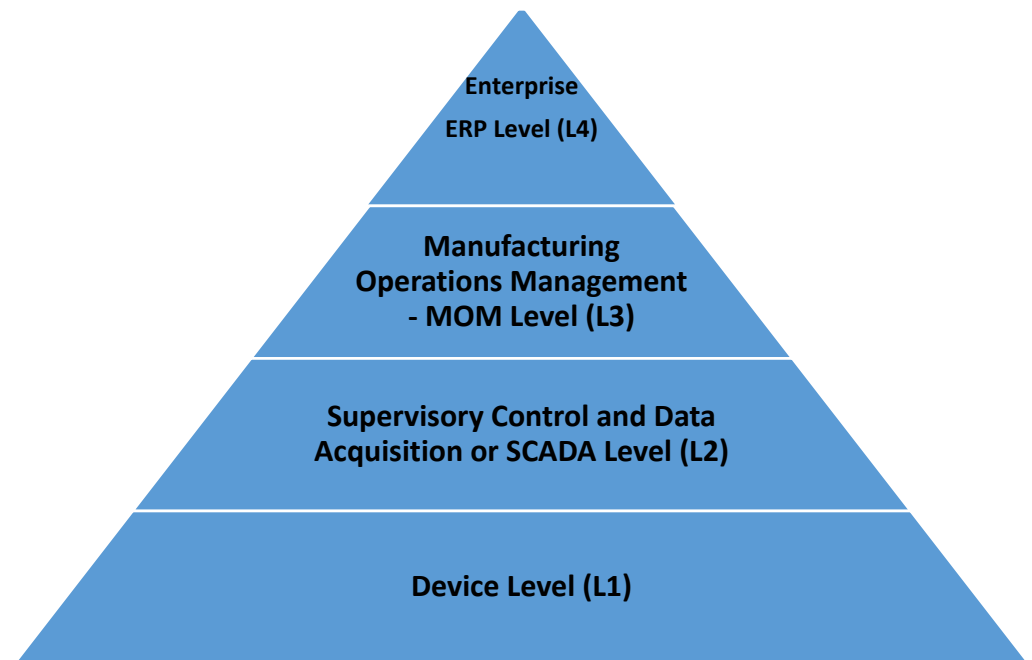
- *In a digital factory the collected data improve virtual models accuracy and simulations*
- *A digital factory acts as a data management layer*



**Fujitsu and INESA Group Smart Manufacturing Project for "Made in China 2025"**

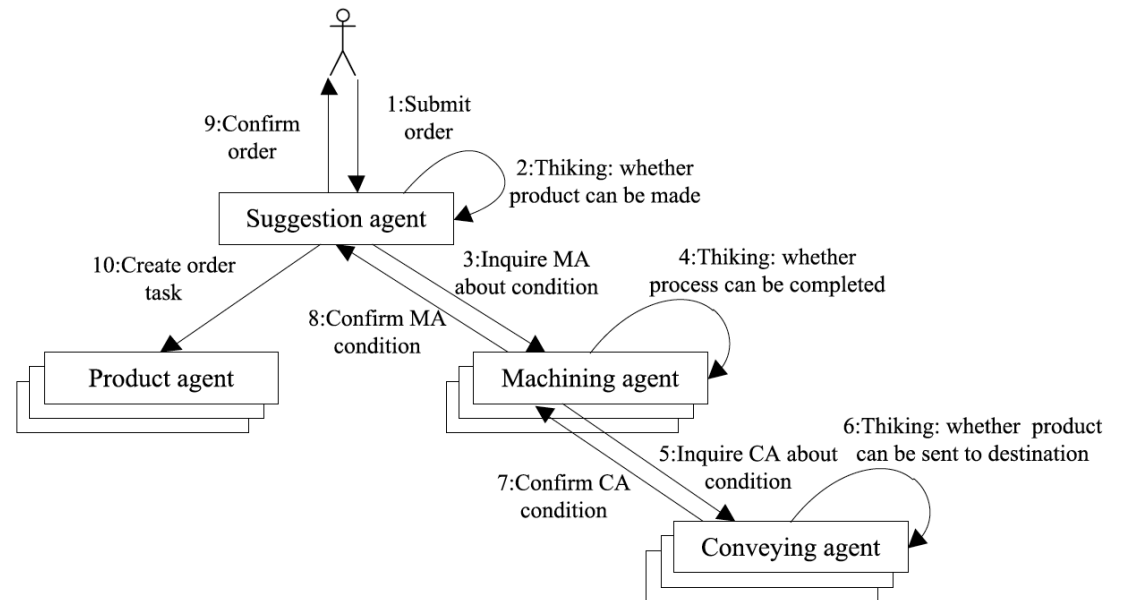
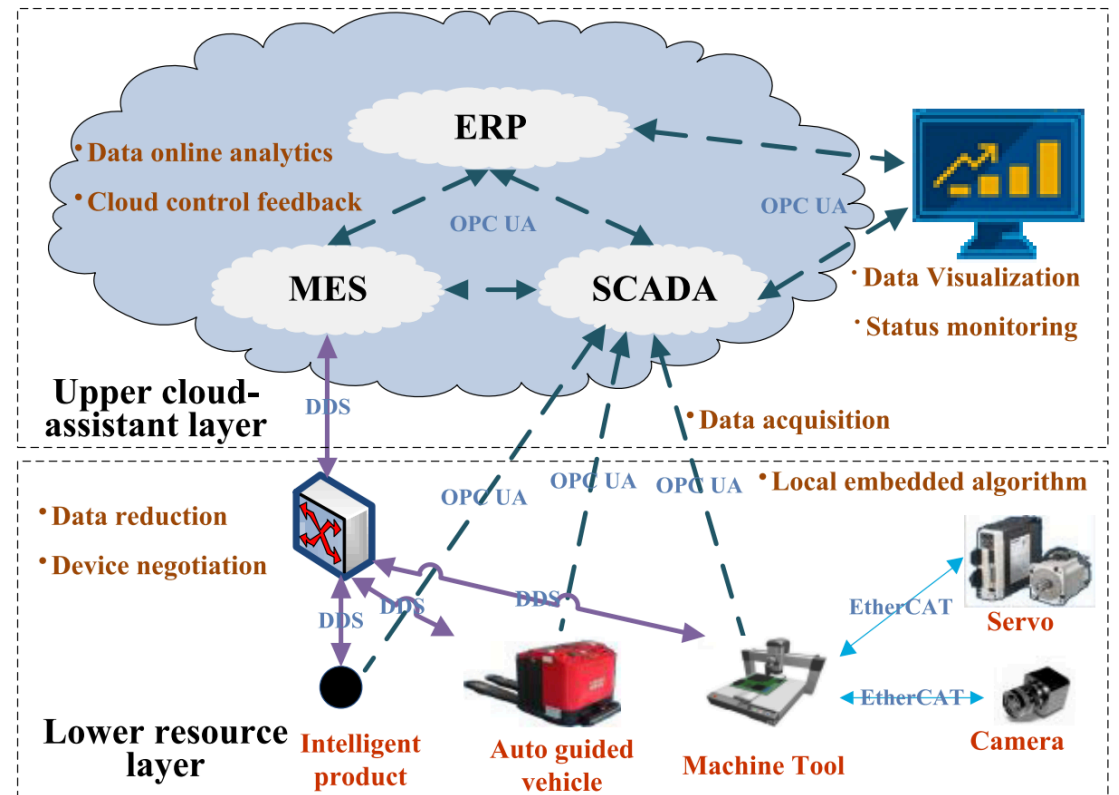
# MAS-enabled digital factory

- *Agent-based manufacturing is a highly distributed control paradigm that can cope with challenges of a digital factory*
- *Considering life cycle of a digital factory we identified MAS architectures providing digital abstraction of physical factory with a focus on:*
  - *Vertical Integration*
  - *Abstraction*
  - *Human Integration*



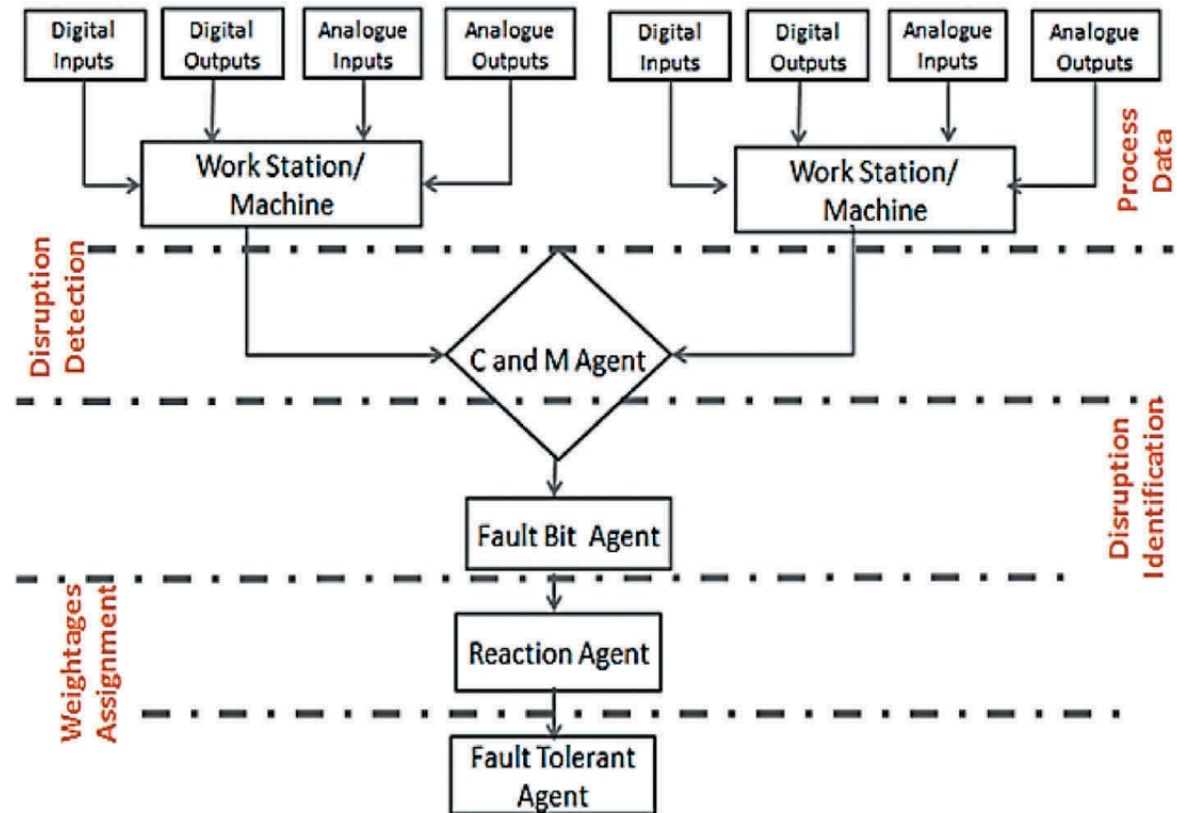
# CASOA: An Architecture for Agent-Based Manufacturing System in the Context of Industry 4.0 (Tang H et al)

- Cloud-based architecture based on agents which cooperate to carry out global manufacturing tasks
- Ontology combined with agents
  - Hierarchical knowledge model used from agents
- Scheduling is optimized compared to traditional methods



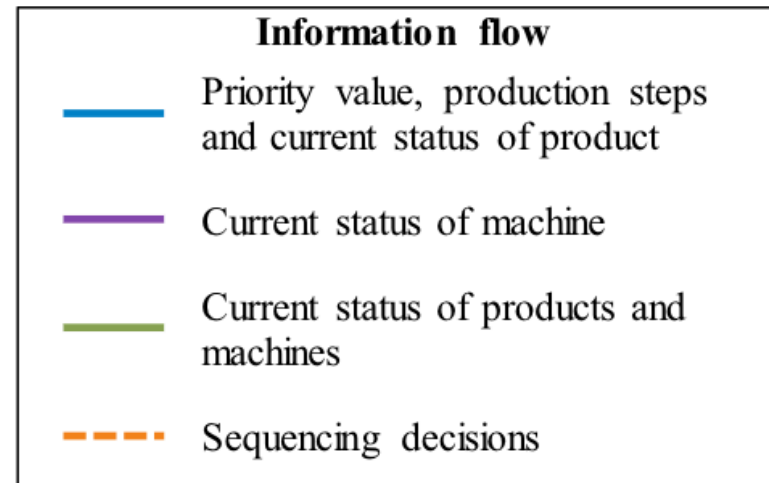
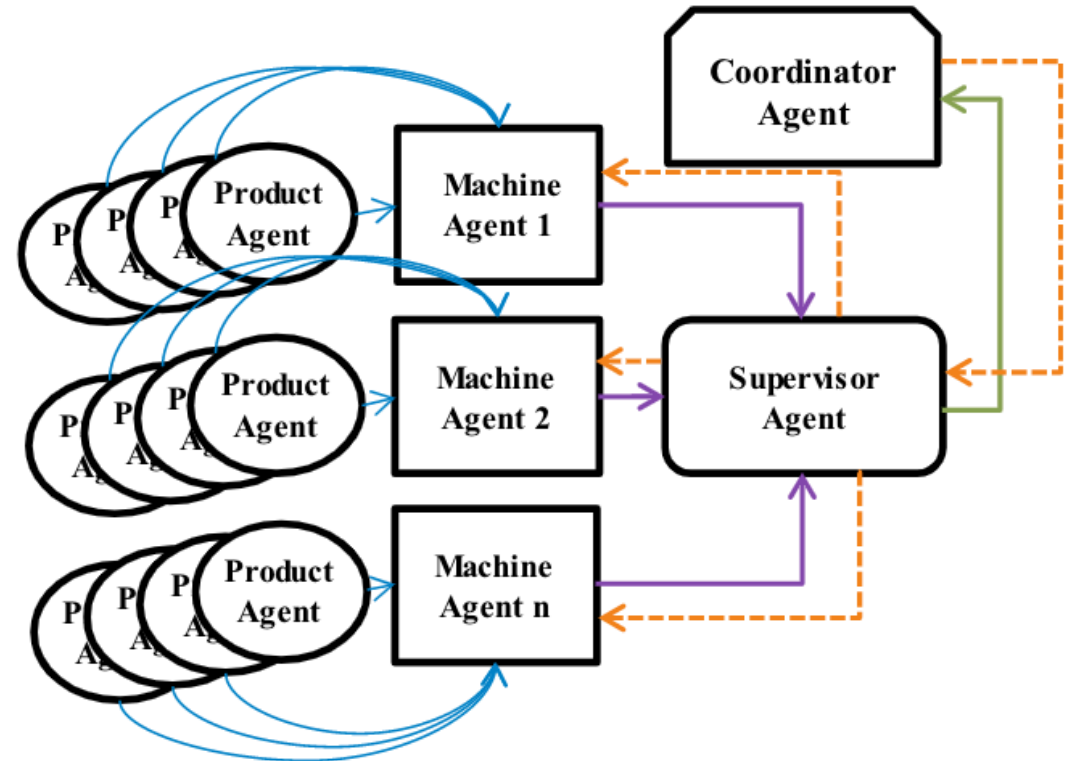
## Agent-based fault tolerant framework for manufacturing process automation (Zubair H et al)

- Deployment of Agent-Based Fault Tolerant Framework (ABFTF) in a manufacturing process for Fault detection
  - Events are gathered from the shop floor and analyzed in order to determine possible disruptions
  - The results showed a significant reduction in the process downtime, for different types of disruptions



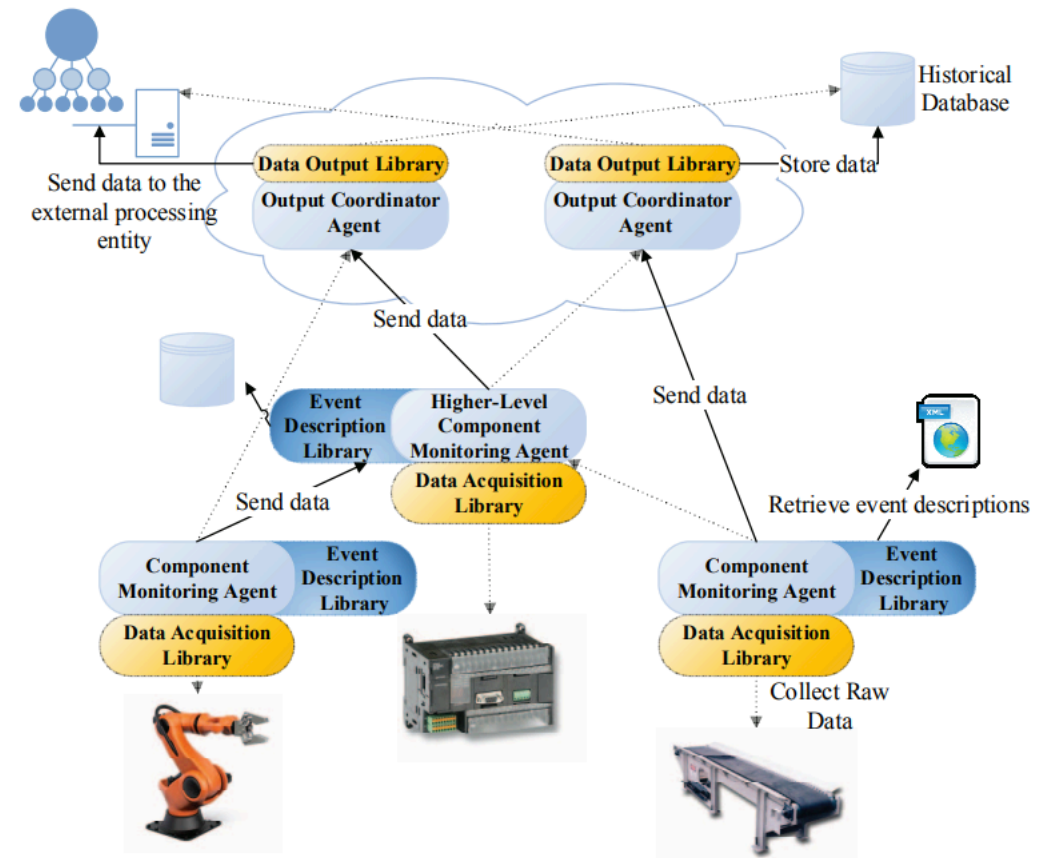
Potential of a multi-agent system approach for production control in smart factories  
(Saeidlou et al)

- MAS architecture for dynamic and adaptive production scheduling
  - Tolerant to changes of the network topology
- Supervisor agents update the coordinator about status of product and machine agents
- Evaluation of 4 real-case scenarios has shown flexibility and ability of the architecture to react to machine breakdown as well as good performances in production scheduling



# An agent-based monitoring architecture for plug and produce based manufacturing systems (Rocha AD et al)

- MAS middleware to deal with monitoring at different manufacturing levels
- Knowledge-based system stores unwanted events
- CNP and FIPA protocols for communications and negotiations between agents



# Conclusions

Main advantages of software agents in digital factories:

- Autonomy

- Adaptation

- Decentralization

- Robustness

Some limitations:

- Simplicity

- Human integration

- Real-Time

**Thank you for your attention!**