Intelligents Agents supporting Digital Factories

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Agenda

- 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

- 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

- *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
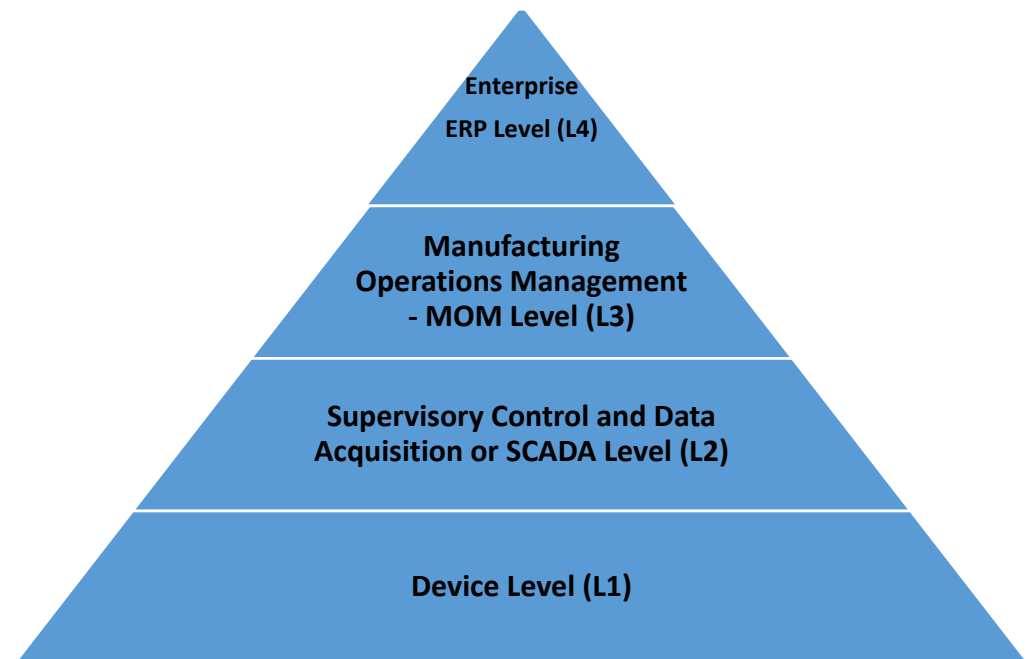
Digital Factory

- *In a digital factory the collected data improve virtual models accuracy and simulations*

- *A digital factory acts as a data management layer*
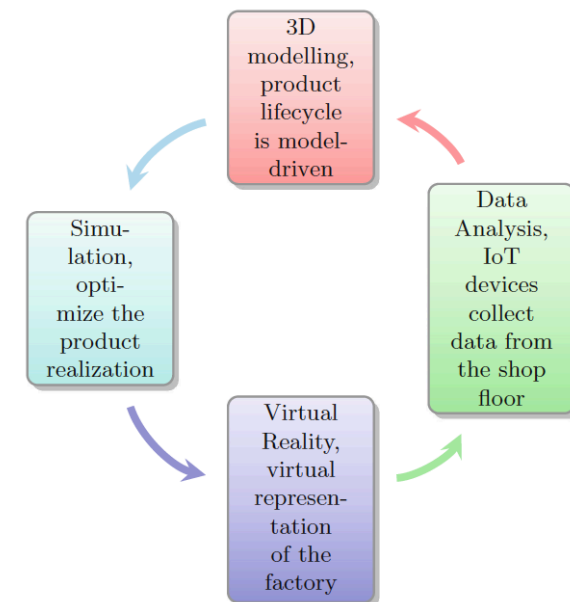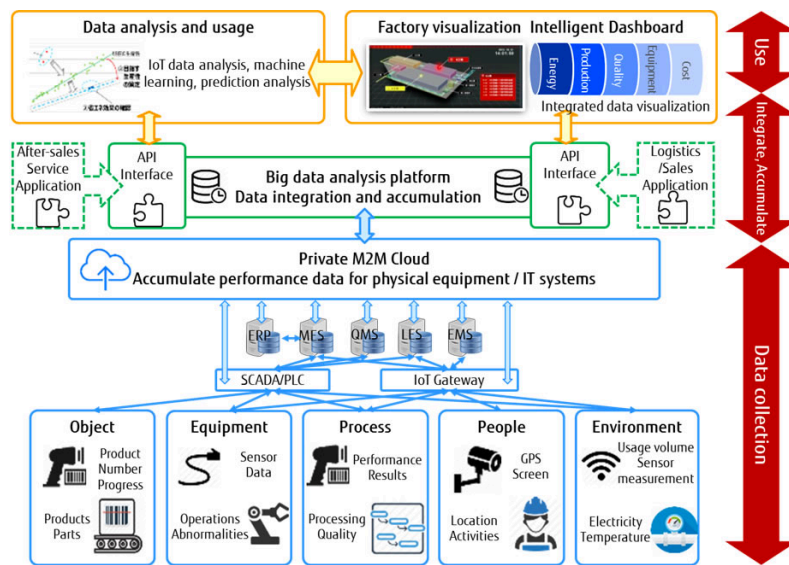
**Fujitsu and INESA Group Smart Manufacturing Project
for "Made in China 2025"**

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*

Enterprise

ERP Level (L4)

Manufacturing Operations Management - MOM Level (L3)

Supervisory Control and Data Acquisition or SCADA Level (L2)

Device Level (L1)

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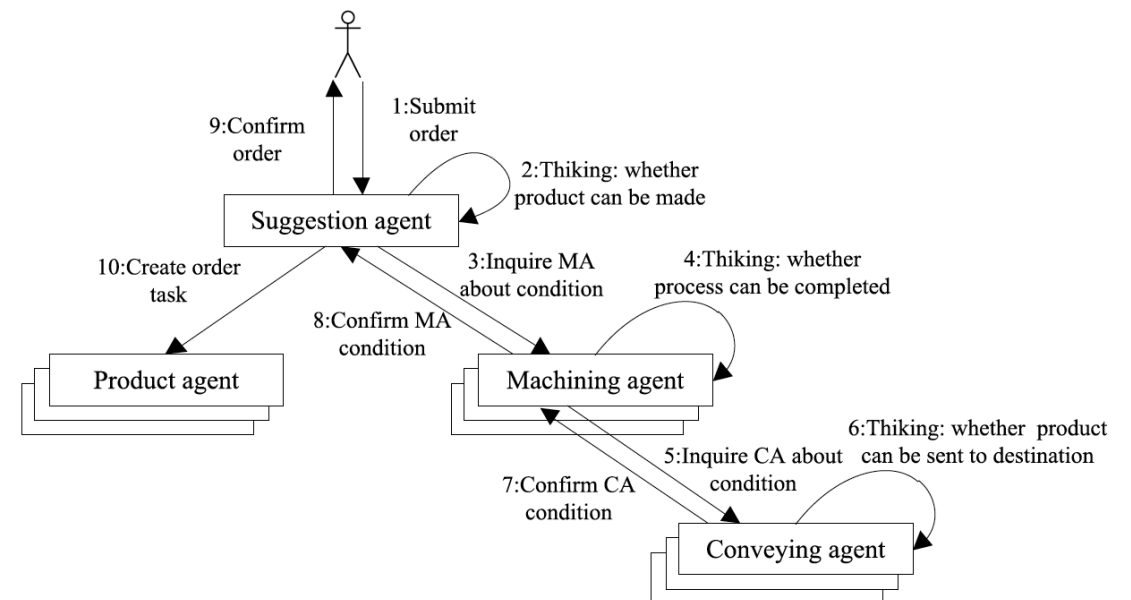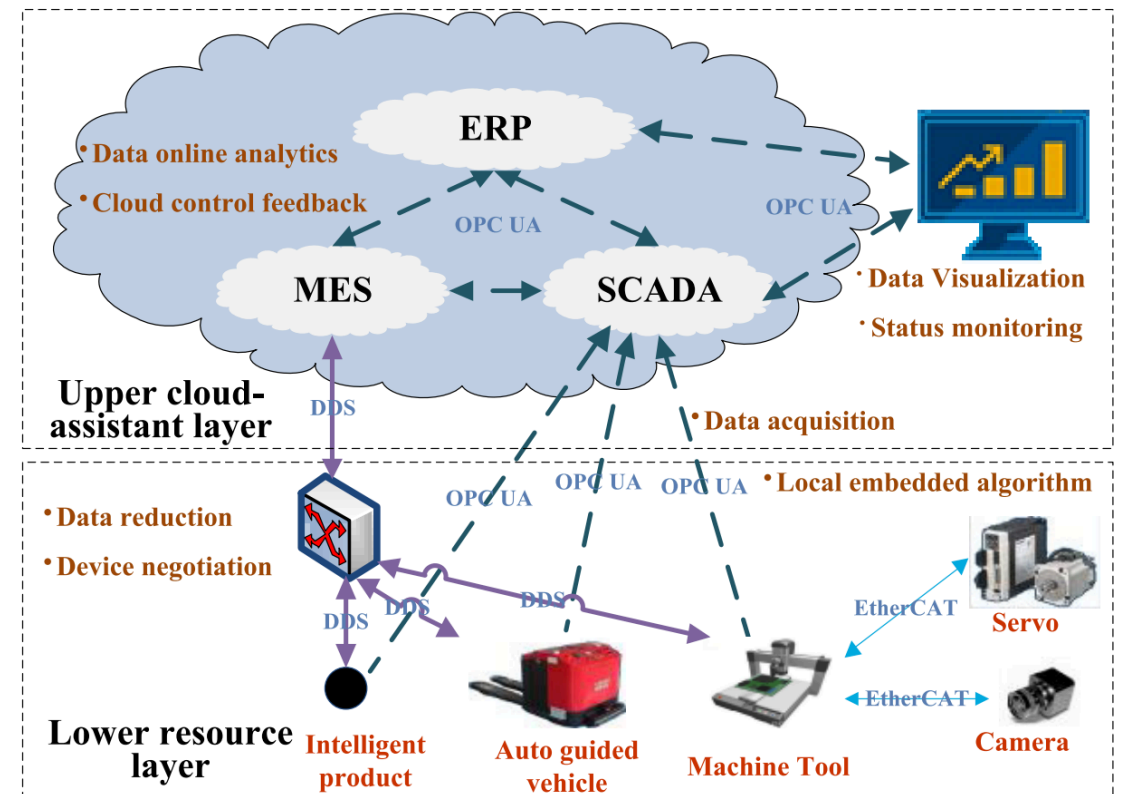
Agent-based fault tolerant framework for manufacturing process automation
(Zubair H et al)

- 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
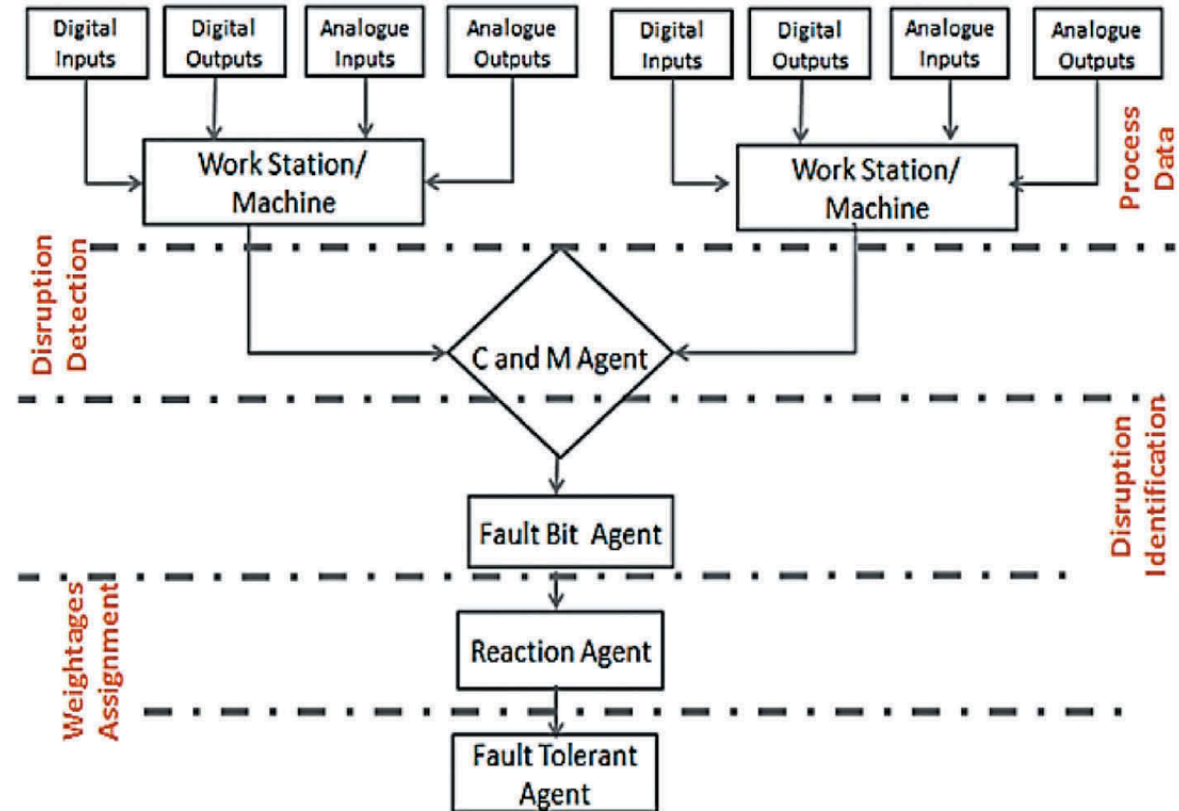
Potential of a multi-agent system approach for production control in smart factories

(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
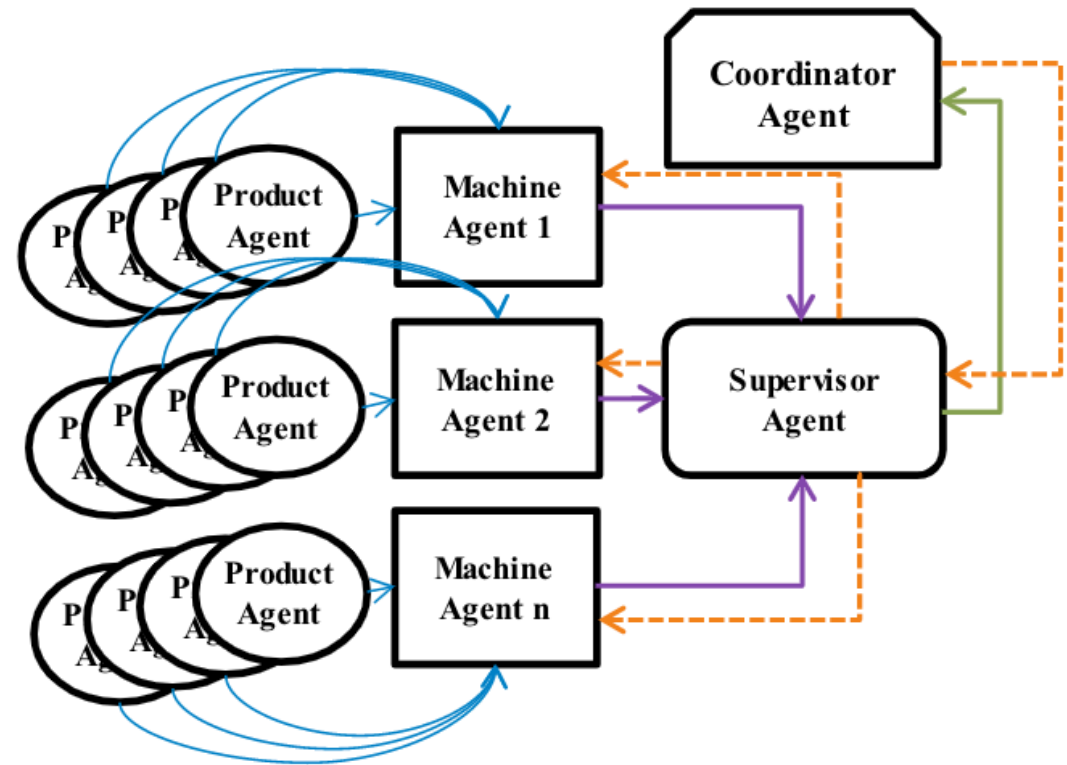

Information flow

—— (blue)	Priority value, production steps and current status of product
—— (purple)	Current status of machine
—— (green)	Current status of products and machines
- - - - (orange dashed)	Sequencing decisions

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
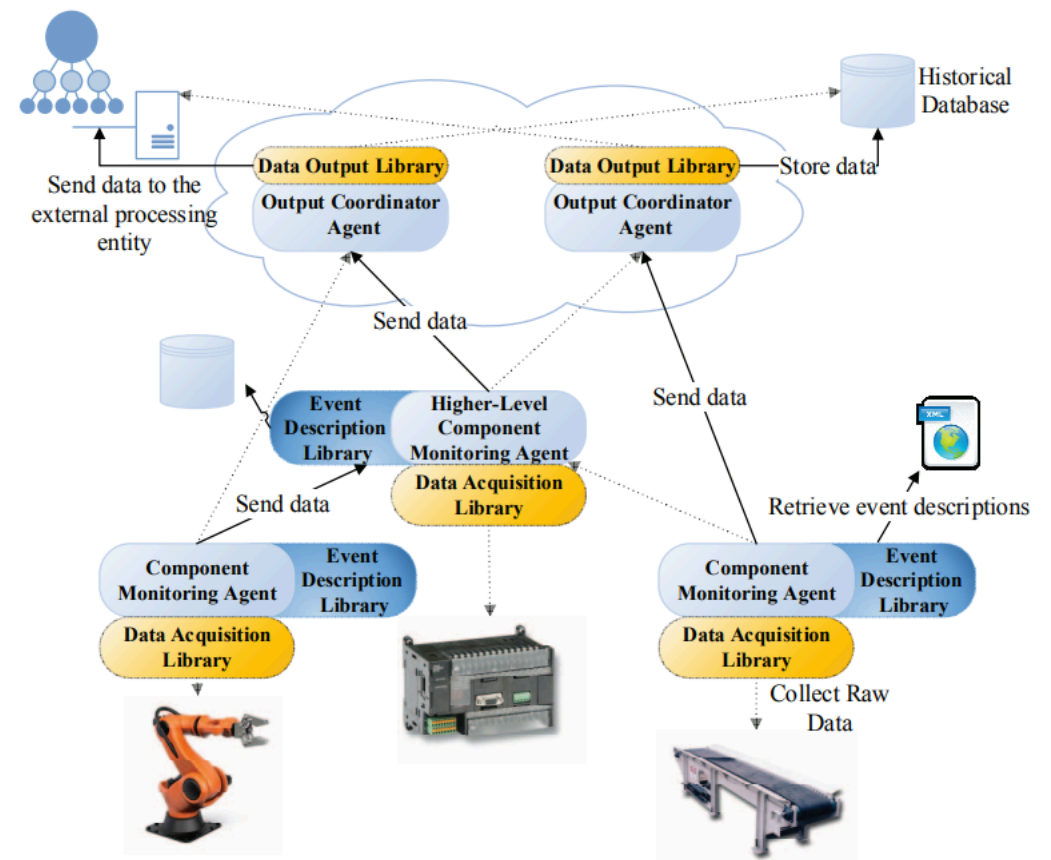
Conclusions

Main advantages of software agents in digital factories:

      Autonomy

      Adaptation

      Decentralization

      Robustness

Some limitations:

      Simplicity
      Human integration
      Real-Time

Thank you for your attention!