Paving the Way to Industry 4.0: an Approach based on Multi-Agents System and Complex Event Processing

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Meftah Zouai obtained his PhD in Computer Science at the University of Biskra (Algeria) in 2021. In 2016, he obtained a Master in Networks Technologies and Communication. Currently he is performing a PhD in Computer Science and Engineering at the University of Cádiz (Spain). His research interests focus on Multi-agent and embedded systems and the integration of cloud computing and context-awareness in service-oriented architectures in the Internet of Things and the Industria 4.0.

Introduction

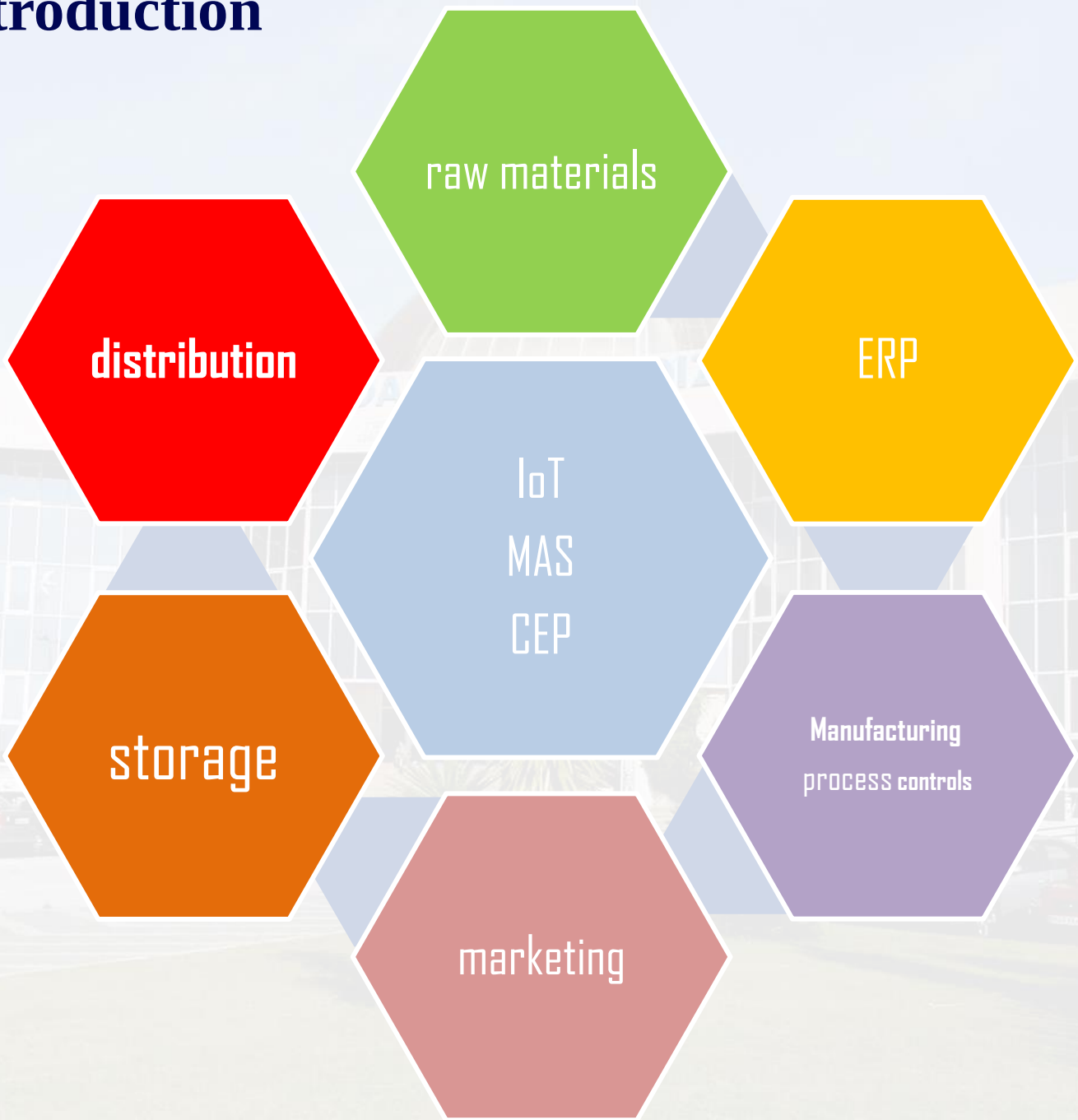
1st revolution	*2nd revolution*	*3rd revolution*	*4th revolution*
			
Mechanization, steam and water power	*Mass production and electricity*	*Electronic and IT systems automation*	*Cyber Physical systems*

Introduction

Introduction

Cloud computing

Introduction



Background

Industrial IoT

"*...the industrial internet is an internet of things, machines, computers and people enabling intelligent industrial operations using advanced data analytics for transformational business outcomes, and it is redefining the landscape for business and individuals a like*"[i]

[i]What is IIoT? The Industrial Internet of Things (Primer industrial internet Consortium)

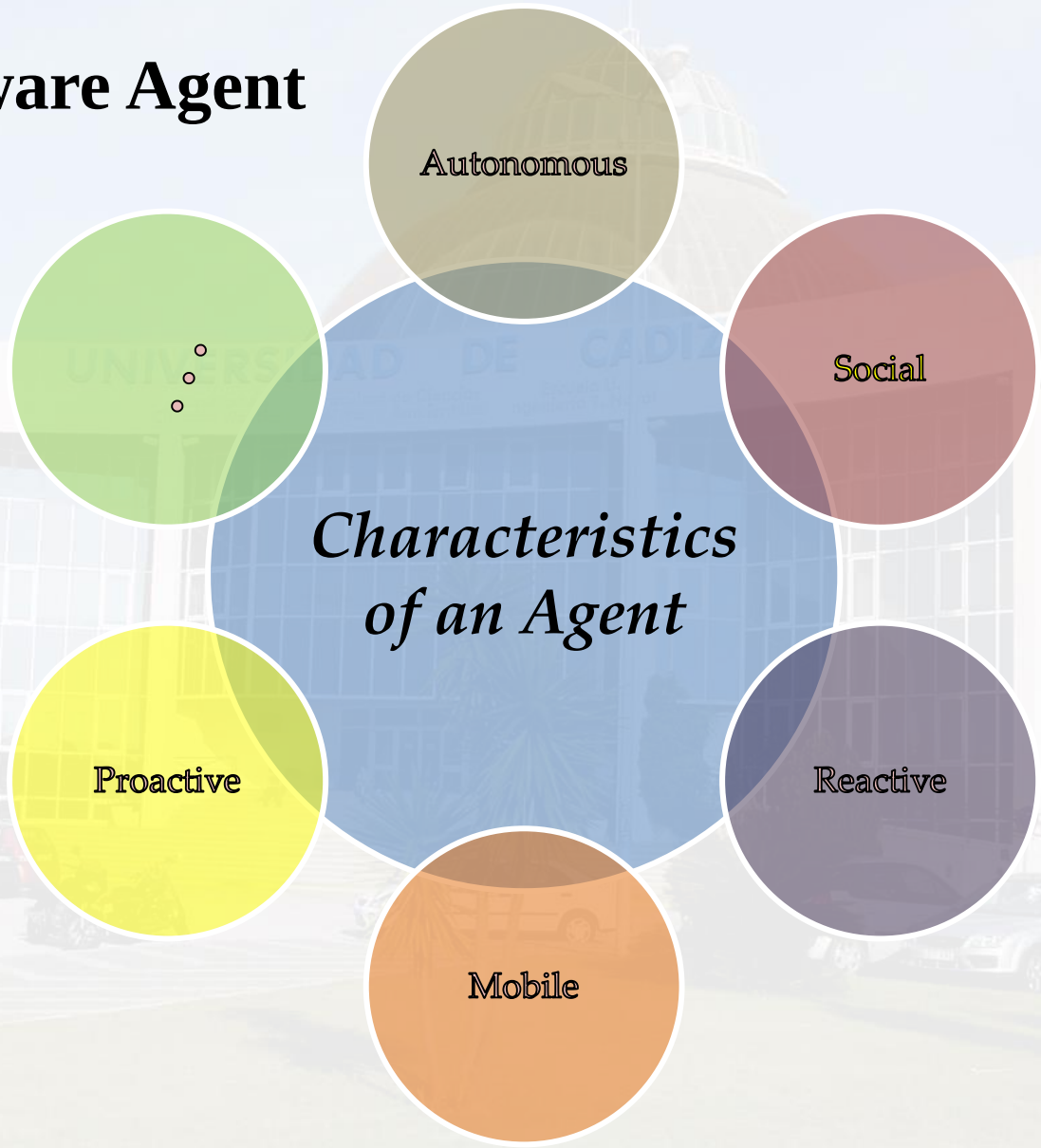
Background

Software Agent

The agent is a software system that has a specific purpose in being able to react with a certain degree of independence and autonomy in a complex and dynamic environment. This agent is characterized from a conventional software by its size and by the objectives and agendas on which it is based to accomplish its tasks based on a set of knowledge and representation of predetermined objectives .

Background

Software Agent



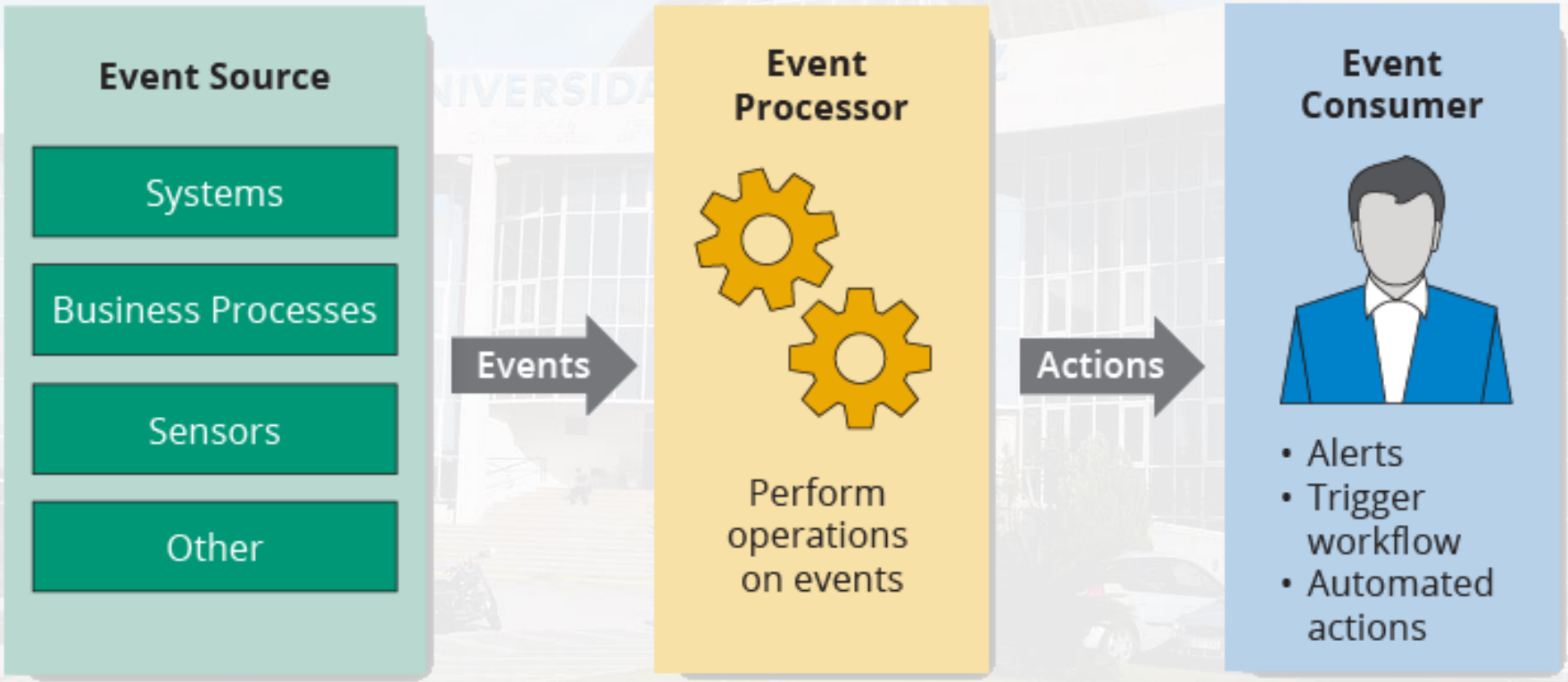
Complex Event Processing

CEP is a technology that allows the capturing, analyzing and correlating of a large amount of heterogeneous data (simple events) with the aim of detecting relevant situations in a particular domain .

What we do is defining a series of event patterns that specify the condition that must be met from the content of the events of one or more incoming data streams for a situation of interest to be detected. This situation of interest detected by an event pattern is named complex event.

The software that permits the analysis of streaming data according to the defined patterns in real time is the CEP engine. Among the complex event engines, Esper stands out due to its maturity and performance, as well as the wide coverage of its EPL event pattern definition language

Complex Event Processing



Related Works

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With linking all the elements of the production chain together, it leads to the creation of a large volume of data related to the production stages, the status of the product, the state of the production machines, the follow-up of the product quality and the state of stocks. In other words, this system provides information about the product, from the time it was raw material to the marketing stage, and to follow up on customer feedback after receipt and use. The volume of this information is called Big-Data, In turn, next to this term, the '3V' of Big-Data appeared, which refer to the Volume, Speed and Variety of the data generated by these systems, The first 'V' (Volume) refers to the huge amounts of information generated. The second 'V' (Velocity) refers to the speed with which said data is generated. Finally, the third 'V' (Variety) refers to the heterogeneity of these data that are generated. The ingestion and processing, analysis of this Big-Data is the one on which we are going to focus the main objectives of our research.

Related Works

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In general, many of the currently existing solutions for processing heterogeneous data sources are forced to carry out a normalization process or a pre-processing of the data to be able to analyze said information. In most cases, the normalization stage requires a lot of processing load, consuming resources and time. In addition, it is quite common in these systems to store the information to later reuse it in the analysis systems, thus causing storage costs.

Related Works

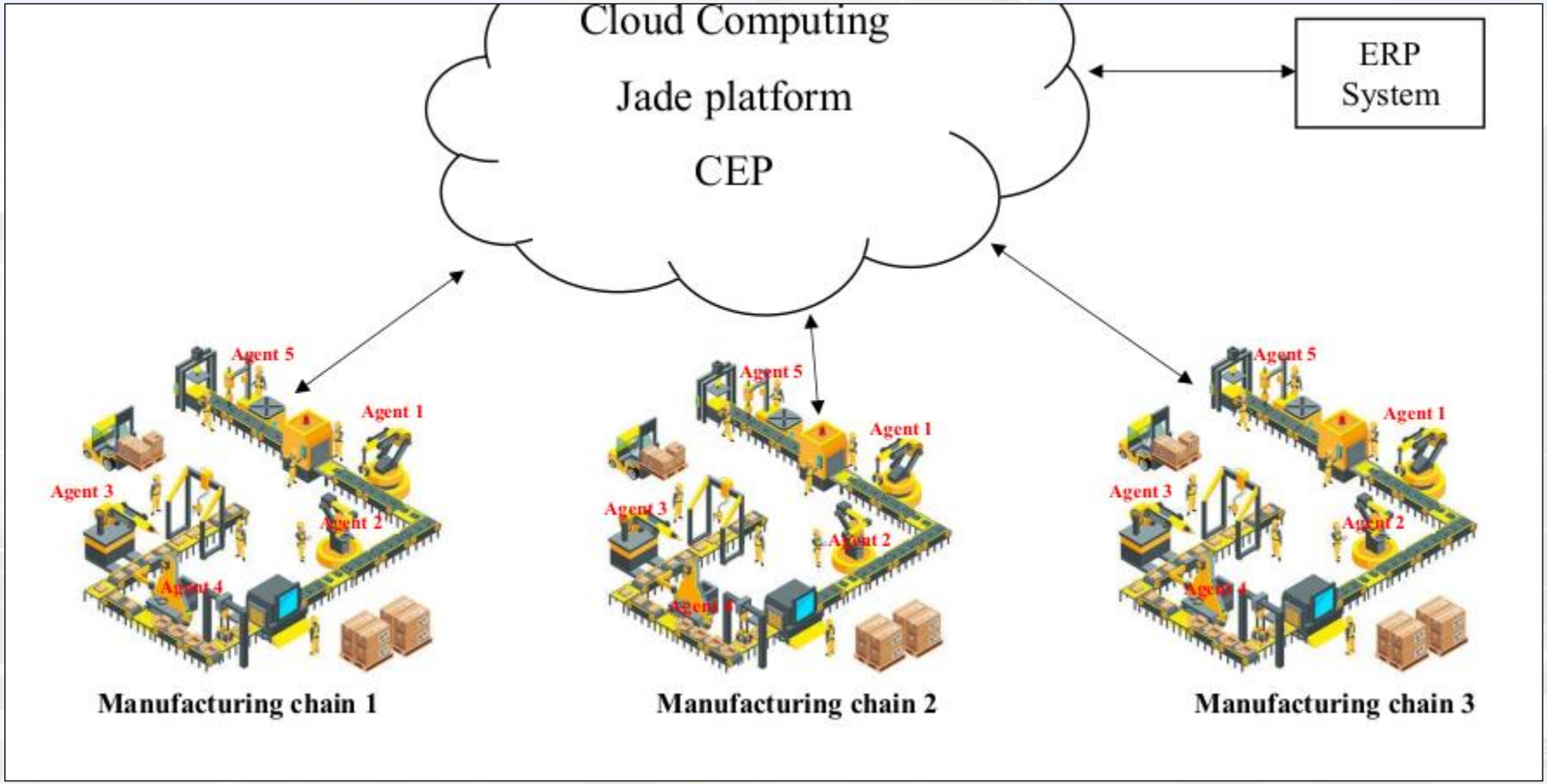
Some works have tried to solve this problem by carrying out homogenization in data sources, which is not very efficient if we consider large networks of IoT devices with a multitude of devices as data sources. Others, process batches of this heterogeneous information in order to normalize it, however, that means that we are not processing the information in real time, then situations of interest can go unnoticed and not be detected in time.

Related Works

Among the various solutions currently in place, come propose to use MAS to process and analyze the large amount of information produced for the various interests of the factories, and these solutions rely on the use of agents interacting with each other, applying the features of MAS overall system. The MAS cleans and monitors, collects data, and makes group decisions, and machine learning for Prediction and Health Management (PHM) of devices.

Therefore, in order to tackle this problem consisting of the need to collect this huge data from IoT, process it and analyze it in real time; in this paper, we propose a research plan based on the use of agent-based architectures, artificial intelligence and CEP to achieve agility and flexibility, as explained in the following section.

Proposal


Cloud Computing
Jade platform
CEP
ERP System
Agent 5
Agent 1
Agent 3
Agent 2
Agent 4
Manufacturing chain 1
Agent 5
Agent 1
Agent 3
Agent 2
Manufacturing chain 2
Agent 5
Agent 1
Agent 3
Agent 2
Agent 4
Manufacturing chain 3

Conclusion

We have shown our work-in-progress proposal for a cooperative Industrial IoT architecture using the agent paradigm and CEP. We will benefit, on one hand, from agent features to enrich the device with autonomy, coordination and cooperation qualities between a set of manufacturing chains, while on the other, we will benefit from CEP to process the collected data in real time to improve the decision making and have a competitive advantage. Besides, once the proposed architecture is fully implemented, we expect to test it in a real manufacturing scenario.