

# Service reconfiguration in dynamic environments: a service-oriented multi-agent system approach

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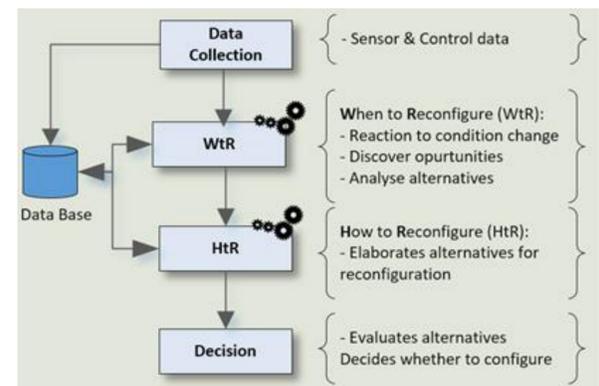
## Introduction

- One of the most important goals of companies and organizations is to continuously deliver high quality products to raise their competitive position.
- Complex and dynamic environments are favorable to perturbations such as broken machines, performance deviations, etc. Which requires adaptive and responsive systems.
- Several researchers suggest flexible or evolvable paradigms that provide more flexibility, robustness and re-configurability systems

The analysis of the state of the art shows that it is worth studying

- “when should the system evolve”
- “how should the system be reconfigured”

- **Event** - event-driven approach (similar to the corrective maintenance), deals with unexpected/reactive events
- **Periodic** - on a scheduled basis it promote new services periodically (preventive maintenance) based on a time interval,  $\Delta$ , which may be dynamically adapted
- **Trend** - recognize a tendency or pattern in the service performance



*How to Reconfigure module (HtR)* create several solutions, by exploring “what-if” questions supported by Self-organization methods.

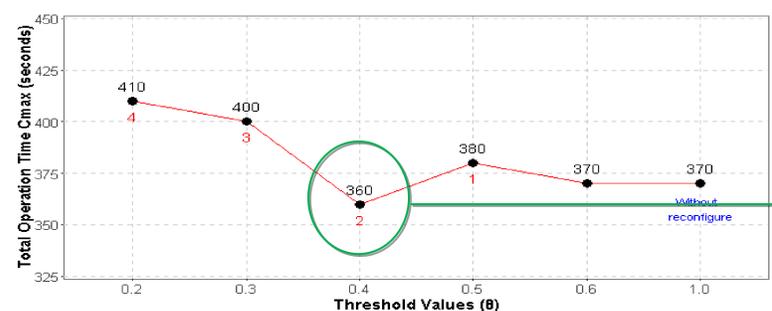
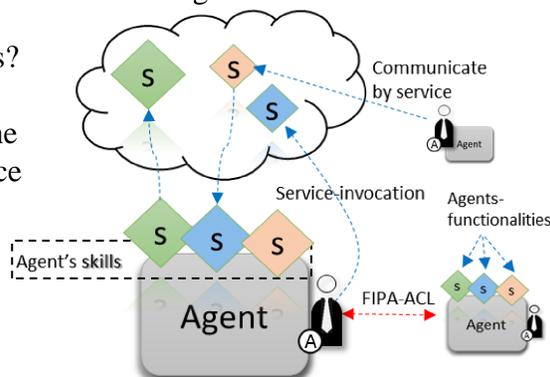
- **Self-organization** (self-\* actions) allows to regulate the service reconfiguration in environments where it is difficult to predict the global behavior (e.g. the overall production plan)

## Methods

- The insertion of intelligent agents facilitates the improvement of the strategies that perform the service reconfiguration

What are the expected benefits?

- Agent can encapsulate the behavior logic as a service
- Agent can change intelligently a service characteristics
- Multi-agent systems and service-oriented offers a continuous and intelligent adjustment of triggers for the reconfiguration process



Outputs for a specific production batch simulation:

- Accurate number of service reconfigurations performed
- Explores trigger strategies mechanisms: **what** to change, **when** to trigger such modification and **how** to make it represents a wiser and maximization of the services [2]

## Results

**What to reconfigure**, namely what self-\* actions (self-adaptation and self-optimization) the agents can perform? [1]

Feature	Description	Effort
Agent	Change the MAS structure, e.g. plugging a new machine station	High
Service	Change the catalogue of offered services by using pluggability characteristics, e.g., offering a new drilling operation	High
Service properties	Modification of the service properties, e.g., modifying the quality measurements of a specific tool	Low

**When to Reconfigure** module (WtR) is responsible for monitoring the agent performance and discover the needs and opportunities for reconfiguration based event, periodic and trend triggering policies [2].

## Conclusions

- Addresses solutions for real industrial applications
- Aligned with some characteristics of the Industrie 4.0 initiative, namely the distributed intelligence and methods for self-\*, e.g. adaptation, organization and configuration.
- The preliminary experimental results validate the feasibility of such triggering strategies for service reconfiguration leading to more efficient and agile systems
- We can generalize these techniques to other domains (smart-grids, physical internet)

## References

- [1] Rodrigues, N., Leitão, P., & Oliveira, E. *Adaptive Services Reconfiguration in Manufacturing Environments Using a Multi-agent System Approach*. In Multiagent System Technologies: MATES 2015, Cottbus, Germany, 2015.
- [2] Rodrigues, N., Leitão, P., & Oliveira, E. *Triggering Strategies for Automatic and Online Service Reconfiguration* In Iberian Conference on Information Systems and Technologies CISTI'2016 Gran Canaria, Spain. June 2016.