Microservices Architectures and Technical Debt: A Self-adaptation View

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Outline

- Motivation
- MSA and technical debt
- MSA and self-adaptation
- MSA and self-protection (security)
- Conclusions

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Motivation

- MSA and self-adaptation
  - Self-healing, autonomic controller for deployment, regression testing, resilience, controller failure
    - Distributed nature of MSA
  - Insight taken: emergent and fuzzy
    - centralised vs decentralised
- MSA and technical debt
  - There are no primary or secondary studies analysing the principles of MSA in light of TD
  - No guidelines for evaluating the debt capacity

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Motivation: State-of-the-art

- Not much significant has been published on MSA and self-adaptation
  - Relative new field, not yet stable in terms of what is the key foci of change
  - Some misguided proposals
- (Surprisingly!!) Both are about **change**
  - Possible explanation: in software engineering, in particular, software architectures the basis has bee MAPE-K loop
    - Essentially, a centralized entity
  - Architecture vs deployment
    - Tools for handling change at deployment
      - Eg, Kubernetes

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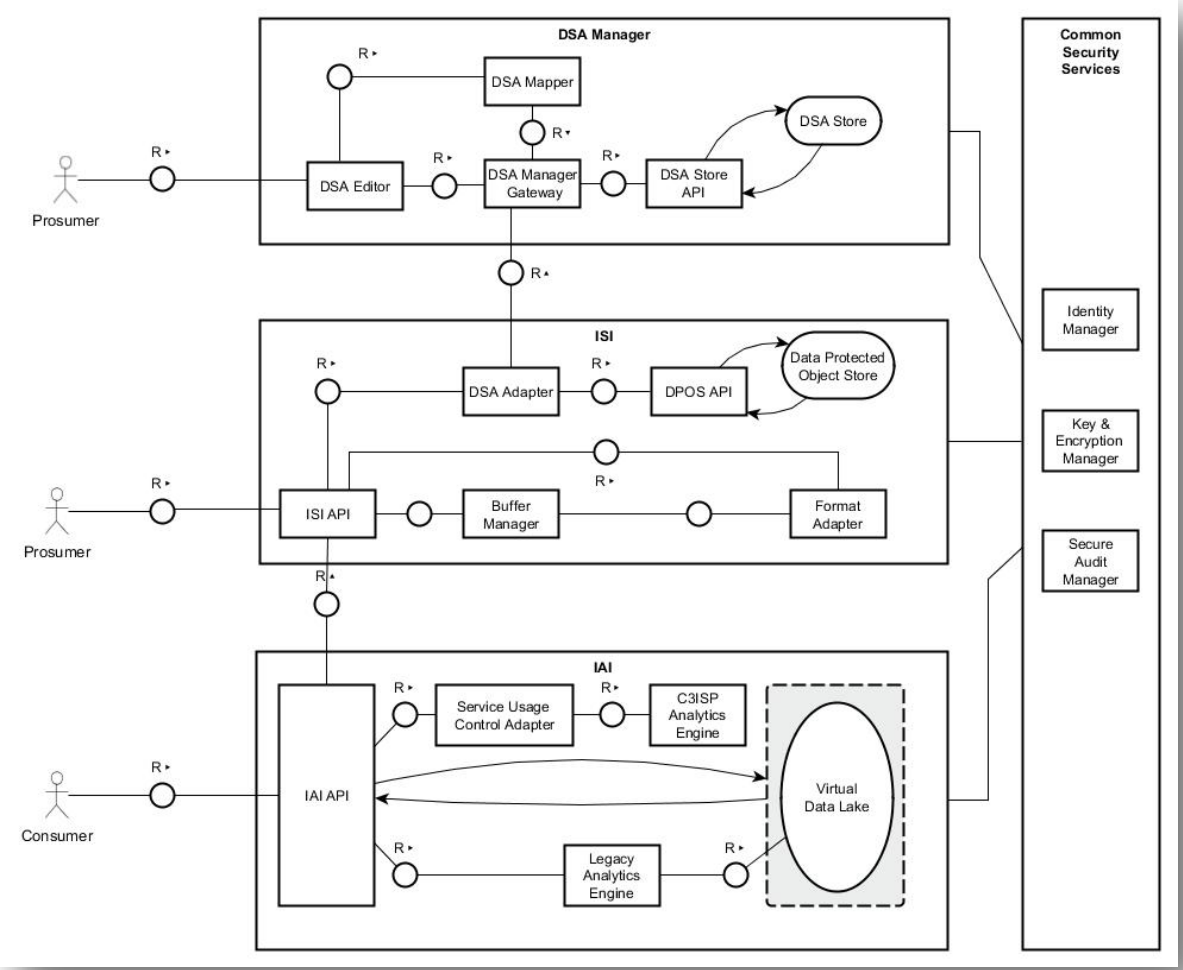
C3ISP
Collaborative and Confidential Information Sharing and Analysis for Cyber Protection

- 3 physical servers
- 10 VMs
- 22 micro-services
- 3 OSS packages
- 120+ Open API REST services
- ~300,000 lines of code (Java)

All deployed by a Continuous Delivery engine



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MSA and Technical Debt

- Technical debt
  - design decisions that consciously or unconsciously compromise system-wide quality attributes
- Assumptions or methods can negatively affect an MSA-based software system during its lifetime
- Awareness of TD and its implications
  - Developers can be more cautious while making decisions
- To reduce TD
  - Quality of attributes of an MSA-based system should be analysed at architecture level
    - Testing, security and reliability

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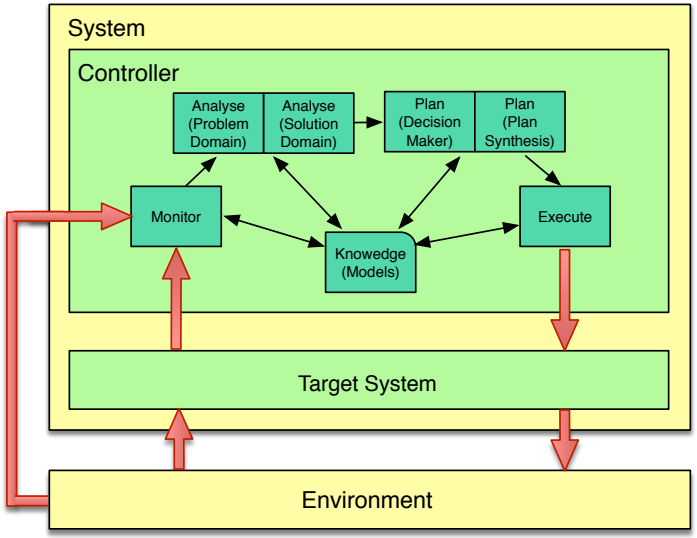
MSA and Technical Debt

- Testing
  - Large systems with many connections between services makes integration testing more challenging
- Security
  - Attack area increases since there are more points of entry, lack of global view since containers deployed in the cloud, individual microservices may not be trustworthy, system complexity, etc
- Reliability
  - Complex deployments with many services and connections tend to reduce the reliability of services, nothing to handle failures in connections

MSA and Self-adaptation

- Self-adaptation
  - A system is able to modify its behaviour and/or structure in response to changes
    - Feedback control loop, and software engineering techniques



- Testing
  - Generate automatically new integration test plans when changes in the architecture
- Security
  - Identify malicious components and protect the MSA-based system
- Reliability
  - Known as self-healing

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Type of Control

- From centralised to decentralised
  - Single component or distributed amongst several components
- Self-adaptation
  - Feedback control loop, relies on system models from different perspectives
- Self-organization
  - Multi-agents, ant colony optimisation, swarms
- There is no single unique solution for self-adaptive MSA
  - Orchestration vs choreography
  - Several factors involved in controlling functional and non-functional attributes
    - Specialisation vs generalization of controllers

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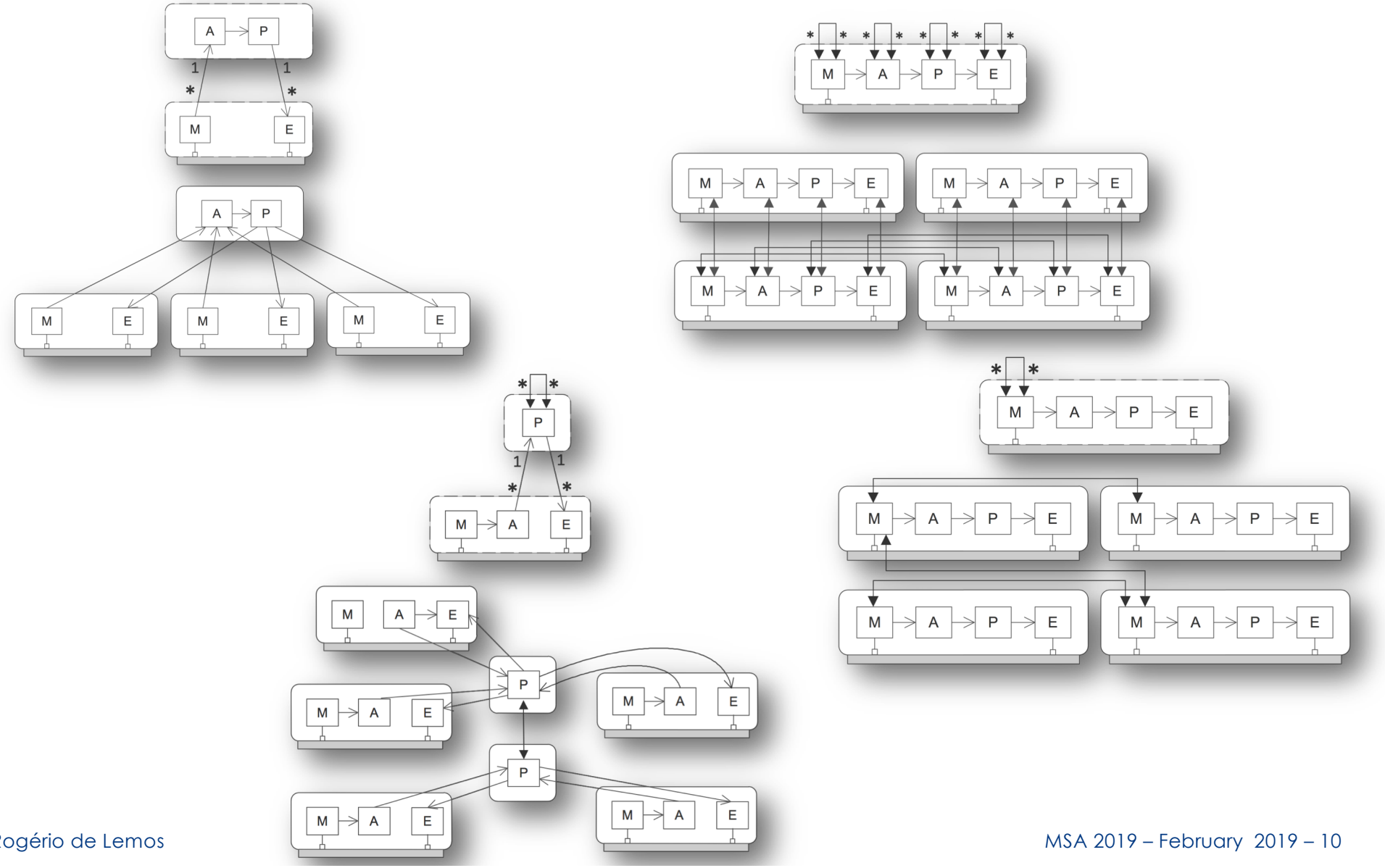
Patterns for Decentralized Control in Self-Adaptive Systems [Weyns 2013]



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MSA and Self-protection

- Security services should rely on orchestration
  - Information sharing, each node cannot maintain a model of system, compromised nodes lack self-awareness, etc
- Detection and protection against malicious containers
  - Containers may have the right to access other services, but they abuse
  - Their malicious behaviour should be detected
  - Containers should be isolated from the system
    - Impact on reliability or availability is another analysis

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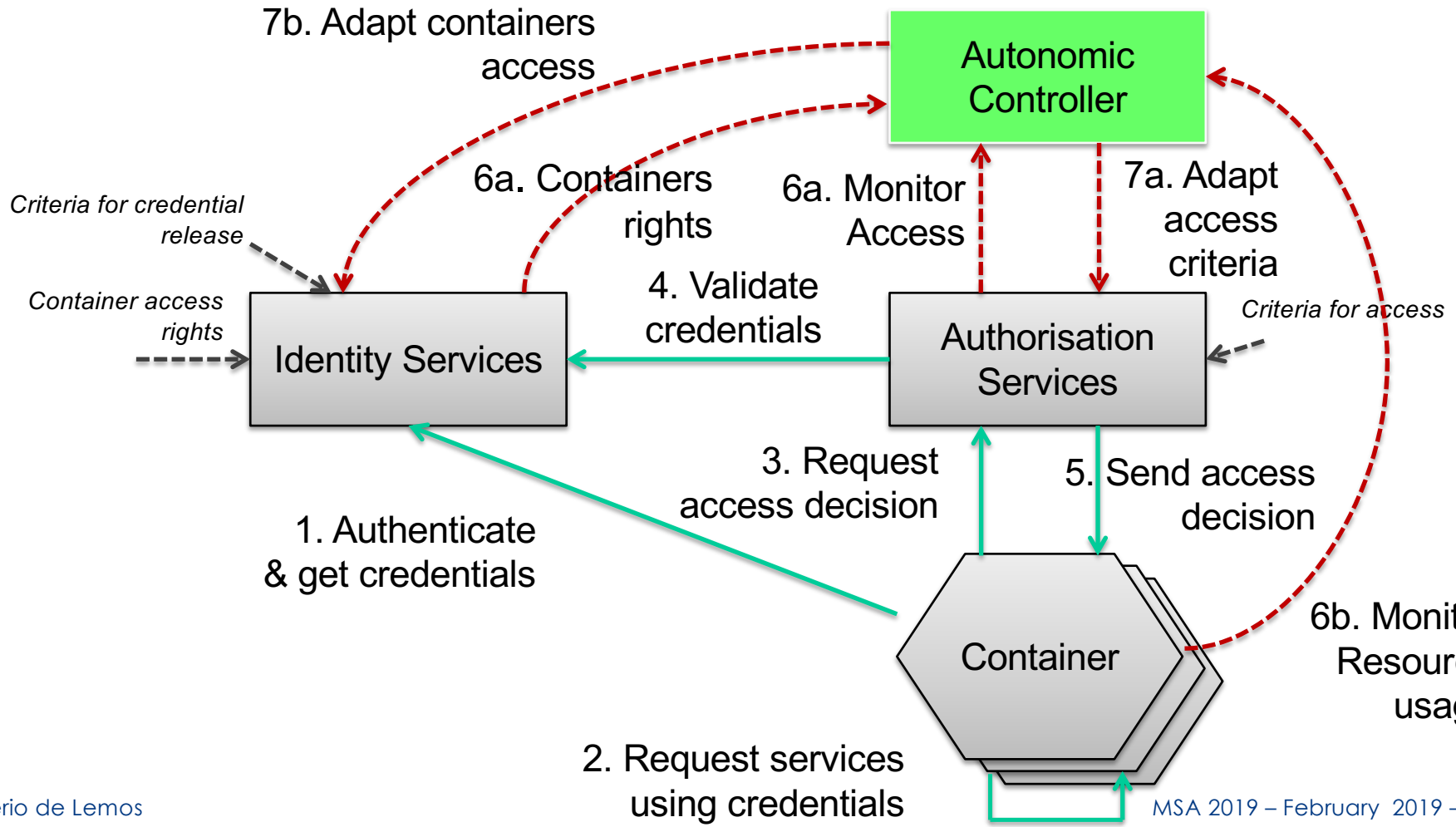
Self-protection against Malicious Microservices



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Conclusions

- Design decisions lead to trade offs
  - MSA has benefits, but also has some drawbacks
  - Lack of discussion regarding technical debt
    - What about lessons learned from similar SE initiatives?
- Self-adaptation offers an opportunity for handling change
  - A single MAPE-K loop is not the solution
  - Resilience of MSA-based microservices comes with a cost related to complexity
- The notion of 'autonomy' is misplaced
  - Functional and non-functional
- How to protect MSA-based solutions against malicious microservices

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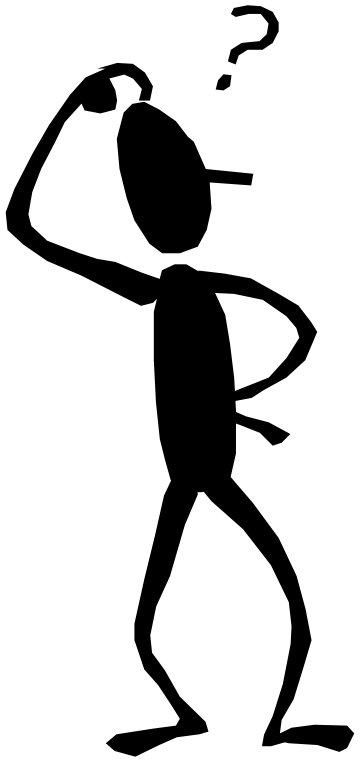

Thank you!

Dortmund. February 2019.