UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

itee PhD information technology electrical engineering

DIETI UNINA

Marco Barletta

Container orchestration in mission critical environments: advantages and challenges

Tutor: Marcello Cinque

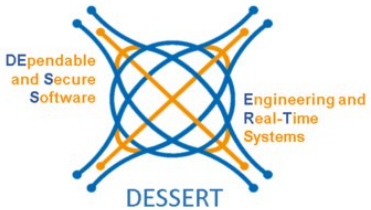
Cycle: XXXVII

Year: Second

itee PhD information technology electrical engineering

My background

- MSc degree in Computer Engineering (October 2021)
- Research group: DEpendable and Secure Software Engineering and Real Time (DESSERT) group
- PhD start date: 01/11/2021
- Scholarship type: UNINA



Research field of interest

Mission critical environments require more and more flexibility

Adapt to changeable conditions while
respecting strict **non-functional** constraints

Examples:
- Industry 4.0
- 5G networking and beyond

Changeable market requests
Changeable environment

Recent computing paradigms could satisfy these requirements
Examples: Edge/Fog computing

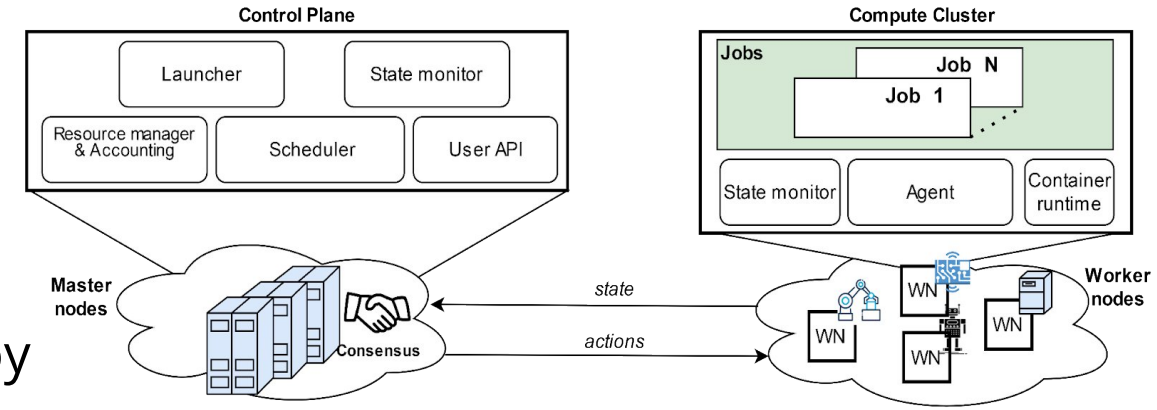
How? **softwarization**, **virtualization**, and **orchestration**
Resource sharing, consolidation, offloading, etc.

Research field of interest

Orchestration systems are distributed systems that automatically **manage** the packaged software **lifecycle** over a computing infrastructure.

They provide:

1. Automatic placement and deployment
2. Monitoring of the state of the cluster
3. Migration and re-deploy of the containers
4. Scaling of applications



Orchestration systems are a standard de-facto in cloud environments, behaving as Cloud-OSes.

Research activity: Overview

Problem:
Orchestration systems provide useful feature but …
- do not properly distinguish the criticality of applications
- increase complexity and risks of failures
- eventually get to desired state with little timing guarantees

Objective:
Evaluate non-functional characteristics
Design and **test** solutions to improve dependability metrics.

Contribution:
- **Design** of a multi-criticality orchestration system.
- Evaluation of **timeliness** and **fault-tolerance** of Kubernetes.

Research activity: Overview

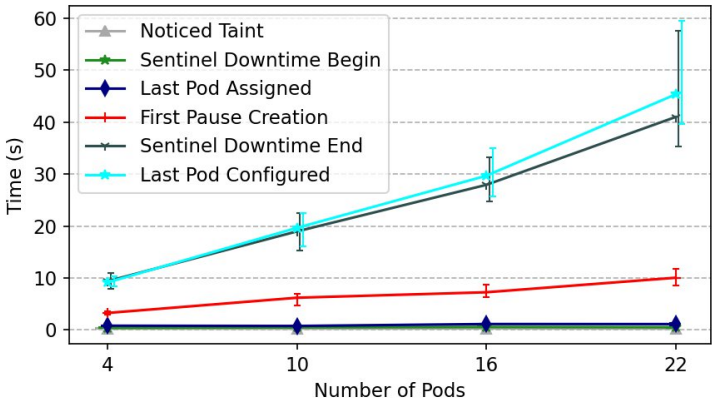
First year:
Study of the functionalities needed in mission-critical environments:

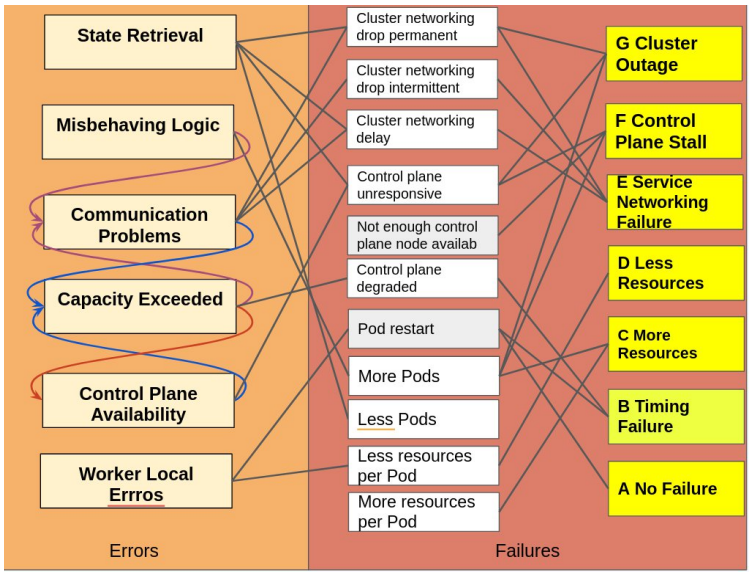
- Criticality-aware **placement**
- Multiple **virtualization** technologies
- Suitable **monitoring**

Second year:

- Timing predictability:
  Asynchronous event management prevents the **prioritization** of apps

- Fault-tolerance:
  Can **recover** from a broad range of faults and errors, but easy to **overload**

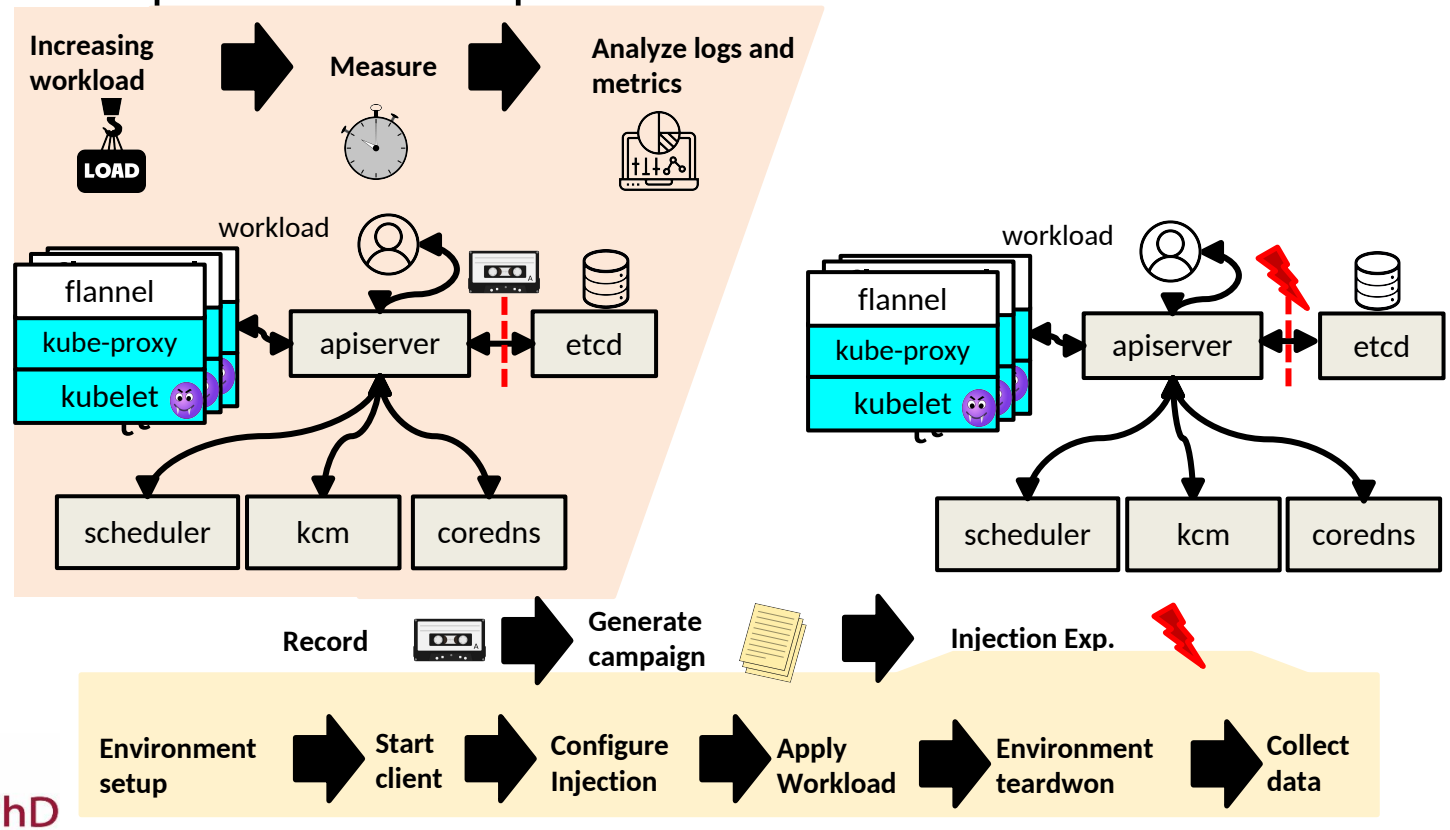




Research activity: Overview

Methodology:

1. Measure the behaviour under increasing synthetic load
2. Analyze through log analysis and monitoring metrics
3. Repeat experiments in presence of fault/errors



Summary of study activities

Ad hoc PhD courses:

- IoT Data Analysis
- How to boost your PhD

Conferences / events attended:

- The 33rd IEEE International Symposium on Software Reliability Engineering (ISSRE 2022), hybrid mode, Charlotte, USA 01/11/2022, *presenting author*

***Period abroad*:**

- *University of Illinois at Urbana Champaign, Champaign, USA 12/04/2023 to 22/12/2023*

Products

[M1]	*"SLA-Driven Software Orchestration in Industry 4.0" M.Barletta, M.Cinque, C. Di Martino. IEEE IoT Magazine* *M. Barletta, M. Cinque, L. De Simone, R. Della Corte* *IEEE Internet of Things Magazine*
[C1]	*"Partitioned Containers: Towards Safe Clouds for Industrial Applications"* *M Barletta, M Cinque, L De Simone, R Della Corte, G Farina, D Ottaviano* *2023 53rd Annual IEEE/IFIP International Conference on Dependable Systems – Disrupt Track*
[J1]	*"Criticality-Aware Monitoring and Orchestration for Containerized Industry 4.0 Environments"* *M. Barletta, M. Cinque, L. De Simone, R. Della Corte* *ACM Transactions on Embedded Computing Systems*
[P1]	*Patent Application 327300-WO-PCT* *M. Barletta, C. Di Martino*

Presentation organization

- CONTENT
  - Cover
  - Your background
    - Graduation MS, DIETI group, cooperations
    - Type of fellowship (University, company-funded, etc.)
  - Your research field
    - Specific (1 minute)
  - Summary of study activities
    - Courses attended, schools, seminars, etc.
  - Your research activity (3 minutes)
    - idea, methodology, developments, expected results, validation
  - Your products
    - List papers, tools, awards (if any), etc.
  - Tutorship
    - list courses of tutorship activities authorized by ITEE Board)
  - Next year