This work was supported in part by the *Spanish Ministry of Science and Innovation* under *TestBUS* (PID2019-105455GB-C32) and *EQUAVEL* (PID2022-137646OB-C32)

CONTACT US

Toward an efficient End-to-End test suite execution

Cristian Augusto

Advisor: D. Claudio de la Riva

Doctoral Symposium

34th IEEE International Symposium on Software Reliability Engineering

giIS Software Engineering Research Group

Universidad de Oviedo

Agenda

1. Motivation and Context
2. Objective
3. RETORCH:
    1. Approach
    2. Validation
4. RETORCH*
    1. Approach
    2. Validation
5. Completion of the Phd.
6. Future work

Motivation and Context

- Continuous Integration Systems (CI) where the suites are executed at each repository change
  - Test Suites not executed as much as required →

    Not enough time || resources used
  - Potential defects missed → 20-40% more expensive to fix
- Even more challenging with expensive tests, like End to End (E2E) testing, due to:
  - Long execution times.
  - Expensive resources.
  - Entire System required.

Motivation and Context

- Traditional techniques are not useful in E2E testing → reduced-prioritized test suite requires the same expensive **resources**.

- **Virtualization** and **Cloud execution** emerge as solution → puts new challenges on top of the already faced on-premise

Objective

Optimize E2E test suite execution

IMPROVING:

Execution Time

Number Resource Redeployments

Execution Cost

THROUGH:

Resource identification

Selection of a Cost-effective Cloud and Test configuration

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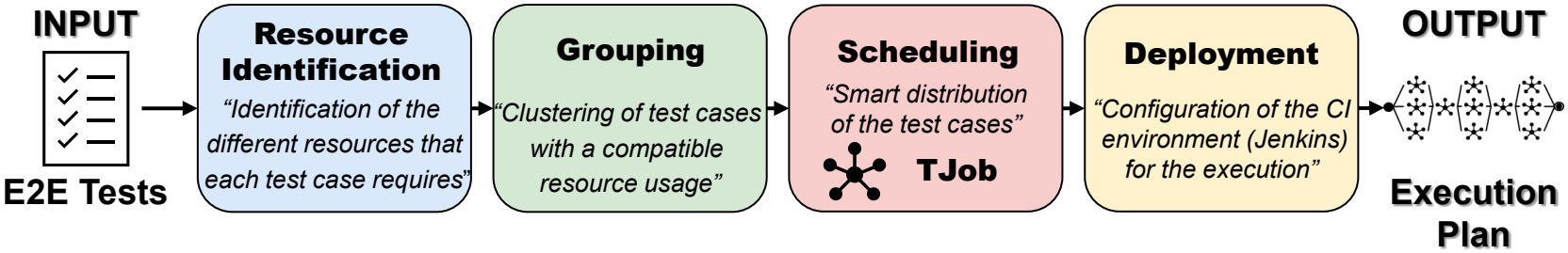
RETORCH: Resource Aware End-to-End Test ORCHestration



Key Concept: Resource

"Physical, logical or computational entity that is required during the execution of a E2E test suite"

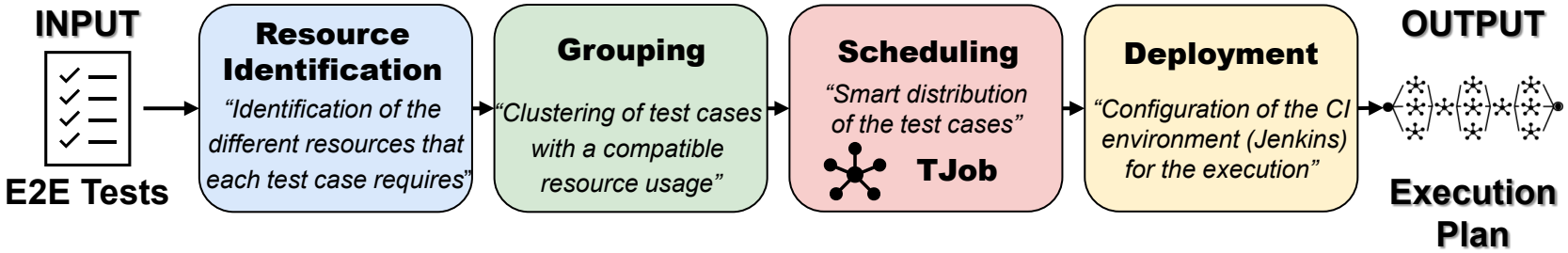
ACCESS MODE

How the test case access the resource

ATTRIBUTES

Extra information about how can be used

RETORCH: Resource Aware End-to-End Test ORCHestration



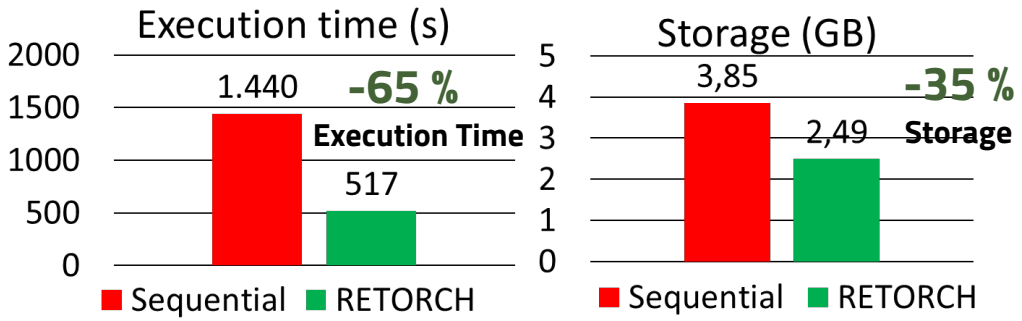
Validation:

Demonstrator:

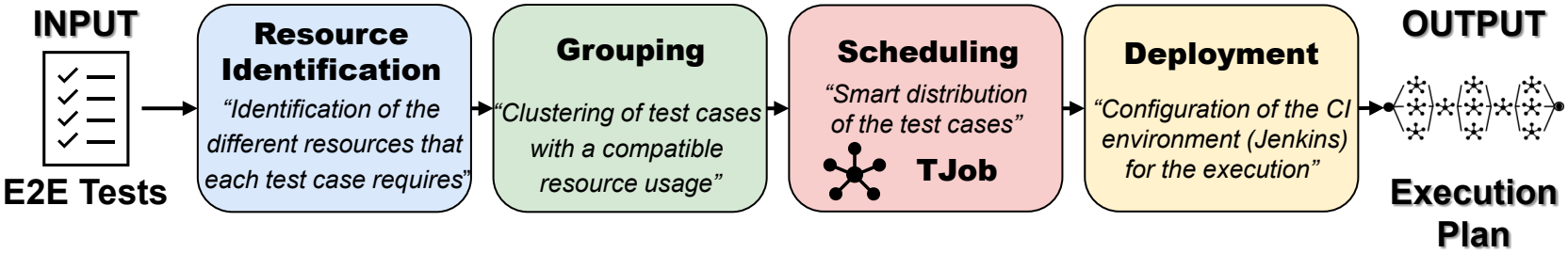
FullTeaching

- *21 E2E tests.*
- *10 resources.*
- *Access modes → read, read write, dynamic, no-access…*

RETORCH achieves savings:



RETORCH: Resource Aware End-to-End Test ORCHestration



Journal Articles:

Springer

*Software Quality Journal (**JCR Q2**, IF: 1.460)*

Conferences:

ICSE 2020

42nd Int. Conf. in Software Engineering

QUATIC 2019

12th Int. Conf. on the Quality of Inf. and Communications Technology

Awards:

everis an NTT DATA Company

Best thesis Dissertation SISTEDES-EVERIS

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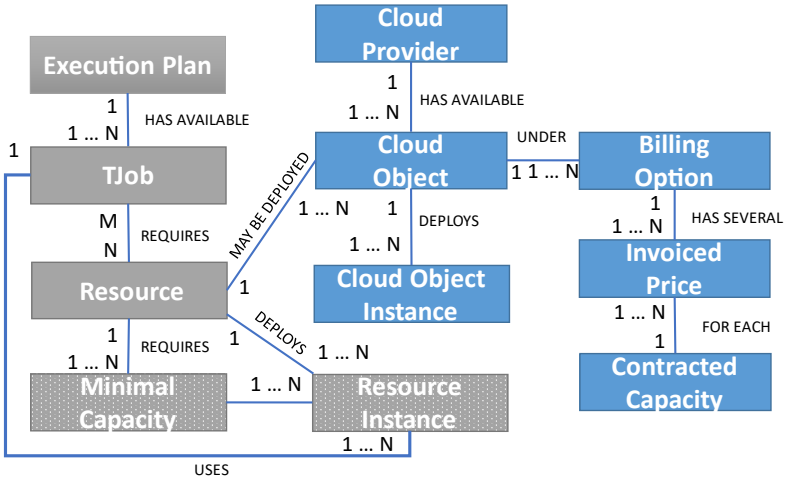
RETORCH*: A Cost and Resource aware Model for E2E Testing in the Cloud

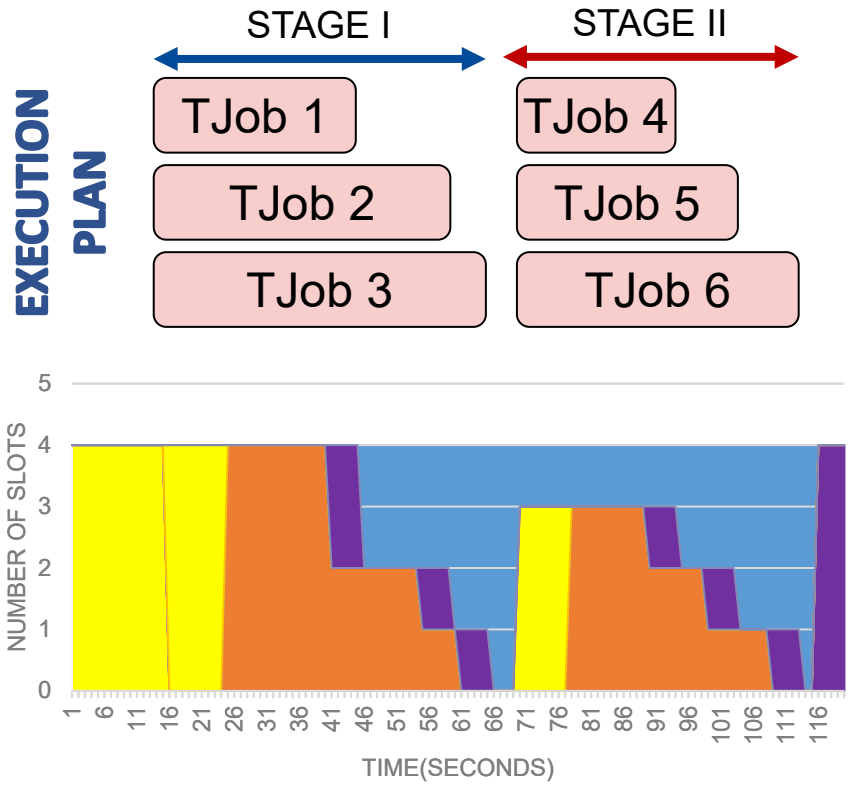
"Improve the Test and Cloud Configuration based on the (monetary) cost to achieve an efficient E2E test execution"

RETORCH* Model of the E2E Test execution in the Cloud:

- **Test configuration**: represents the scheduled test suite given by RETORCH
- **Cloud configuration:** represents the configuration of the Cloud Infrastructure



RETORCH*: A Cost and Resource aware Model for E2E Testing in the Cloud



Execution Plan

"TJobs scheduled in sequential or parallel to reduce time/resources"

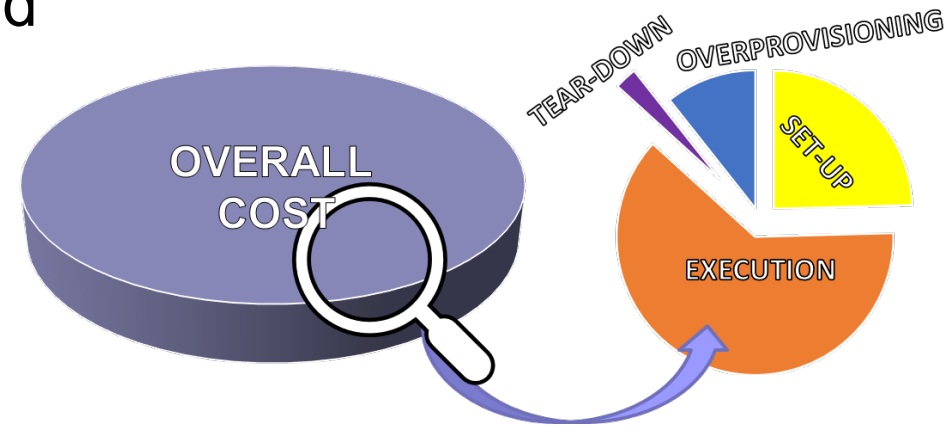
Usage Profile

"Shows how the different resources use the contracted Cloud Infrastructure"

RETORCH*: A Cost and Resource aware Model for E2E Testing in the Cloud

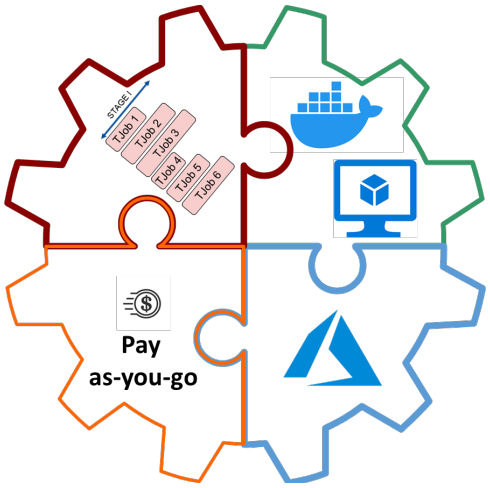
RETORCH* Cost Model to compare different Test and Cloud Configurations:

- Not only overall cost-based (billed):
  - Testing cost:
    - Set-up
    - Execution
    - Tear-down
  - Overprovisioning cost



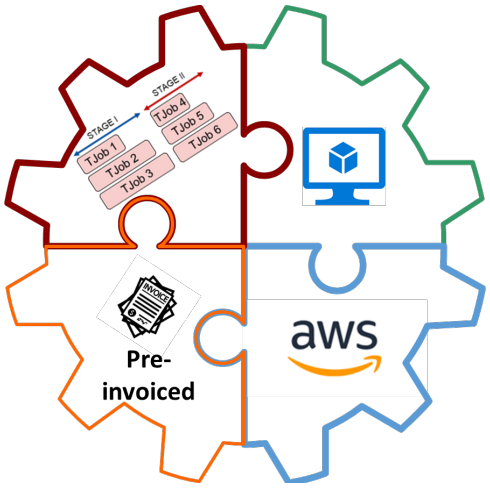
RETORCH*: A Cost and Resource aware Model for E2E Testing in the Cloud

Alternative I



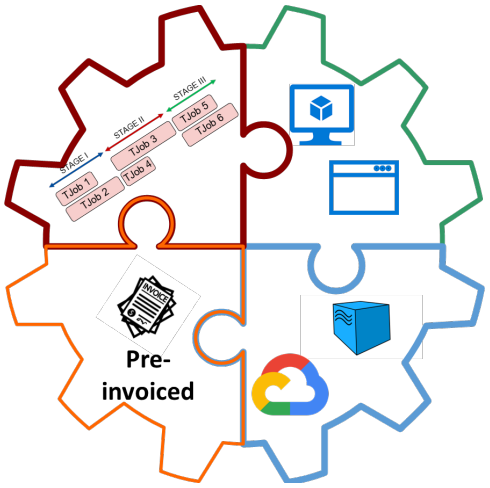
Overprov:
Set-up: $$
Exec: $$$
Tear-down: $
Overall: $$$$$$

Alternative II



Overprov: $$$$$
Set-up: $
Exec: $
Tear-down: $
Overall: $$$$$$$$

Alternative III



Overprov: $$
Set-up: $$
Exec: $$$
Tear-down: $
Overall: $$$$$$$

RETORCH*: A Cost and Resource aware Model for E2E Testing in the Cloud

Validation:

FullTeaching Test Suite

- *Demonstrator of H2020 European Project (ElasTest)*
- *21 E2E Test Cases*
- *10 different resources and several access modes.*

RESEARCH QUESTIONS:

RQ1: Cost/efficiency choosing different Cloud Object categories?

Different Cloud Objects:
- *Virtual Machine*
- *Containers*
- *Services*

RQ2: Cost/efficiency choosing different Billing Options?

Different Billing Options:
- *As-you-go*
- *Pre-invoiced*

RQ3: Cost/efficiency setting different Execution Plans?

Different Execution Plans:
- *4-Parallel*
- *3-Parallel*
- *5-Parallel*

RETORCH*: A Cost and Resource aware Model for E2E Testing in the Cloud

Results:

RQ1:

The cost/efficiency depends on the category:

- ***Containers**: attractive in terms of efficiency and overall cost*
- ***Virtual machines**: less efficient but good testing cost .*
- ***Services**: employ all the cost in the test execution.*

RQ2:

The cost/efficiency is affected by the billing option:

- ***Pre-invoiced** becomes more attractive than **As-you-go** beyond a certain threshold*

Validation performed during my PhD. Internship in the ISTI-CNR (PISA)

RQ3:

The Execution Plan impacts in the cost/efficiency:

- *The **capacities** and **time** required depends on the Execution Plan*
- ***Changes** in the Execution Plan →*
- *Cloud Infrastructure **misalignment** →*
- *No longer retain its **efficiency***

RETORCH*: A Cost and Resource aware Model for E2E Testing in the Cloud

Results:

Conferences:

26th Jornadas de Ingeniería Del Software y Bases de Datos (SISTEDES 2022).

Journal Articles:

Cristian Augusto, J. Morán, A. Bertolino, C. de la Riva, and J. Tuya, "RETORCH: A Cost and Resource aware Model for E2E Testing in the Cloud"*

Awards:

Best Student Academic Paper of the SMILESENG22

PhD. Internship in the ISTI-CNR (PISA)

Completion of the Ph.D.

RETORCH*: Validation and experimentation with more case studies

[eShop] on containers

PIGGY METRICS

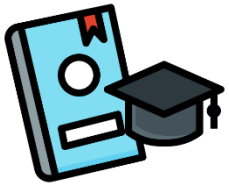
staffjoy

Online BOUTIQUE EST. 2015

Open-Source Microservice Benchmark TrainTicket by CodeWisdom@Fudan University

ExplorViz

Thesis writing and defense



Intending to defend his Ph.D. thesis in the middle of the year 2024.

Future Work

- Conduct a more in-depth study on the effects experienced by development teams involved in multiple projects.
- Implement RETORCH*model into the orchestration tool to optimize the Execution plans
- Automate the recommendations through a bot engine

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