Daniele Lombardi

Predictability and Security of Edge-based Cyber Physical Systems

Tutor: Prof.ssa Valentina Casola

Cycle: XXXVII   Year: First

My background

- MSc degree: Computer Engineering

- Research group/laboratory: RFI / SecLab

- PhD start date: 01.01.2022

- Scholarship type: None

- Research fellowship, founded by Rete Ferroviaria Italiana S.p.A.

Research field of interest

Safety-critical system

The **railway infrastructure** is a clear example of

- Cyber-physical system - -

- In many instances, it would be incredibly beneficial to **handle data on the device** where it's generated, e.g., best performance, low latencies, AI/ML support, low operational costs and so on...

- ... but there are new challenges to address about the trustworthiness [1], i.e. **predictability**, **security**, **safety**.

INTERNET OF THINGS — CLOUD — EDGE LOCAL PROCESSING — CORPORATE DATA CENTER
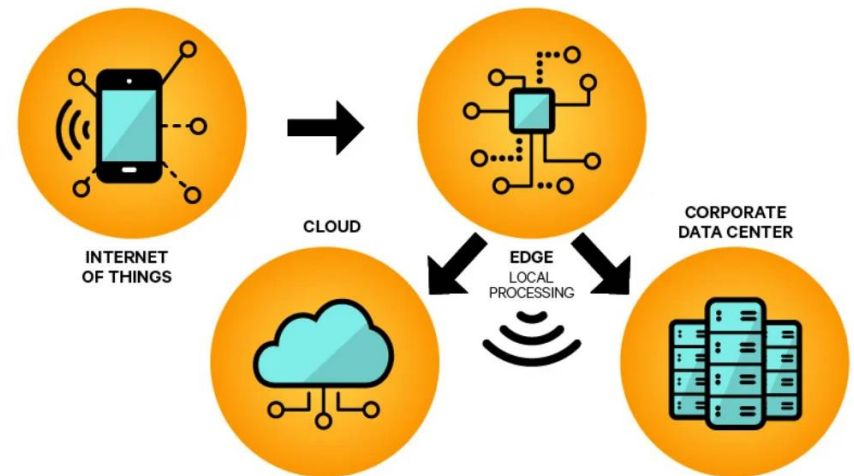
Edge-computing

[1] José Manuel Gaspar Sánchez, Nils Jörgensen, Martin Törngren, Rafia Inam, Andrii Berezovskyi, Lei Feng, Elena Fersman, Muhammad Rusyadi Ramli, and Kaige Tan. 2022. *Edge Computing for Cyber-physical Systems: A Systematic Mapping Study Emphasizing Trustworthiness*. ACM Trans. Cyber-Phys. Syst. 6, 3, Article 26 (July 2022), 28 pages

Summary of study activities

- **Ad hoc PhD courses:**
  - Virtualization technologies and their applications
  - Statistical data analysis for science and engineering research
  - Data science for patient records analysis

- **Seminars:**
  - 12, mainly related to security issues and critical systems

- **Research Areas:**
  - A1: Predictability of critical systems (railway domain)
  - A2: Threat Intelligence (railway domain)

Research activity: Overview (1)

- **Problem**
  - Edge computing can be leveraged to bring real-time computing closer to peripheral devices
  - Several possible causes undermine system **predictability**, so it is important:
    - To be able to confidently and accurately estimate the **Worst Case Execution Times** for system schedulability,
    - To quantify the errors made when measuring latencies

- **Objective**
  - **Define** a methodology to temporally characterize *complex edge systems,* in order to estimate their predictability, i.e., system ability to meet the temporal requirements of critical tasks.

itee **PhD**
information technology
electrical engineering

Research activity: Overview (2)

- **Methodology**

  I. In-depth analysis of the state of the art regarding temporal analysis techniques adopted in industrial settings, highlighting their pros and cons

  II. Design of a **hybrid timing analysis** methodology, application context-independent, that, relying on *pre-existing artifacts* (i.e., MCDC test-cases) of the software development cycle and *non-intrusive tracing*, can accurately and reliably estimate system timing-behavior

  III. Development of an **analytical model** for measuring interrupt latencies, that can also consider errors committed during measurements

  IV. Evaluation of the proposals in a **real industrial case-study** (among the numerous RFI-DIETI joint projects)

Products for Research Activity 1

[P1]	Title: *Behavioral characterization of real-time systems owing hybrid timing analysis* Authors: S. Barone, V. Casola, S. Della Torca, D. Lombardi Conference: HiPEAC 2023, *Workshop on Next Generation Real-Time Embedded Systems 2023* Status: under review
[P2]	Title: *Interrupts-latency measurement: an evaluation model* Authors: M. Barbareschi, S. Barone, V. Casola, D. Lombardi Journal: ACM Transactions on Embedded Computing Systems Status: under review
[R1]	Title: *Testing non intrusivo di MASK* Type: Deliverable on Software tests Authors: S. Barone, S. Della Torca, V. Coppola, D. Lombardi Status: Released Project: Joint Project between DIETI and RFI on CPS testing
[R2]	Title: *Testing non intrusivo di RfiOS* Type: Deliverable on Software tests Authors: S. Barone, S. Della Torca, V. Coppola, D. Lombardi Status: Under development Project: Joint Project between DIETI and RFI on CPS testing

Products for Research Activity 2

[R1]	Title*: Cyber-Physical Threat Intelligence service for MAIA platform* Type: Software platform and deliverable Authors: A. P. Amirante, S. Della Torca, D. Lombardi Status: Released Project: MAIA, joint project on security of railway infrastructure

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