Enhancing Safety with RISC-V based SPIDER Autonomous Robot

A Use-Case from ECSEL FRACTAL Project

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Agenda

1. **FRACTAL Project**
2. **SPIDER Autonomous Robot Use-Case**
3. **Safety and Security in Automotive**
4. **Safety Services**

FRACTAL PROJECT

A Cognitive Fractal and Secure EDGE based on a unique Open-Safe-Reliable-Low Power Hardware Platform Node

The OBJECTIVE of FRACTAL project is to create a COMPUTING NODE

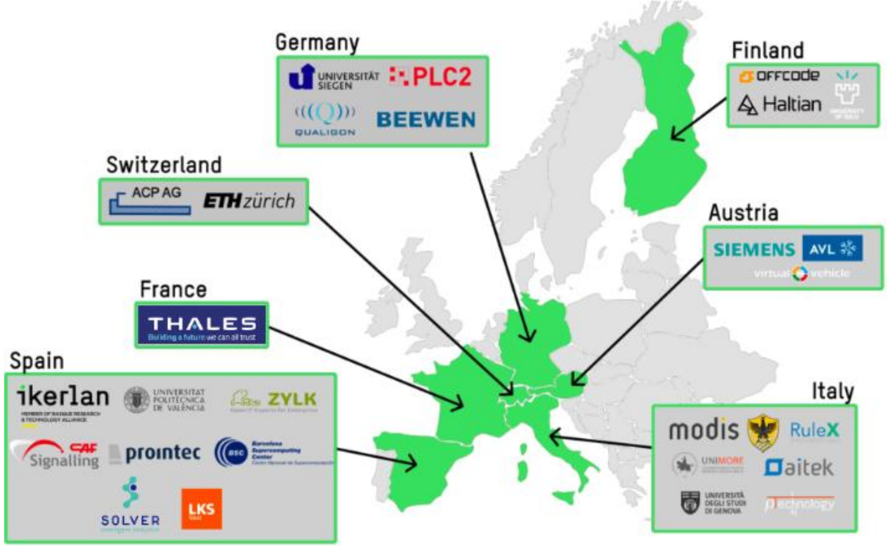
as the building block

of scalable Internet of Things

The two main general characteristics of

our node would be:

COGNITIVE + FRACTALITY



fractal-project.eu

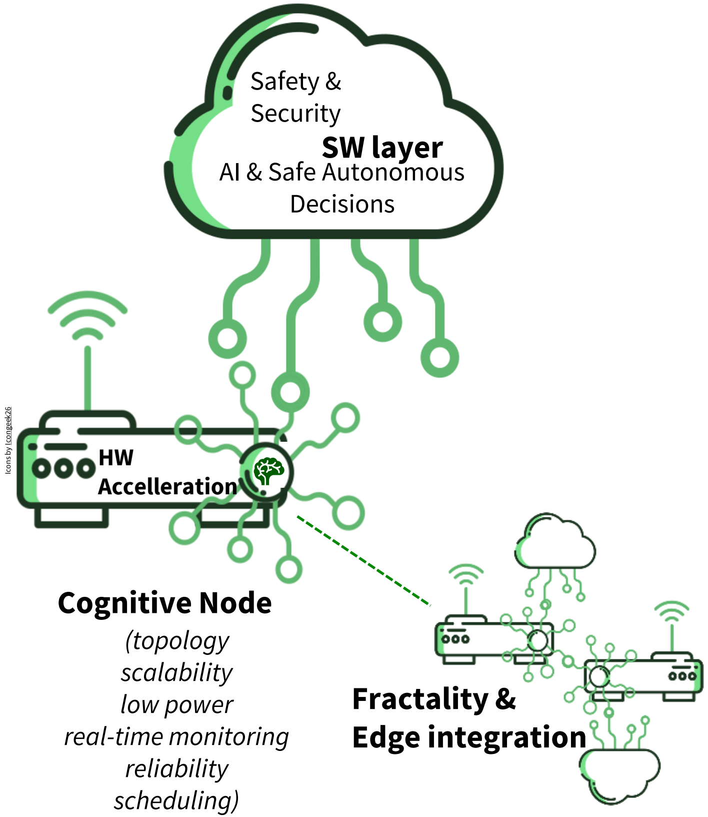
FRACTAL Strategic Objectives

1 To design and implement an **open-safe-reliable hardware platform**. It will be used for building the cognitive edge nodes of variable complexity.

2 To **guarantee extra-functional properties** of FRACTAL nodes (dependability, security, timeliness and energy-efficiency).

3 To **evaluate and validate data analytics with AI**. To identify the largest set of working conditions, while preserving safe and secure operations

4 To integrate **fractal communication** and remote management features into the nodes.



Cognitive Node

(topology scalability low power real-time monitoring reliability scheduling)

Fractality & Edge integration

SPIDER AUTONOMOUS ROBOT USE-CASE

SPIDER Autonomous Robot Use-Case

Smart PhysIcal Demonstration and Evaluation Robot

www.v2c2.at/spider

Objective 1

Co-execution of safety-relevant, security-relevant, as well as AI based tasks

Objective 2

Guarantee extra functionality of fail-operational capabilities

SPIDER™
Mobile Platform for the Development and Testing of Autonomous Driving Functions

Use-Case Architecture

SELENE

noel-V
RISC-V

Path Tracking Node

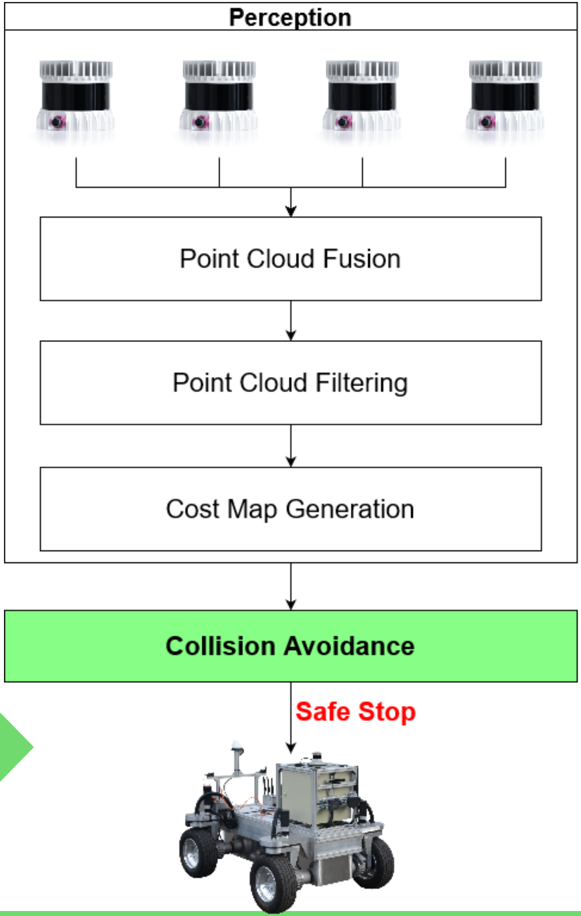
- Redundant, and accelerated AI model execution

ROS

Collision Avoidance Node

- Redundant Execution
- Monitoring of RISC-V cores

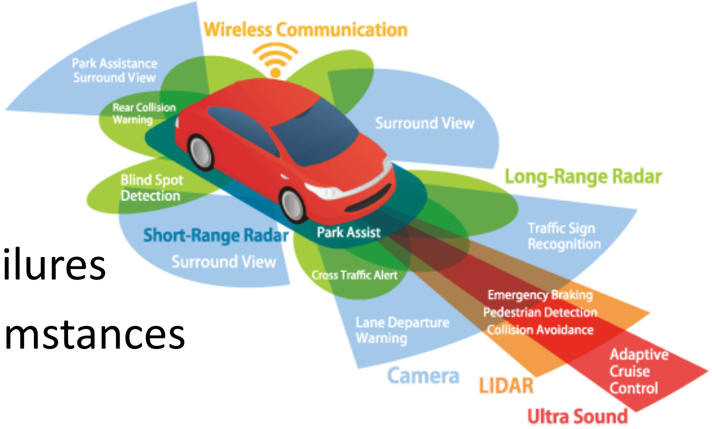
ROS



SAFETY AND SECURITY IN AUTOMOTIVE

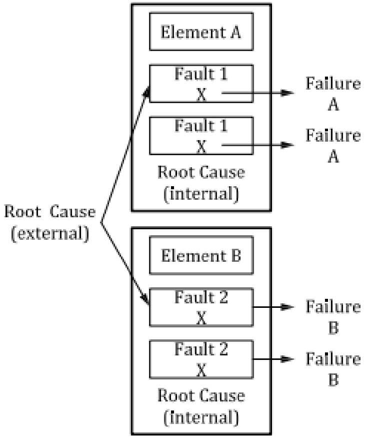
Safety and Security in Automotive

- **Safety in automotive** is driven by **ISO 26262** (2018)
- In automotive, the **safety-critical system requires** the highest Automotive Safety Integrity Level (ASIL) risk classification **-> ASIL-D**
- **Automated driving** functionalities **require systems** that can meet **ASIL-D requirements**
- These systems need to accomplish **Automotive fail-operational capabilities**
  - Controlling failures, such as common-cause failures
  - Maintaining system operation under any circumstances

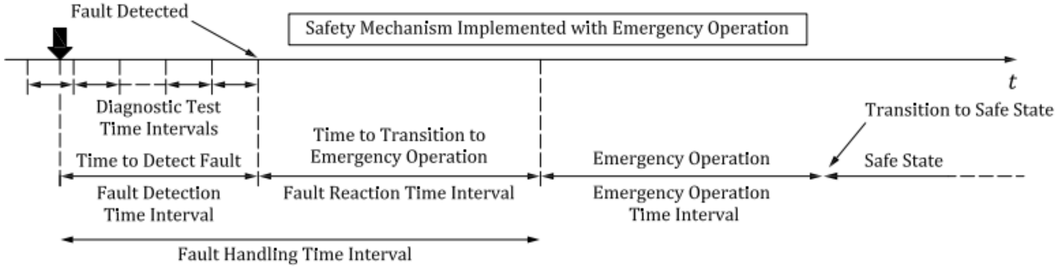


Safety and Security in Automotive

- Common-cause failures: **failure of two or more elements of an item** resulting directly from a single specific event or root cause
- Mitigation strategies (Safety measures):
  - **Redundancy** helps in improving the reliability and availability of a system.
  - **Diversity** aims to achieve independence



- Fault Tolerant Time Interval
  - **Safety Mechanism**
  - Emergency Operation



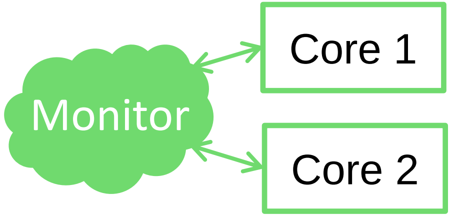
(*)Figures from ISO 26262 (2018)

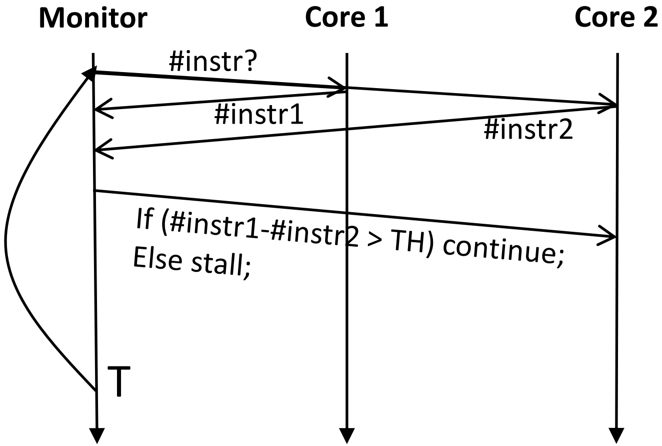
SAFETY SERVICES

Safe Software Diverse Redundancy Library

Prevention of common cause failures.

- All cores can be used by less critical apps
- SafeSoftDR creates independent copies of input and output data
- Function is executed in a diverse (time-staggered) redundant execution
- Results are compared
- Upon a mismatch, an appropriate safety measure should be triggered



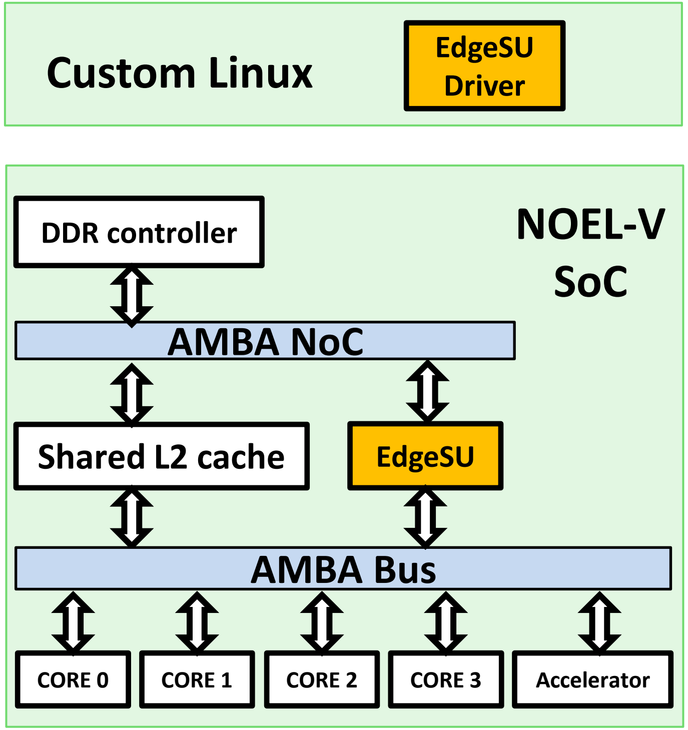


Released open-source: https://gitlab.bsc.es/caos_hw/software-diverse-redundancy-library

Safe Statistics Unit

Multicore timing interference monitoring

- Non-intrusive interference monitoring
  - Per core interference quota allocation
  - Measure total execution time
  - Measure interference of each core or accelerator
  - Per core Interrupt signalling



Released open-source: https://gitlab.bsc.es/caos_hw/hdl_ip/bsc_pmu

THANK YOU

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