A Model-driven development framework for highly Parallel and EneRgy-Efficient computation supporting multi-criteria optimisation

AMPERE – A model-driven development framework for highly parallel and energy-efficient computation supporting multi-criteria optimization

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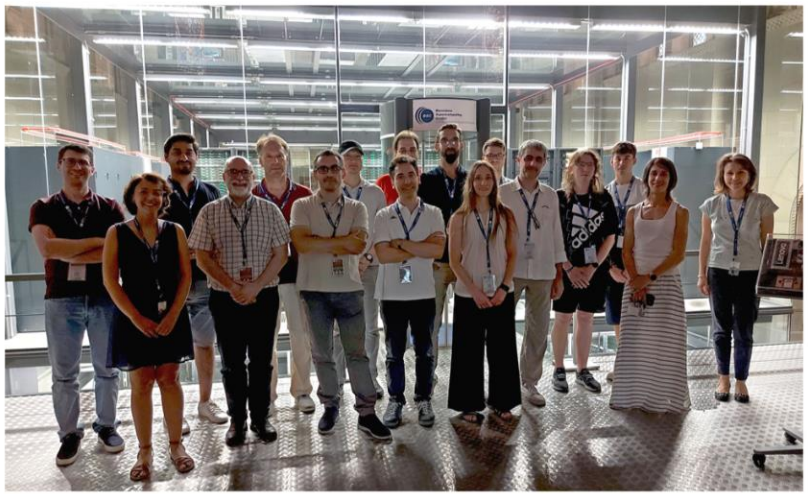
Sara Royuela (on behalf of Eduardo Quiñones)

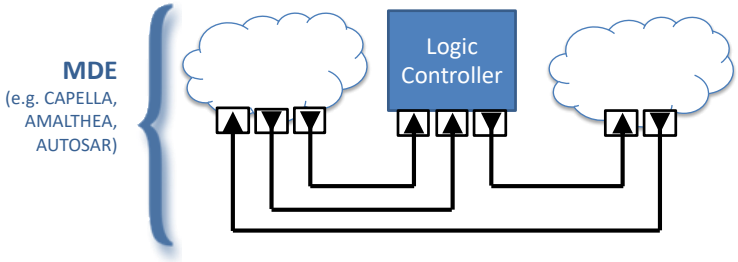
The AMPERE project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 871669

General Information

- AMPERE: A model-driven development framework for highly parallel and energy-efficient computation supporting multi-criteria optimization
- ICT-01-2019 - RIA (Research and Innovation Action)
- January 2020 – June 2023 (42 month)
- €4.9 million
- Partners:



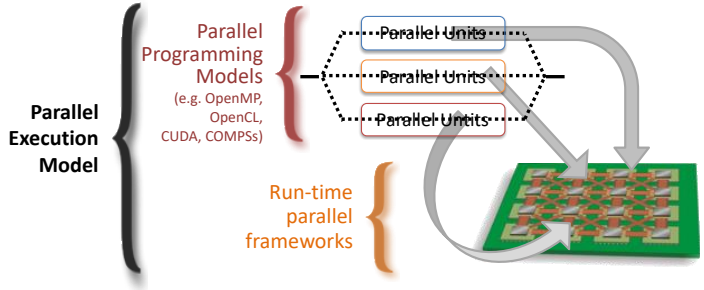
Motivation



Model Driven Engineering (MDE) in CPS

1. Simplify the construction of complex systems and facilitate integration and **composability**
2. **Formal verification** of functional and non-functional requirements
3. **Correct-by-construction paradigm** via code generation
   - Suitable for single-core or very limited multi-core support

Bridge the gap between the MDE used for CPS and the PPM supported by parallel platforms

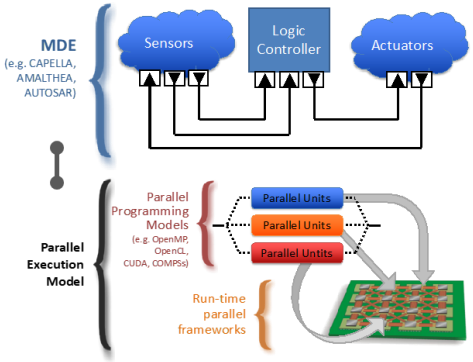


Parallel Programming Models (PPM)

1. Mandatory for **SW productivity** in terms of
   - *Programmability*: Parallel abstraction hiding HW complexities
   - *Portability*: Compatibility w. multiple HW platforms
   - *Performance*: Efficiently exploit parallel capabilities of HW
2. **Efficient offloading** to HW acceleration devices for an energy-efficient parallel execution

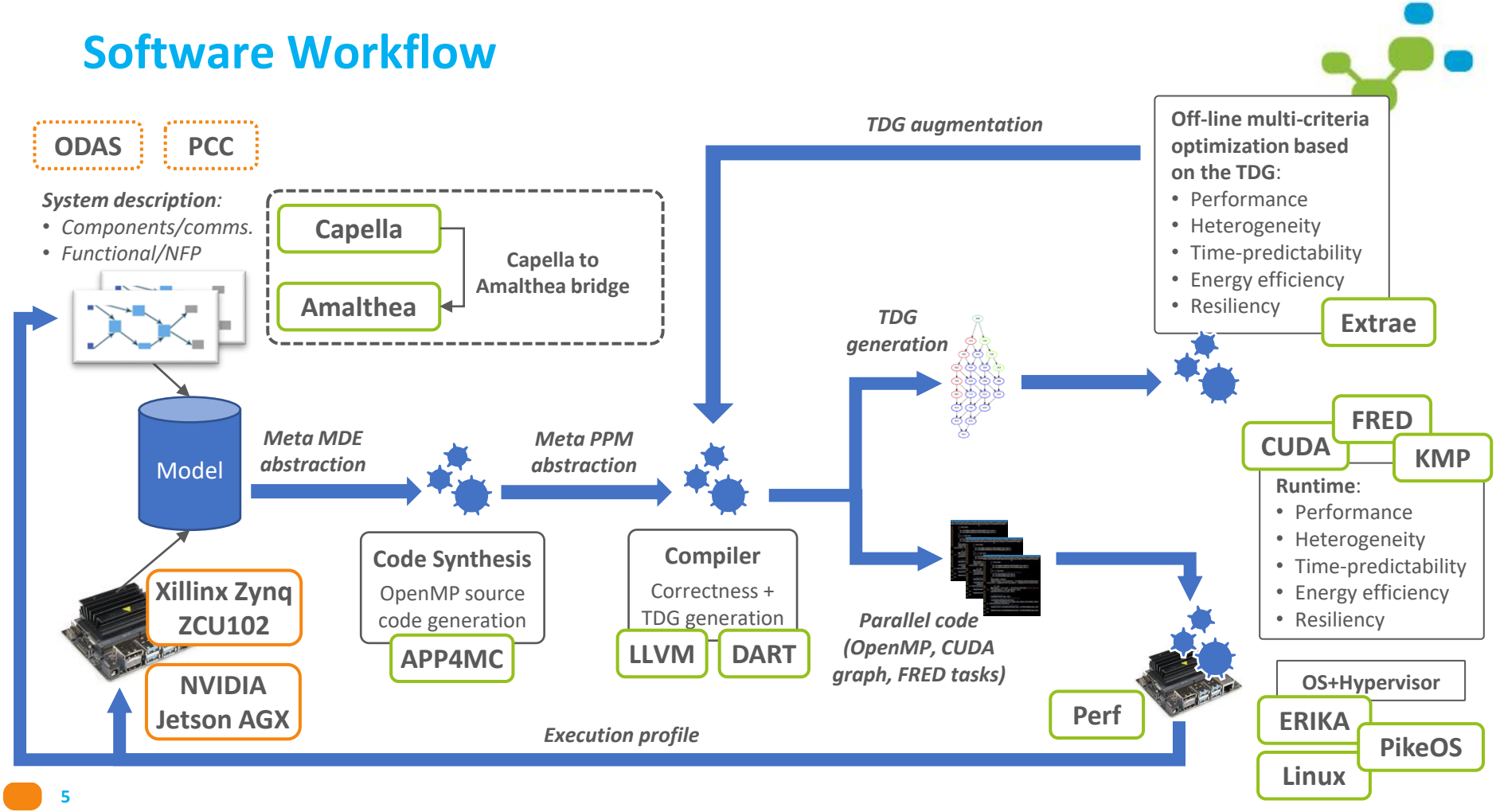
Vision

Bridge the gap between the MDE used for CPS and the PPM supported by parallel platforms



1. **Synthesis methods** for efficient *parallel* source code generation, keeping *non-functional* and *composability* guarantees.
2. **Run-time parallel frameworks** that guarantee system *correctness* and exploit the *performance* offered by parallel architectures.
3. **Integration** of *parallel* frameworks into *MDE frameworks*.

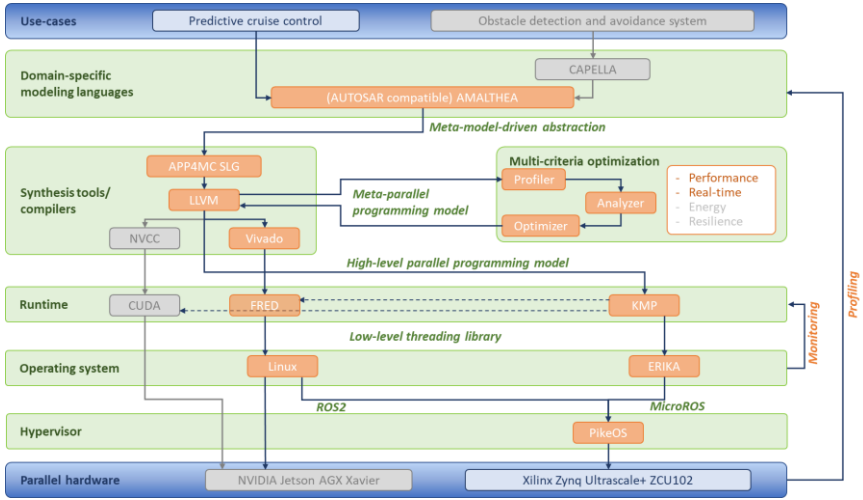
Software Workflow



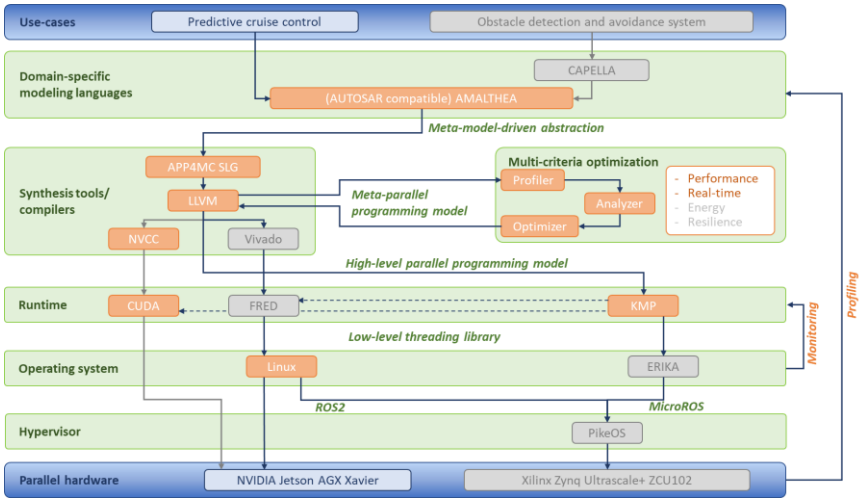
Modular design

- Conceived to implement different SW architecture instances (with different capabilities)
  - → Increase exploitation opportunities

Example 1 of a SW Architecture Instance



Example 2 of a SW Architecture Instance

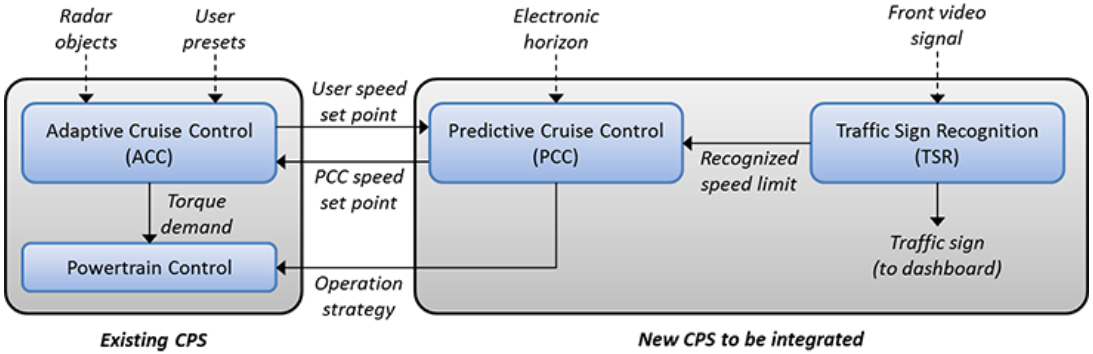


Automotive use-case: Predictive Cruise Control

- **Predictive Cruise Control (PCC)**
  - Extends Adaptive Cruise Control (ACC) by calculating the vehicle's future velocity curve using the data from the electronic horizon
  - Improve fuel efficiency (in cooperation with the powertrain control) by configuring the driving strategy based on data analytics and AI

AMALTHEA description:

- 49 real-time tasks
- 1488 runnables
- 10598 labels

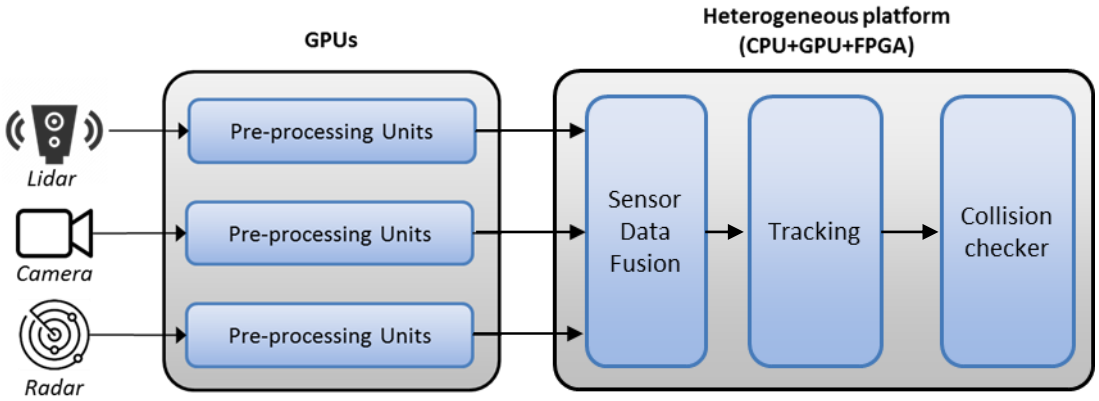


Railway use-case: Obstacle Detection & Avoidance System

- **Obstacle Detection and Avoidance System (ODAS)**
  - ADAS functionalities based on data fusion coming from tram vehicle sensors

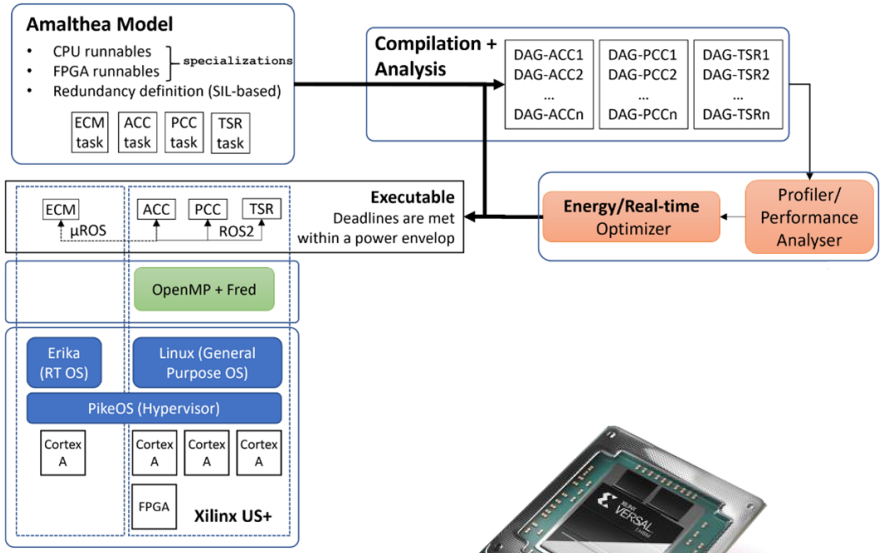
AMALTHEA description:

- 6 real-time tasks
- 20 runnables
- 19 labels

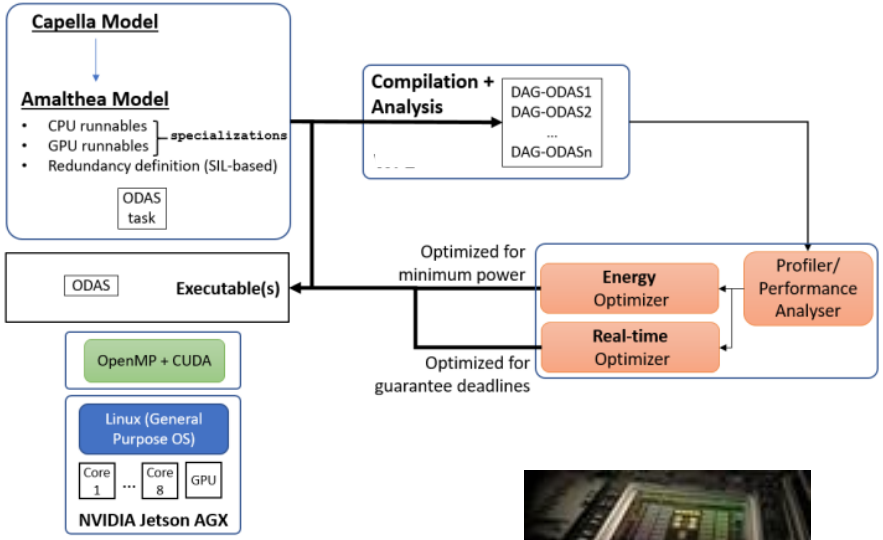


Use cases deployment

Predictive Cruise Control (automotive)



Obstacle Detection Avoidance System (railway)



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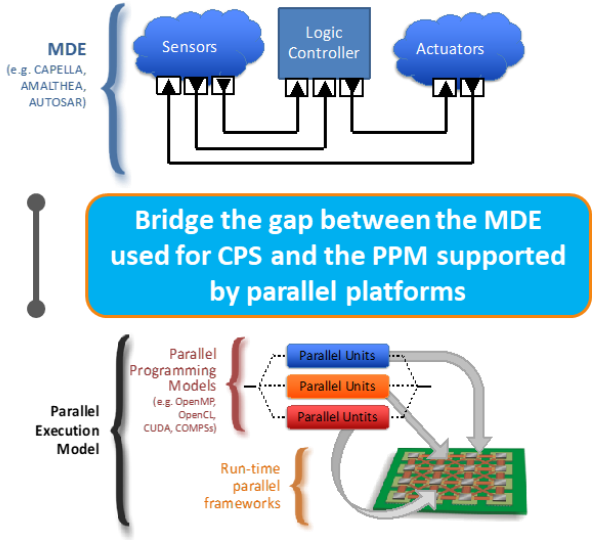

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