

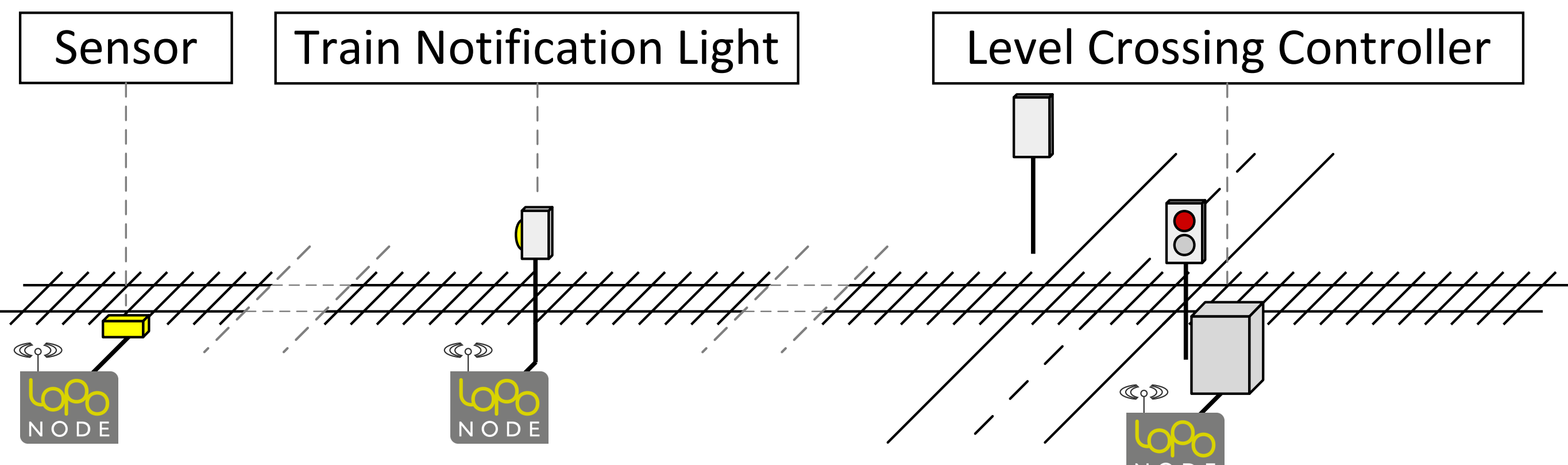
Masterstudium:
Technische Informatik

Towards a Toolchain for Asynchronous Embedded Programming based on the Peer-Model

Thomas Hamböck

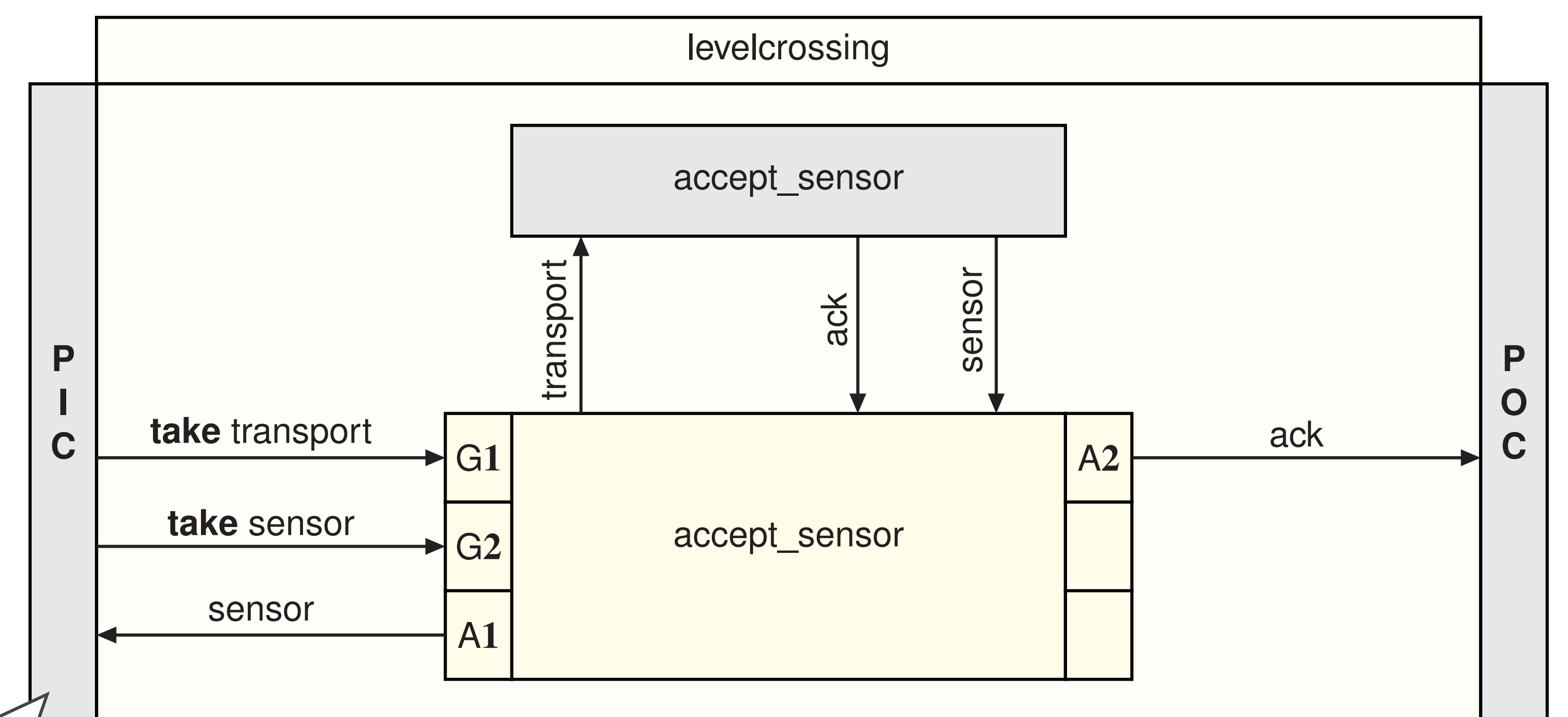
Technische Universität Wien
Institut für Computersprachen
Arbeitsbereich: Programmiersprachen und Übersetzer
Betreuerin: A.o.Univ.-Prof. Dr. Dipl.-Ing. eva Kühn

Problem Statement

- Cost-effective alternative to copper cables based on low-power wireless nodes
 - Motivating use case from railway domain:
 - Notification of train arrival at level crossing
- 
- Requirements strongly depend on environmental setting
 - Flexible model and toolchain for embedded programming is missing

Peer Model (PM)

- Foundations: concurrency, decoupling, scalability
- Modelling of timed, concurrent and distributed flows
- Main concepts: Peer, Container, Entry, Wiring

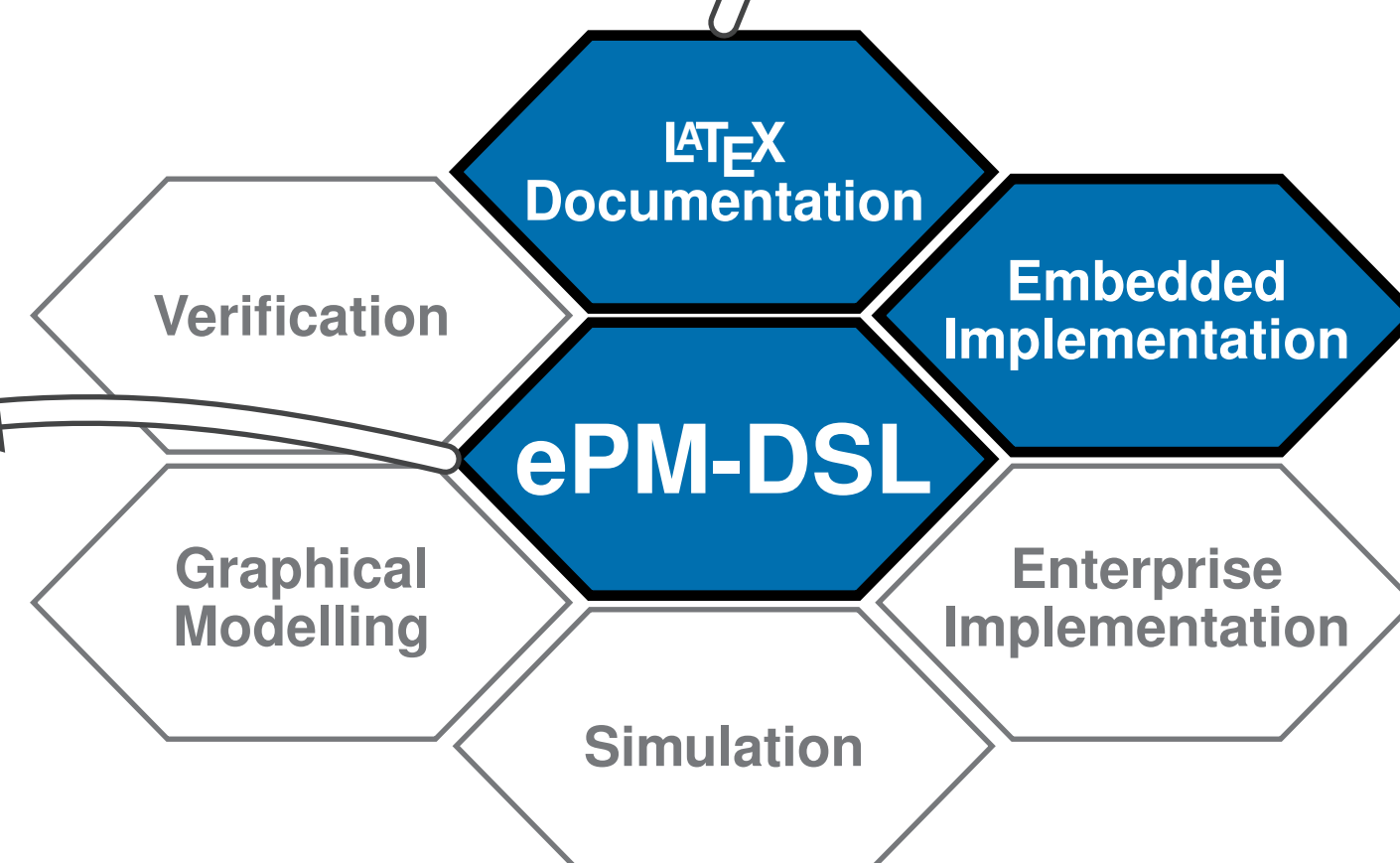


Methods

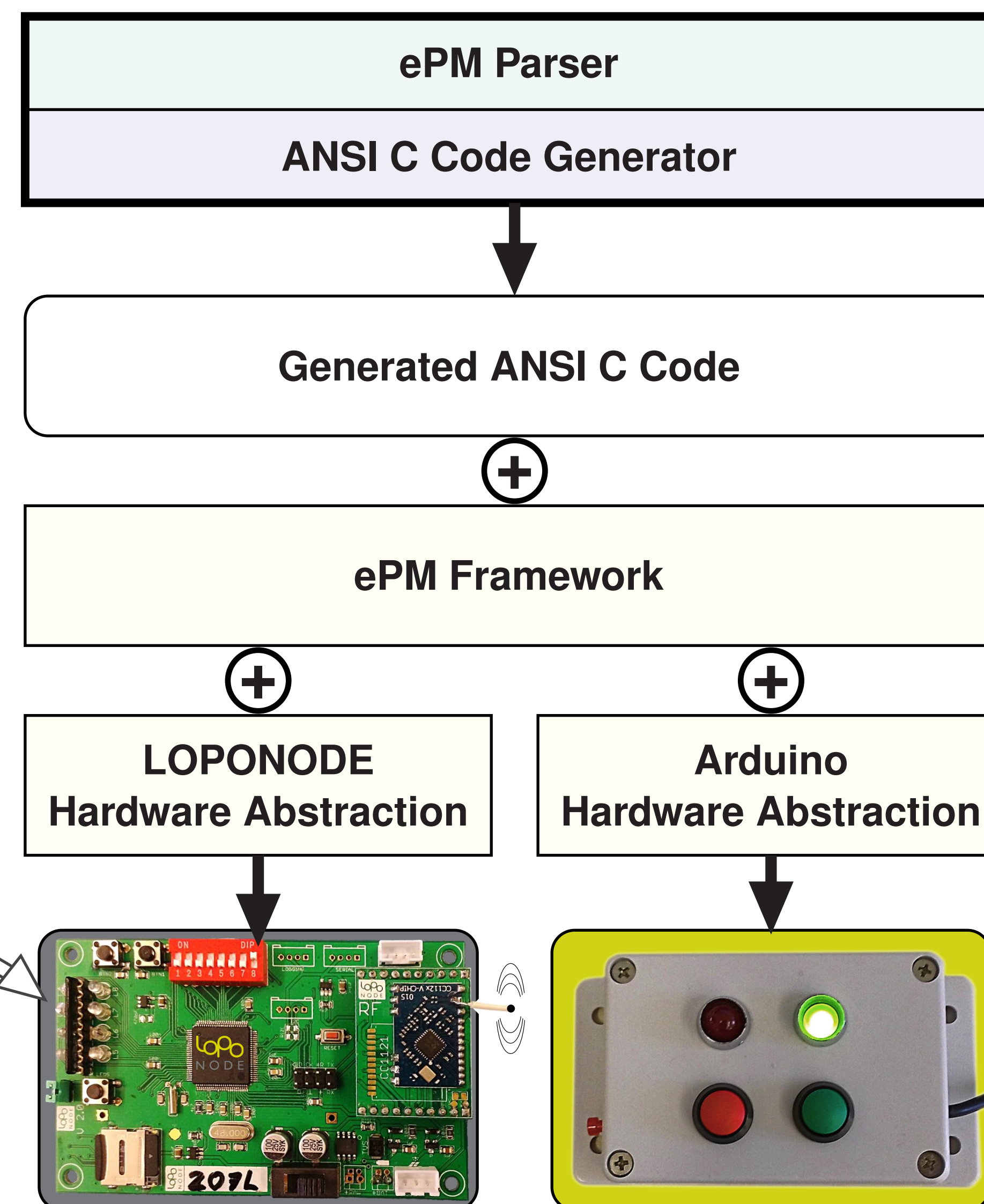
- Space-based coordination middleware
- Embedded variant of the Peer Model (**ePM**)
- Domain Specific Language (**DSL**)
- Code generation: **DSL** → **ANSI C**
- Evaluation in three different use cases:
 - Railway notification
 - Light switch
 - Industrial automation
- Fieldtests beside a railway track

Toolchain

```
wiring accept_sensor is
begin
  take transport;
  take sensor[all];
  running service accept_sensor;
  deliver sensor[all] to PIC;
  deliver ack[all];
end wiring accept_sensor;
```



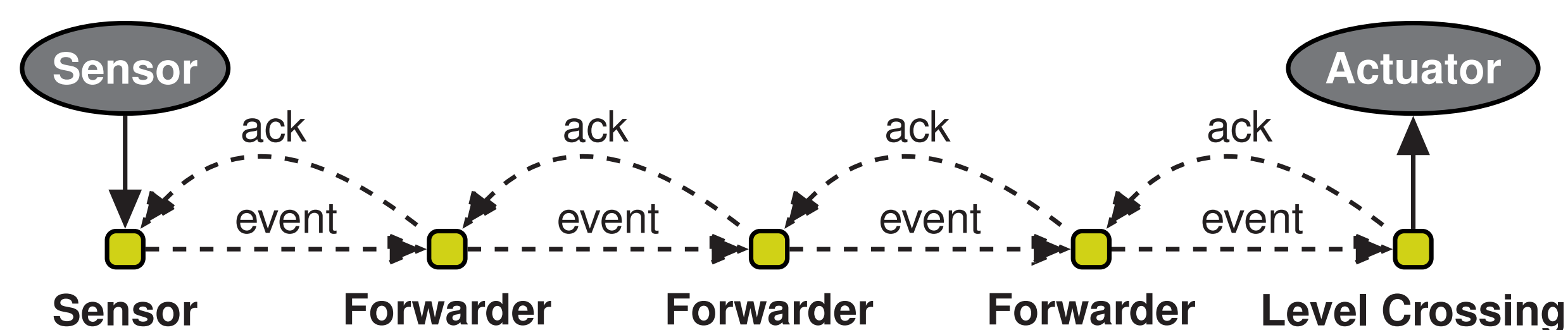
ePM Implementation



- **LOPONODE: LOW-POWER NODE**
- **Platform-independent abstraction**
- **ANSI C implementation for Arduino and LOPONODE**
- **Energy aware by sleep mode usage**

Fieldtests

- **Different strategies tested:**
 - Explicit point-to-point acknowledgement
 - Implicit point-to-point acknowledgement



- **Fieldtests near Weikendorf showed promising results**



Pictures taken by eva Kühn

Evaluation & Conclusion

- Code size metrics showed **high code reusability**
- **Better energy consumption** than native implementation
- Fieldtests demonstrate **stability and feasibility**
- **Suitable model** for distributed embedded applications
- Future work
 - Implementation of security concepts
 - Tests with new wireless transceivers

Reference & Funding

- eva Kühn, Stefan Craß, and Thomas Hamböck.
Approaching Coordination in Distributed Embedded Applications with the Peer Model DSL.
In Software Engineering and Advanced Applications (SEAA), 2014 40th EUROMICRO Conference on, pages 64–68, Aug 2014.

This work was partially funded by:

LOPONODE Middleware funded under the programme “FFG BRIDGE”, project number 834162
LOPONODE Proof-of-Concept funded by the industrial partner ÖBB Infrastruktur AG