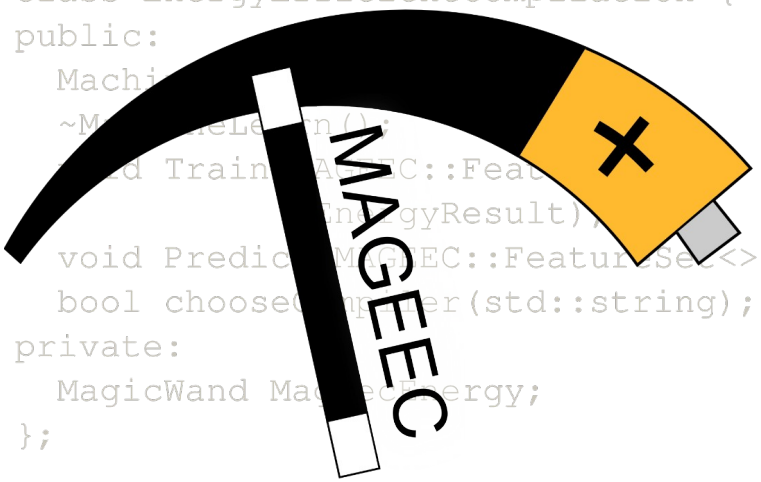
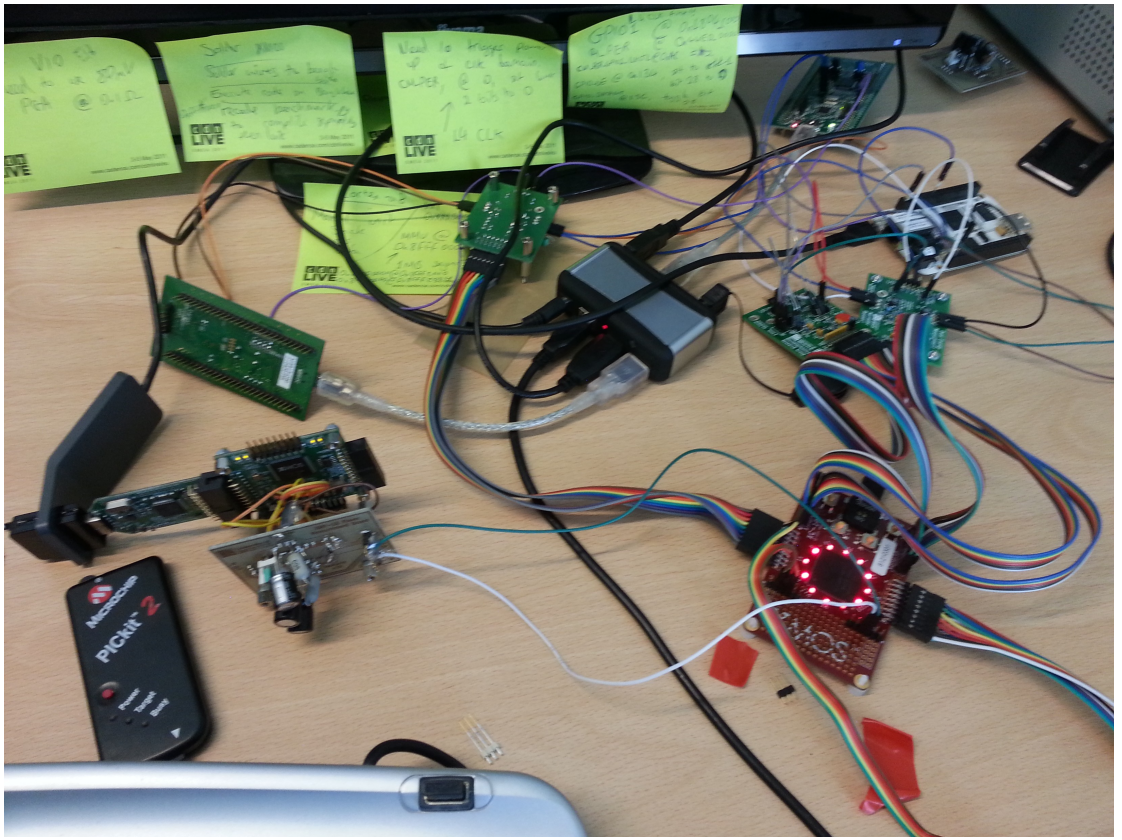


MAchine Guided Energy Efficient Compilation

Jeremy Bennett, CEO Embecosm

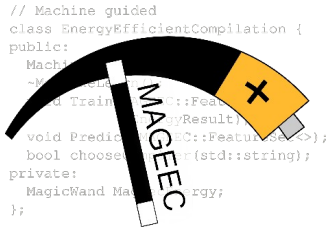
The Impact of Different Compiler Options on Energy Consumption



James Pallister
Embecosm / University of Bristol

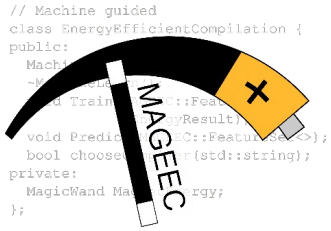
Simon Hollis
University of Bristol

Jeremy Bennett
Embecosm



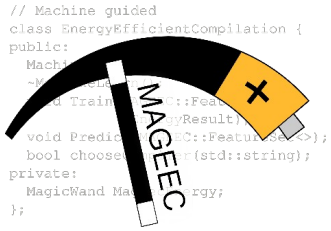
Motivation

- Compiler optimizations are claimed to have a large impact
  - performance
  - code size
  - energy usage
- No *extensive* study prior to this considering
  - different benchmarks
  - individual optimizations
  - different platforms
- This work looks at the effect of
  - many different optimizations
  - 10 benchmarks
  - 5 platforms.
- Over 200 Optimization passes covered by around 150 flags



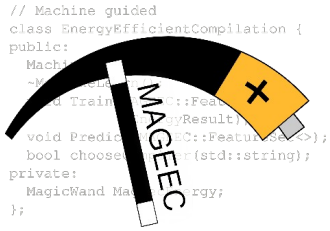
Key Components

- Importance of benchmarks
  - new set defined for embedded systems
- Choice of platforms
  - Epiphany, XMOS and 3 flavors of ARM
- How to explore 2^150 combinations of options
  - fractional factorial design
- Energy measuring hardware
  - *not* simulation
- Result: Large dataset of extensive results



Results

- Time ≈ Energy
  - true for simple pipelines
  - mostly true for complex pipelines
  - good first approximation
- Optimization is very unpredictable
  - difficult to model the interactions between optimizations
- There is only modest commonality
  - some common options for a single architecture
  - some common options within the ARM family
  - sometimes common options across a benchmark



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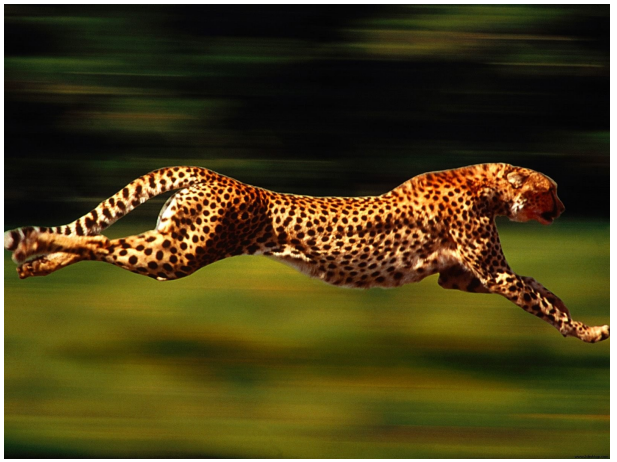
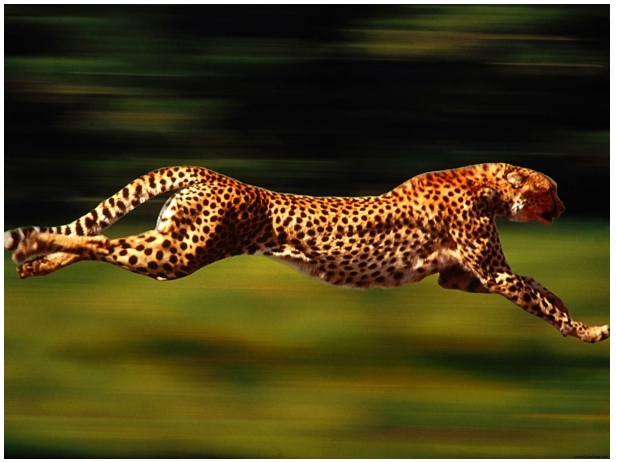
  - sometimes common options across a benchmark
- **Summary: You can't predict which optimizations are best**

What is MAGEEC?



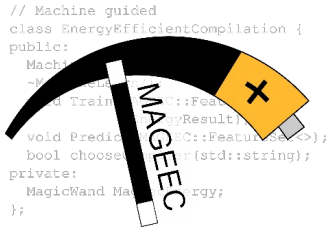
Today we optimize for speed or space

What is MAGEEC?



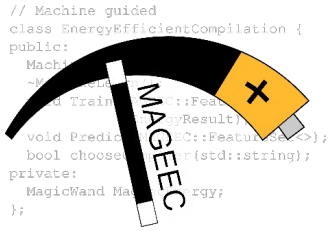
Today we optimize for speed or space

What if we could optimize for energy usage?



How We Got Here

Research into
modeling energy usage



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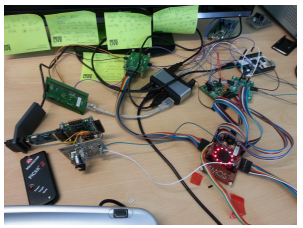
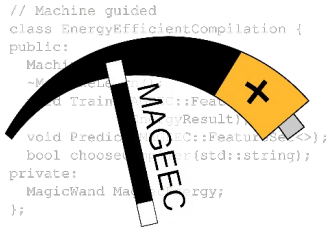


Research into modeling energy usage

Energy measurement



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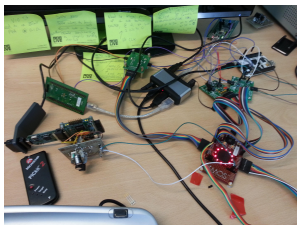

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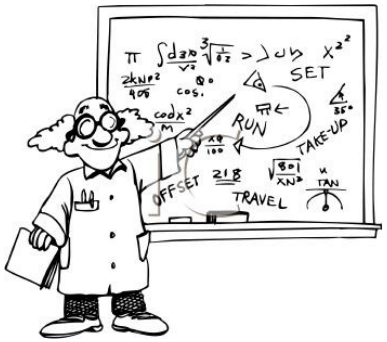
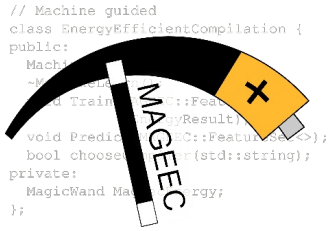


Research into feedback directed optimization



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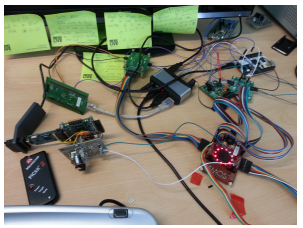
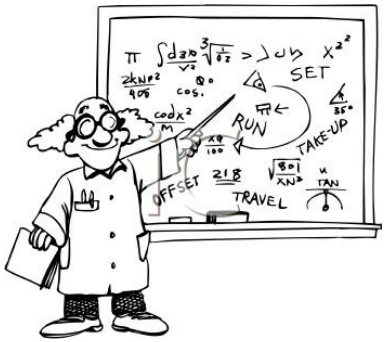


Energy
measurement



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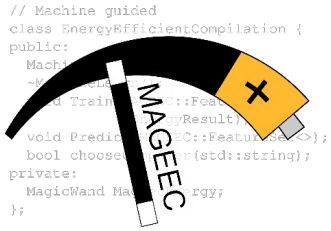
MILEPOST



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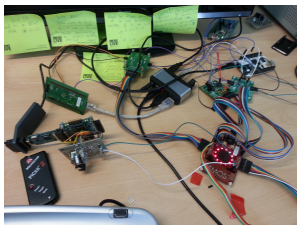
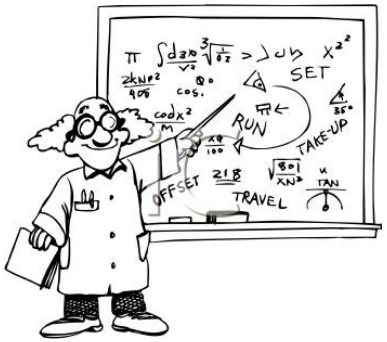


Technology Strategy Board
Driving Innovation

Research into
modeling energy usage

Energy
measurement



MILEPOST

Research into feedback
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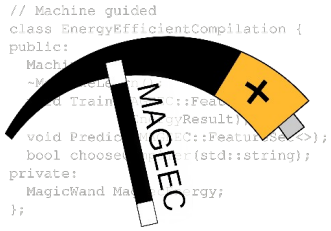

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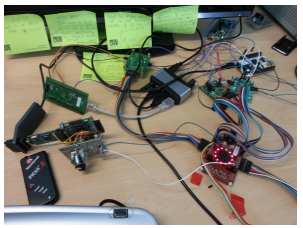

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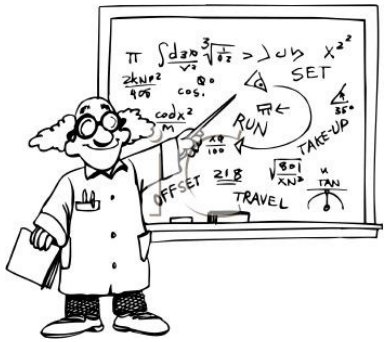

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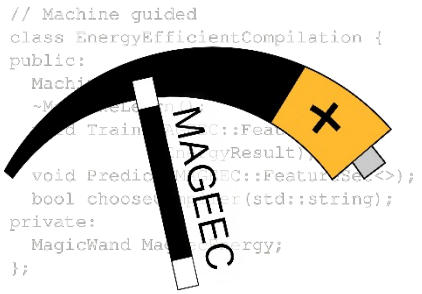
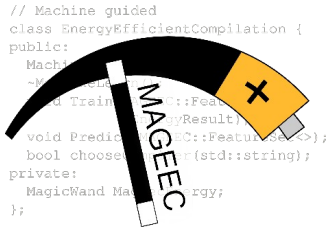
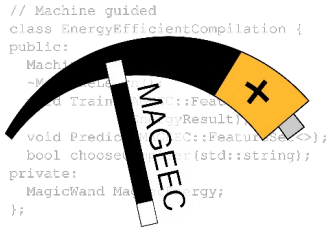




What's New?

Objective is energy optimization



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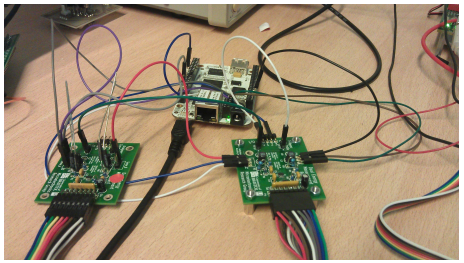
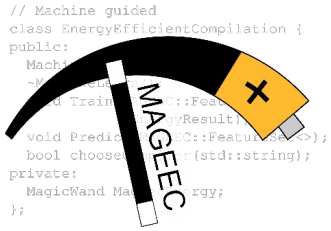


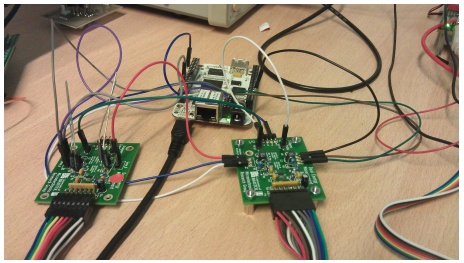
Energy measured *not* modeled



What's New?

Objective is energy optimization

Generic framework: GCC *and* LLVM initially



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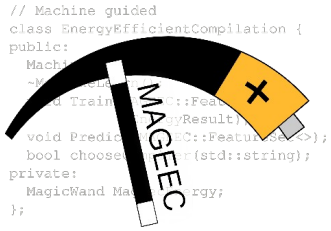

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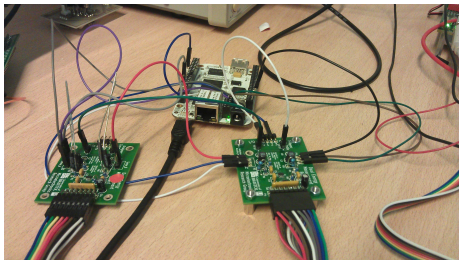
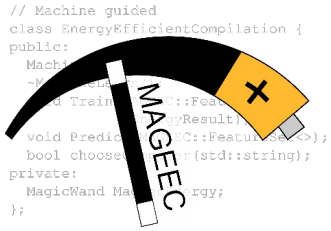
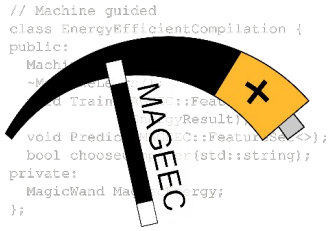


Energy measured *not* modeled

Working system, not research prototype

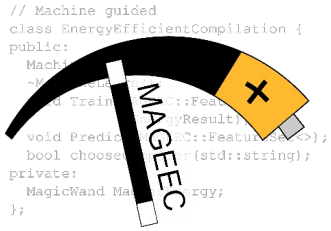


Implementation



Our Plan

- Implement MILEPOST concepts in a generic way.



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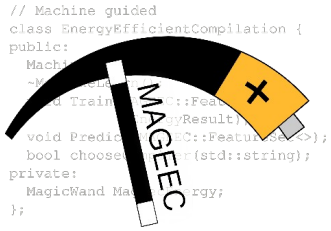
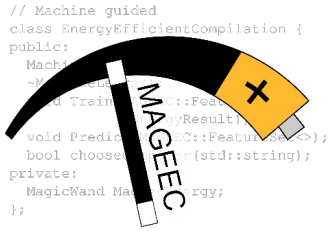
- Train and evaluate based on real hardware energy measurements and existing passes.

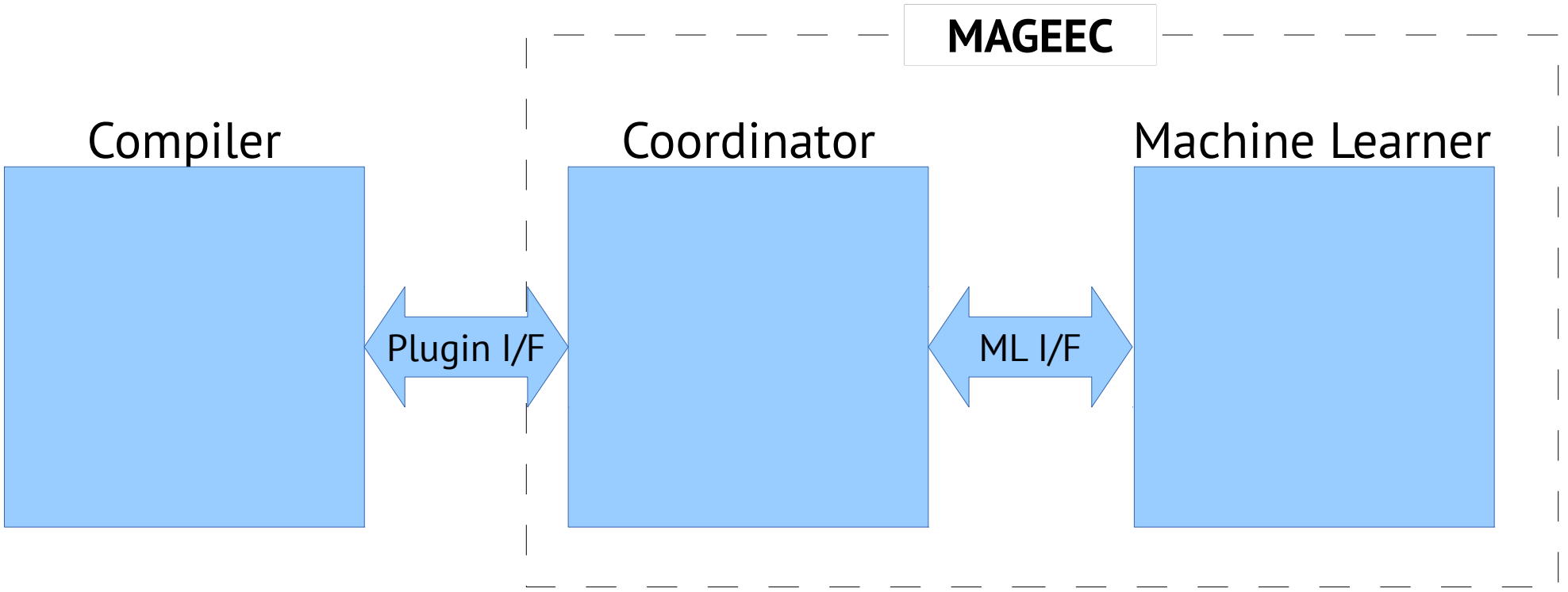


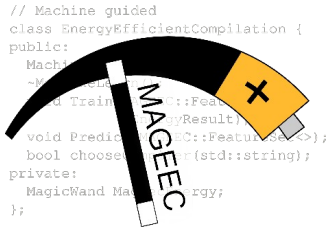
Our Plan

- Implement MILEPOST concepts in a generic way.
- Train and evaluate based on real hardware energy measurements and existing passes.
- Write and evaluate optimization passes specifically for energy efficiency (Jörn Rennecke).



Overall Design





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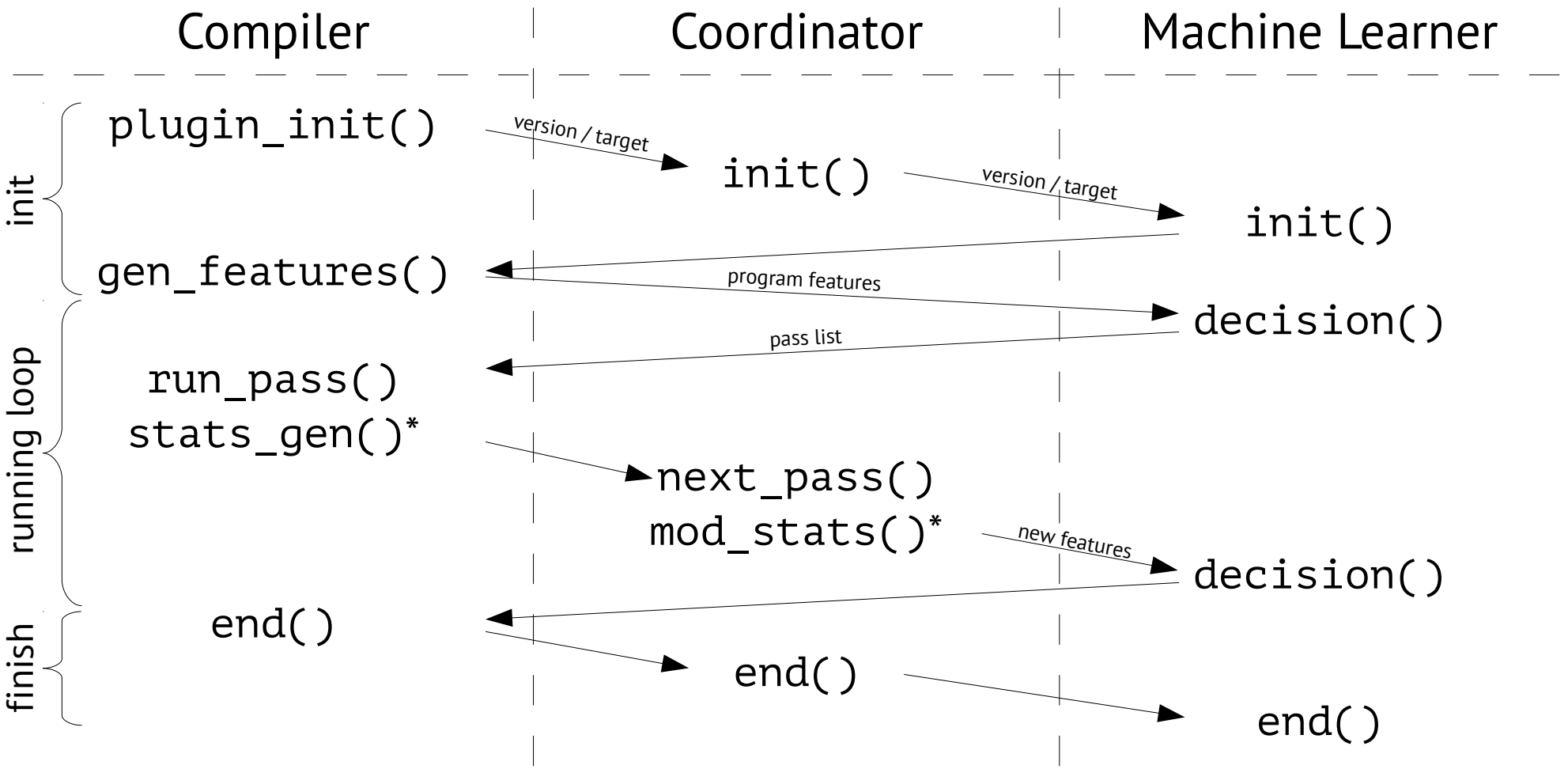
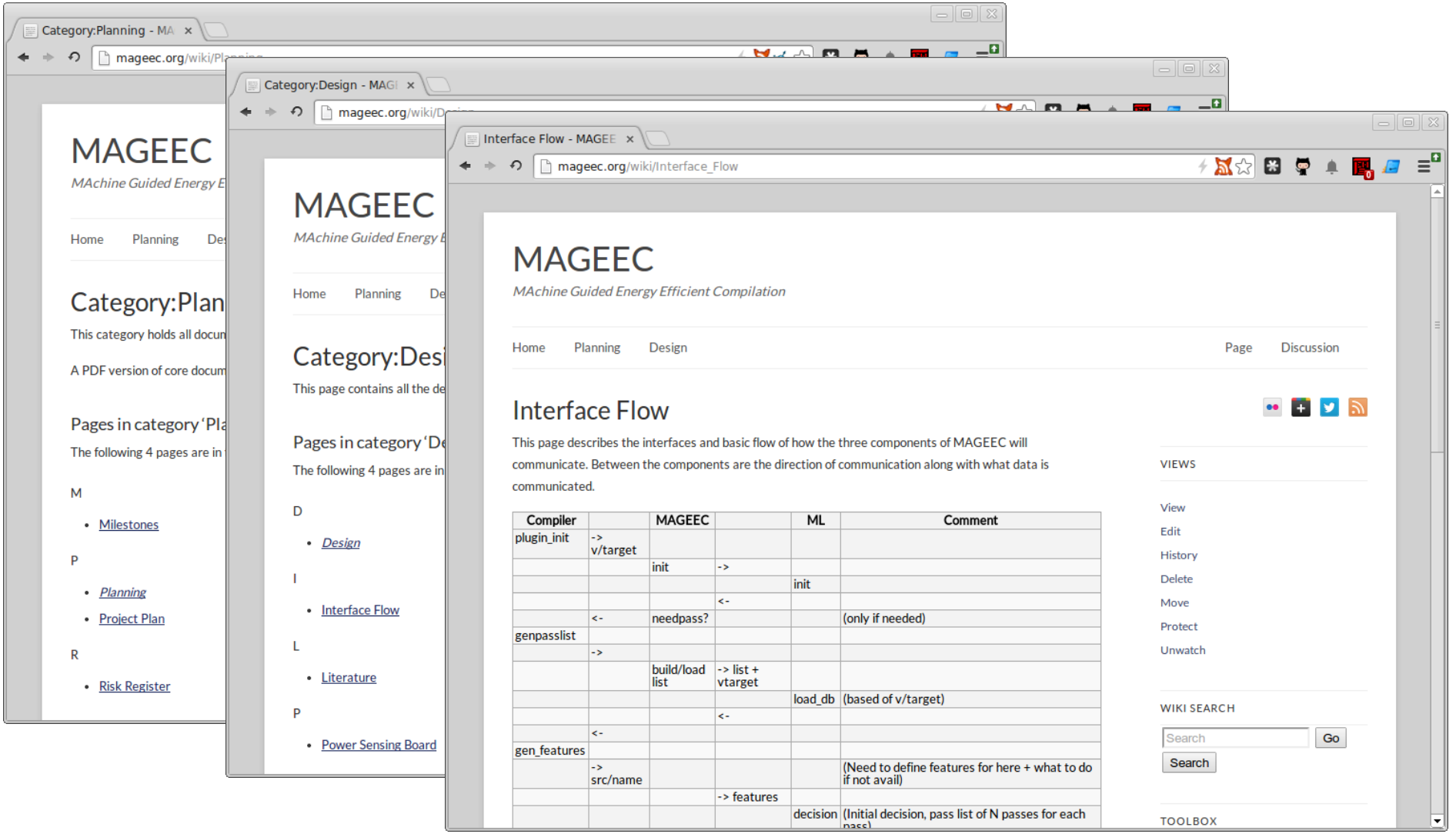
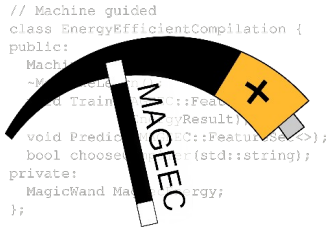


* may be gen_features()

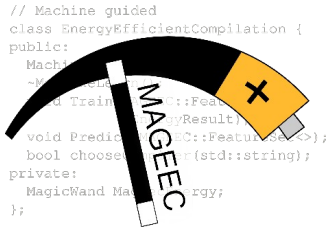
Community Involvement





Further Reading

- Energy measuring and modeling
  - *The software drained my battery.* Kerstin Eder & Jeremy Bennett, NMI Yearbook 2012, www.embecosm.com/resources/articles/#EAR12.
- MILEPOST GCC - Feedback directed optimization
  - ctuning.org/milepost-gcc
- Measurement of compiler energy usage
  - *Identifying Compiler Options to Minimize Energy Consumption for Embedded Platforms.* James Pallister, Simon Hollis, Jeremy Bennett arxiv.org/abs/1303.6485
- MAGEEC
  - mageec.org



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