

Computing Systems R&D Lab

Department of Informatics Engineering (DEI)

Presented by:

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Computing Systems R&D Lab Organization

This Lab is organized in
**three main research
groups:**

- **SPECS:** Special-Purpose Computing Systems, Languages and Tools
- **DECS:** Distributed and Embedded Computing Systems
- Mobile and Distributed Computing

On addressing complex problems with Informatics Engineering tools

On Researching and Developing new technology and new techniques

Close contact with Industry

Current Lab Members

João M.P. Cardoso
PhD, Prof.



Ali Azarian
PhD student



Pedro Pinto
PhD student



Ricardo Nobre
PhD student



Pedro Souto
PhD, Prof.



João Bispo
Pos-Doc



Tiago Carvalho
PhD student



Adriano Sanches
PhD student



Luís Reis
PhD student



Miguel P.
Monteiro
PhD, Prof.



Work Topics of Post-Docs and PhD Students

I am working on task-level pipelining techniques



I am working on runtime-aware compiler techniques



I am working on techniques to identify sequences of compiler optimizations



I am working on a MATLAB to C compiler



I am working on runtime Java improvements



I am working on techniques to map more efficiently computations to FPGAs



I am starting my PhD on multitarget OpenCL generation



Team activities

Programming...



Relaxing...



Preparing Conferences...



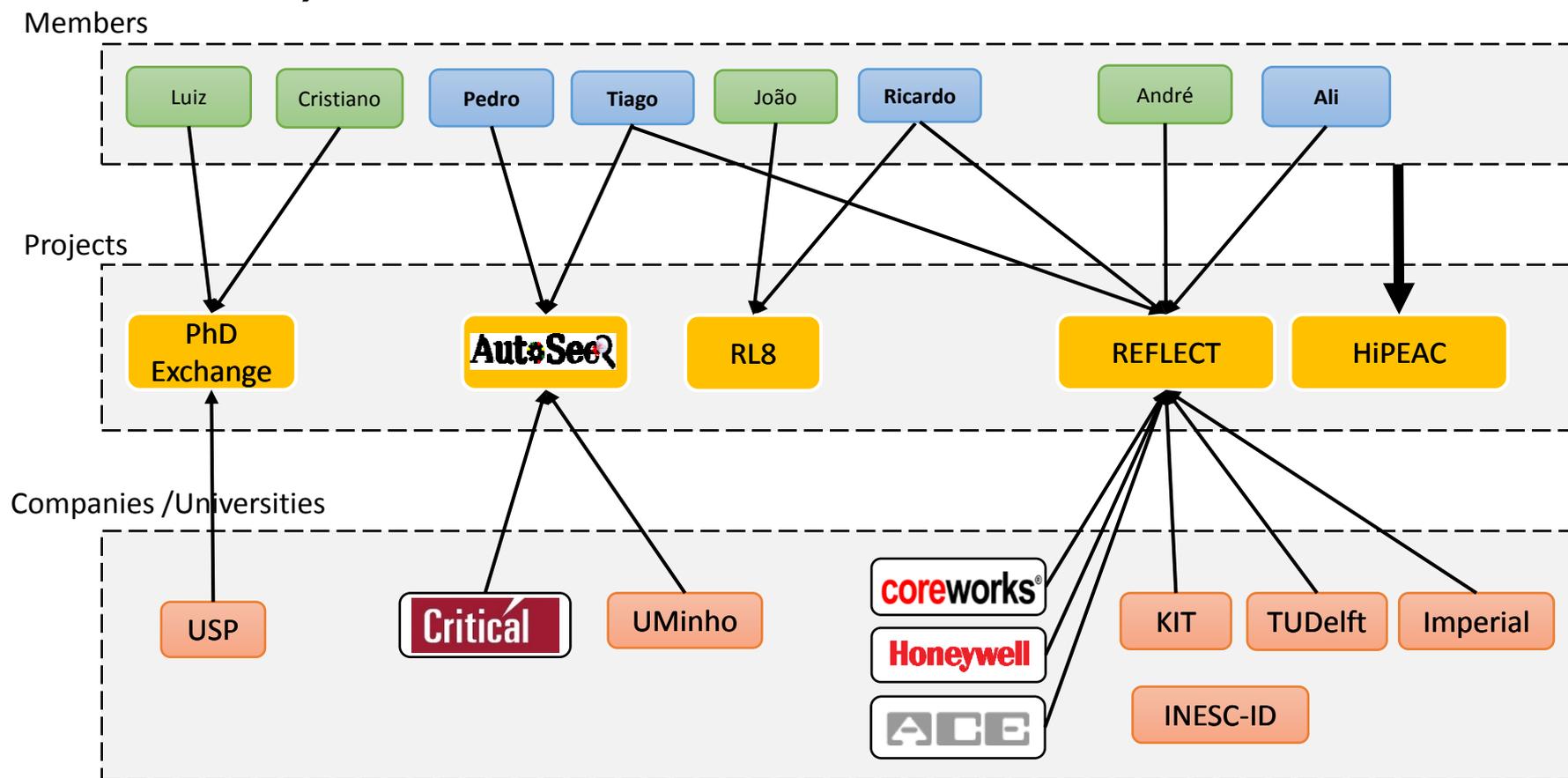
Presenting...



Participating in panels...



Projects/Collaborations (2012-2014)



Accelerate!▶▶

- Development cycles (tools, domain-specific languages)
- Execution of applications (compiler techniques, hardware acceleration)



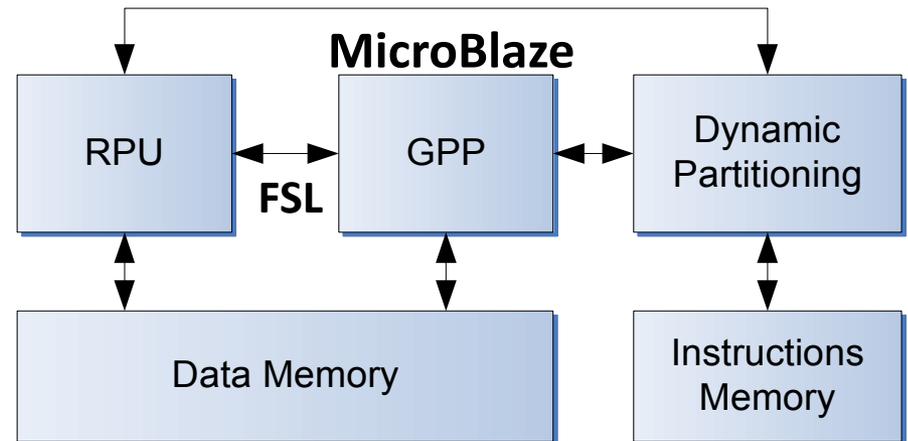
to accelerate changes
to accelerate achievements
to accelerate innovation

Binary Acceleration with Megablocks

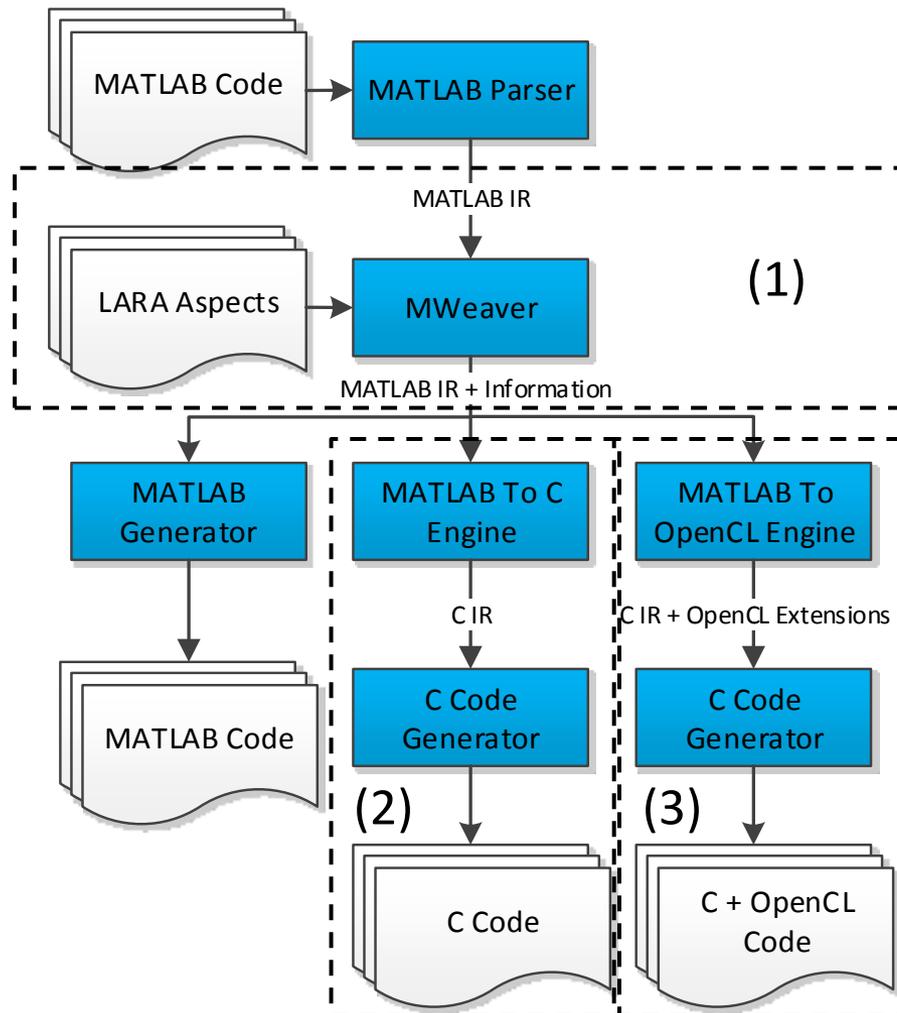
- Proposed loop-like pattern in the trace of a program (Megablock)
- Detects and moves automatically computation from CPU to specialized hardware (RPU)
- Prototype that profiles and generates HW offline, moves computation at runtime

Megablock
Pattern

```
...  
0x00000194 sra r5, r5  
-----  
0x00000180 andi r3, r5, 1  
0x00000184 addik r4, r4, 1  
0x00000188 addk r7, r7, r3  
0x0000018C xori r18, r4, 32  
0x00000190 bneid r18, -16  
0x00000194 sra r5, r5  
-----  
0x00000180 andi r3, r5, 1  
0x00000184 addik r4, r4, 1  
0x00000188 addk r7, r7, r3  
0x0000018C xori r18, r4, 32  
0x00000190 bneid r18, -16  
0x00000194 sra r5, r5  
-----  
0x00000180 andi r3, r5, 1  
...
```



Matisse - MATLAB to C Compiler



MATLAB Weaver (1)

- Transforms MATLAB IR
- LARA Aspects:
 - Adds information (types, shapes)
 - Code Instrumentation
 - Transformations

MATLAB To C Engine (2)

- Specializes MATLAB to C
- Type-inference, code transformation, optimizations...

MATLAB To OpenCL Engine (3)

- Extension to MATLAB to C engine
- Luís Reis master thesis



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Now (after 20 Years

**A FANTASTIC
MOMENT™**

- We no more rely on clock frequency scaling...
- Multicore and manycore architectures are to stay
- GPGPUs and FPGAs accelerate complex applications
- Back to experts of the underlying computing resources
- New programming models are Now very much needed!
- Almost everything we do depends on computing (computing is everywhere!)



Our Lab is committed to expose students to those challenges, to expose them to complex real-life problems and to problems from predictions (trends)

Computing Systems R&D Lab

Scientific Areas involved (ACM):

- Computer systems organization, including Architectures, Embedded and Cyber-physical systems, Real-time Systems, Dependable and Fault-tolerant Systems and Networks
- Software notation and tools

This Lab hosts projects in the following areas:

- Domain-Specific Languages (DSLs)
- Compilers
- Reconfigurable Computing (including FPGAs)
- Embedded Computing (including high-performance embedded computing)
- Distributed Computing, and Mobile Computing

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Compilation to Hardware

- From software to hardware
 - Generating hardware specific to the input software
 - Achieving performance benefits (acceleration), energy savings, reduction of power dissipation peaks

