Overview of EASE results 2009

Prof. Per Runeson
– Director
EASE in a nutshell

10 years of research
8.6 MSEK funding/year (+2 MSEK in kind)
7 research challenges
5 industry partners
4 research themes
2 academic partners
1st phase started Oct 1, 2008
Vision

The vision of the center is to be a world class applied software research facility for embedded software applications in order to ensure that the industrial partners have a competitive advantage with respect to competency and innovation of novel solutions and effective engineering of embedded software applications with physical and logical mobility.
## Themes’ progress

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<td>B</td>
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Theme B - motivation

- Processor computation frequencies cannot scale any more
- Multiple cores introduced
- New problem: parallelize computation
Theme B1: CAL

data flow language
.cal for actors
.nl for networks

actor AddUntilOverflow() int X, int Y =>
  intSum:
  run: action X:[x], Y:[y] ==> Sum:[sum]
  guard sum >= 0
  var
   int sum=x+y
  end
  drain: action X:[x], Y:[y] ==> end
  terminate: action Y[lastToken] ==> end

priority
  run > drain;
end

schedule fsm run:
  run (run) --> run;
  run (drain) --> drain;
  drain (terminate) --> drain;
end

end
Theme B2 – thread level speculation

- Javascript study
- Dynamic extraction of parallelism
- Loops allocated to threads
  - data dependency violations identified
  - roll-back
Theme B plans

- Mapping and partitioning of computation graph to threads/cores
- Mapping CAL to EIT’s hardware architecture
  - one actor per core
  - several actors per core
- Implementation of Thread-level speculation in two types of JavaScript engines
  - register-based (V8)
  - stack-based (SpiderMonkey)
Theme C - motivation

• Software engineering efficiency is a key competitiveness factor
  – Volvo: 90% of new innovations in electronics; 80% thereof in software
  – Ericsson: 80% of R&D is connected to software

• Open source software and agile approaches popular means to improve – How good are they?
Research Study: Ingres Corp.

- Open source project, UC Barkley in 1970
- Spawned into Sybase, MS SQL server 1980
- Acquired by CA in 1994 for $310 million from ASK
- CA Open-sources Ingres database in 2004
- 5000 customer base in 2004
- 10000 customer base 2008, with 136 companies of Fortune 500 group
- 2008 revenue $68 million, up 32% from 2007.
- Used in other CA products, too expensive to maintain
- Major competitors: MySQL (open source), Oracle (proprietary)
Research Results

• Overall code quality improved, but statistically the improvement was not significant.
  – Code quality of changed files decreased
  – Code quality of newly added files increased significantly

• Most changes to front end, in contrast to supplier expectations
Theme C plans

- Case study on quality aspects - especially about responsibilities
- Android study will be conducted with SEMC
- Agile framework development continued. Culture and mindset important factors identified today. Continued work with Softhouse and SEMC.
Theme D - Alignment
Alignment Challenges in Industry

- Largest empirical study on alignment so far
- More than 20 interviews in 7 companies
- Transcription and qualitative analysis
- So far more than 30 empirical challenges in 8 groups

1. Organization and processes
2. People
3. Tools
4. Requirements process
5. Testing process
6. Change management
7. Traceability
8. Measurement
Consequences of Misalignment

- Non-testable requirements
- Unimplemented requirements
- Unsatisfied customer needs
- Wasted time and effort
- Missed defects, lower product quality
- Out-of-date requirements & test cases
- “Blame game”, unsatisfied employees
- Low trust in tools
Future of Theme D

- Further understanding of alignment challenges
- Technology for supporting alignment
- Measurement of alignment benefits and misalignment costs
Theme A – new plans

PalCom - Ad hoc combination

- Combining existing devices/services in new ways - ad-hoc (not planned). w/o involving development on either side.
- Standardization of services - easier for integrators, but should not be limiting.

Support for Product-line architectures

- Supporting organizing software as variants of components.
- Looking at development situation at SE, AXIS, and ABB
Industry Excellence Center - Embedded Applications Software Engineering

EASE Activity Report 2009

How to deal with 100mbit/s in your handheld device without burning your fingers?

To receive and render high-definition video can get any computer to go hot. When the computer is hand-held, this must be far more effective both to avoid burning your hands and to save battery.

In coming techniques it is more energy efficient to split the computations on more and slower processor nodes than do all the computations on one fast processor. Thus, the industry is about to introduce multicore processors also in handhelds units.

A challenge for multicore processors is to keep all of them busy. Traditional programming languages are sequential by nature. This leads to that when programs written in traditional languages are mapped to multicore processors, a processor core often has to wait for results calculated in another core. Research on compilers for multicore has been going on since the 1980s and few believe that drastic progress needed for tomorrow’s multiprocessor systems are possible.

CAL compiler for multicores
EASE theme B attacks some of the problems with multicores systems by developing techniques for compilation of the programming language CAL. The compiler maps the application to process threads, processor cores and memory adapted to target processor that today might have two or four cores with shared memory, but in a few years probably has much more of both cores and memories.

CAL is an open source based language and tool set (http://cal-l.com) based on data flow graphs, which means that the language does not force calculations to be done in a particular order, but only describes the actual data and control dependencies that exist between different parts of the program. CAL is therefore more suitable for mapping applications to multi core systems. Thus, the final step in the compilation gets better conditions for distributing the computations between cores and memories.

– In 2009, the project has demonstrated new and working mapping techniques. The focus for 2010 is partly to integrate these techniques into the CAL environment and secondly to increase the flexibility in the CAL environment as such. Thus we will be able to plot the findings in an industry environment, says Per Andersson, Post-doc at LTH.

Speculative execution
Another approach to keep processor cores busy is to perform speculative parallel execution, i.e. dynamically generate parallel activities from a serial program. However, if the speculation is wrong the system needs to restore the execution to an earlier state and restart in a safe mode.

– Initial studies during 2009 show promising results for web applications targeted at mobile devices, says Hakan Granath co-ordinator EASE theme B.

Heading for excellence

The need for innovation, research, and highly skilled software engineers has never been bigger than today in the software industry. Collaboration between universities and industry is one of the most important access factors for companies to stay competitive in the future. EASE combines industry relevant research and academic excellence. The mutual exchange of people, challenges, ideas and results provides an exciting environment for novel solutions for embedded software applications.

During 2009 much effort has been put into scaling up activities and recruit new employees. Thus, at year-end 2009, thirteen senior researchers and six PhD students are working within EASE. During the year we have also established procedures for frequent interaction between the industry partners and researcher and strengthened the foundation for the exchange that is one of the main objectives of the center. An exchange that is starting to spread research findings in both industry and academia.

This annual report summaries the EASE research 2009. These findings we, where possible, will make available at our public web pages. But the best way to share the results are, of course, to join EASE, and that way participate in formulating the research questions. Therefore, we now intensify our efforts to attract more partners and thus expand.

While 2008 was a year of start-up and designing ways of working and 2009 was a year of scaling up and start to deliver. Focus for 2010 is yet more of delivering, broadening the industry base and to found studies for coming eight years of EASE.
http://ease.cs.lth.se/