Fakultät Informatik Institut für Software- und Multimediatechnik, Lehrstuhl Softwaretechnologie

The journey has just begun

RACR - MQUAT

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Agenda

1 The past

2 The present

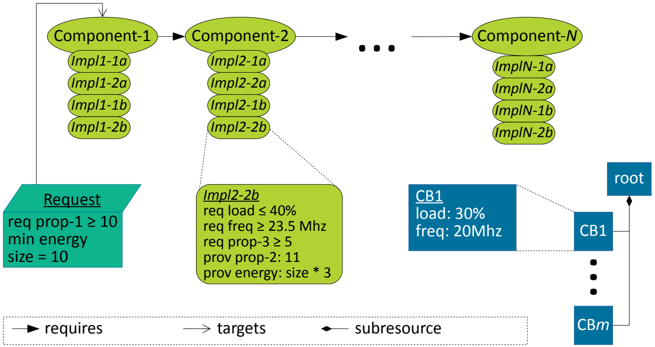
3 The future

Where we started

- MQuAT concept [GKP+14]
  - Self-adaptive system optimizing for multiple qualities
  - Component-based design for both hardware and software
  - Quality contracts capturing requirements and guarantees of components
- THEATRE [GWC+10] as a Java-based implementation of MQuAT
  - Knowledge represented using EMF-(Meta)Models
  - Optimization problem solved by transformation to ILP
  - Designed for distributed operation (see HAECubie) using Master-Slave-Pattern [Sah96]

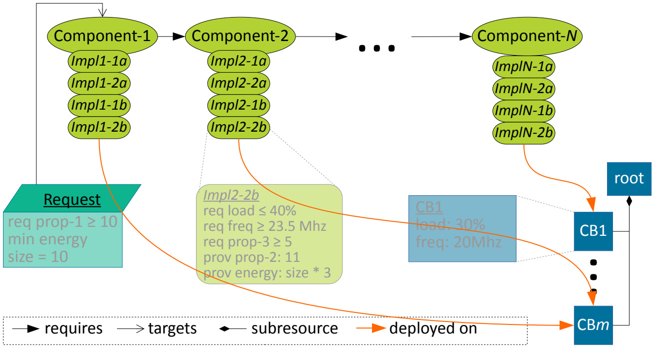
The optimization problem

Mapping *n* components on *m* resources



The optimization problem solved

Mapping *n* components on *m* resources



What was the problem

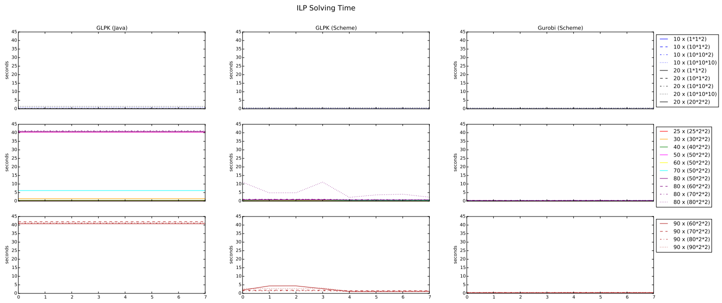
- ILP-Solution branded “unusable” for bigger systems
  - current measurements disprove this, see next slides
  - ILP still generated from scratch for each request
  - measurements on Cubieboards still to be done for new approach
- EMF-Model (element)s somewhat ambiguous or superfluous
  - component requirement possible on both, component- and mode-level
  - structure and variant model contain similar information
  - general approach of structural model not easy to use (especially for ILP-Generation)

Measurement on solving times

- Measurement on solving times
  - Context: System Generator to generate ILP for increasing size of systems
  - 23 different sizes of systems, 40sec timeout
  - Format of ILP adopted for glpk via own Python script
- Result for Java-based solution
  - Timeouts: glpk 10/23, lpsolve 8/23
- Result for RACR-based solution (enhanced ILP)
  - All but one systems solved within 5sec (outlier 12sec)

Measurement on solving times (2)

- Even better performance using Gurobi (commercial solver)



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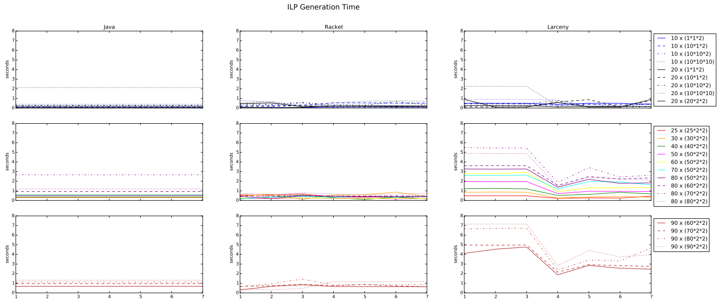
How we want to achieve scalability

- Use RACR [Bür12]
  - **R**eference **A**ttribute Grammer **C**ontrolled **R**ewriting
  - Specify knowledge as an ASG[1] whose structure is defined by a RAG[2]
  - RAG is a combination of structural and variant model, avoiding duplicate information
  - Analyses run on ASG now run inherently **incremental** and are defined **declarative**

[1]Abstract Syntax Graph, i.e. an Abstract Syntax Tree with references
[2]Reference Attribute Grammar

Current state, compared to existing work

- Not quite there yet:



TECHNISCHE UNIVERSITÄT DRESDEN

General Facts

- `https://bitbucket.org/rschoene/racr-mquat`
- IPython Notebook[3] used for measurement plots
- Main language: Scheme
  - implementations used: Racket[4], Larceny[5]
- Measurement and test scripts: Python

[3]http://nbviewer.ipython.org/urls/bitbucket.org/rschoene/racr-mquat/raw/master/ilp-measurement.ipynb
[4]http://racket-lang.org/
[5]http://www.larcenists.org/

Code Facts

Using cloc[6]

Language	files	blank	comment	code
Scheme	15	224	316	2287
Python	8	81	44	509
Bourne Again Shell	1	0	0	2
SUM:	24	305	360	2798

[6] http://cloc.sourceforge.net/

Current pitfalls

- Different input formats accepted by lp_solve and glpk
  - Transformation (mostly syntactical) needed
  - Still, different solution computed (GLPK occasionally ignore binary variables, value e.g. 0.348485)
- Slow running Larceny
  - Unexpected as Larceny compiles to machine code
- Caching not fully exploited
  - Some constraints still unnecessarily recomputed

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Where we should go next

- Do not transform to ILP
  - Implement an heuristic similar to RACRtune demo[7] of Daniel Langner and Johannes Mey
- Apply static analysis where appropriate, e.g.
  - Abstract Interpretation [CC77, Ros90] to estimate energy consumption [JM06, RMM03]
  - Describe decisions [Dan15]
  - Find configurations, which can never be used
  - Unify constraints (in contracts) of modes
- Extend AG
  - Describe multiple systems and their interaction, e.g. [WSG+13]
  - Include behavior model for more fine grained description

[7]Shown at HAEC review and OUTPUT'15

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