TECHNISCHE UNIVERSITÄT DRESDEN

Department of Computer Science, Software Technology Group

ResUbic

Approximating Quality Contracts for Energy Auto-Tuning Software

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Europa fördert Sachsen. ESF Europäischer Sozialfonds SACHSEN
Bundesministerium für Bildung und Forschung
DFG Deutsche Forschungsgemeinschaft
DRESDEN concept Exzellenz aus Wissenschaft und Kultur

Problem

Context

- Prediction of (component-based) software's non-functional properties (NFPs)
- QoS Contracts used to specify non-functional behavior
- Self-Optimization w.r.t. energy consumption (and other NFPs)
  - Energy / Multi-Quality Auto-Tuning (EAT / MQuAT)

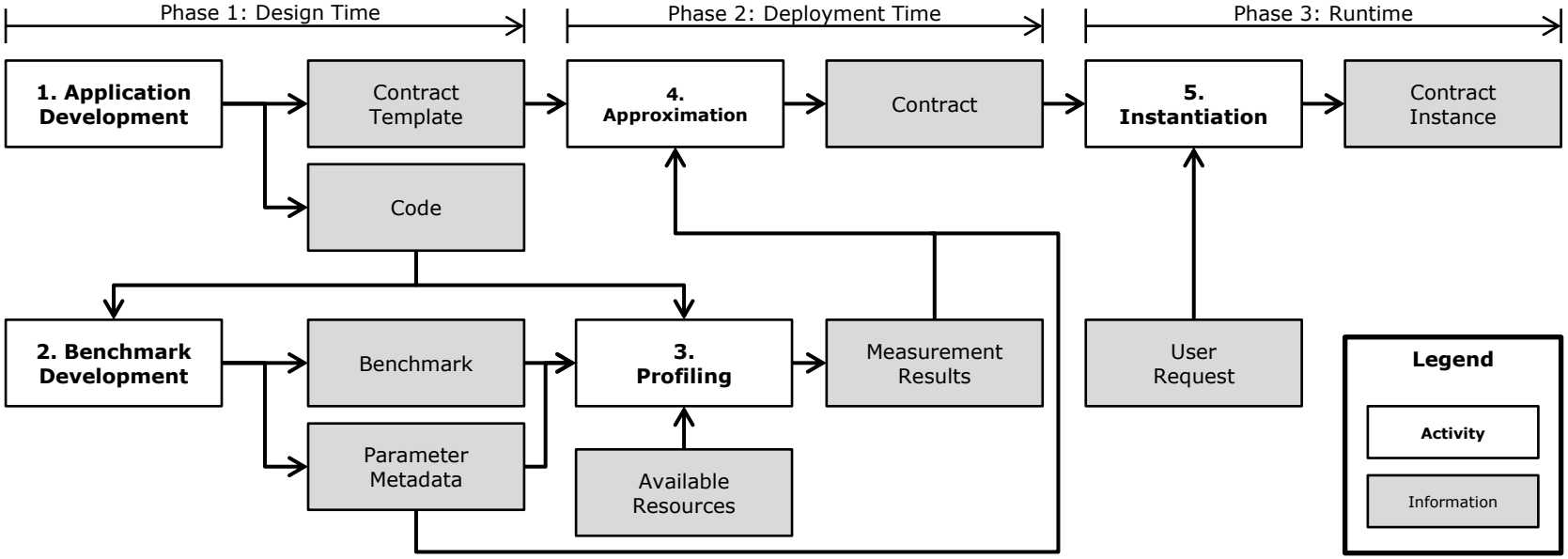
Problem

- Derivation / Computation of QoS Contracts for EAT/MQuAT
- Concrete values of NFPs depend on
  - Utilized hardware
  - User request

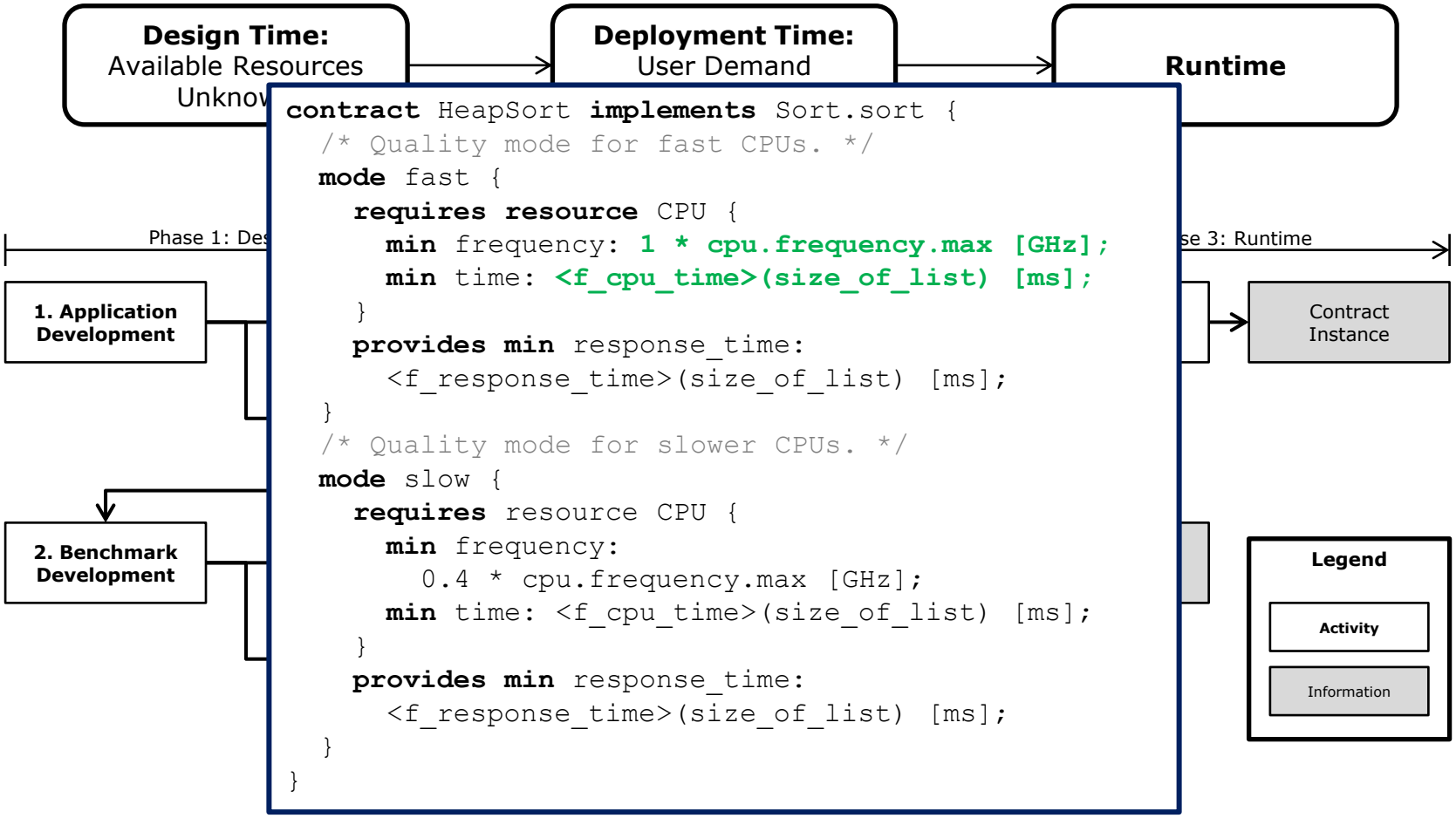
Goal/Solution

- 3-Phase approach:
  1. contract template (hardware- and user-independent),
  2. contract (user-independent),
  3. contract instance

Approach: Quality Contract Creation

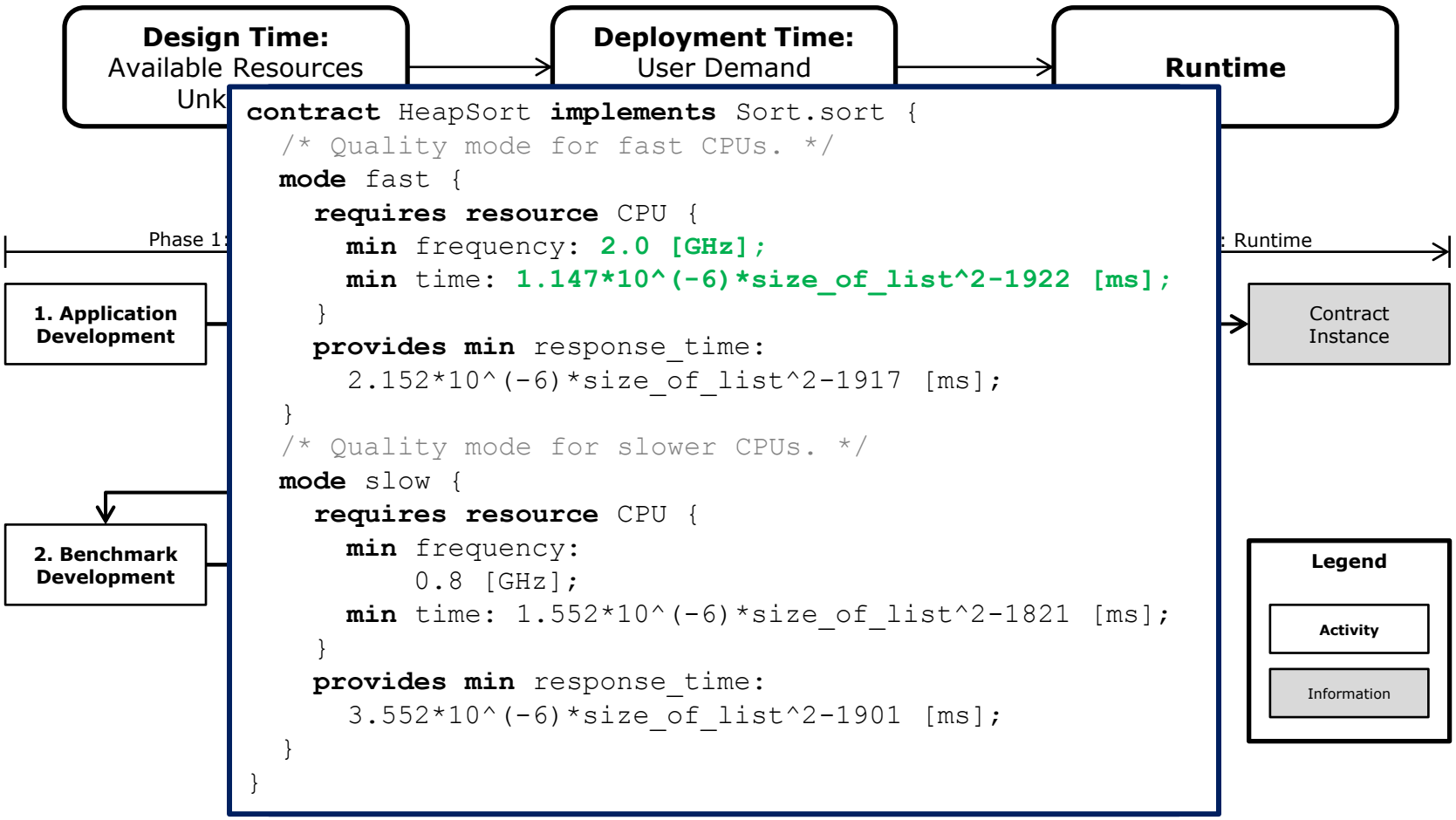


Approach: Quality Contract Creation



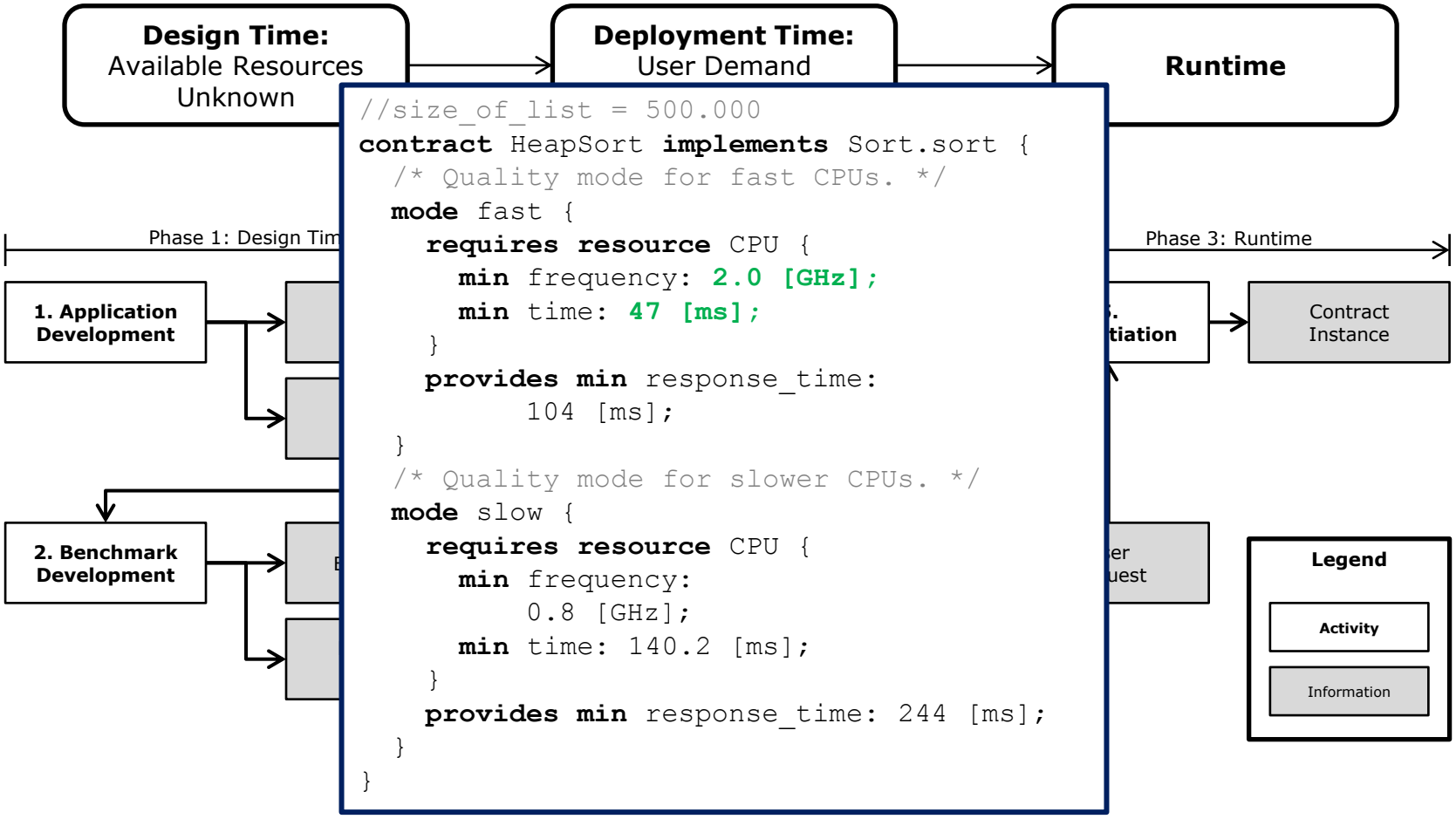

```
contract HeapSort implements Sort.sort {
  /* Quality mode for fast CPUs. */
  mode fast {
    requires resource CPU {
      min frequency: 1 * cpu.frequency.max [GHz];
      min time: <f_cpu_time>(size_of_list) [ms];
    }
    provides min response_time:
      <f_response_time>(size_of_list) [ms];
  }
  /* Quality mode for slower CPUs. */
  mode slow {
    requires resource CPU {
      min frequency:
        0.4 * cpu.frequency.max [GHz];
      min time: <f_cpu_time>(size_of_list) [ms];
    }
    provides min response_time:
      <f_response_time>(size_of_list) [ms];
  }
}
```

Approach: Quality Contract Creation




```
contract HeapSort implements Sort.sort {
  /* Quality mode for fast CPUs. */
  mode fast {
    requires resource CPU {
      min frequency: 2.0 [GHz];
      min time: 1.147*10^(-6)*size_of_list^2-1922 [ms];
    }
    provides min response_time:
      2.152*10^(-6)*size_of_list^2-1917 [ms];
  }
  /* Quality mode for slower CPUs. */
  mode slow {
    requires resource CPU {
      min frequency:
          0.8 [GHz];
      min time: 1.552*10^(-6)*size_of_list^2-1821 [ms];
    }
    provides min response_time:
      3.552*10^(-6)*size_of_list^2-1901 [ms];
  }
}
```

Approach: Quality Contract Creation



Discussion

1. Are there further dependencies not covered by the presented approach?

2. Does it make sense to *directly cover energy consumption* in QoS contracts or is it better to *compute the potential consumption* based on the derived resource utilization?

3. Measureability of NFPs
   - Minimum runtime requirement – OS tasks and Hardware's SMM introduce deviations of >20ms.
   - Reproducability – How to determine a sufficient amount of context factors to consider for a benchmark setup?

Thank You!

Contact

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Qualifune

COOL Software