Worst-Case Execution Time

IL2212 Embedded Software

Matthias Becker and Ingo Sander

Royal Institute of Technology
Stockholm, Sweden
mabecker@kth.se, ingo@kth.se

Outline

1 Definition

2 Measurement Based

3 Static WCET Analysis

4 Hybrid WCET Analysis

5 Further Reading

Definition

- Many of the parameters that describe a real-time task are obtained from the environment
  - For example T_i and D_i
- C_i, Worst-Case Execution Time (WCET) is a parameter that depends on the program and the compute platform.

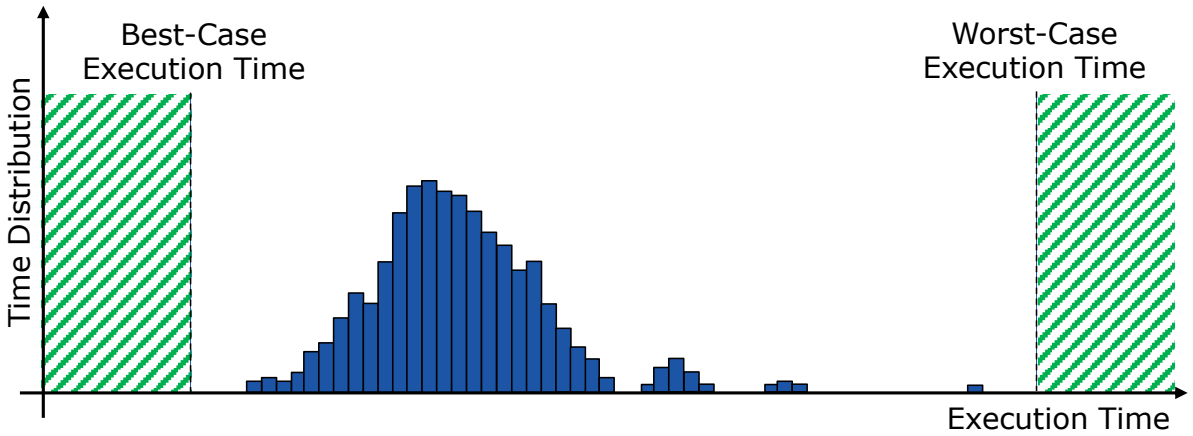
$$\tau_i = \{T_i, C_i, D_i\}$$

Worst-Case Execution Time (WCET)

The longest execution time needed by a processor to complete the task without interruption over all possible input data.

Questions

- How long will the computation take based on some input data?
- What is the longest time it may take?
- What is the fastest time it may take?



Outline

1 Definition

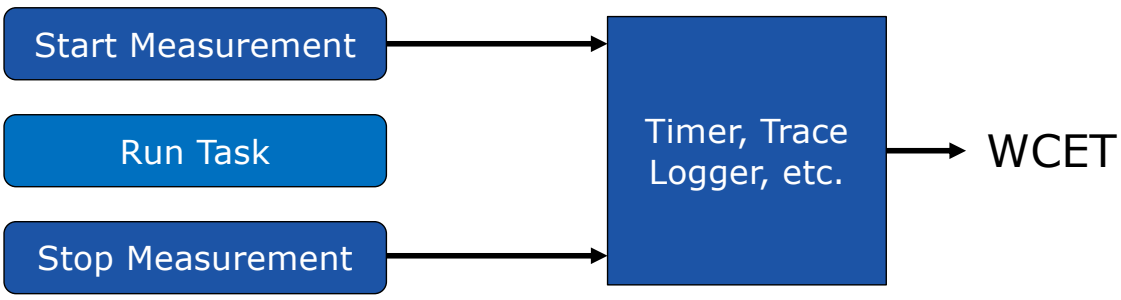
2 Measurement Based

3 Static WCET Analysis

4 Hybrid WCET Analysis

5 Further Reading

Measurement Based



- A medium sized task has 1040 different paths
  - Testing all paths is intractable!
- Determining the set of tested inputs is non trivial to trigger the WCET
- Processor state during execution has also influence on the WCET
- A systematic approach is required

Measurement Based

- The measurement itself might affect the WCET
- Measured values will never be larger than the worst-case value
- A margin must be added on top of the measured values to safely over approximate the measured data.
  - How large a margin is good enough?

Outline

1 Definition

2 Measurement Based

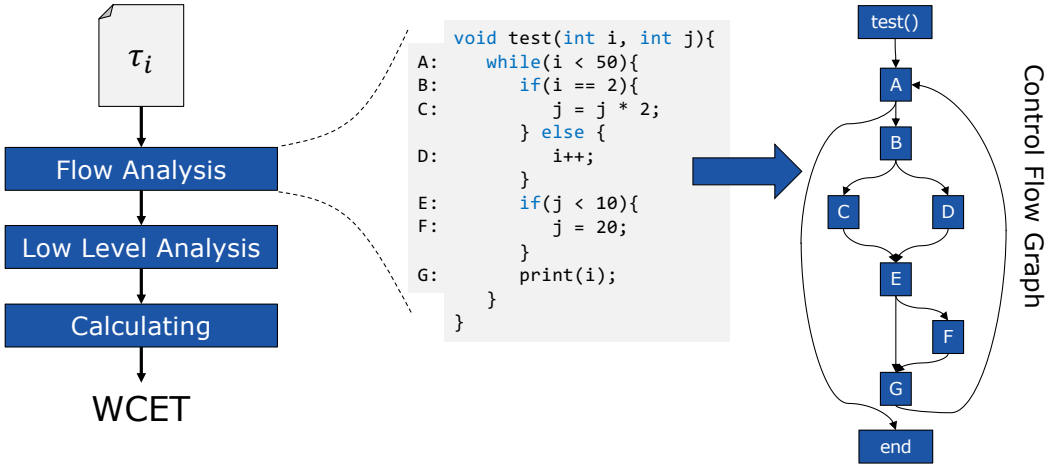
3 Static WCET Analysis

4 Hybrid WCET Analysis

5 Further Reading

Static WCET Analysis

- Instead of measuring the WCET, the program code can also be analyzed
- The program is never executed in the processor
- An abstract model of the hardware is used
- The possible control flow through the program is generated



Outline

1 Definition

2 Measurement Based

3 Static WCET Analysis

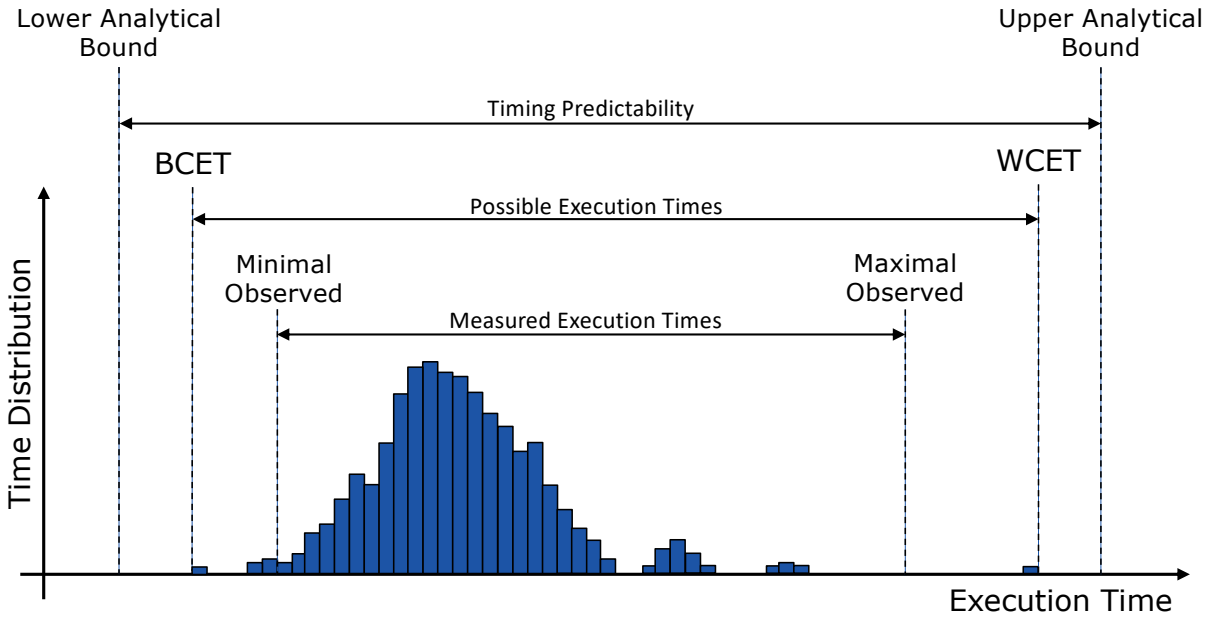
4 Hybrid WCET Analysis

5 Further Reading

Hybrid WCET Analysis

- A combination of static analysis and measurement based analysis
- Small code sections are instrumented and measured
- Performance metrics are recorded
- The information of the code together with the recorded data is used to compute the WCET estimate
- Many industrial domains apply this type of WCET analysis (i.e. automotive, avionics, space, etc.)

Summary



Outline

1 Definition

2 Measurement Based

3 Static WCET Analysis

4 Hybrid WCET Analysis

5 Further Reading

References

Reinhard Wilhelm, Jakob Engblom, Andreas Ermedahl, Niklas Holsti, Stephan Thesing, David Whalley, Guillem Bernat, Christian Ferdinand, Reinhold Heckmann, Tulika Mitra, Frank Mueller, Isabelle Puaut, Peter Puschner, Jan Staschulat, and Per Stenström. The worst-case execution-time problem—overview of methods and survey of tools. ACM Transactions on Embedded Computing Systems, 7(3):1–53, 2008. ISSN 1539-9087. doi: http://doi.acm.org/10.1145/1347375.1347389.