

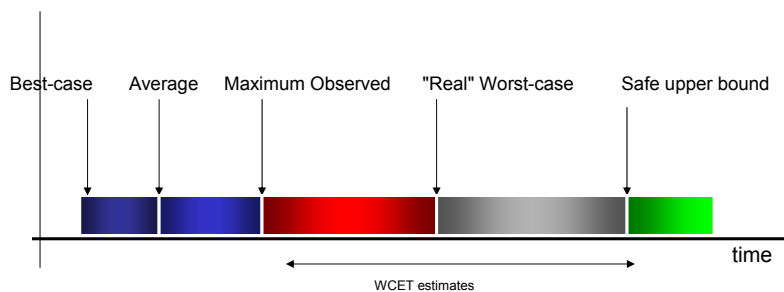
Revising the meaning of WCET. (and its impact on scheduling assumptions)

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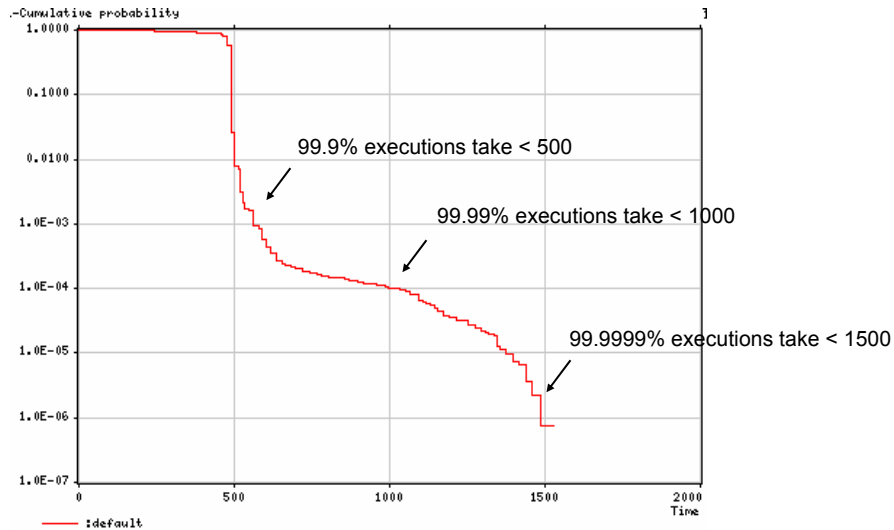


Execution time definitions

- C_i is an **estimate** of the real WCET
- BIG variability between average and WC execution
- Estimate of the WCET (can we afford to underestimate?)
 - Depends on applications.



Execution time profiles



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WCET assumptions

- Safe estimates (at all cost) ?
 - Absolute vs. probabilistic view?
 - Impact of misspredicting the WCET.
 - It is more probable that other things go wrong
- Analysability vs. predictability.
 - *Predictability* is too strong, and restrictive,
 - *Analysability* may be enough
- What can be provided
 - **Measured** execution Time profiles (ETP) , **WCET** ETP
 - Execution profiles. Per mode of operation + distinct events.
 - **Dependencies** (peaks are highly dependent, correlated)
 - Structural
 - Temporal (*when an alarm happens, everyone goes crazy...*)
 - Theory of copulas is the right tool to model dependency.
 - Applied to WCET analysis
 - To be applied to schedulability analysis

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CPU vs. *outside* CPU

- WCET Research too focused on modelling the CPU
- But systems have:
 - DMA, sharing same memory
 - DSP, sharing the same bus
 - Arbitration to access other devices
 - Memory management units
- Focus on the feature that have the largest impact, others can be “approximated”.
 - Cache has by far the largest impact
 - Cache misses “looks” like HD Page faults!
- Example (real HW):
 - Cache hit = 2 cycles
 - Cache miss = 40 cycles
 - Cache miss together at worst instant with DMA transfer = 80 cycles
 - But very unlikely to happen **every** time.

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WCET - Scheduling

- Typical assumptions on WCET
 - “task running in isolation, not interrupted, no preemptions”
- Typical schedulability analysis assumptions: (**possibly all wrong**)
 - C_i : WCET is **known, constant** and **accurate**.
 - C_i does not change over time
 - Mode changes
 - HW impact (interrupts/ preemptions/ ...)
- Actual execution time depends on schedule, circular dependency.
 - Cooperative scheduling
 - Cache Partitioning and Locking
 - Locking interrupt code outside cache!
 - Control of mode changes.
- Strategies for scheduling:
 - handle WCET overruns,
 - Opportunities for **gain time**!!! LOTS (less on *slack time*)
 - Careful with “Correlation” and dependencies
 - Long execution times tend to happen together associated to single events. E.g. mode changes

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Measured vs. Computed profiles

- Applicable to all resources
 - Execution time (WCET)
 - Cache misses
 - Number of accesses to external buses, and other HW features
 - Memory consumption
- *“The best model of a system is the system itself”*
 - Observational systems:
 - Trace Box
 - CPU support for observing behaviour system
 - CPU support for injecting HW test vectors