Real Time Systems – SS2016

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Time

What is time?

Time

What is time ?

historical: time is based on astronomical phenomena.

day Time distance between two maximum altitudes

of the sun

year Time distance between the recurrence of a

distinct position of the sun

month Time distance between 2 times new moon

Standards for time

Astronomical criterion: Universal Time (UT)

UT0: defined by earth rotation

(accuracy: approx. 0.1 s), direct from observation

Axis of the earth is swinging periodically (p=435d)

UT1 corrects UT0 by this swinging

UT2 corrects UT1 by the variability of

the earth rotation (e.g. from tide friction)

Earth rotation is slowing down by 2×10^{-9} a year,

but this is not linear.

The length of a day differs by approx. $1{,}5 \times 10^{-10}$ s.

Universal Time Coordinated (UTC)

Basis for the legal time

Based on atomic timescale that approximates UT1.

Once a year a leap second is inserted by the International Earth Rotation Service (IERS)

UTC is kept within 0.9 seconds of UT1

modified by 24 time zones, Day light saving.

Definition: atomic timescale and UTC have the identical value on January, 1st 1958

atomic timescale (TAI) - UTC=31 seconds

(TAI: Temps Atomique International)

Time in Operating Systems

Operating Systems try to give the „world time“ or a "tic-time":

- Application interface depend on operating system.
- Typical time based functions are:
- Actual (world) time
- Adjustment of computer time
- Time based execution
- Delay by a certain time
  (sleep(), usleep(), nanosleep())
- periodical activation (getitimer(), settimer())
- time-stamp for persistent objects
- access, last modification { information by using stat() }

Where do we get the time from?

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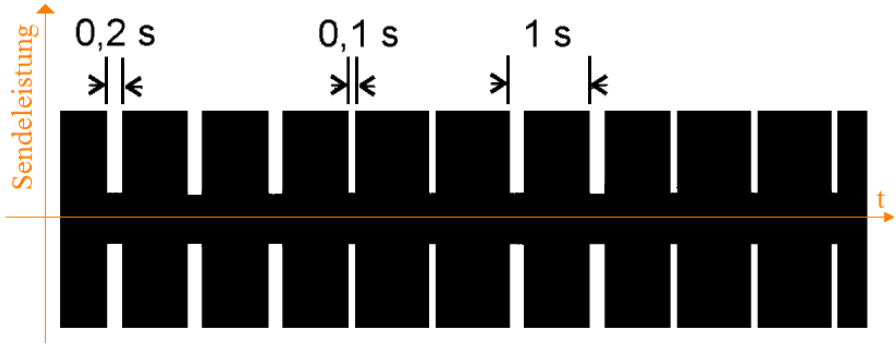
Where you get the time from ?

DCF77 (https://en.wikipedia.org/wiki/DCF77)

(https://en.wikipedia.org/wiki/DCF77)



Von Herbertweidner - Eigenes Werk, Gemeinfrei, https://commons.wikimedia.org/w/index.php?curid=18941779

Von derivative work: Fujnky (talk)Dcf77.jpg: Alexis.robert - Dcf77.jpg, Gemeinfrei, https://commons.wikimedia.org/w/index.php?curid=5262028

Execution Times

Definition: Job:

a Job J is a single CPU-time requirement to perform a computational sequence

Definition: execution time/Ausführungszeit:

execution time is the duration of a specific Job
between Job request and Job completion

Definition: net execution time/Netto-Ausführungszeit

net execution time is the execution time for a Job when
the CPU is used exclusively for this specific Job.

Execution Times

If the job is an Algorithm, the execution time may differ from request to request. (example division)

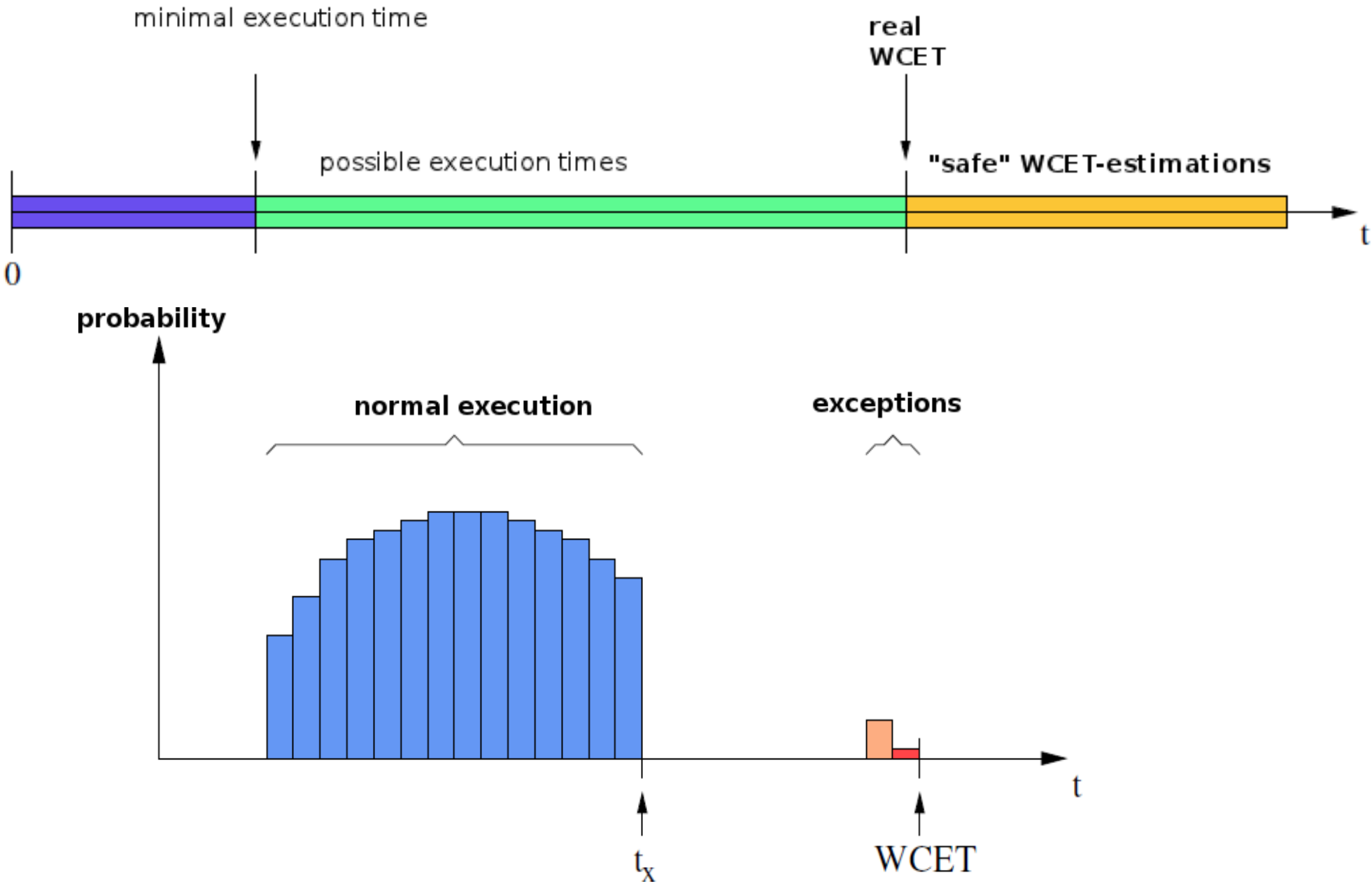
What are the important execution times ?

- Minimal net execution time (ideal case)
- Maximum net execution time (worst case)
- Average net execution time

Commonly the maximum net execution time is called:

Worst Case Execution Time (WCET)

WCET


minimal execution time
real
WCET
possible execution times
"safe" WCET-estimations
0
t
probability
normal execution
exceptions
t
t_x
WCET

Execution Times

Soft Real Time Systems could be developed to meet the average execution time.

Hard Real Time Systems have to meet the maximum execution time in any case.

Worst Case Execution Time – WCET

- Relevant for deadlines is the maximum execution time of a program on a certain hardware.
- The WCET is the maximum limit of the variable execution time. The WCET is often an estimated value.
- The estimated value of WCET has to observe two constraints:
  1. It must not be less than the real WCET (otherwise the deadline will be exceed some point time).
  2. It should be as near as possible to the real WCET (otherwise computing power will be wasted ⇒ the system gets more expensive).

Calculating WCET

Two different levels:

1. macroscopic examination:
   What does a computer program do?
2. microscopic examination:
   What happens inside the microprocessor?

Two methods:

1. Statical WCET Analysis:
   Calculating execution time based on the computer program.
2. Dynamical WCET Analysis:
   Measurement of an adequate number of execution runs on a certain hardware

Theory and Practice

When we plan a System in the exercises we have to possibilities:

a) we do it theoretical.
In this case we use the maximum net execution time
and name it as execution time Δt_{exec}

b) we do it practical. We measure the time for the job and estimate the WCET (which is the
maximum gross execution time/maximale Brutto-Ausführungszeit and
name it as execution time Δt_{exec}