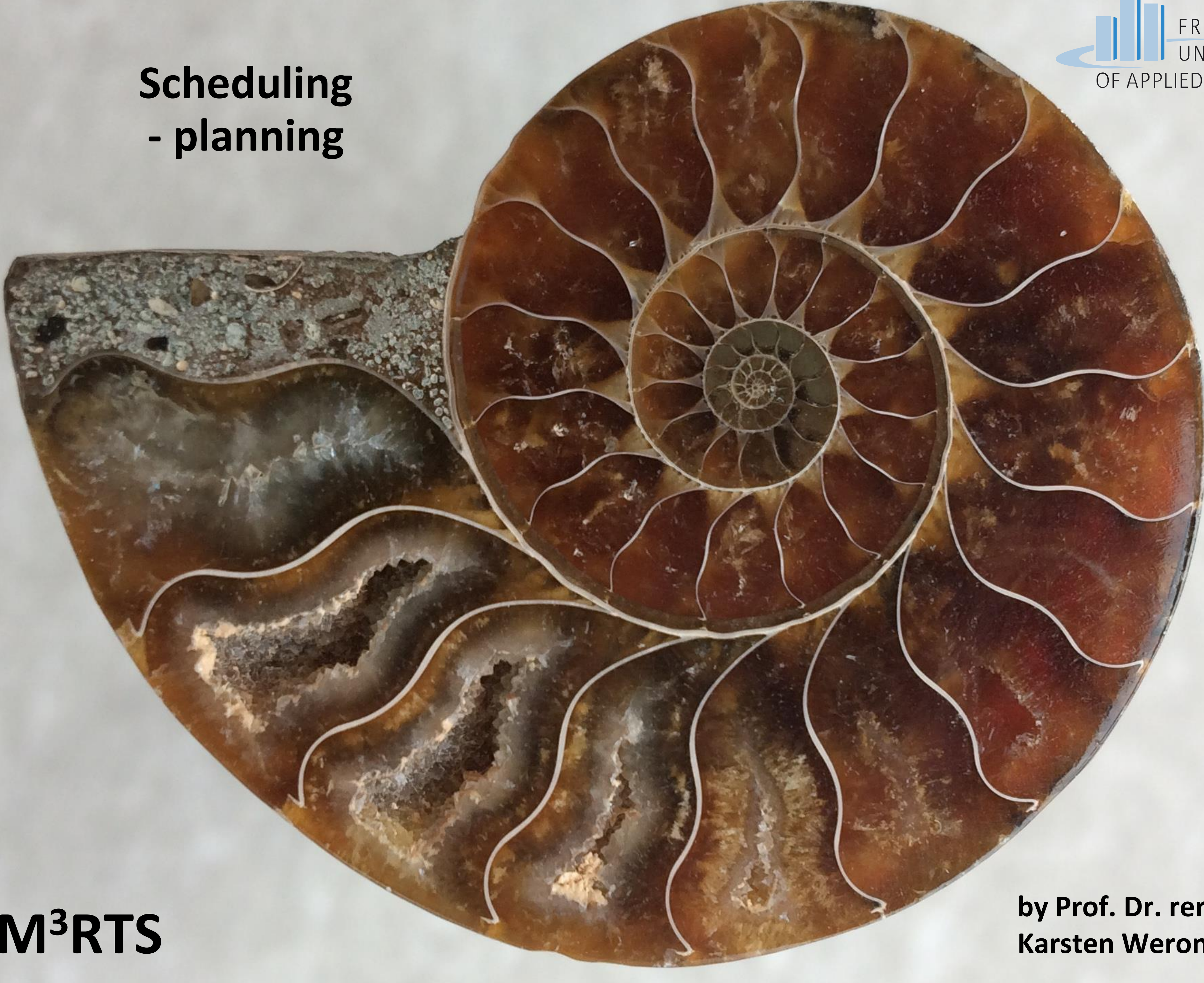

FRANKFURT UNIVERSITY OF APPLIED SCIENCES

Scheduling - planning

M³RTS

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M^{3}Real-Time-Systems SS 2017

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Scheduling

The aim for RT-planning

Find a relation between a set of jobs and
the resources to perform these jobs, that

- all required resources (computation time, memory, devices, etc.) are available to the jobs and
- the achievement of all time-related requirements is guaranteed

A Schedule

- A **schedule** or a **timetable**, as a basic time-management tool, consists of
  - a list of times at which possible tasks, events, or actions that are intended to take place, or/and
  - of a sequence of events in the chronological order in which such things are intended to take place.

The process of creating a schedule

- deciding how to order these tasks and how to commit resources between the variety of possible tasks –

is called **scheduling**, and

a person responsible for making a particular schedule may be called a **scheduler**.

Definition: Schedule

For RTS:

Definition:

A schedule of a set of jobs is called feasible(viable) when
each job can be completed with its individual Deadline.

To schedule means
to decide, which process will be processed in which time frame.

But how to find such a feasible schedule ?

Scheduling (non-)optimial Algorithm (Strategy)

Definition:

An scheduling algorithm is called optimal if
it is able to create a schedule
in those cases in which an feasible (zulässig/machbar) schedule exists.

A non-optimal scheduling algorithm may not be able
to create an feasible schedule.

Simplification

For the scheduling the time will be divided evenly
into reasonable time-slices.

For RTS scheduling you aim to describe your problem as
a periodic problem to have a finite problem to solve.

If you have a solution for one period you have it for all the time.

Let assume that all tasks will be independent.

Scheduling Problems

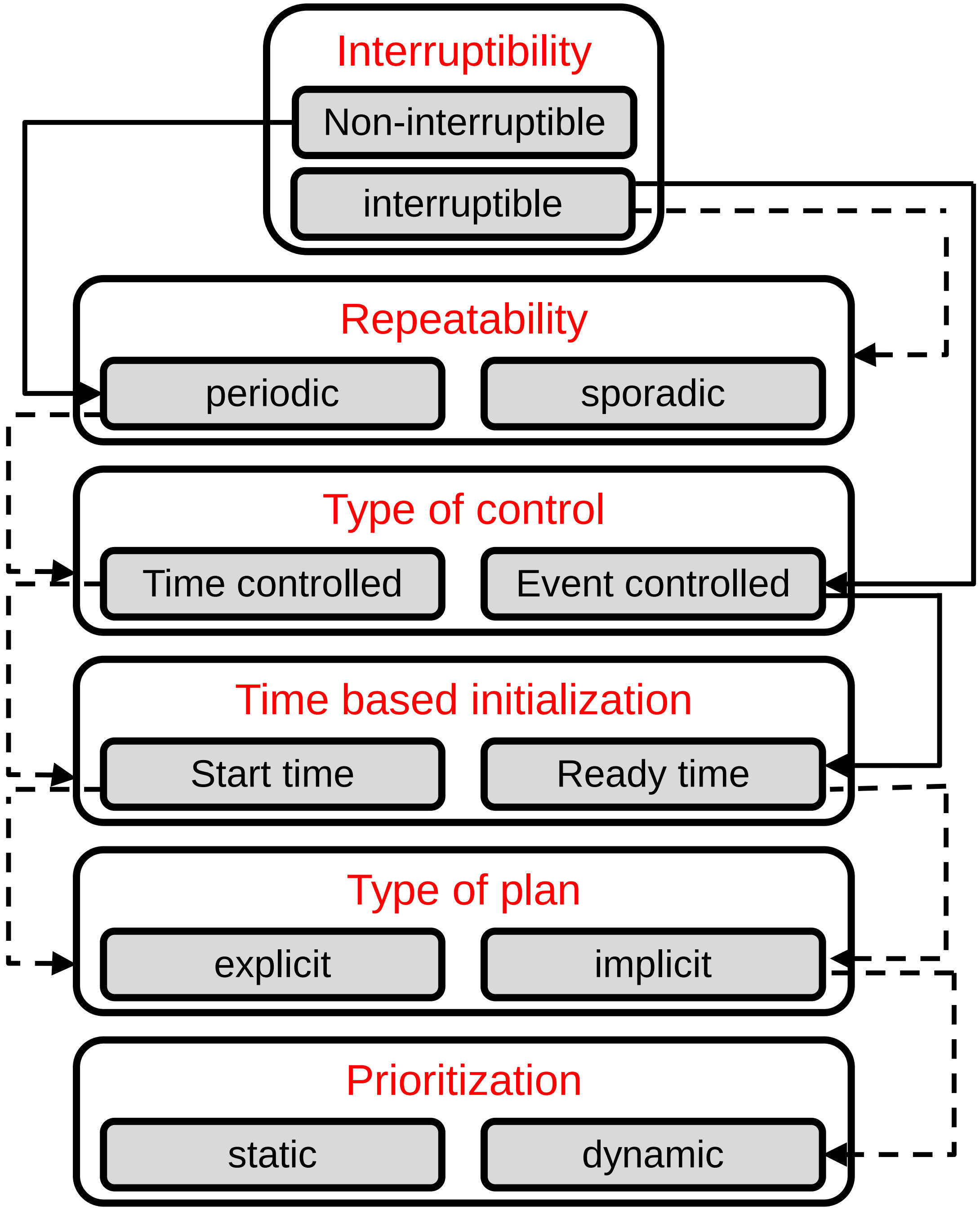
Given a set of tasks (ready queue)

- Check if the set is schedulable
- If yes, construct a schedule to meet all deadlines (feasible)
- If yes, construct an optimal schedule
  e.g. minimizing response times

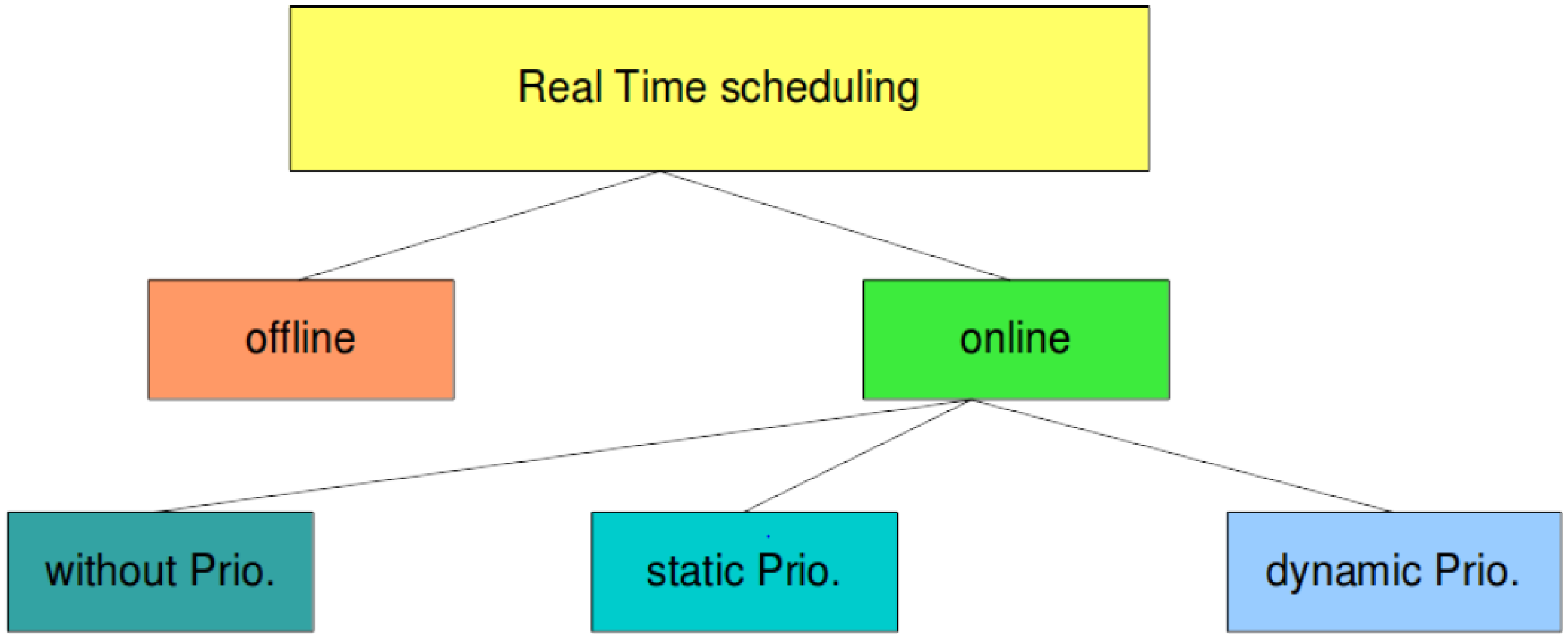
Combination of Categories of Processes and Plannings

Processes

Realtime Planning



Classification of RT-scheduling Algorithms



FIFO (First in First Out)
Round Robin
SJF (Shortes Job First)
SRT (Shortes Remaining Time)

RMS (Rate Monotonic Sch.)
DMS (Deadline Monotonic Sch.)

EDF (Earliest Deadline First)
LRT (Latest Release Time)
LST (Least Slack Time first)

EDF earliest deadline first

EDF has dynamic priorities.

Each tasks priority is calculated depending on deadline:

- An executable task with a shorter deadline has always a higher priority than the other tasks.
- An executable task with higher priority will always interrupt a task with lower priority
- A task with the same priority is not interrupted.

Basic Rate Monotonic Analysis (BRMA)

Assumptions of rate monotonic Scheduling and Analysis

- All the threads are periodic
- There is no interaction, blocking due to
  unavailability resources, priority inversion among the threads
- Thread switching in the system is instantaneous
- Each Thread has a constant execution time and
  the execution time does not change with time
- The deadline for a thread is starting o next period of the thread.
- The priority of each thread is determined by its period. The shorter the execution time period of a thread, the higher the priority
- All threads in the system are equally critical.
- Aperiodic threads are limited to system initialisation and failure recovery and do not have hard deadlines.

Rate Monotonic Scheduling (RMS)

Basic Rate monotonic analysis formally proves whether a given set of real-time threads can be schedulable to meet their deadlines if the threads were scheduled using rate monotonic scheduling.

RMS is a priority based preemptive scheduling, in which the threads with the lower periods should be given higher priorities and vice versa. In the RMS, the priority is solely determined by its period only with the rule "lower the period higher the priority and vice versa"

There are some schedulability test for RMS using BRMA.

There is also a method called "Extended RMS".
This removes some of the assumptions.

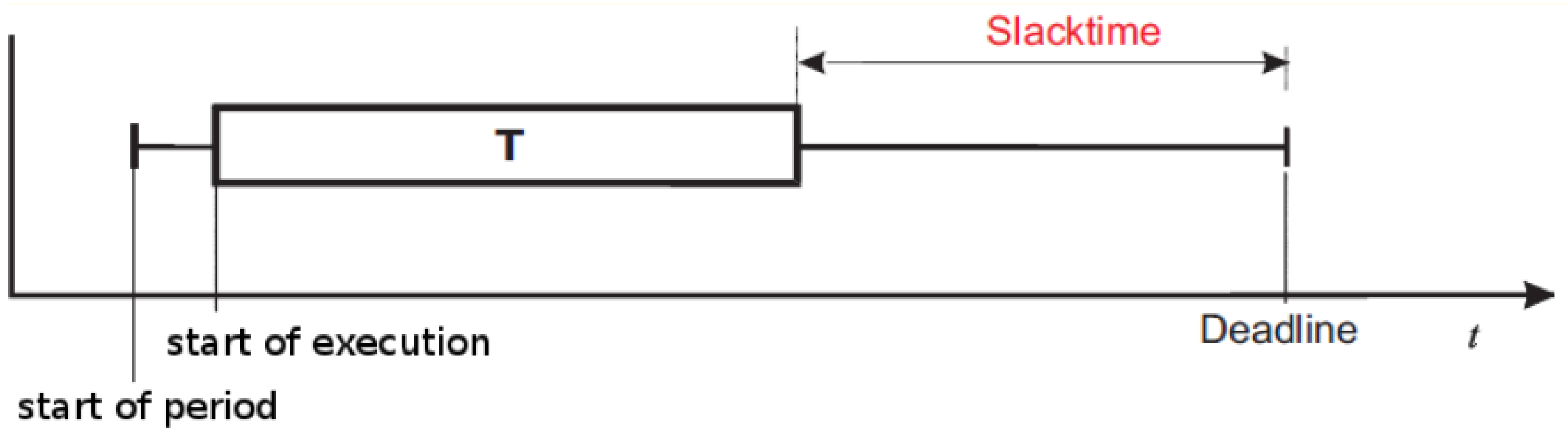
You need to know: If a system can not be schedulable by RMS, the system can not be schedulable with an other static priority assignment

Least Slack-time First

LSF has variable priorities.

Priority is calculated from difference of deadline and (remaining) execution time (Slacktime),

- Shorter Slacktime = higher priority,
- An executable task with higher priority will always interrupt a task with lower priority.



Schedulabilitytest

Before you start to schedule your system you have to check that there exists at least one feasible schedule.

Depending on the set up you have to go through different schedulability tests.

There are two major types of test

- necessary tests (notwendig)
- sufficient tests (hinreichend)

Necessity Tests

Necessary means:

- if one of the appropriate necessity test fails then there is no feasible schedule!
- If one or more or all necessity test are fulfilled then there may be or may not be a feasible schedule!

Sufficient Test

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Sufficient means:

- if you find at least one sufficient necessity test, than the task package is feasible schedulable.

- If you can't find a suffice necessity test, than a feasible schedule may exist or may not exists.

Load test

Load test is a necessity requirement:

- make all possible execution requests **i** periodic
- take this as the worst case maximum for the load

Load of a task:

$$U_i = \frac{e_i}{D_i}$$

System load:

$$U = \sum_{i=1}^{n} U_i = \sum_{i=1}^{n} \frac{e_i}{D_i}$$

Where ei is the execution time and Di time until expiration time of dead,

Where Pi = Di

Load U = 1 means the processor never idles

Load U > 1 there is no feasible schedule

Load U < 1 means: this test does not exclude that a feasible schedule may exist