

Master of Science in Information Technology - Information Security  
CMU-Portugal

FACULDADE DE CIÊNCIAS

# Distributed Real-Time & Embedded Systems

## Paradigms for Real-Time – V Scheduling Analysis with Cheddar

Prof. José Rufino

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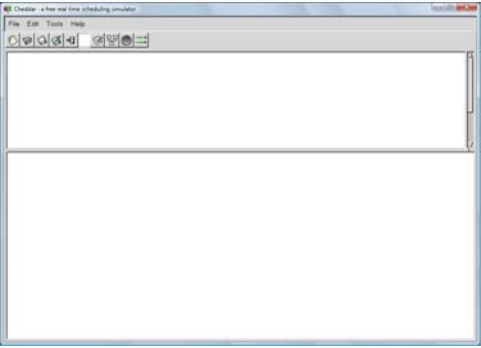
## Summary

- Demonstration in Laboratory
  - Scheduling Analysis with Cheddar

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## Scheduling Analysis Tool - Cheddar



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## Cheddar – Linux Installation

- Installation: "root" access is required
  - Decompress the installation package *Cheddar-DRTES*, available from the course web page.  
File: [Cheddar-2.1-linux-bin-drtes.tgz](#)
  - Decompress command:  
`tar zxvf Cheddar-2.1-linux-bin-drtes.tgz`
  - At the decompressed directory type the installation command:  
`make -f Makefile.drtes`
- After installation: documentation available from directory
  - `/usr/local/share/cheddar/docs`

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## Cheddar – Linux User Configuration

- User Configuration:
  - In file `.bash_profile` include the following two lines:  
`LD_LIBRARY_PATH=/usr/local/lib/gtkada/:SLD_LIBRARY_PATH`  
`export LD_LIBRARY_PATH`
  - After modification of the file `.bash_profile`, type the following command to make changes effective: `source .bash_profile`
  - This command is required only during initialization; no longer required in further work sessions.
- Program Invocation – at a terminal type the following command: `cheddar &`

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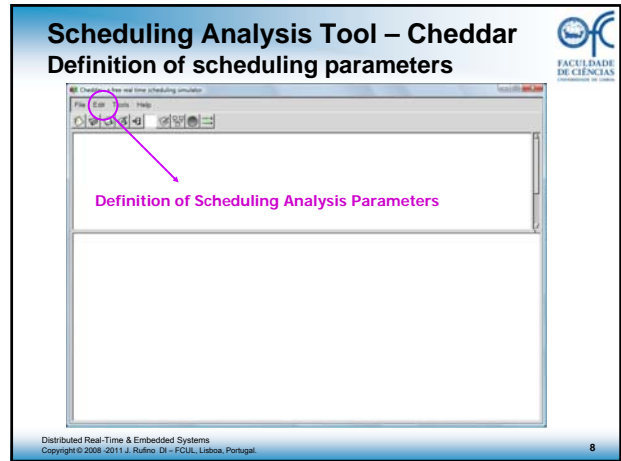
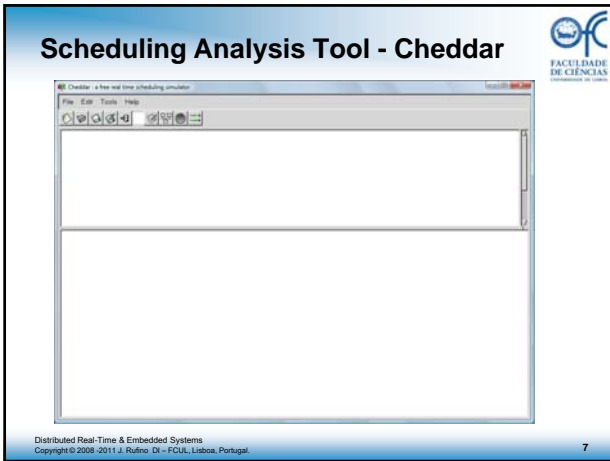
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## Cheddar – Windows Installation

- Installation: only a few simple steps
  - Download the installation package available from the Cheddar web page or from the course web page.  
File: [Cheddar-2.1-win32-bin.zip](#)
  - Decompress the installation package file. The following directory should be created:  
`Cheddar-2.1-win32-bin`
- Program Invocation:
  - At directory `Cheddar-2.1-win32-bin` start cheddar by clicking the Cheddar icon.
- After installation: documentation available from directory
  - `Cheddar-2.1-win32-bin/docs`

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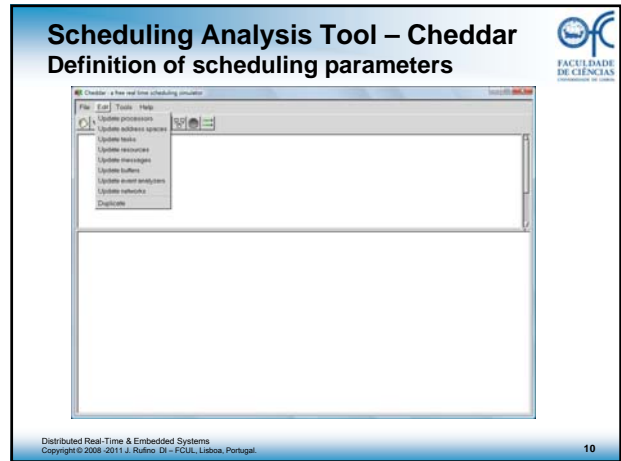
**Scheduling Analysis Tool – Cheddar**  
**Definition of scheduling parameters**

- Processor definition:
  - Includes scheduling algorithm.
- Address space definition
  - Only relevant for memory buffer utilization analysis.
- Task set definition.
- And...

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**Scheduling Analysis Tool – Cheddar**  
**Rate Monotonic Analysis – Example**

1. Given the set of periodic and independent tasks with the following temporal parameters:

Periodic Task	Period $T_i$	Deadline $D_i$	Execution Duration $C_i$
A	100	100	20
B	150	150	40
C	350	350	100

Use a compression factor = 10 (greatest common divider)

- Prove that the rate monotonic algorithm provides a feasible schedule for the task set
- Trace the corresponding temporal diagram.

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**Scheduling Analysis Tool – Cheddar**  
**Rate Monotonic Analysis – Example**

<<< Instructor guided resolution >>>

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### Scheduling Analysis Tool – Cheddar Definition of scheduling parameters

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### Scheduling Analysis Tool – Cheddar Definition of scheduling parameters

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### Scheduling Analysis Tool – Cheddar Definition of scheduling parameters

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### Scheduling Analysis Tool – Cheddar Definition of scheduling parameters

- Cheddar Tools may be used for setting up task priorities
- Example: RM algorithm
  - Tools
    - Scheduling
      - Set Priorities according RM

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### Scheduling Analysis Tool – Cheddar Schedulability Test

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### Scheduling Analysis Tool – Cheddar Temporal Diagram

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### Scheduling Analysis Tool – Cheddar Open/Save Definition Files

Project Management Options

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### Scheduling Analysis Tool – Cheddar Open/Save Definition Files

use a .xml extension filename

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### Scheduling Analysis Tool – Cheddar Definitions: Visualization with a browser

Some Browsers:  
may need file  
pre-processing  
with filter x2ff.

\$> x2ff file.xml

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### Scheduling Analysis Tool – Cheddar Definitions: Visualization with a browser

Style and Project Files

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### Scheduling Analysis Tool – Cheddar Working Directory

- Initial configuration available from the course web page:
  - Decompress the file package: DRTES-Cheddar.zip
  - Definitions of processors and task sets for selected scheduling problems.
  - Configuration files for visualization of definitions in a browser.

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### Scheduling Analysis Tool – Cheddar Definition Files

Solving Selected Scheduling Problems

XML Definition Files

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### Scheduling Analysis Tool – Cheddar Rate Monotonic Analysis – Example

3. Given the set of periodic and independent tasks with the following temporal parameters:

Periodic Tasks	Period $T_i$	Deadline $D_i$	Execution Duration $C_i$
A	20	20	10
B	50	50	25

Use a compression factor = 5 (greatest common divider)

- Prove that the rate monotonic algorithm does not provide a feasible schedule for the task set
- Identify in the temporal diagram the first task deadline miss

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### Scheduling Analysis Tool – Cheddar Rate Monotonic Analysis – Example

<<< Resolution by Students >>>

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### Scheduling Analysis Tool – Cheddar Schedulability Test

Schedulability analysis  
Example E3: tool reports a non feasible schedule

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### Scheduling Analysis Tool – Cheddar Temporal Diagram

Temporal Diagram  
Example E3: temporal diagram

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### Scheduling Analysis Tool – Cheddar Earliest Deadline First – Example

4. Given the set of periodic and independent tasks defined in the previous example, with the following temporal parameters:

Periodic Tasks	Period $T_i$	Deadline $D_i$	Execution Duration $C_i$
A	20	20	10
B	50	50	25

- Proof that the task set (Exercise P3) can be scheduled by the EDF algorithm.
- Trace the corresponding temporal diagram.

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### Scheduling Analysis Tool – Cheddar Earliest Deadline First – Example

<<< Resolution by Students >>>

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## Scheduling Analysis Tool – Cheddar Least Laxity First Scheduling– Example



7. Given the set of periodic and independent tasks with the following temporal parameters:

Periodic Tasks	Period $T_i$	Deadline $D_i$	Execution Duration $C_i$
A	4	4	1
B	6	6	3
C	12	12	3

- Check whether or not there is a feasible schedule for this task set task according to the LLF algorithm.
- Trace the corresponding temporal diagram.
- How does Cheddar solves ties in task scheduling?

## Scheduling Analysis Tool – Cheddar Least Laxity First – Example



<<< Resolution by Students >>>

## Scheduling Analysis Tool – Cheddar Least Laxity First Scheduling– Example



11. Given the set of periodic and independent tasks with the following temporal parameters:

Periodic Tasks	Period $T_i$	Deadline $D_i$	Execution Duration $C_i$
A	100	100	25
B	150	150	75
C	300	300	75

- Check whether or not there is a feasible schedule for this task set task according to the LLF algorithm.
- Trace the corresponding temporal diagram.

## Scheduling Analysis Tool – Cheddar Least Laxity First – Example



<<< Resolution by Students >>>

Was any ill-effect observed in task scheduling?

## Bibliography References



- Exercises Book:
  - J. Rufino – Task Scheduling Exercises, DI-FCUL, CMU-Portugal, Lisboa, Portugal, 2008. Available from the course web page.
- The Cheddar Project Web Page
  - <http://beru.univ-brest.fr/~singhoff/cheddar/>

Thank you for your participation.

Final questions?

<http://osc.di.fc.ul.pt/drtes>



*Soft Watch at the Moment of First Explosion*  
Salvador Dalí, 1904