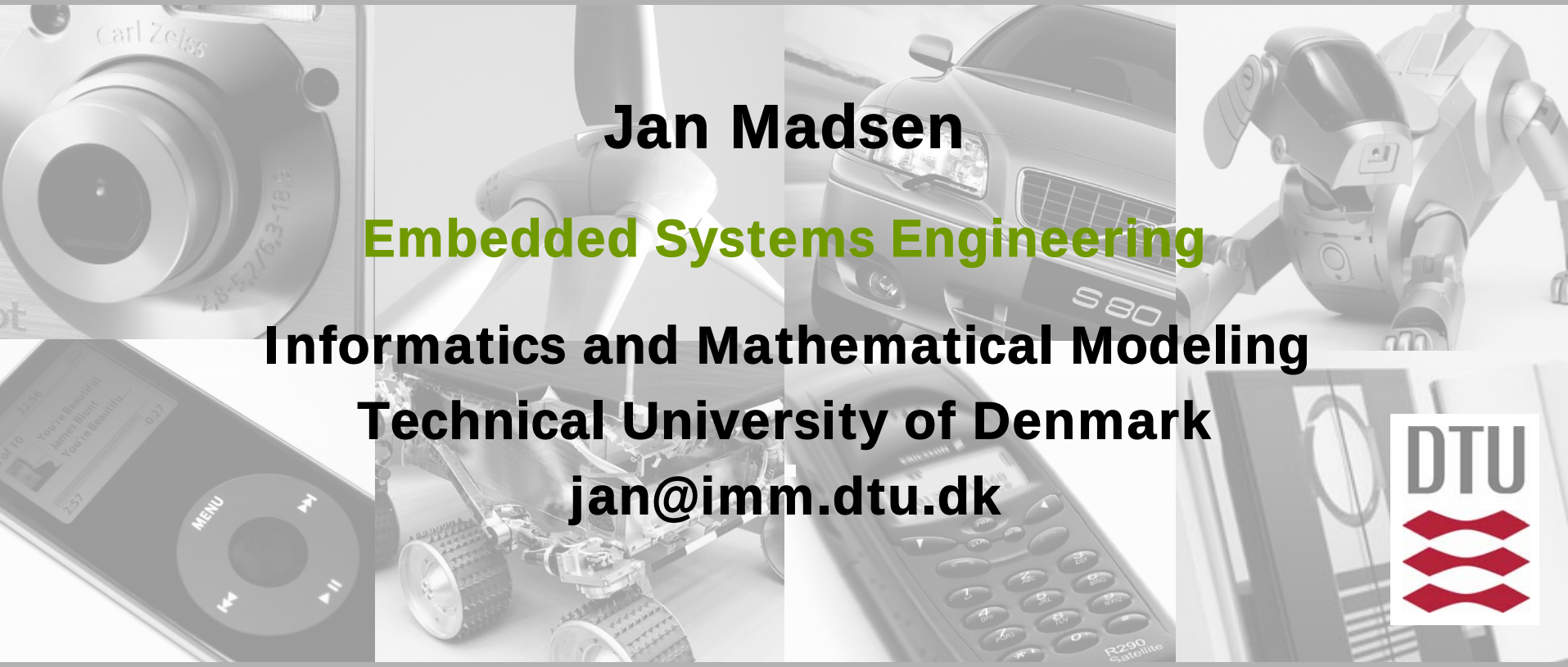
If Formal Analysis is the answer
What was the question?



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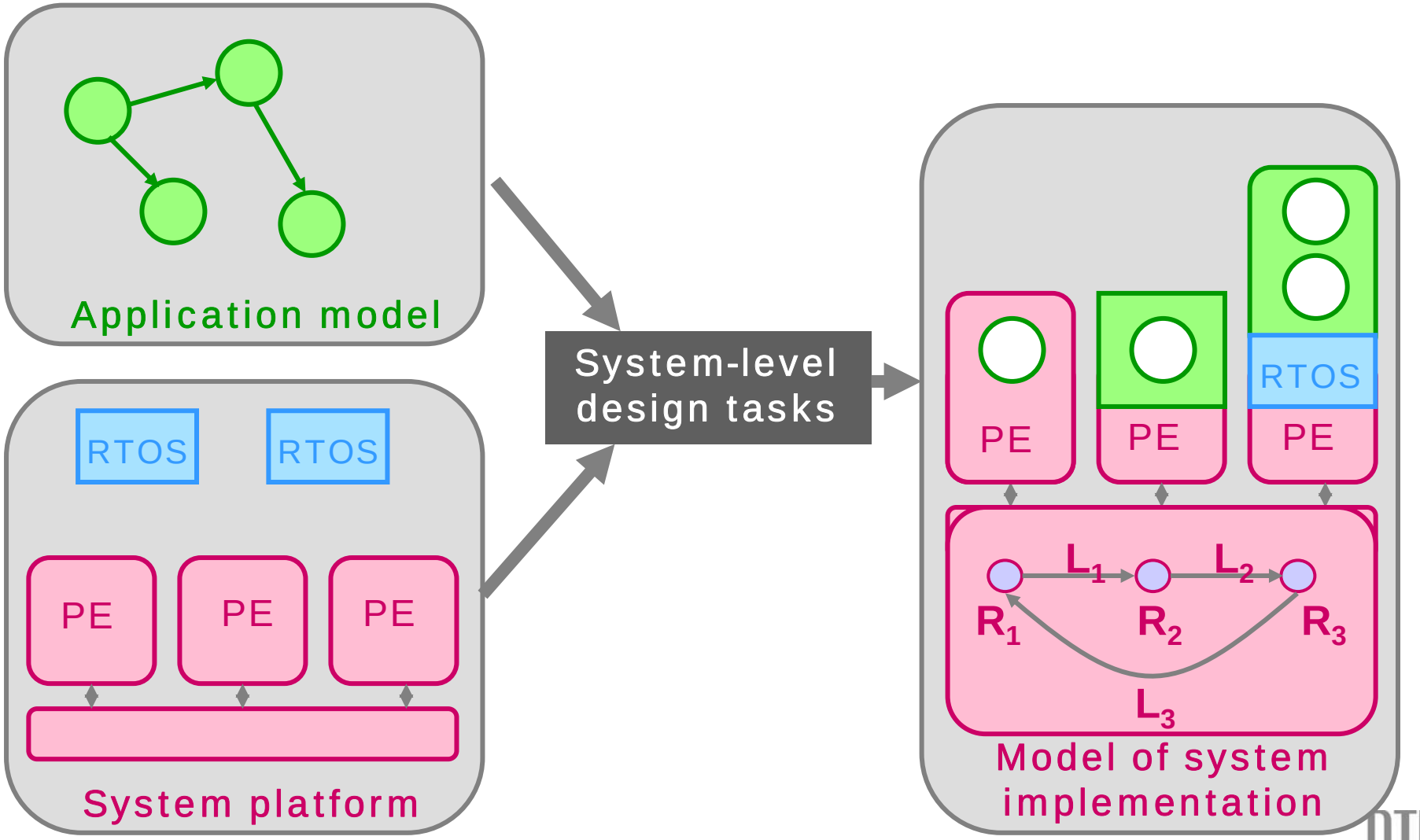
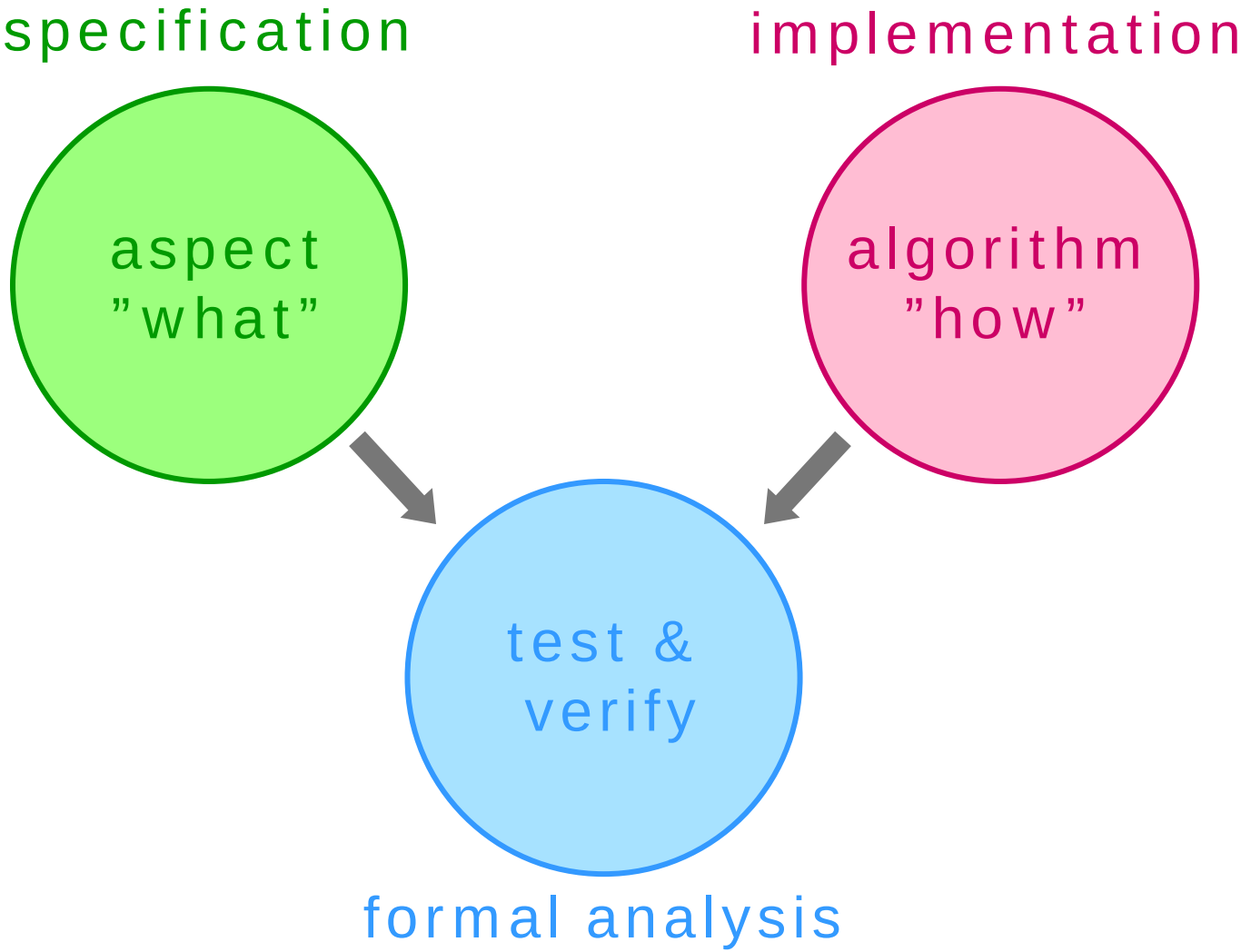
Motivation


Application model
RTOS
RTOS
PE
PE
PE
System platform
System-level design tasks
PE
PE
RTOS
PE
L_1
L_2
L_3
R_1
R_2
R_3
Model of system implementation

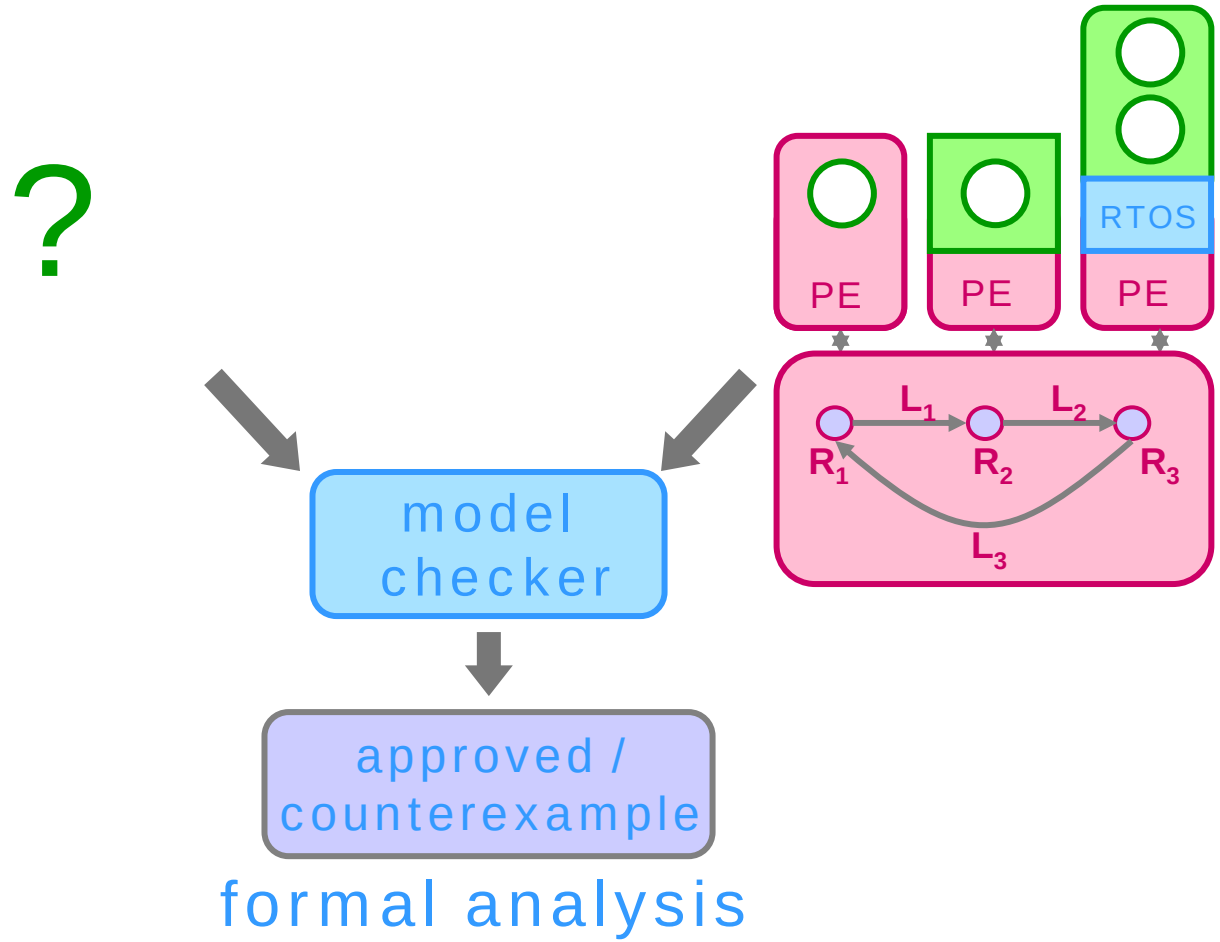
Formal analysis



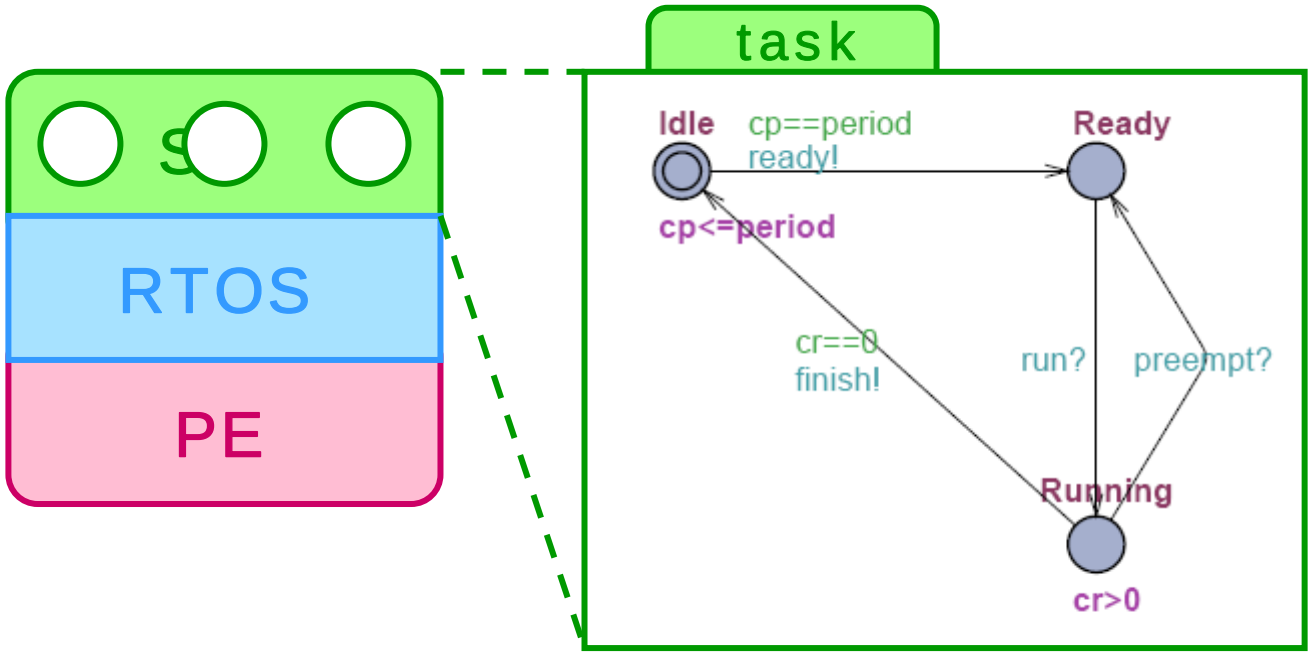
Formal analysis

specification

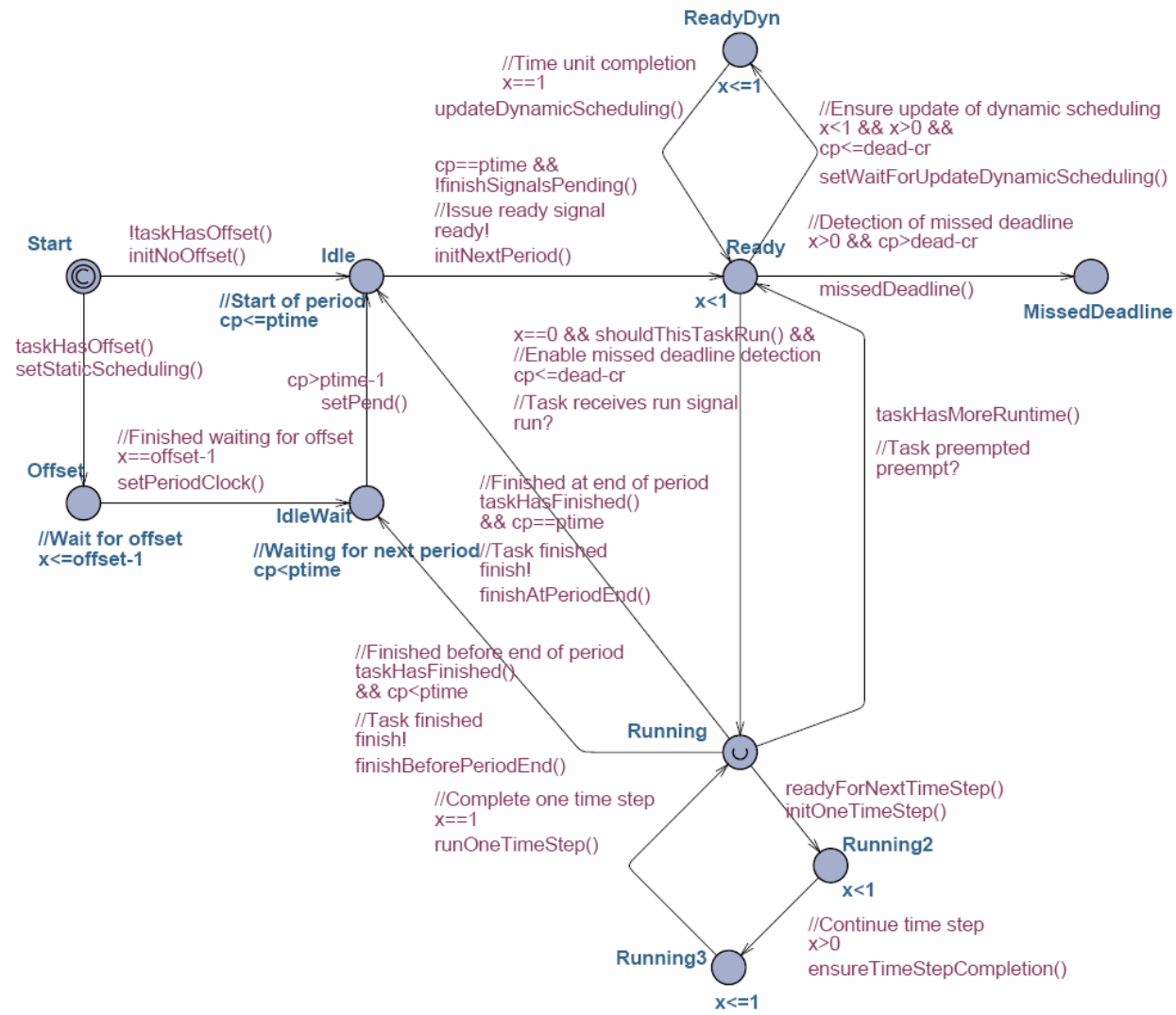
implementation



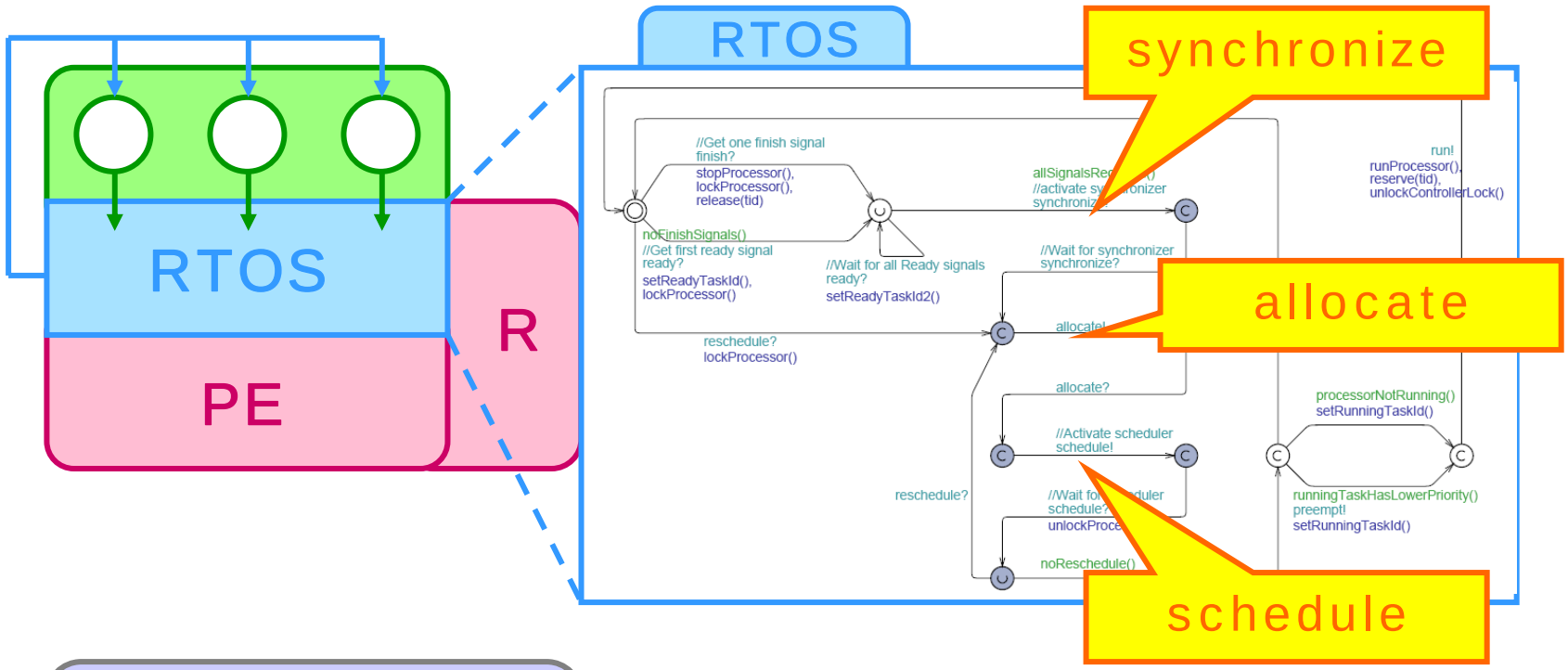
Formal model: task



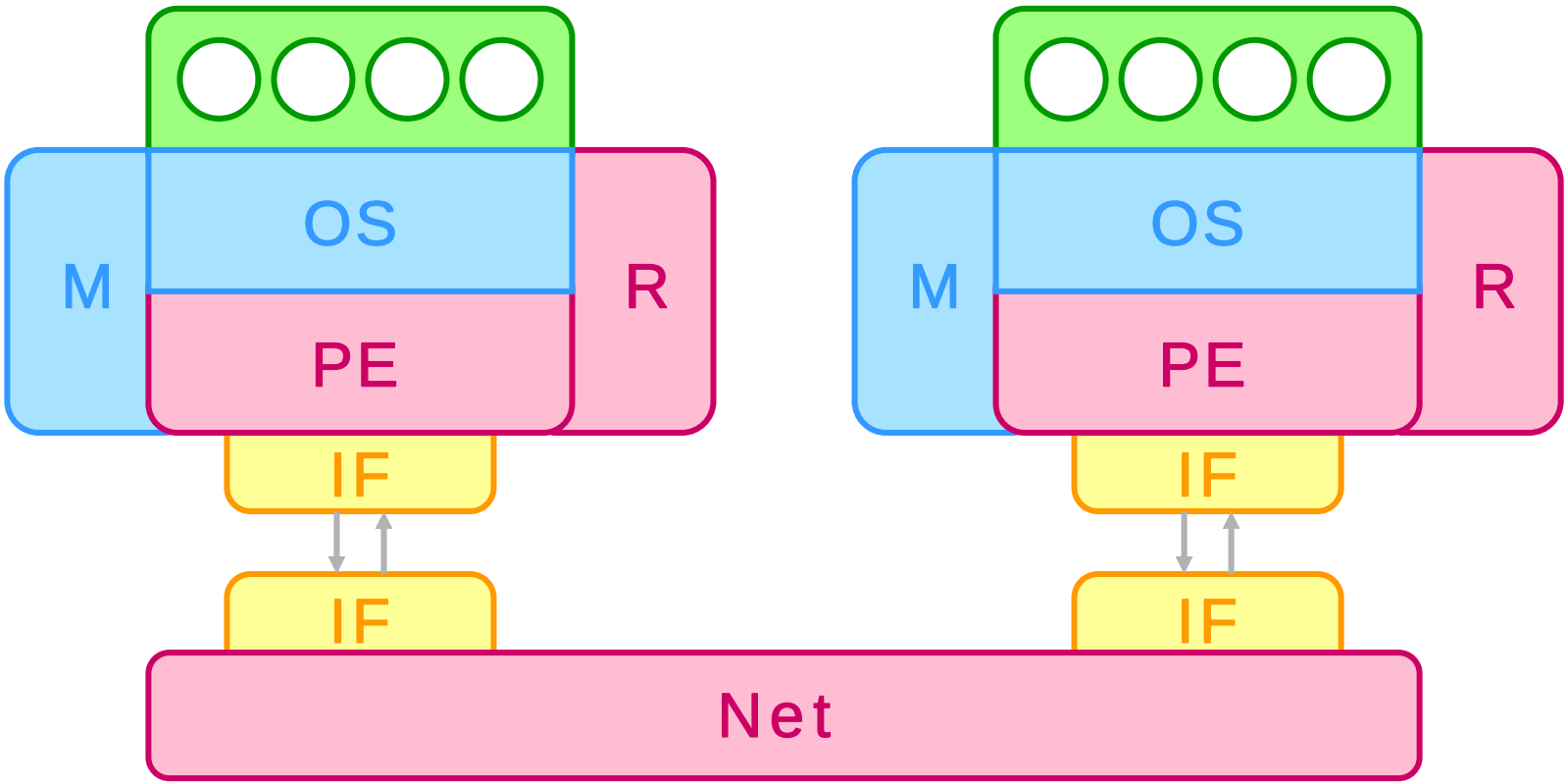
Formal model: Complete task model



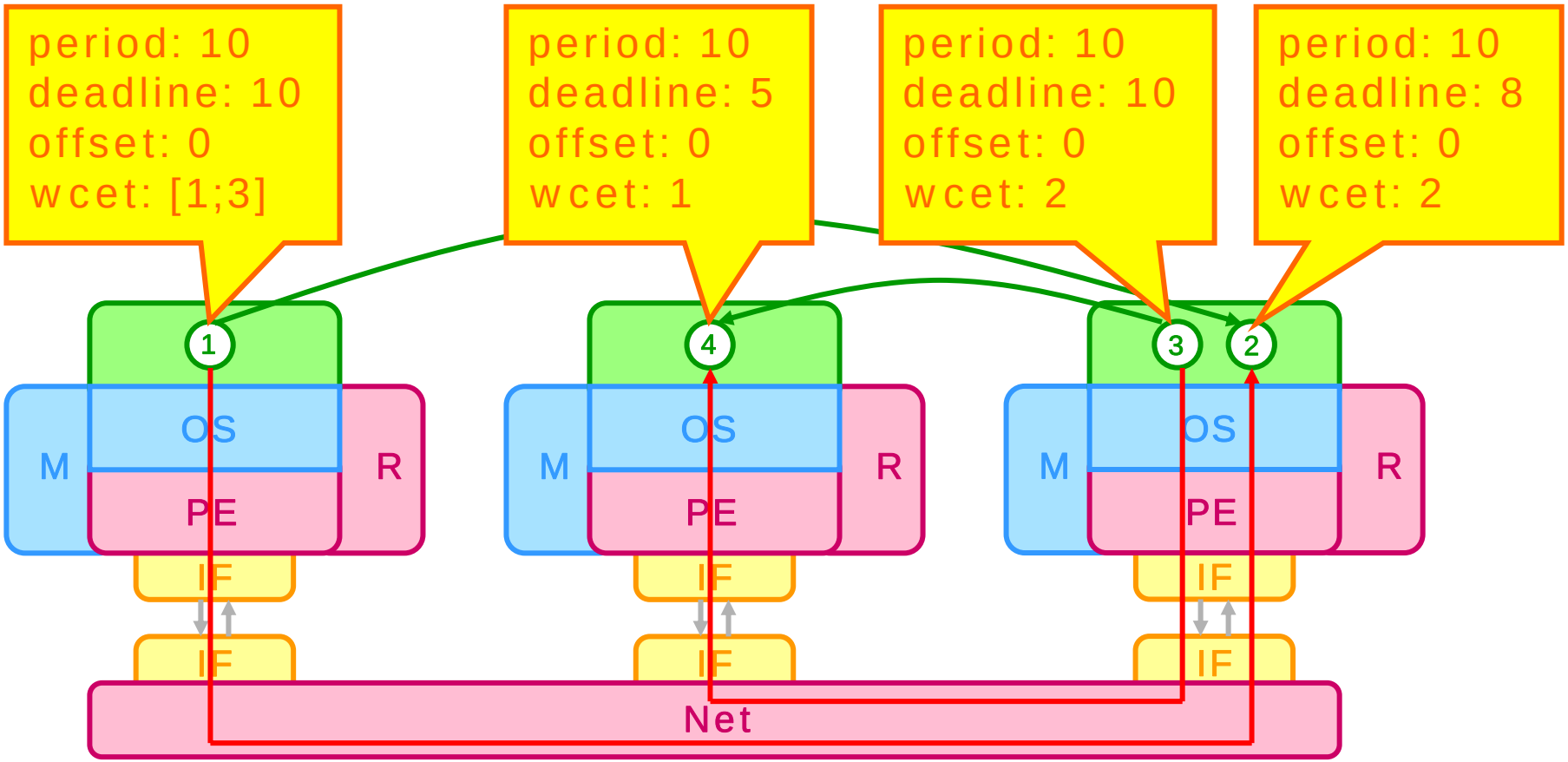
Formal model: RTOS



E<>AllFinish
E<>MissedDeadline
…

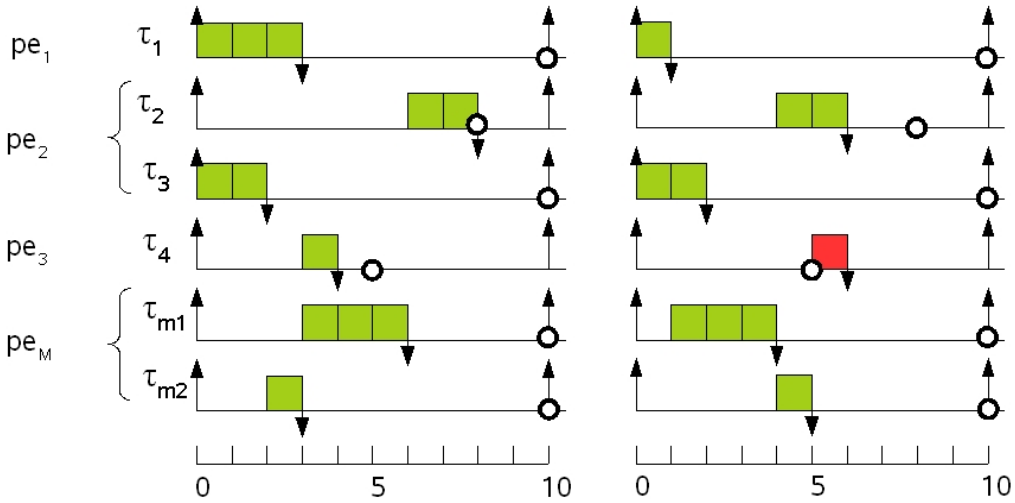

OS
M
R
PE
IF
IF
Net
OS
M
R
PE
IF
IF

MPSoC: Timing Analysis



MPSoC: Timing Anomaly

```
E<>allFinish(): true          E<>missedDeadline: true
                5   10                        5
Task: 1 1110000000            Task: 1 100000
Task: 2 0000001100            Task: 2 000011
Task: 3 1100000000            Task: 3 110000
Task: 4 0001000000            Task: 4 00000X
Task: 5 0001110000            Task: 5 011100
Task: 6 0010000000            Task: 6 000010
```



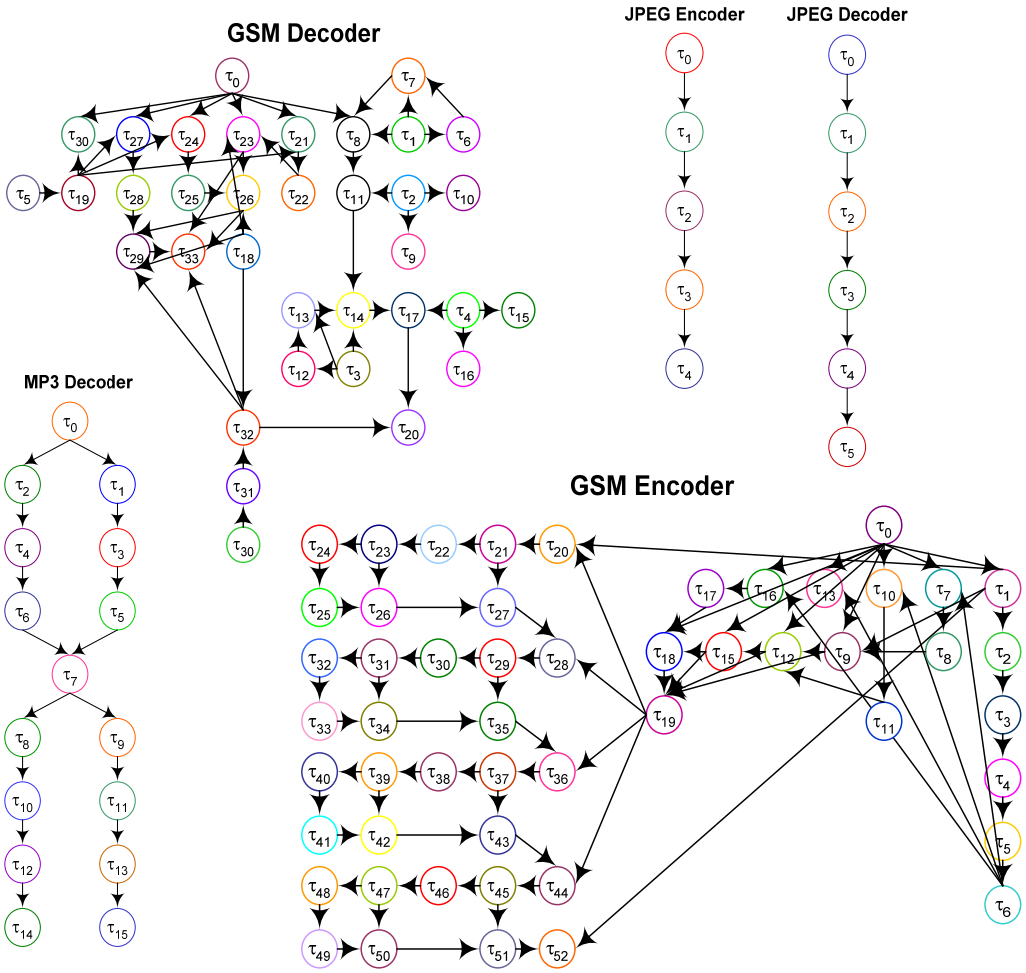
MPSoC: Performance metrics

- E<>AllFinish
  - Will all tasks eventually finish?
- E<>MissedDeadline
  - Will any task eventually miss its deadline?
- E<>preempted
  - Will any task be preempted at some time?
- E<>Task1.cp > *limit*
  - Will the response-time of task 1 exceed a certain limit?

MPSoC: Performance metrics

- E<>totalCostUsed(*cost*) > *limit*
  - Will the total sum of *cost* on all processors exceed a certain *limit* ?
  - E.g. E<>totalCostUsed(Power) > 145
- E<>totalCost[*processor*][*cost*] > *limit*
  - Will the *cost* on a specific *processor* exceed a certain *limit* ?
  - E.g. E<>totalCost[PE1][Memory] > 56

Handling realistic applications?



Smart phone

[Application from Marcus Schmitz, TU Linkoping]

Smart Phone

- 114 tasks on 6 25MHz GPP processors
- Periods from 0.02 to 0.5 sec
- Hyperperiod 12.500.000 cycles
- 2511 tasks in the hyperperiod
- Worst-case execution
- Execution from 52 to 266.687 cycles
- Granularity on 400
- Verified in 2.5 hours

Thank you

- Acknowledgements
  - Aske Brekling (PhD student)
  - Jens Ellebæk (MSc. student)
  - Kristian Staalø Knudsen (MSc. student)
  - Michael R. Hansen (Associate Professor)