

# Computational Models for Embedded Systems

## Laboratory Assignment 01

### Assignment 1: Model checking



**Theoretical aspects**  
Model checking



**Assignment Objectives**  
Verification using model checking.  
JSpin

#### Assignments

**Model checking Tool**  
Promela modeling and JSpin LTL properties.

**Assignment 1a. – as part of the lab activities**

**Assignment 1b. – as part of the final exam**



#### Assignment 1a. - UBB-Goes-Green – problem/solution

- **Sample Problem: A day in a life of ... a parent and a child.**
  - 2 actors: parent (P) and child (C)
  - At least 2 “signals” between the actors (from P to C and from C to P)
  - Example: P and C both in “sleeping” state; P wakes ups first and “signals” the C to wake up (thus, the C wakes up); P and C both “eating” state; C “signals” the P she/he finished the breakfast (P and C both “get dressed”); P “signals” the C to go to car (thus, C is in the state “in Car”), they both arrive to work/school in 30 minutes; after a period of time the C “signals” the P to come and pick her/him from school (thus the P picks her/him) and both go home; at home, P “signals” the C she/he has time to “play” (thus, the C comes and plays with the P); after a while the C “signals” the P to go to sleep (thus, they both go to sleep).
  - LTL formulas: “The P always waits for the C to finish breakfast before getting to car.” or “The state after *school* is *home*”, etc.
- Create your own Problem Statement - related to UBB-Goes-Green
- Work in teams of 2 members.
- Task 01
  - Option 1) SDG documentation (provided in the first week)
    - Task 5 from the Assignment\_SDG
      - Create, based on your findings in Assignment\_SDG and provided solutions, the Problem Statement for your lab.
      - Example: Recycle Paper Solution
        - Actors: Teacher (T), UBB-Recycle-Center (UBB-RC)
        - Signals: T to UBB-RC (haveExamPapersToRecycle) and UBB-RC to T (doYouHaveOtherPapers?);
  - Option 2)
    - Read UBBGoesGreen report on 2018/2019/2020
    - <http://green.ubbcluj.ro/>
    - [http://green.ubbcluj.ro/wp-content/uploads/Raport-de-dezvoltare-sustenabila\\_2018.pdf](http://green.ubbcluj.ro/wp-content/uploads/Raport-de-dezvoltare-sustenabila_2018.pdf)
    - Read and create for 3 universities in the list - a A4 paper mindmap (or mindmap in Miro in Teams) with key words about strategies/solutions for improvement at UBB (in teams of 3 students)
      - <http://greenmetric.ui.ac.id>
    - Create, based on your mindmap and provided solutions, the Problem Statement for your lab.
      - Example: Recycle Paper Solution
        - Actors: Teacher (T), UBB-Recycle-Center (UBB-RC)
        - Signals: T to UBB-RC (haveExamPapersToRecycle) and UBB-RC to T (doYouHaveOtherPapers?);
- Task 02
  - Translate the problem (interactions) using JSpin model checker.
  - Write 3 LTL formulas and check them.

#### Assignment 1b. - Embedded systems – problem/solution

- **Sample Problems:**
  - Example: Air humidifier (Smart Humidifier)
    - Actors: humidity sensor (HS), temperature sensor (TS), humidity controller (HC)
    - Signals: HS to HC and TS to HC; HC adjust by a mist level;
    - Remark: Research and study about how an air humidifier works. Use various colors for leds, various (1 to 4) mist output level, various (1 to 3) humidity settings, various time.
  - Example: Detection on the conveyor (ultrasonic (distance) sensor)

# Computational Models for Embedded Systems

## Laboratory Assignment 01

- if the bottles are too high/small/fallen or checking whether the box is full or empty with bottles
- Actors: distance sensor (DS), process fallen controller (FC)
- Signals: DS to FC
- Remark: Research and study how detection on a conveyor works.
- Example: Bulb with light sensor (photodiode, Smart Bulb)
- Example: Soil moisture sensor (Smart Garden)
- Create your own Problem Statement - related to Embedded systems
- Work in teams of 2 members.

Turn in (for each Assignment 1a., 1b.):



- (a) Problem statement in natural language (specify the actors, the signals and describe the interactions).
- (b) Promela \*.pml file with the solution.
- (c) Write 3 LTL formulas and check them with the JSpin model checker.
- (d) The output of the Spin model checker.
- (e) An archive with all the above files must be submitted in Teams, under the Assignment 1 (the name of the archive: Name1Name2\_MC\_1a.zip, Name1Name2\_MC\_1b.zip)



### Assignment and Delivery date for Assignment 1a:

1. Assignment date: laboratory 1
  2. Delivery date (first): laboratory 4 (maximal grade 300XP: 100 XP for Option 1) for the tasks in Assignment\_SDG or Option 2) for UBB-Goes-Green problem - mindmap, 200 XP for UBB-Goes-Green problem – Promela solution + LTL formulas)
  3. Delivery date (last): laboratory 7 (maximal grade 150: 50 XP for Option1) or Option 2), 100 XP for UBB-Goes-Green problem – Promela solution + LTL formulas) **if time available.**
- Remark: The solutions must be presented in class (during lab hours).



### Assignment and Delivery date for Assignment 1b:

1. Assignment date: laboratory 1
2. Delivery date: Date of the final exam (maximal grade 300XP: 100 XP for Embedded System problem – Problem statement, 200 XP for Embedded System problem – Promela solution and LTL formulas)