

# Assignment 2: Modelling with time

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**To do:** Develop Uppaal and Reo models as requested, and write a report using LaTeX, including screenshots of the requested timed automata and connectors.

**To submit:** The *report* in PDF **and** the developed *Uppaal models* **and** the developed *Reo models*. Send by email a unique zip file “ac2-N.zip”, where N is your group number.

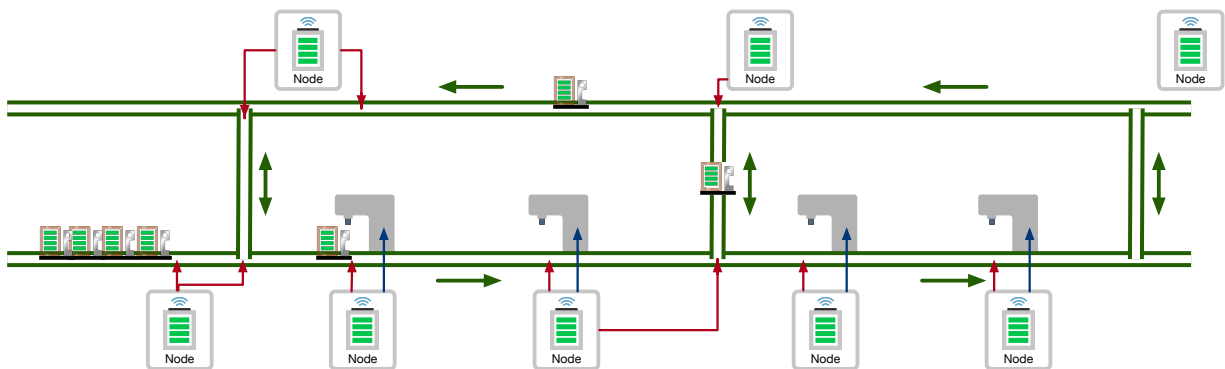
**Deadline** 1 Jun 2018 @ 23h59 (Friday)

## Part I - Real time

**Exercise 1. [Conveyor-belt in a factory]** A manufacturing factory has an assembly line where products are being taken in conveyor belts from station to station. At each station, the product evolves – for example, some holes are drilled, some screws are attached, or some hardware components are soldered.

In this factory, every product is labelled with an unique RFID tag, read at every station while modifying the product. The products are transported from station to station, taking time to navigate between stations and to be modified. Each station can only hold a product at a time.

Furthermore, each station can inspect for each product (based on its RFID tag) what stations modified it, and will require a set of dependencies. For example, the 4th station may require the 1st and 2nd station to be applied to the product before accepting it.



**1.1.** Model a concrete scenario of this factory as an UPPAAL model, i.e., with a number of products and topology of conveyors and stations of your choice. Use an automata for each product and for each station, and parameterise the model by (at least) the following constants:

- Speed of the conveyor, and

- Time required at each station.

Justify clearly your decisions (assumptions and abstractions) made in this modelling exercise.

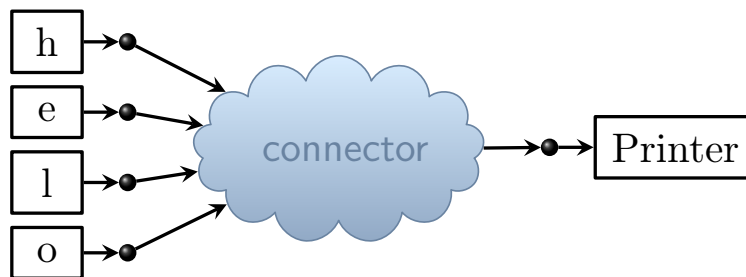
**1.2.** Express a property in UPPAAL's CTL logic for each item below.

1. A specific product  $P$  can become completed, i.e., pass all its associated stations.
2. A specific product is guaranteed to take less than  $T$  time to be completed.
3. If a specific product passes by a station  $N_2$ , then it will have passed by station  $N_1$ .

**1.3.** For each property find different values for the parameters, which satisfy and reject them. If a given property is always true or false, justify informally why.

## Part II - Coordination

**Exercise 2. [Writing components]** Consider 4 components, each producing a character 'h', 'e', 'l', or 'o' whenever requested, and a component that prints a received value to the screen.



**2.1.** Build a connector that will produce the word "hello".

**2.2.** Use the mCRL2 toolset to produce the LTS of the behaviour of the connector above (2.1).

**2.3.** Write 2 desired properties in mCRL2 that hold in your proposed connector.

**2.4.** Build a timed automata for a similar connector that waits at most 5 time units before producing any letter, and after this time it ignores the letter and proceeds to the next letter.

**2.5.** Define the timed automata of a timed channel of your choice, and use it to produce a Reo connector with the same behaviour as the timed automata above (2.3).