Assignment for the course 2R770, design and analysis of embedded systems, Spring 2003

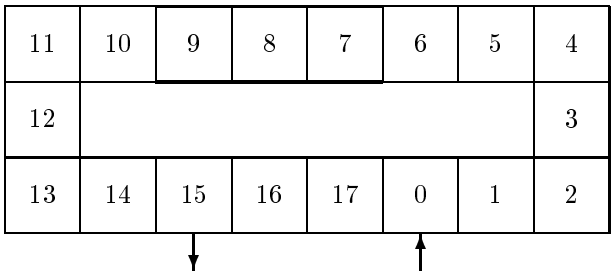
Jan Friso Groote (thanks to Jasper Peeters and Walrik Dirkx)

Context

Nyquist is a typical embedded system company in Eindhoven, delivering high precision actuators (especially, motors). The main activity of the company is to buy the actuators and sensors, build special controlling units and program these such that fully functional systems are delivered.

One of the products Nyquist has recently developed is a tray transport system. Trays containing magnets are moved in a counter-clockwise direction by magnetic coils forming a so-called linear motor system. Below I give an impression of how the system looks like, but full details should become available during a visit at Nyquist.

The system is divided in the following units.



Each unit consists of three coils positioned besides each other. Trays are as big as a single unit, and each unit has a sensor indicating above which coils there is a part of a tray.

At unit 0 a robot puts some item on the trays. This is processed at coils 7,8 and 9, where the trays must be adjacent to each other. The finished product is removed from the system at coil 15. When a tray arrives at unit 2, a special rail system will guide the tray to unit 4. Only one tray can be moved from 2 to 4 at the same time, and none of the units may be occupied by another tray in the mean time. Similarly, only one tray can be moved from unit 11 to 13.

Each unit has its own processor and all the processors are connected to each other via a firewire network.

The main purpose of this assignment is to design the control of this system. It may be assumed that the hardware can be adapted to the logical design. The design must be such that it is correct.

Assignment

1. First the system must be designed under good weather conditions, i.e. under the assumptions that there are no failures in the system. The following three steps must be carried out:

   (a) Identify the control system that must developed to control the hardware. Define the inputs and output from the control system to its environment.

   Define a logical architecture for the control system. Define exactly which the input and the outputs of all subsystems are, and give a global indication of the responsibilities of each subsystem. Define all the behavioural requirements on the whole system.

   (b) Design the behaviour of each subsystem in the system.

   (c) Verify that the requirements do indeed hold on the system under any circumstance.

2. Adapt the model such that mistakes can occur, such as failure of the protocol to deliver messages, sensors that do not detect the presence of a tray and trays that get stuck. Adapt the requirements, and the (sub)systems to deal with these problems and prove that the requirements are still valid for the new system.

3. Combine all the written material into a concise but complete technical report describing the requirements, the design and that explains how the requirements have been proven. The document must be such that from it an implementor can easily implement the system, and those wanting to use the system can easily find out which functionality is guaranteed by the system.