# System Validation Project Report

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## 1 Introduction

This is a project done as part of TU Delft's IN4387 System Validation course. The project concerns designing, modelling and validating a controller for a Transfer system in an Industrial Silicon Wafer production plant. The system consists of a UV Lamp that projects a design onto a wafer inside a vacuum chamber. The wafers are transferred to the Lamp via two Airlocks. The wafers are handled by robots from their initial position on Input stacks to their final position on Output stacks. The wafers move along the production line from their Initial state (on the Input Stacks), are printed on by the Lamp and reach the Final state (on the Output stacks).

## 2 Requirements

### 2.1 System Components

The system consists of the following physical components:

- Lamp/Projector: L

- Inner Doors: DI1, DI2
- Outer Doors: DO1, DO2
- Input Stacks: I1, I2
- Output Stacks: O1, O2
- Airlocks: A1, A2
- Outer Robots: R1, R2
- Inner Robot: R3

## 2.2 Functional Requirements

### 2.2.1 Overall requirements of the System:

- As long as the Output Stacks are not full, wafers keep moving along the production line. (System is deadlock free) **(Safety)**
- Both the Inner and Outer Doors of an Airlock must NOT be open at the same time. **(Safety)**
- Doors must not be closed while the robot is picking up/placing a wafer in the Airlock **(Safety)**

### 2.2.2 System Component Requirements:

These are the individual component requirements:

1. Doors: DI1, DI2, DO1, DO2
    - Inner and Outer Doors (DIx, DOx) of an Airclock (Ax) should never be open at the same time. (Vaccuum must be preserved) **(Safety)**
    - Inner Door (DIx) should be opened ONLY if it's corresponding Outer Door (DOx) is closed and vice versa. **(Safety)**
2. Output Stacks: O1, O2
    - Wafer should not be put on a full Output Stack. **(Safety)**
3. Outer Robots: R1, R2

- The Outer Robot (Rx) should pick the next Input wafer ONLY after delivering a finished wafer to it's corresponding Output Stack (Ox). **(Safety)**

4. Inner Robot: R3

   - The Inner Robot should place the Input wafer on the Lamp ONLY when the Lamp's stack is empty. **(Safety)**
   - The Inner Robot should pick the next Input wafer ONLY after delivering a finished wafer to it's corresponding Airlock (Ax). **(Safety)**

# 3 Interactions

## 3.1 Commands to Actuators

The following are the commands given by the controller to the actuators of the system. The meaning can be interpreted as:

**Command( Target actuator, optional parameters)**

- MoveTo(x, D) [x: R1, R2, R3 ; D: Lamp, Airlocks, Input/Output Stacks] Move to assigned destination.
- PickupWafer(x, D) [x: R1, R2, R3 ; D: Lamp, Airlocks, Input Stacks] Picks up the wafer.
- PlaceWafer(x, D) [x: R1, R2, R3 ; D: Lamp, Airlocks, Output Stacks] Places the wafer.
- OpenDoor(x,s) [x: DI1, DI2, DO1, DO2; s:Open, Close] Opens the corresponding door.
- CloseDoor(x) [x: DI1, DI2, DO1, DO2] Closes the corresponding door.

The commands are valid for the combinations of target Actuators and Destinations shown below:

| | Lamp | Airlock1 | Airlock2 | Input1 | Input2 | Output1 | Output2 |
|---|---|---|---|---|---|---|---|
| Robot1 | | ✓ | | ✓ | | ✓ | |
| Robot2 | | | ✓ | | ✓ | | ✓ |
| Robot3 | ✓ | ✓ | ✓ | | | | |

## 3.2 Reading Sensors

The following are the commands used by the controller to read the data provided by the sensors of the system. The meaning can be interpreted as:

**Command(Target sensor, Return Value by sensor)**

- CheckInputStack(x, s) [x: I1,I2 ; s: Present, Absent]
- CheckOutputStack(x, s) [x: O1,O2 ; s: Full, Empty]
- CheckLamp(L, s) [L: Lamp ; s: Busy, CompletedPrinting]
- CheckAirlock(x, s) [x: A1,A2 ; s : WaferPresent, WaferAbsent]

# 4 Architecture

Figure 1 shows the Architecture of the system described above with five parallel controllers along with the various entities (Sensors and Actuators) they control.

The following is the controller:

1. Controller 1
    - R1, ,

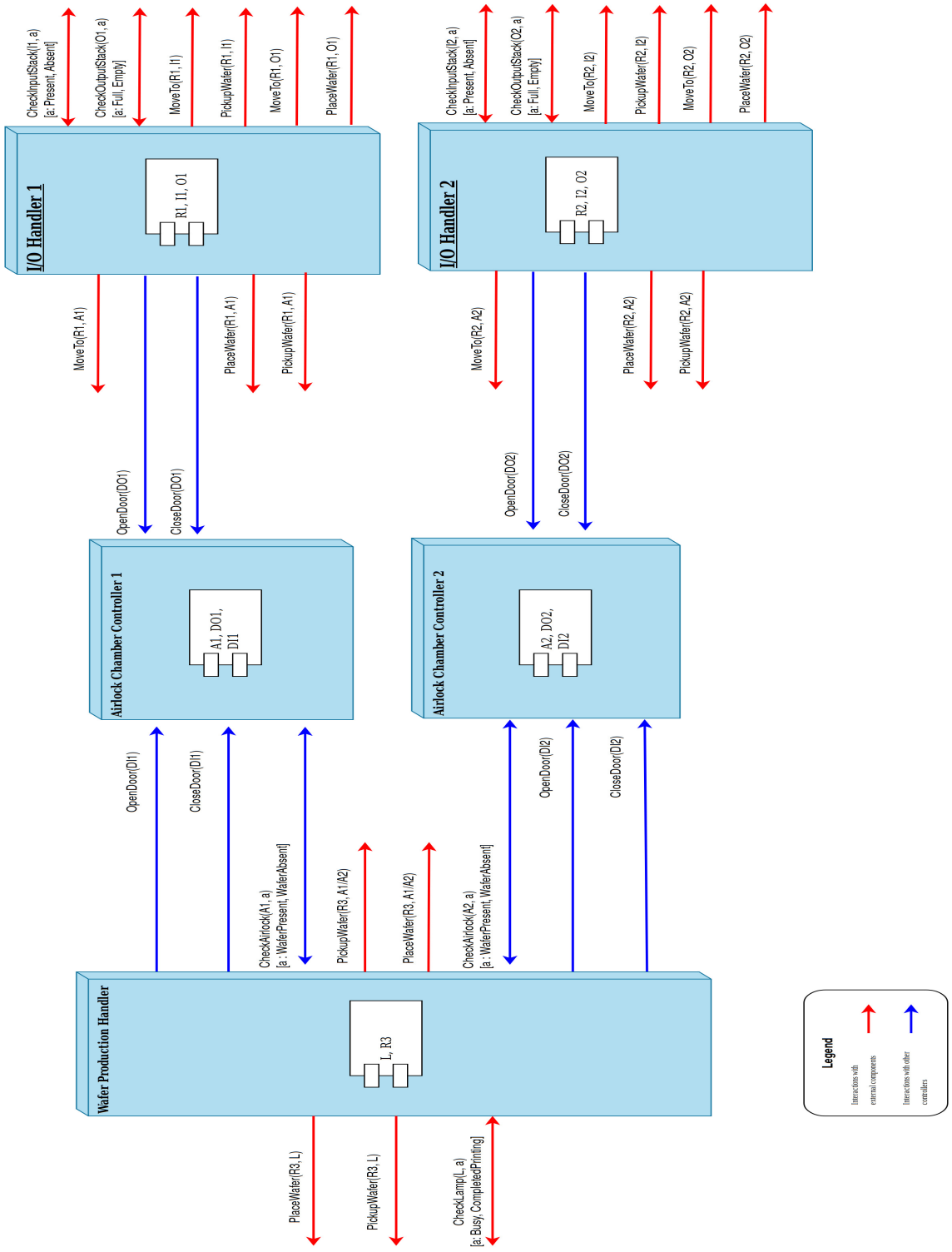


Figure 1: Architecture Diagram of System