

# Master's Thesis

## Verification of IEC 61131-3 Structured Text by SPIN based on an intermediate representation in LLVM

### Problem Statement

Model Checking is a formal method capable of finding errors in software implementations in, for example, safety critical environments. Structured Text (ST) [1] is a programming language standardized in IEC 61131-3 which is used by programmable logic controllers (PLC). Model Checkers typically work on different input languages, such as Promela [2] which is used by SPIN [3]. In order to perform verification with this tool, a transformation of ST to ultimately Promela must be defined. In a previous thesis at this chair, a transformation from ST to the widespread intermediate representation LLVM IR [4] has already been implemented in the chair's verification software ARCADE [5]. The goal of this thesis is to define a transformation from this LLVM intermediate representation to Promela and to implement this in ARCADE, such that the tool chain depicted in figure 1 is completed. The resulting possibilities of verification are then to be evaluated.

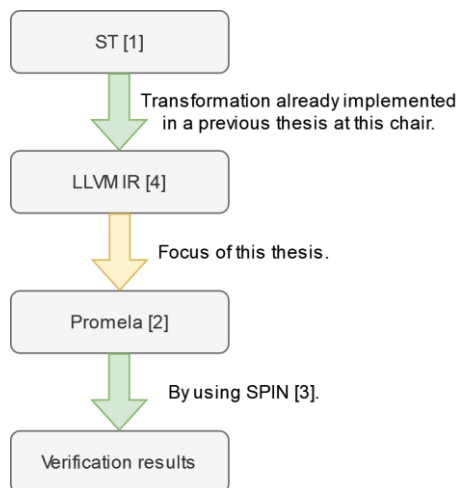


FIGURE 1: THE TOOLCHAIN TO BE COMPLETED.

### Task

- ▶ identifying the fragments of LLVM IR that are relevant for this thesis
- ▶ defining a transformation from LLVM IR to Promela and implementing this in ARCADE
- ▶ evaluation of the implementation and the verification method

### Qualifications

- ▶ experience in C++ is appreciated
- ▶ knowledge of SPIN and Promela is helpful

### Contact and advisor

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[1] IEC 61131-3, ED. 3.0. Programmable controllers - Part 3: Programming languages, 2013

[2] G.J. Holzmann, Design and Validation of Computer Protocols. Englewood Cliffs, N.J.: Prentice Hall, 1991

[3] Holzmann, G.: The SPIN Model Checker, Boston, 2003

[4] LLVM Language Reference Manual. <https://llvm.org/docs/LangRef.html>, 2022.

[5] <https://arcade.embedded.rwth-aachen.de/>