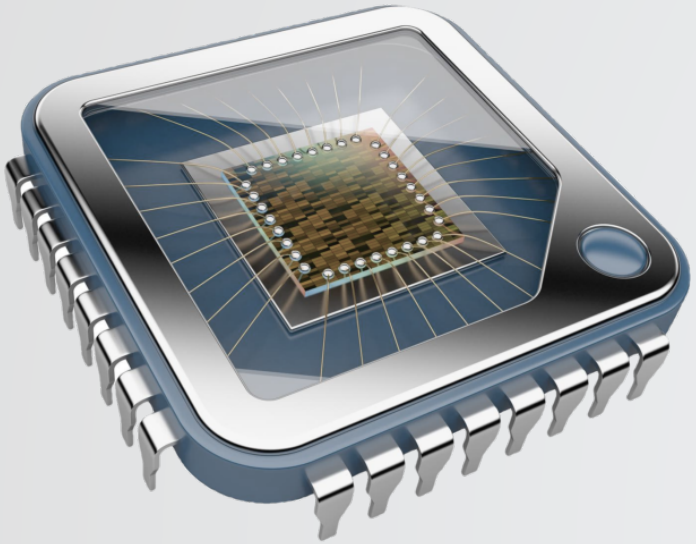
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HomeLab µ8051 ISS/VHDL

Embedded System course - A.A. 2025-2026



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OVERVIEW

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- Introduction
- Software development process
- Cross compilation
- Simulation
- µ8051 ISS/VHDL Homelab
- Demo application
- Conclusion

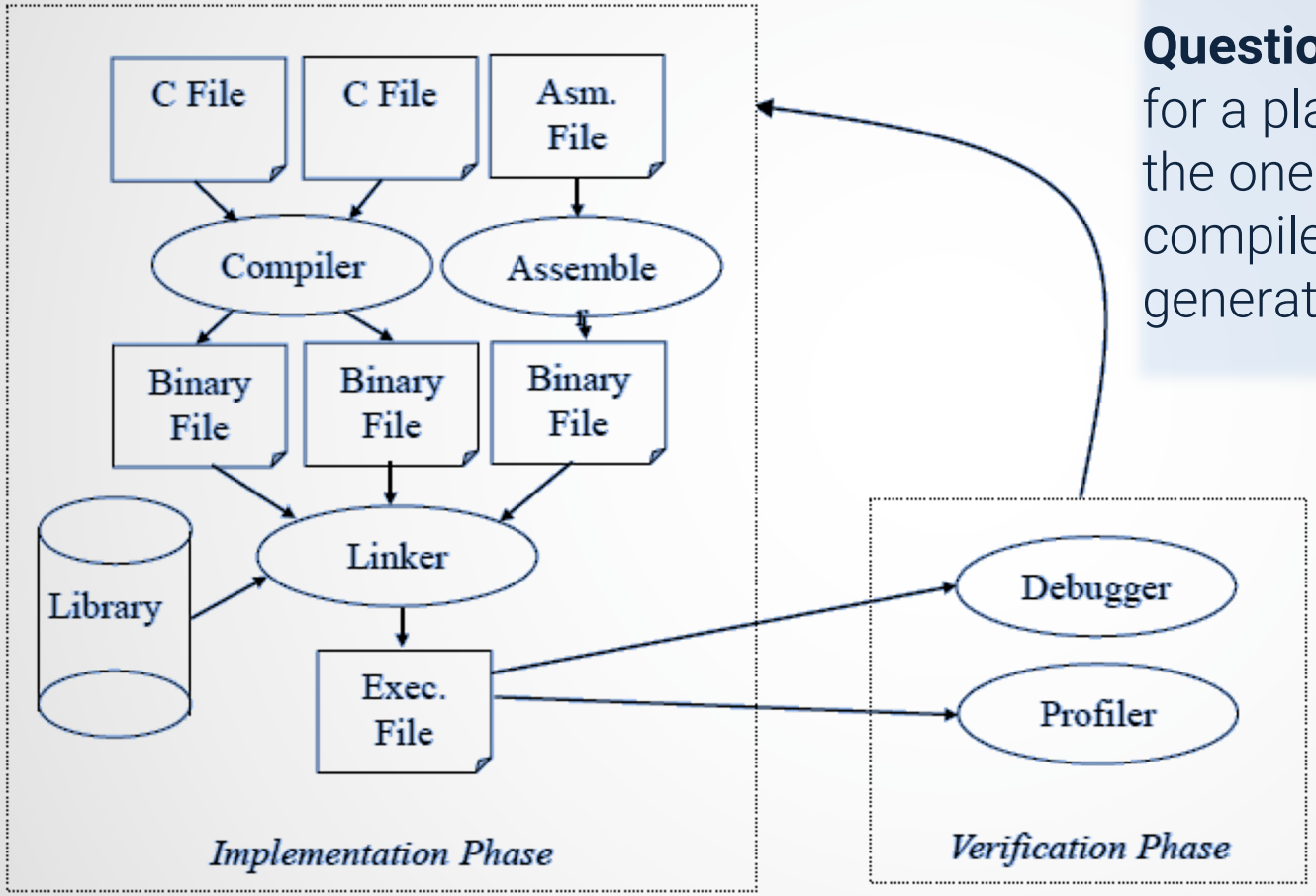
INTRODUCTION

The purposes of µ8051 ISS/VHDL HomeLab are to learn:

1. How to build a C program for a microcontroller.
2. How to check correctness and performance of the developed software.

   Without having the target!

SOFTWARE DEVELOPMENT FLOW



Question: How the *Exec.File* for a platform, different from the one on which the compiler is running, can be generated?



CROSS COMPILATION

Cross Compiler: compiler that is able to create an executable file for a platform different than the one on which it is running on



SIMULATION

The **Simulation** approaches, such as HDL simulation or IS simulation, are used to check correctness and performance of the developed software.

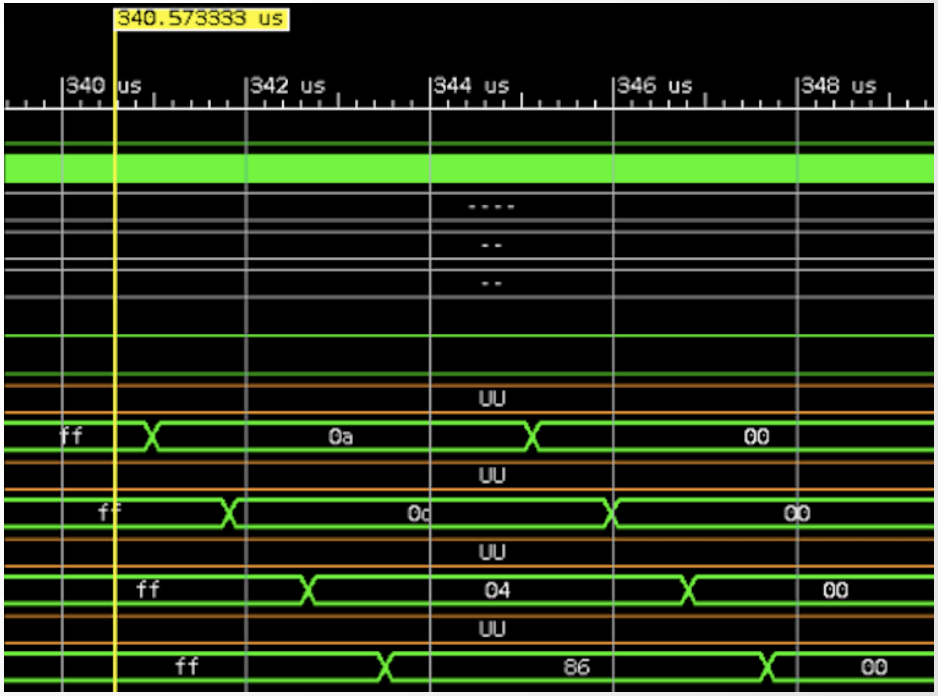
```
sim8051@sim8051:~/workspaces/i8051/divmulSDCC$ ../isasim/
P0      P1      P2      P3
0xFF    0xFF    0xFF    0xFF
0x0A    0xFF    0xFF    0xFF
0x0A    0x0D    0xFF    0xFF
0x0A    0x0D    0x04    0xFF
0x0A    0x0D    0x04    0x86
0x00    0x0D    0x04    0x86
0x00    0x00    0x04    0x86
0x00    0x00    0x00    0x86
0x00    0x00    0x00    0x00

Instructions Executed:                          1209
Execution Time(seconds):                        9e-05
Average Instructions/second:                    1.34333e+07

Clock Cycles Required for 8051:                 19776
Execution Time for 8051(12 MHz)(seconds):       0.001648
Average Instructions/second for 8051:           733617

sim8051@sim8051:~/workspaces/i8051/divmulSDCC$
```

Example of IS simulation

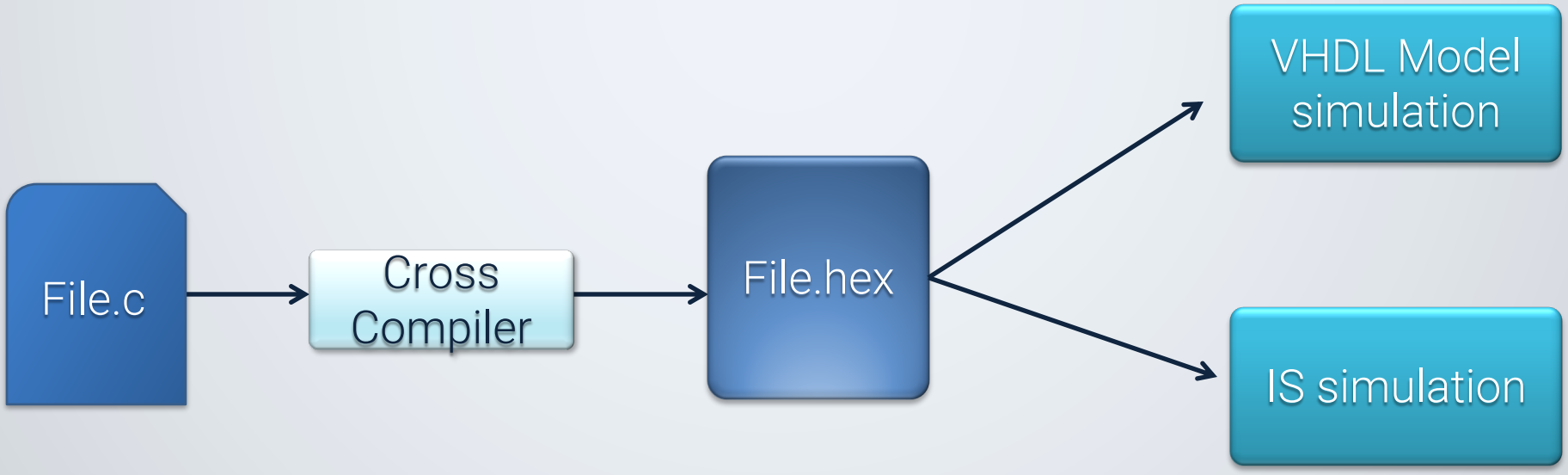


Example of HDL simulation

µ8051 ISS/VHDL HOMELAB

HomeLab purpose is to build a development environment for Intel 8051 microcontroller and to use two simulation techniques to check correctness and performance of the developed software.

HomeLab Workflow



INTEL 8051 MICROCONTROLLER

The Intel 8051 is a single-chip microcontroller (µC) series developed by Intel in 1980.

i8051 Application domains:

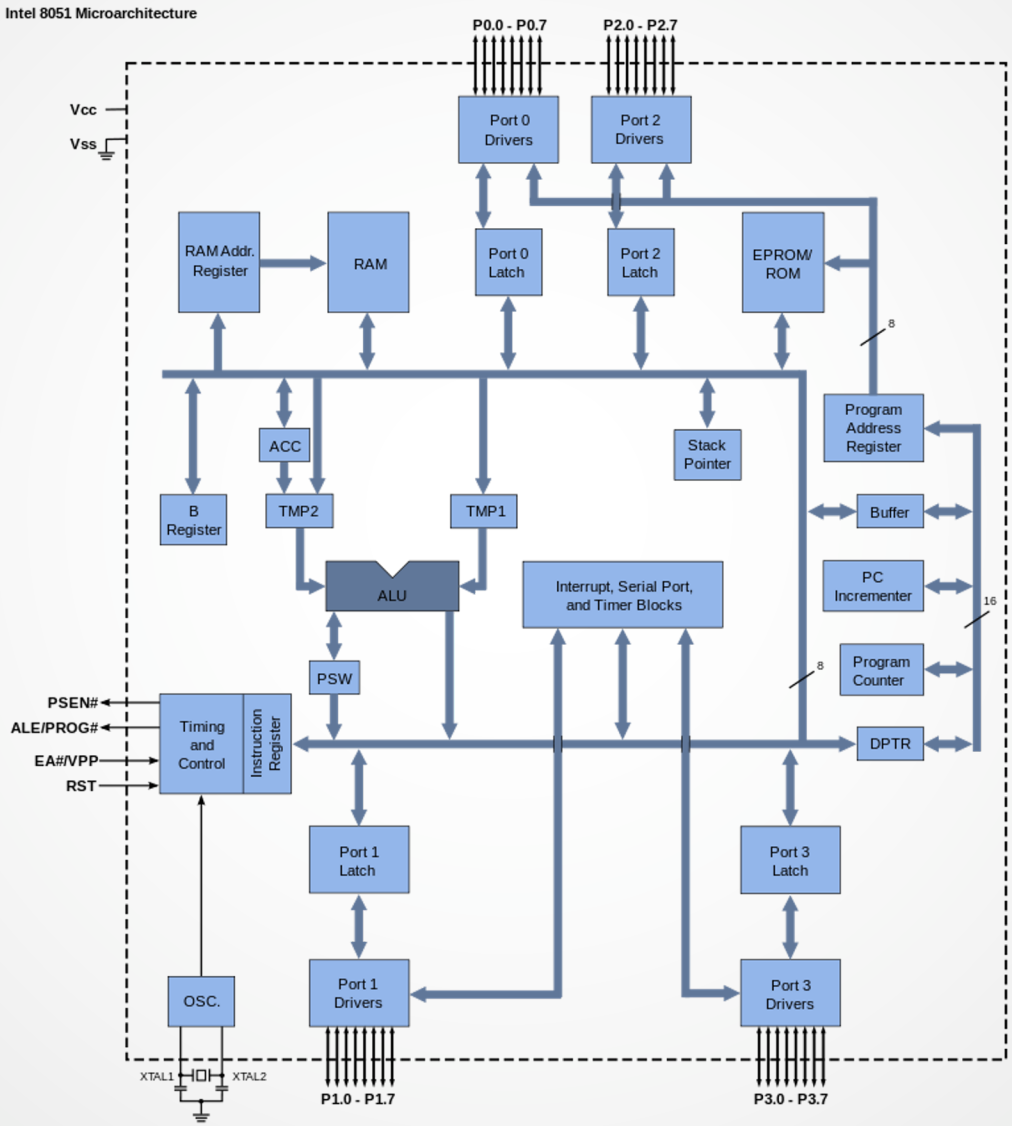
- Embedded Systems;

i8051 Features:

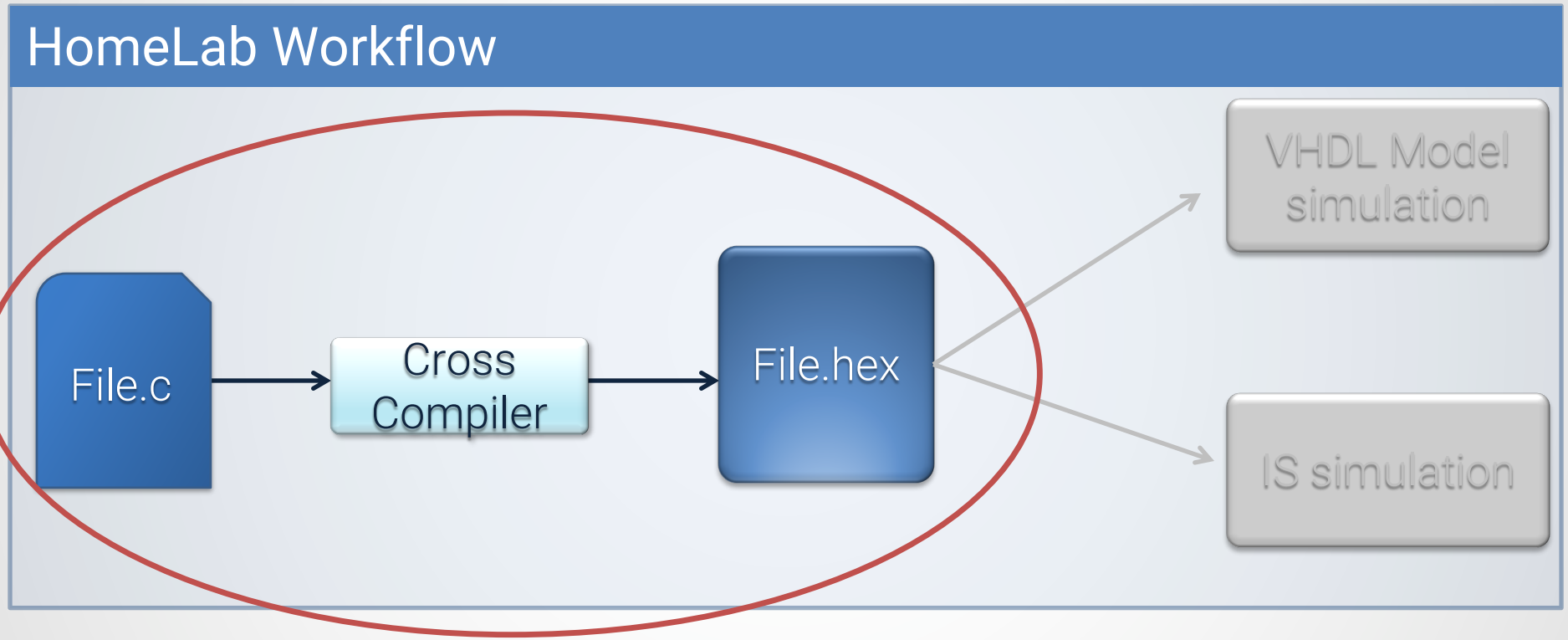
- 8bit CPU;
- Harward architecture;
- Complex instruction set computing (CISC)
- 8-bit Data Bus;
- 16-bit Address Bus

Ref: https://en.wikipedia.org/wiki/Intel_MCS-51

INTEL 8051 ARCHITECTURE



µ8051 ISS/VHDL HOMELAB

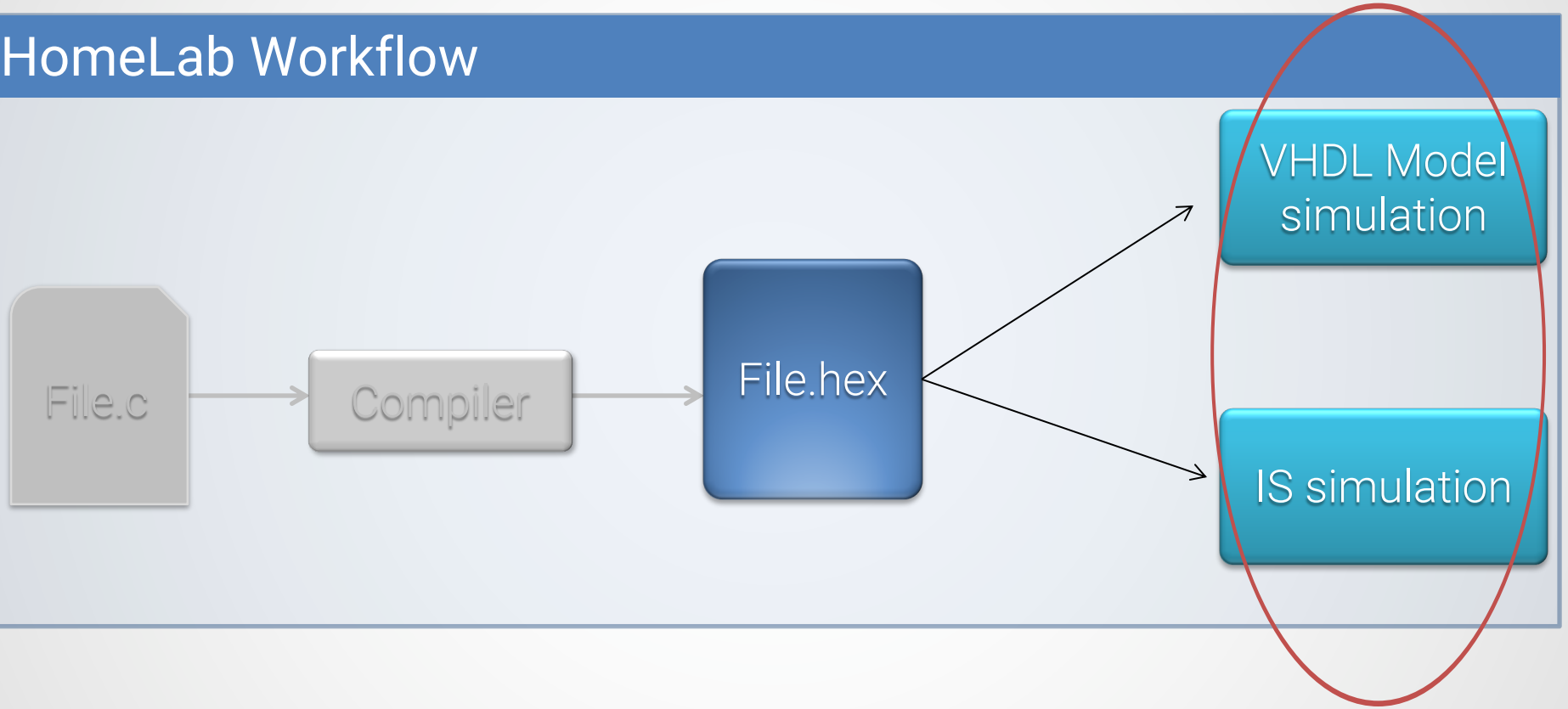


INTEL 8051 CROSS-COMPILERS

- SDCC (http://sdcc.sourceforge.net/)
  - Open source
  - Supports many microcontroller families
  - May be used within most notable IDEs
- KEIL (http://www.keil.com/C51/)
  - Proprietary software
  - Highly optimized
  - Supports a high number of devices
- MikroC (http://www.mikroe.com/mikroc/8051/)
  - Proprietary software

µ8051 ISS/VHDL HOMELAB

HomeLab Workflow



INTEL 8051 SIMULATIONS

- IS Simulation
  - Software simulation provides
    - Information about the expected result and performance on the 8051 target;
    - Information about the performance of the ISS executed by the host;
- VHDL Simulation
  - RT level simulation
    - It allows to analyzing temporal evolution for each signal
  - Requires a bigger amount of computational power and more complex tools

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DEMO APPLICATION!

CONCLUSION

Please remember thatto fulfill this HomeLab each group (i.e., up to 3 students) shall:

ISS
- Install a cross-compiler for 8051
- Build the 8051 ISS
- Write a not so trivial C function for 8051 and send it to the Prof for approval
- Once approved cross-compile the C function for 8051
- Simulate its execution by means of 8051 ISS changing input parameters to identify worst case execution times (with respect to different data types)

HDL Model

- Build the Hex2Rom VHDL generator
- Generate a VHDL model of a ROM containing the HEX related to your function
- Install VIVADO (see Homelab FPGA)
- Create a VIVADO project with the provided HDL and the generated ROM
- Simulate the execution of the system and checks outputs and timing with respect to the ISS ones
- Send a report (few slides) to the Prof for discussion and/or live demo

The homelab can be done in a Linux environment (a lot of details are in the guide in the Homelab folder) or in a Windows one. In the last case, the suggestion is to use KEIL uVision as cross-compiler for the C function and DevC++ to build the ISS (used installation files are available in the Homelab folder).