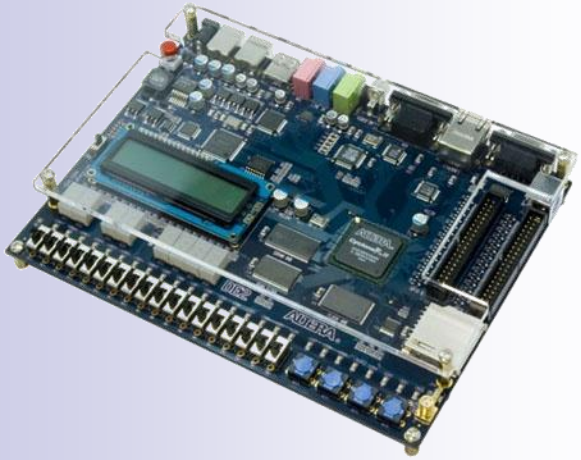
# Logic Systems and Processors

*cz: Logické systémy a procesory*

## Exercise 1: Introduction to Tasks



CTU-FEE in Prague, CR – subject BE5B35LSP

# Teachers

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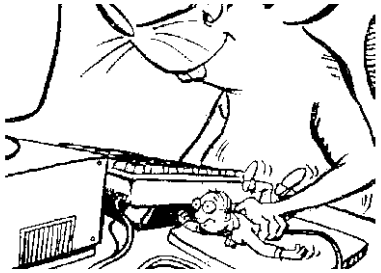
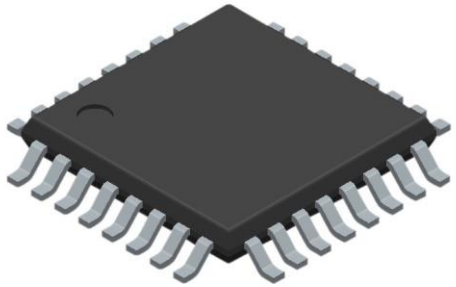
https://susta.cz

# Example: How to Build Small Systems



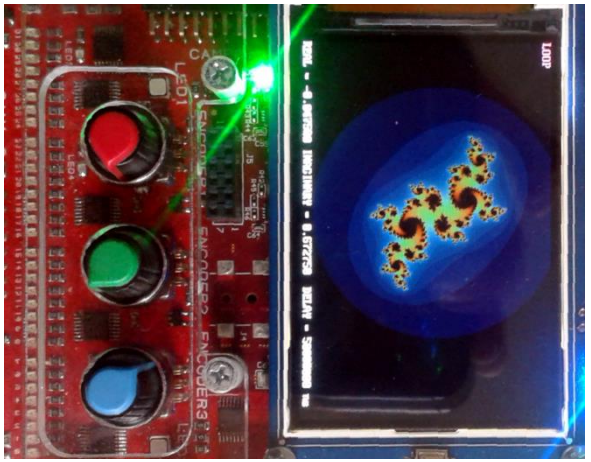


**Microcontroller or microprocessor**

*We write program for ready-to-use processor board.*

**???? connection**

*But how do we connect our peripherals...*

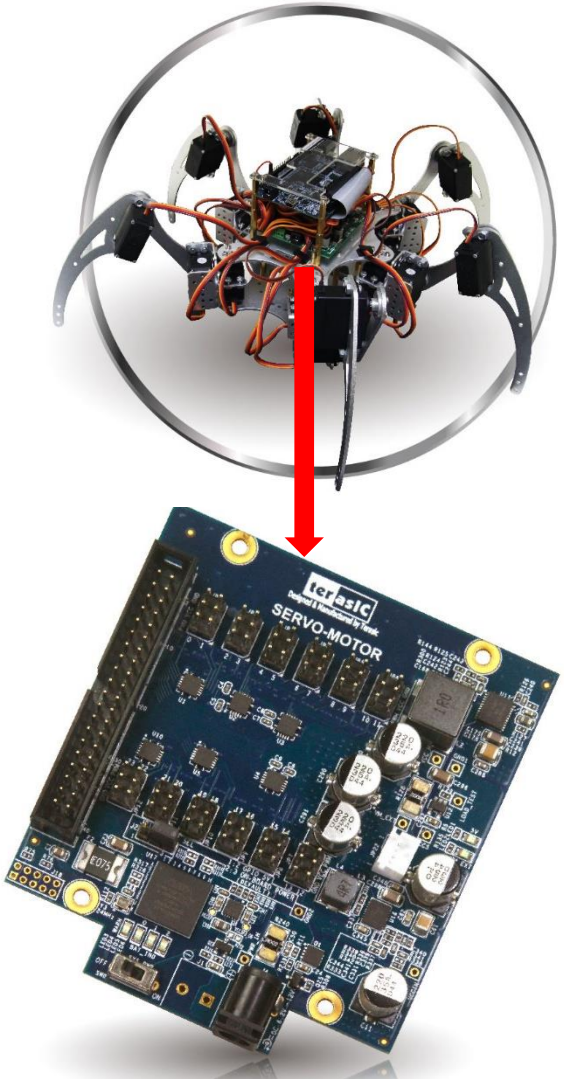


**Peripherals**

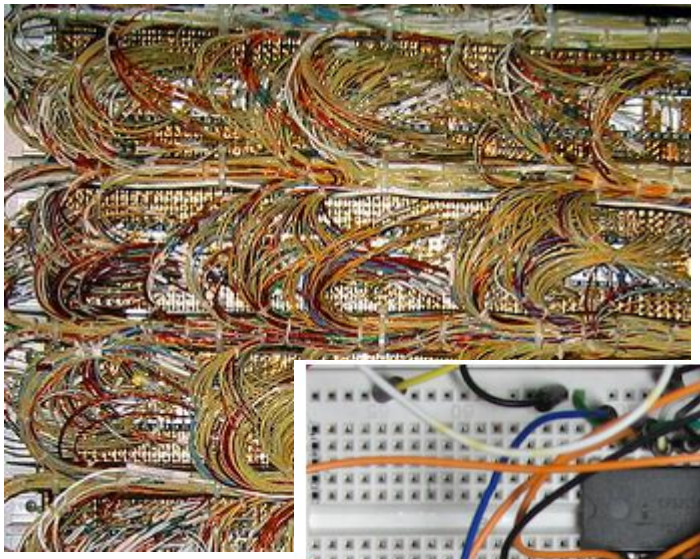
Image: AHAjokes

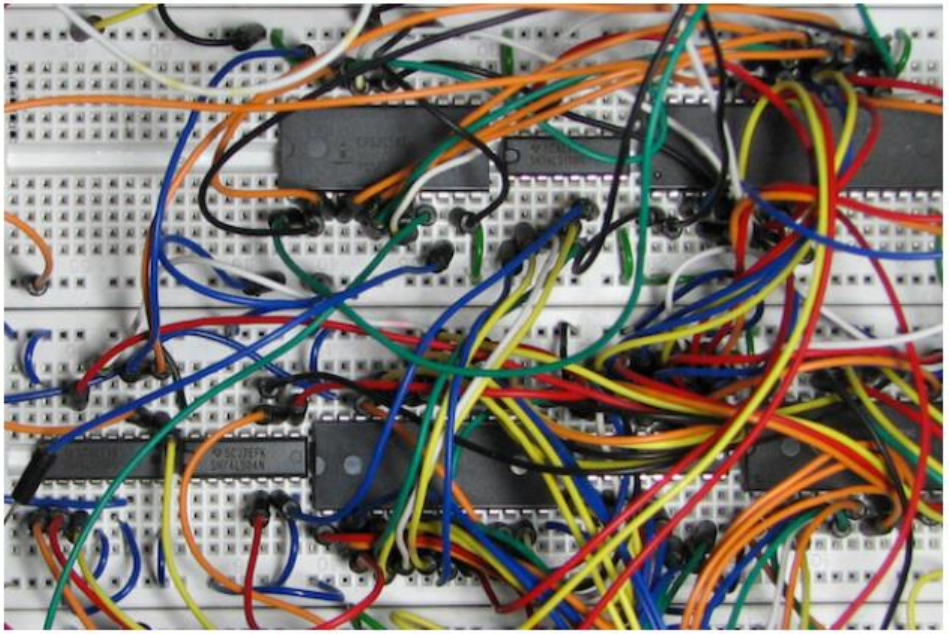
# How do we connect the peripherals?

*Sometimes suitable modules are produced, but we must create the specialties ourselves...*




Terasic: Server Motor Kit

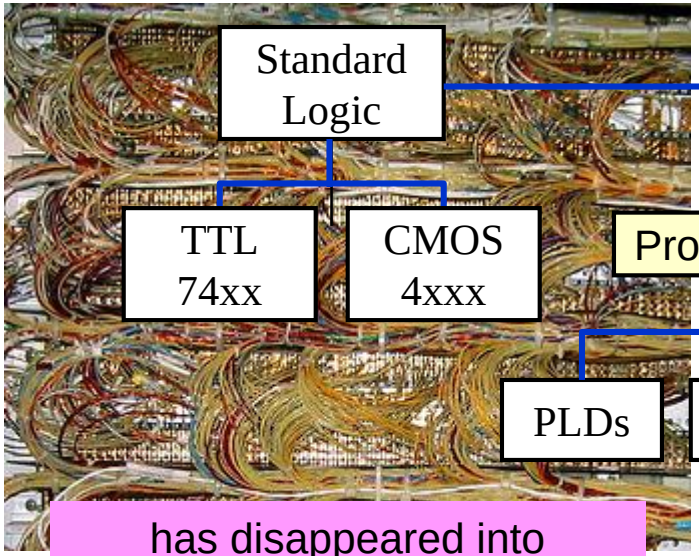




*Interface wired on breadboard*

Source:All About Circuits

# Individually Configurable IO Circuits



has disappeared into annals of history

*produced in large series and can be customized*

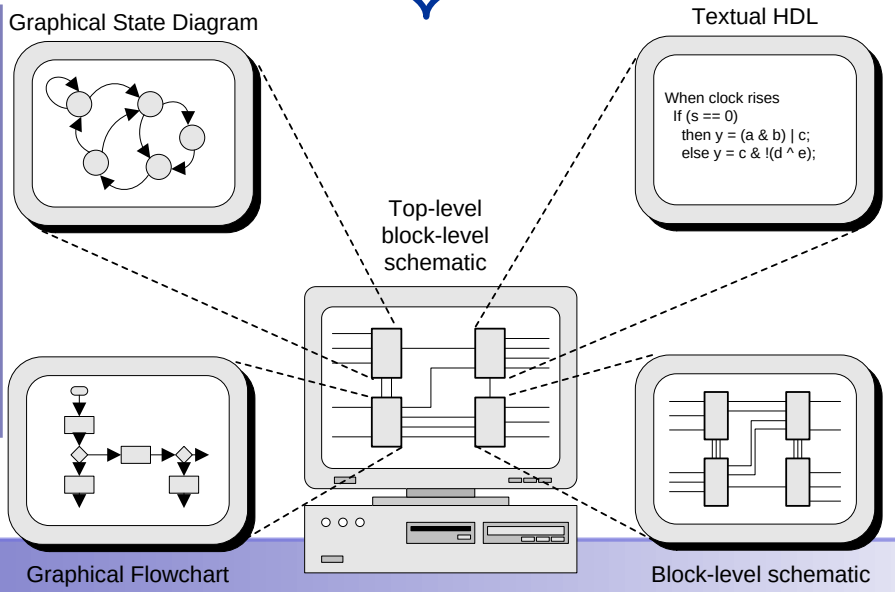
- **ASICs**
  - Standard Logic
    - TTL 74xx
    - CMOS 4xxx
  - Programmable
    - PLDs
    - CPLDs
    - **FPGAs**
  - Semi-Programmable
    - Gate Arrays
    - Standard Cells
  - Full Custom

>=1 >2000 >4000 >=several millions

*cost-effective for a number of pieces*

**ASIC-Application Specific Integrated Circuits**

- Programmable Logic Device (**PLD**)
- Complex PLD (**CPLD** )
- Field Programmable Gate Arrays (**FPGAs**)



**FPGA**

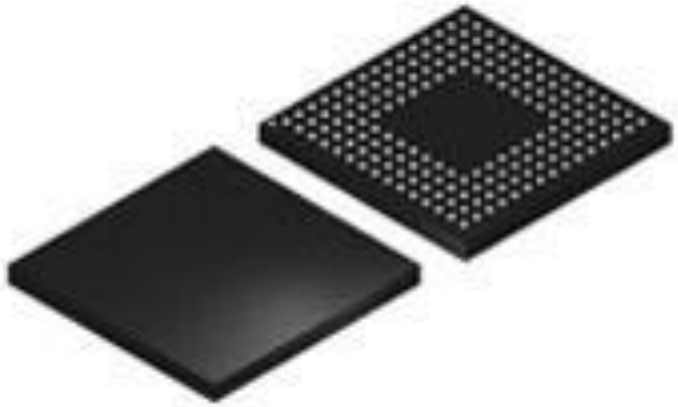
**Field**

**Programmable**

**Gate**

**Array**

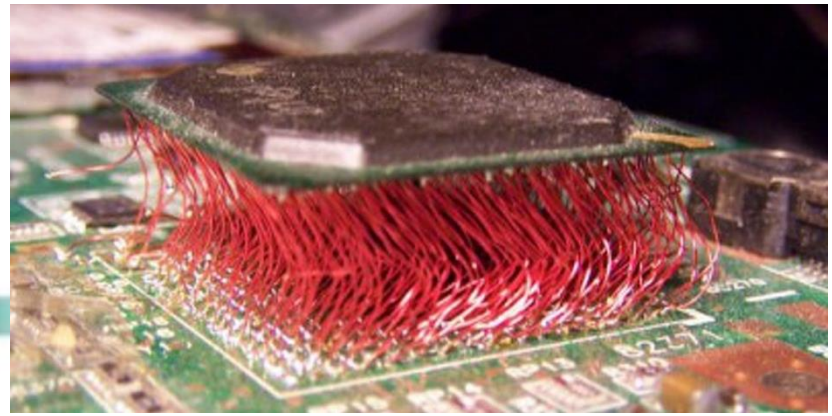
*= programmable (configurable) gate array*

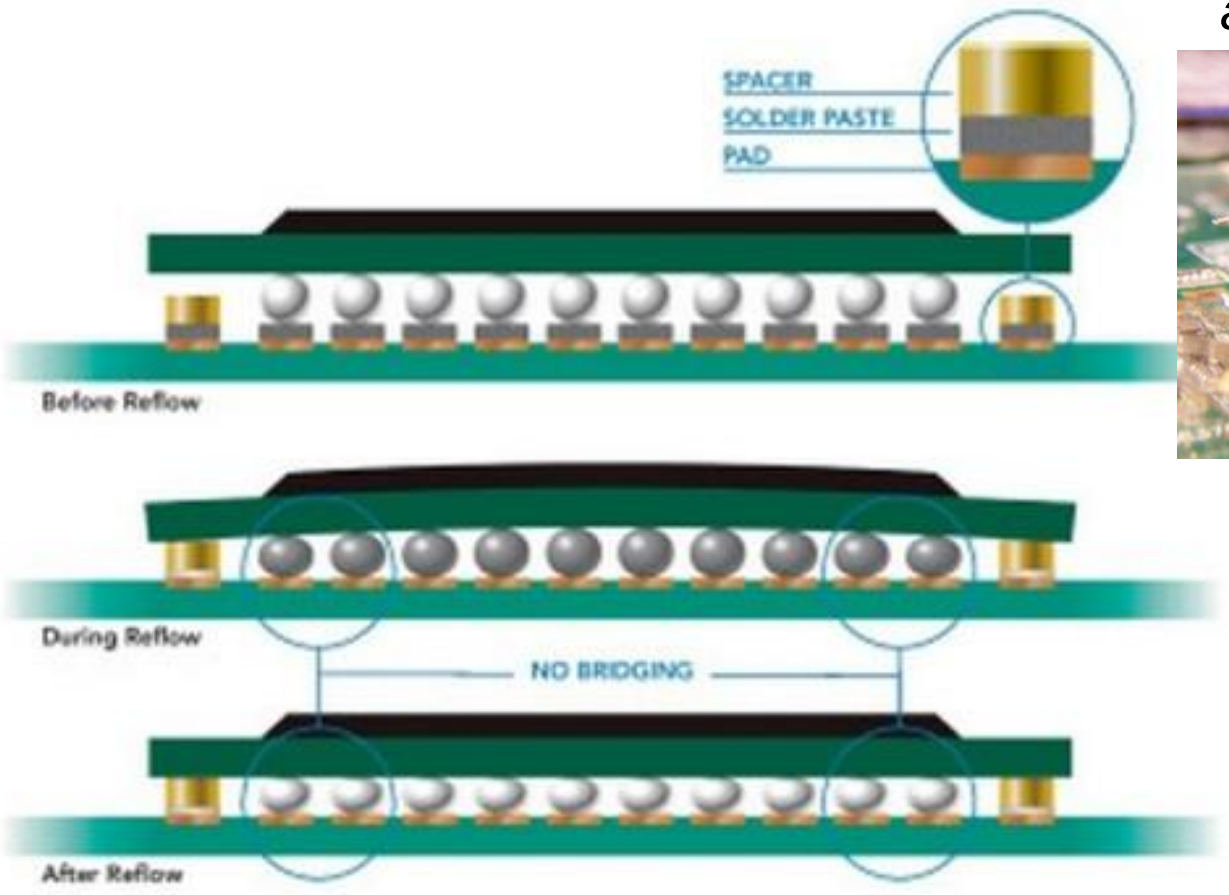



FBGA **chip**
= Fine-Pitch Ball Grid Array

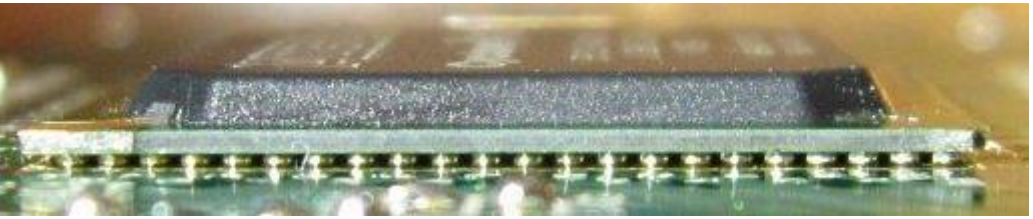
# Detail of Real SMD Soldering FPGA

*and his jokey non-SMD soldering*






**SMD**
Surface Mount Device
on **PCB**
Printed Circuit Board



Source:Fairchild Semiconductors

# FPGA circuits sometimes include processors

## Xilinx Zynq™ 7000 Series

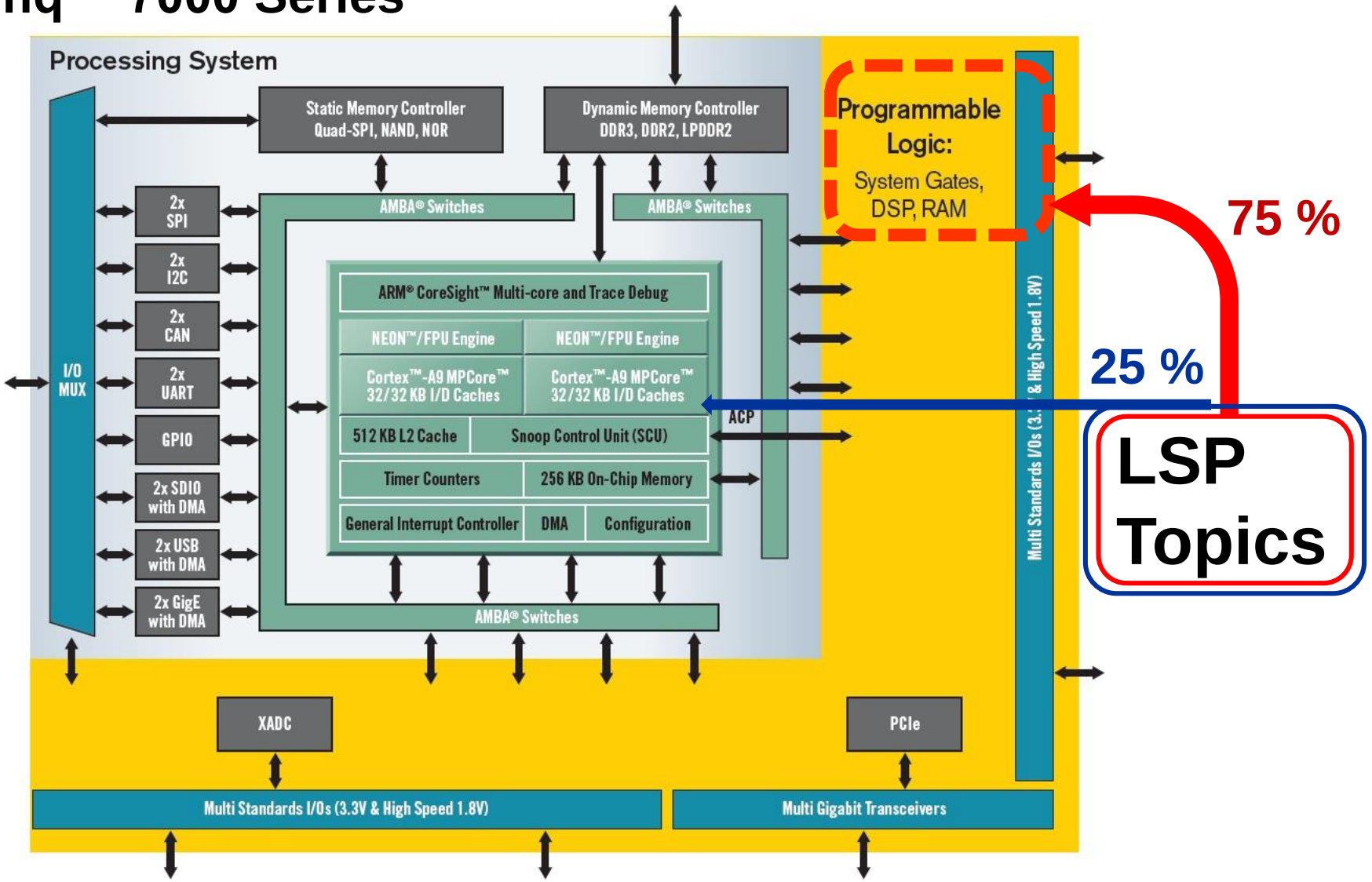
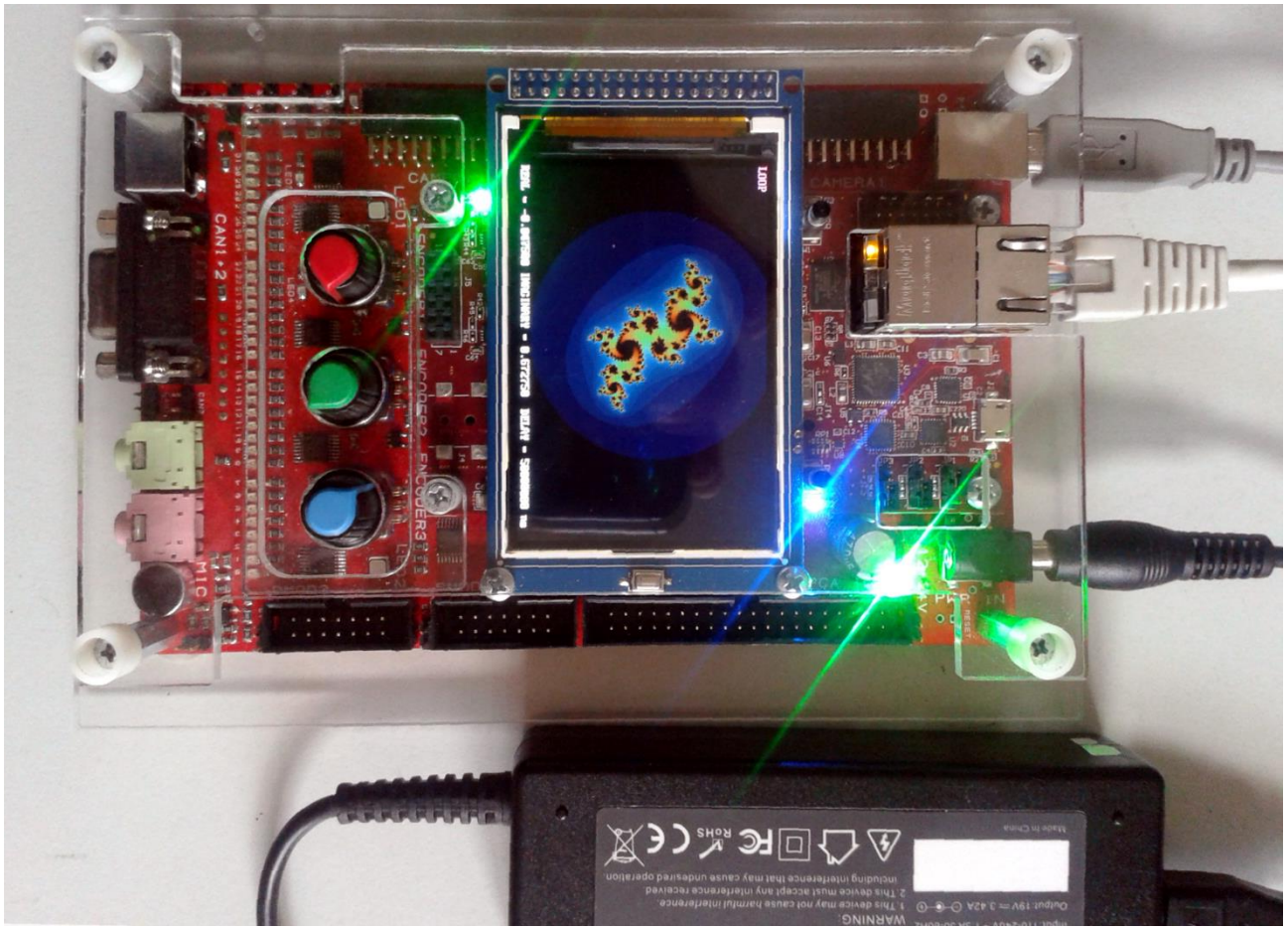



Image source: Xylinx

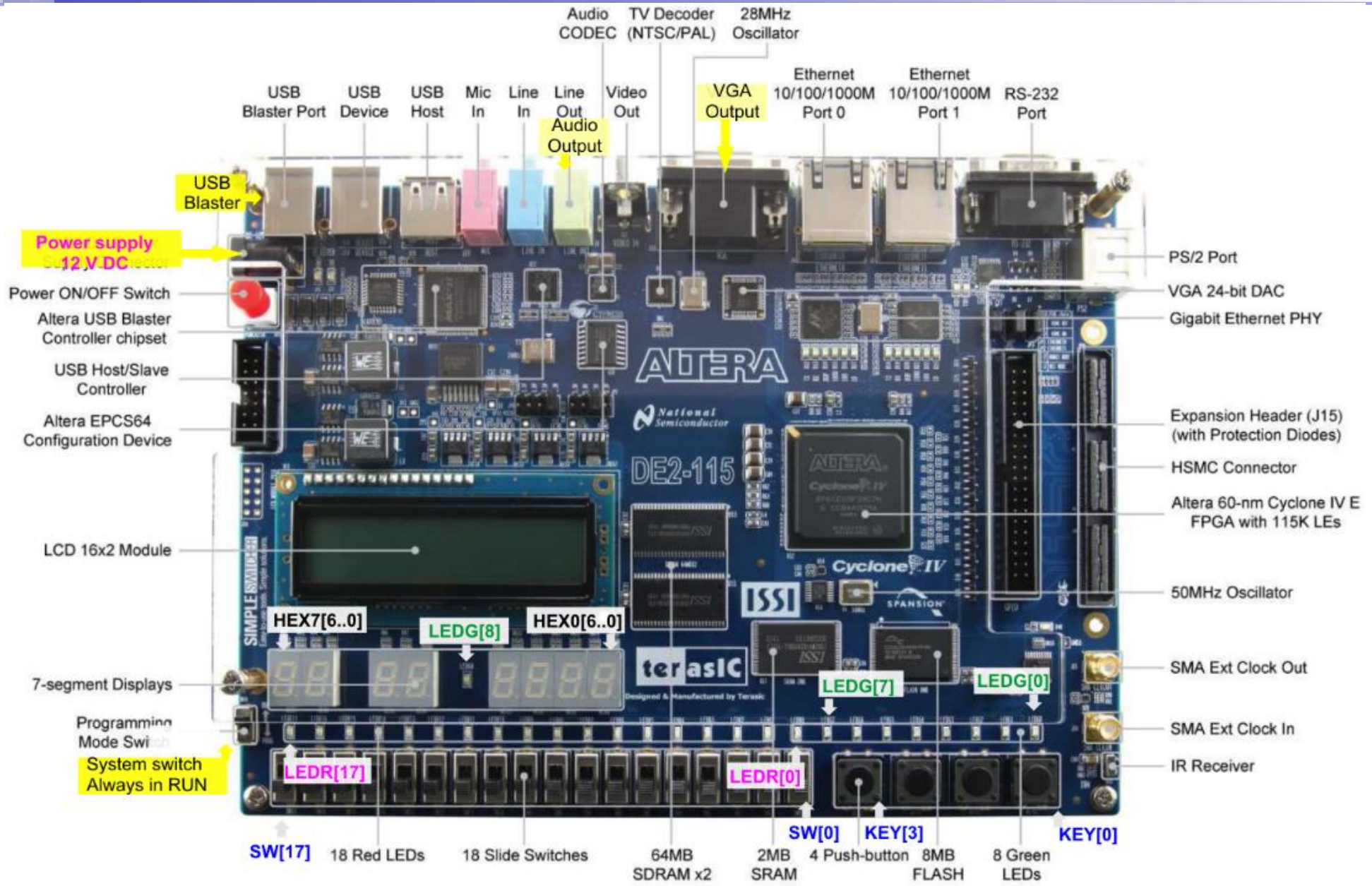
# MZAPO - MicroZed_APO board

*Students in the APO Computer Architecture course will work with Zynq in the lab, but only at the program level.*
*In LSP we will be working on FPGA logic.*



# Video and Embedded Evaluation Kit
# Multi-touch, Second Edition

# VEEK-MT2 other side = DE2-115



# LSP Website

Shibboleth
FELid

**DCENET** = **D**epartment of **C**ontrol **E**ngineering **NET**work

**https://dcenet.fel.cvut.cz/**

They have a public section, FELid, and a link to Moodle

# Our Site

## DCENET

### Department of Control Engineering .NET Website


A0B36APO - Architektura počítačů - stránky vznikly za podpory od projektu

&

AE0B36APO - Computer Architectures - the site was supported by the grant


B0B35LSP - Logické systémy a procesory

&

BE5B35LSP - Logic Systems and Processors

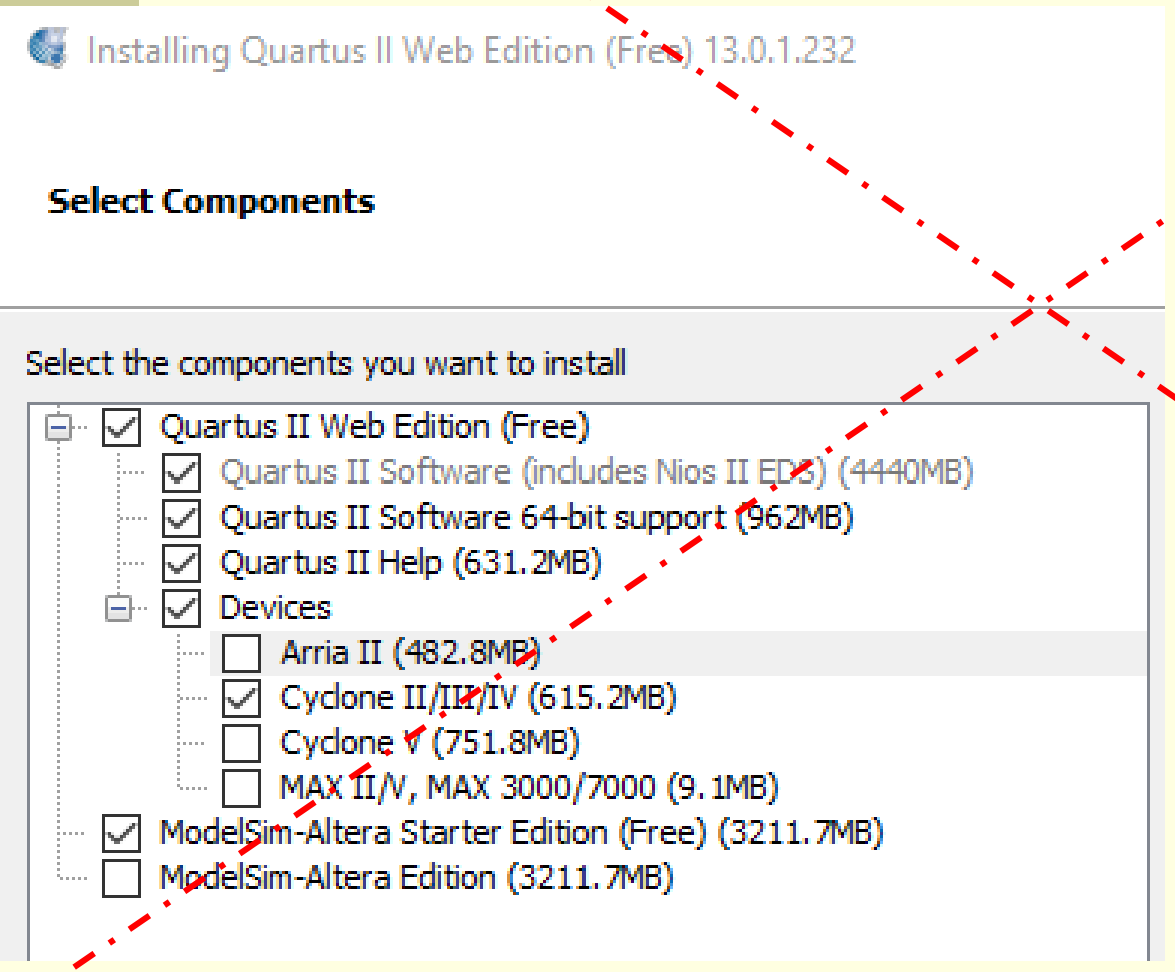
Protokoly na bezpečnost práce

Root site: Department of Control Engineering, CTU-FEE, Prague, CR

Not recommended now - it became unstable in Windows 10 after their recent updates….

# Installing Quartus 13.0sp1 web

https://dcenet.fel.cvut.cz/edu/fpga/install.aspx




- You can work with the older free version, the full version of which is installed in the lab, and we have extensive support for it.
- When installing, choose only **Cyclone II/III/IV**, then it only wants **10 GB**.

# Recommended Quartus Version

## Windows 10

- **Quartus 20.1 Lite** version needs **14 GB** and is on our laboratory computers.
  It includes free modules of the Intel University program and ModelSim.
  *Note: Lite or web versions can be run without a license.*

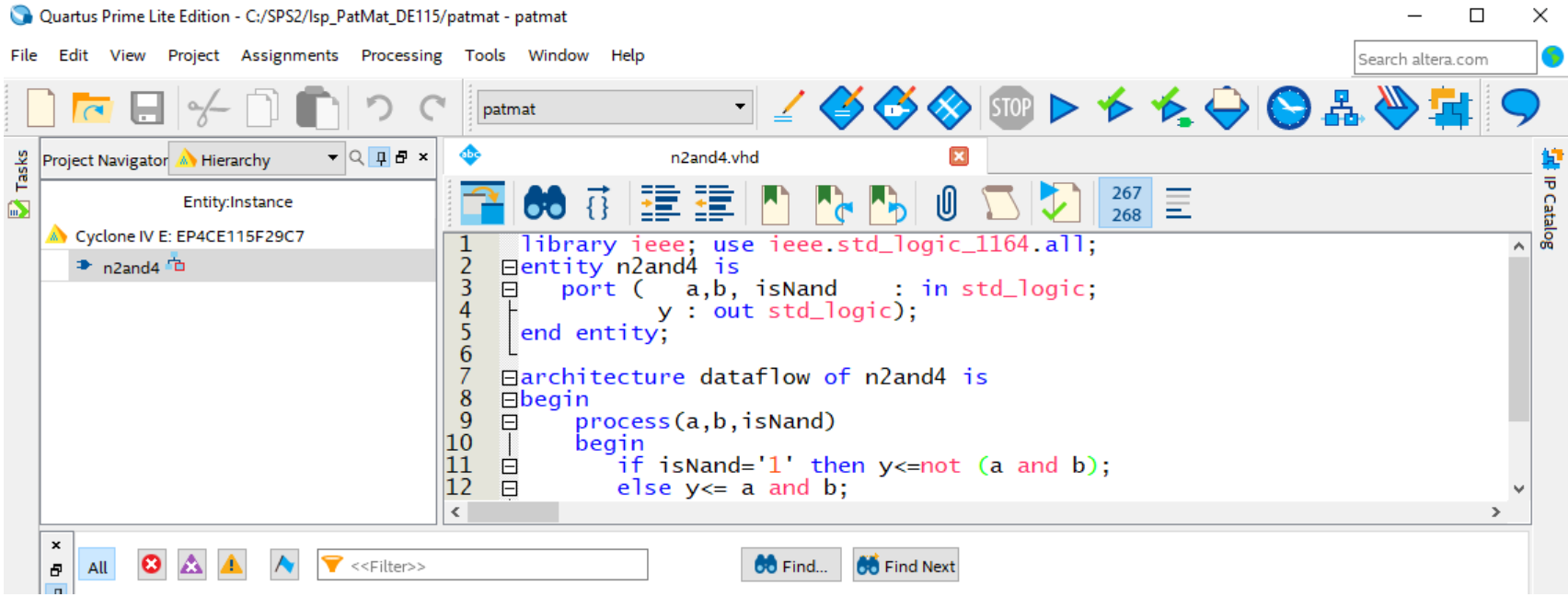
## Windows 11

- You can install 20.1, but it can be a little troublemaker.
- **Quartus 23.1 Lite** is the first version that fully supports Win11 but no longer includes a free ModelSim simulation environment.
- *You need to register Questa simulator individually, which requires many steps, such as two registrations to Intel accounts, mobile and email validations, waiting for enrollment response, authentication via Microsoft Azure…, etc.*
  In the case of Quartus 23.1, it is better to simulate by the free GHDL tool.

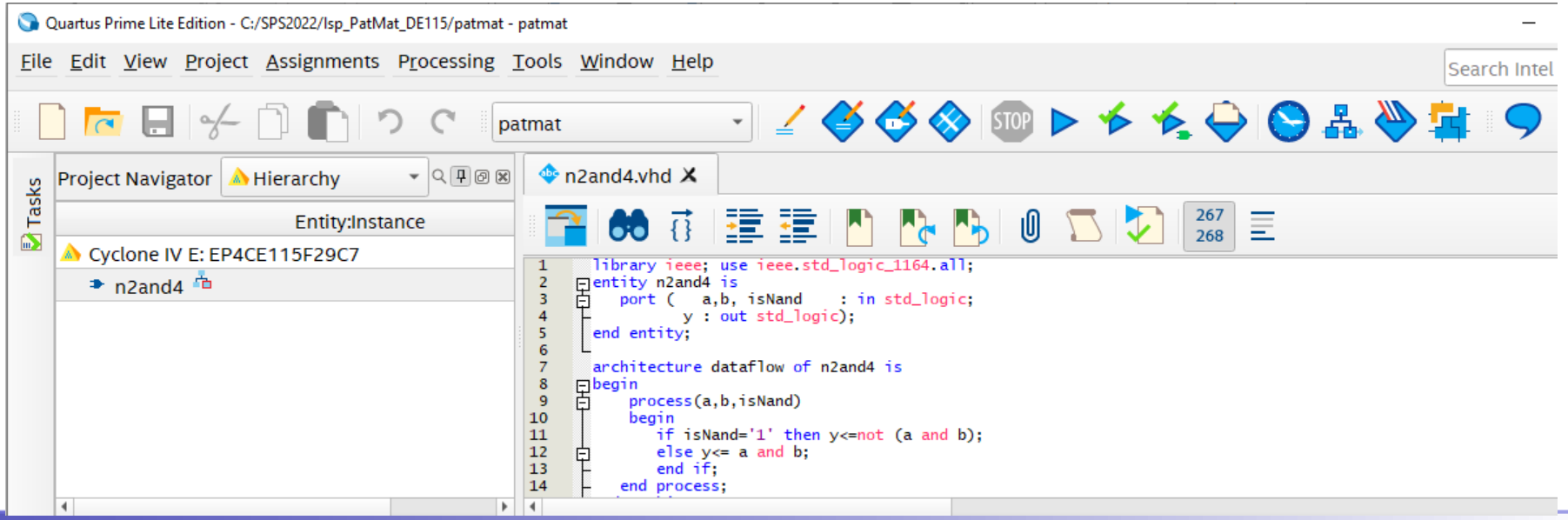
- You can install several different versions of Quartus on your computer. They will not argue with each other.
- Quartus is a Linux program running under Cygwin on Windows and does not write to the Windows registry. It is uninstalled cleanly when the semester is over.

# Quartus 20.1 and 23.1 have the same skins

**Quartus 20.1**

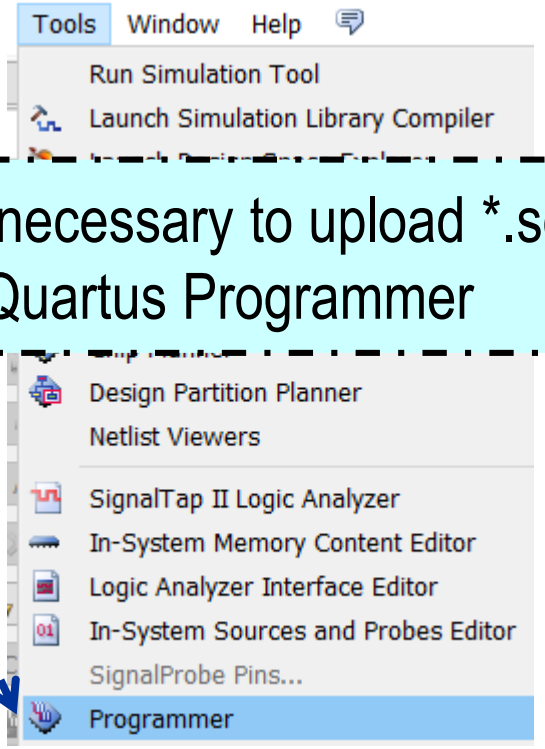



**Quartus 23.1**

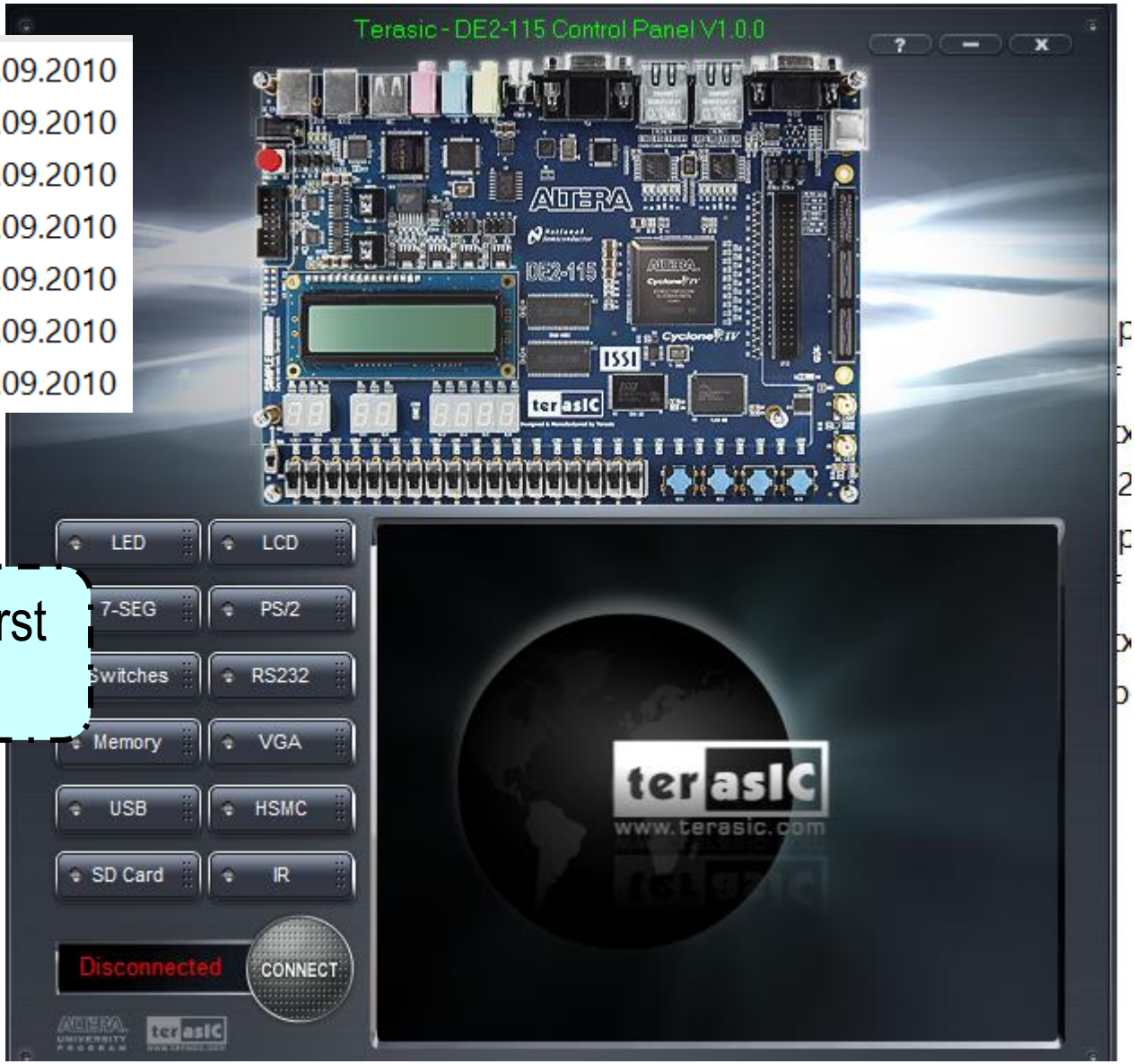


# Control Panel

| | | |
|---|---|---|
| DE2_115_ControlPanel.exe | 16 335 360 | 06.09.2010 |
| DE2_115_ControlPanel.sof | 3 541 384 | 06.09.2010 |
| dinkum_alt.dll | 694 272 | 06.09.2010 |
| jtag_client.dll | 110 592 | 06.09.2010 |
| TERASIC_DOWNLOAD.dll | 519 680 | 06.09.2010 |
| TERASIC_JTAG.dll | 52 736 | 06.09.2010 |
| TERASIC_JTAG_DRIVE.dll | 40 960 | 06.09.2010 |




It is necessary to upload *.sof first via Quartus Programmer



# Today, we'll use a pre-made initial project

## VeekMT2_Quartus20_defaultProject.zip

Page: https://dcenet.fel.cvut.cz/edu/fpga/veek-mt2_en.aspx

VEEK-MT2 BOARD

It consists of a DE2-115 board front panel and a rear 800x480 pixel colour LCD module.

**Contain device: EP4CE115F29C7**

**Family** Cyclone IV E **Package** FBGA **Pin count** 780 **Speed grade 7**

**Parameters:** 114480 logic elements, 3888 kbit embedded memory, 266 hardware multipliers 18x18 bits, 4 PLLs and 528 user pins

**Picture overview** of basic I/O of front DE2-115 board: 1500 x 1000 750 x 500

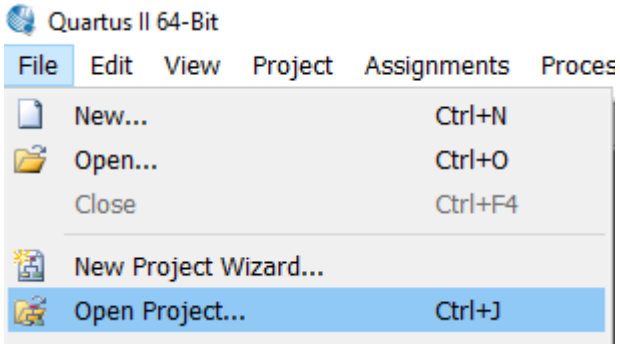
**Important note: The board requires a power supply =12 V.** Always check that you are using the correct one !!!

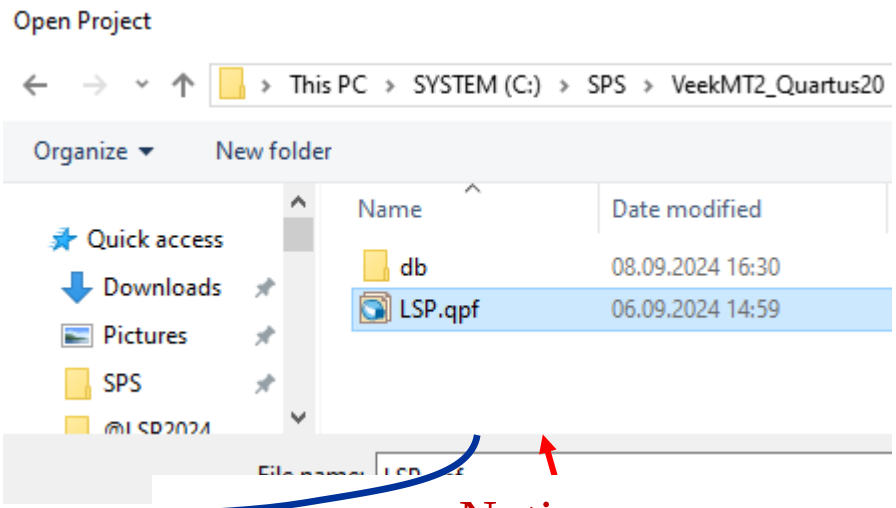
Quartus projects require many complex settings. Beginners are advised to use a ready-made project for Quartus version V20.1 and higher: VeekMT2_Quartus20_defaultProject.zip And read our 1-page tutorial OpenProject.pdf .

⬇

*...in the presentation will be on the next slides*

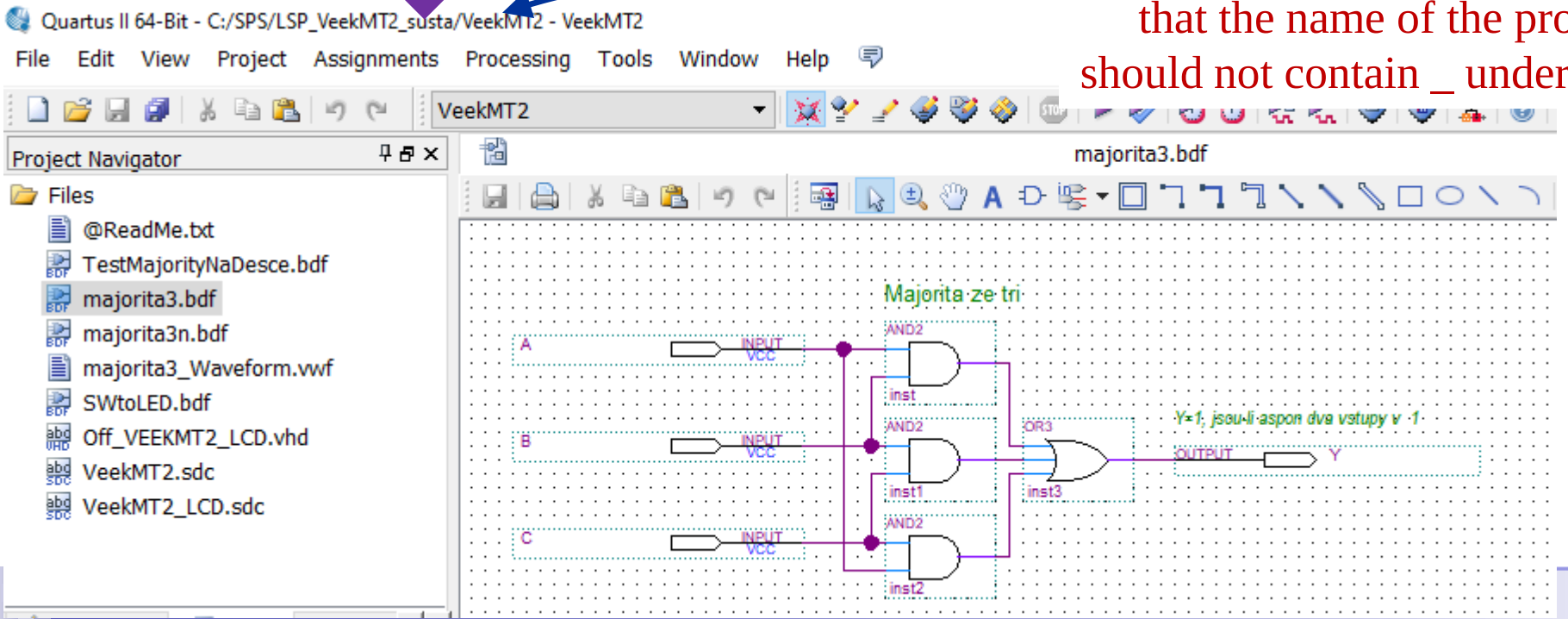
# Opening of the project



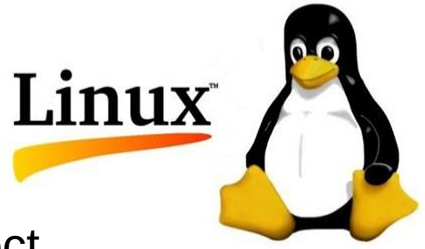

You should rename the created directory after closing Quartus and append your identification to it. Let others know it belongs to you.

Notice,
that the name of the project
should not contain _ underscores!



**Quartus is a Linux program running in CygWin**

*Cygwin is a command-line Linux distribution,*
*which includes popular GNU and other open source tools.*
*It allows you to adapt Linux programs to Microsoft Windows*.




- **Quartus project its own folder** that is never shares with another project.
- All file names and paths must contain only letters (without diacritics), numbers or _ underscores, but not two connected, and not at the beginning and end.
- Do not store projects in Windows folders in our school laboratory, such as **Desktop**, **Downloads**, **Documents**, etc. They are redirected to Active-directory server and contain $ in their paths, which you need not see. Windows shows you only links, not actual folder names.
- It is better to enter project names without _ underscores, the simulation may not work with them. (The reason is hidden somewhere in the window updates:-)
- You can rename the project's top folder or move the whole project to another folder.
- The file names entered in the paths have / slashes as a rule, not \ *backslashes*.
- !!! Spaces and other Windows specialties are strictly forbidden in paths, file names, and entity names (circuit descriptions).

- Do not use non-ASCII characters in comments inside Quartus. Sometimes even Chinese kanji is OK, as the foreign students tried, but sometimes not. :-)

# Example from Default Project

## Majority aka Median Operator