Installing and Using the PYNQ Board

Version 4.4, dated March, 2023

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1 Overview

In the Computation I, Computation II, Embedded control systems, and Vehicle Networking courses each student will use their own PYNQ hardware board connected to their laptop. The virtual machine makes it easier to connect the PYNQ board to your laptop. In this document we describe how to do this.
This document is quit long and detailed. Make sure you that you perform the following steps:

- Section 2: Flash your SD card.
- Section 3: Connecting the PYNQ board to your computer.
- Section 4: Using the virtual machine with the PYNQ board.

Before starting to use the PYNQ board you will need to have installed the Computation Virtual Machine, as described in a separate document.

2 Flash your SD card

Before using your board, you need to copy the SD image on the SD card to be used on the board. To do this please follow these steps:

- Download a portable version of Rufus software from https://rufus.ie/en/.
- Download the SD PYNQ image from pynq_ecs_2022-2023
- Insert your SD card in your laptop.
- Extract the SD image you downloaded.
- Select the extracted SD image in Rufus.
- Flash your SD card with the SD image.

The steps above are illustrated are illustrated below:

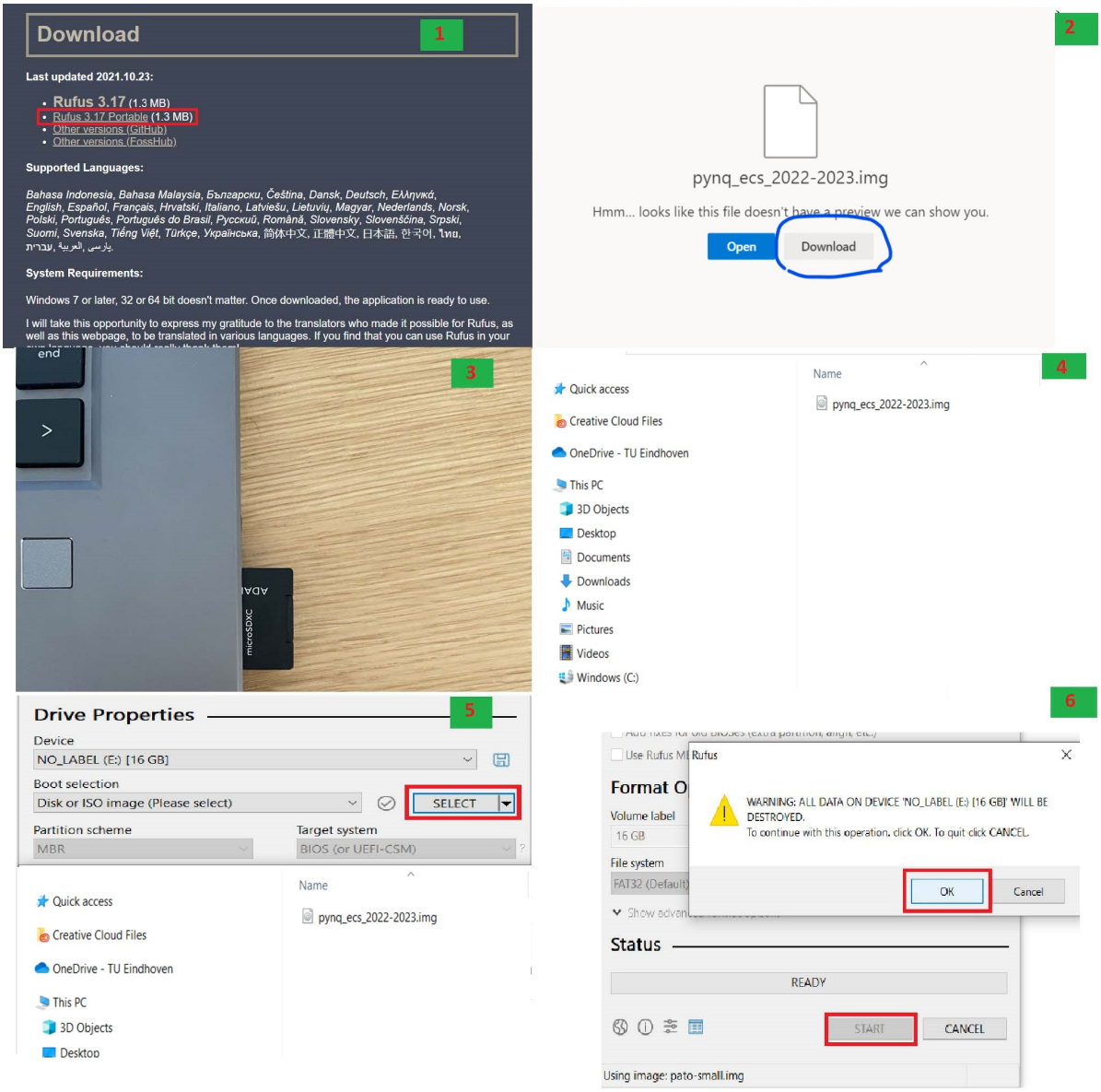

Download
1
Last updated 2021.10.23:
Rufus 3.17 (1.3 MB)
Rufus 3.17 Portable (1.3 MB)
Other versions (GitHub)
Other versions (FossHub)
Supported Languages:
Bahasa Indonesia, Bahasa Malaysia, Български, Čeština, Dansk, Deutsch, Ελληνικά, English, Español, Français, Hrvatski, Italiano, Latviešu, Lietuvių, Magyar, Nederlands, Norsk, Polski, Português, Português do Brasil, Русский, Română, Slovensky, Slovenščina, Srpski, Suomi, Svenska, Tiếng Việt, Türkçe, Українська, 简体中文, 正體中文, 日本語, 한국어, ไทย, עברית, العربية, یارسی
System Requirements:
Windows 7 or later, 32 or 64 bit doesn't matter. Once downloaded, the application is ready to use.
I will take this opportunity to express my gratitude to the translators who made it possible for Rufus, as well as this webpage, to be translated in various languages. If you find that you can use Rufus in your
2
pynq_ecs_2022-2023.img
Hmm... looks like this file doesn't have a preview we can show you.
Open
Download
3
4
Quick access
Creative Cloud Files
OneDrive - TU Eindhoven
This PC
3D Objects
Desktop
Documents
Downloads
Music
Pictures
Videos
Windows (C:)
Name
pynq_ecs_2022-2023.img
5
Drive Properties
Device
NO_LABEL (E:) [16 GB]
Boot selection
Disk or ISO image (Please select)
SELECT
Partition scheme
MBR
Target system
BIOS (or UEFI-CSM)
6
Rufus
WARNING: ALL DATA ON DEVICE 'NO_LABEL (E:) [16 GB]' WILL BE DESTROYED.
To continue with this operation, click OK. To quit click CANCEL.
OK
Cancel
Format O
Volume label
16 GB
File system
FAT32 (Default)
Status
READY
START
CANCEL
Using image: pato-small.img

Figure 1

3 Connecting the PYNQ Board to your Computer

The PYNQ board has much input/output:

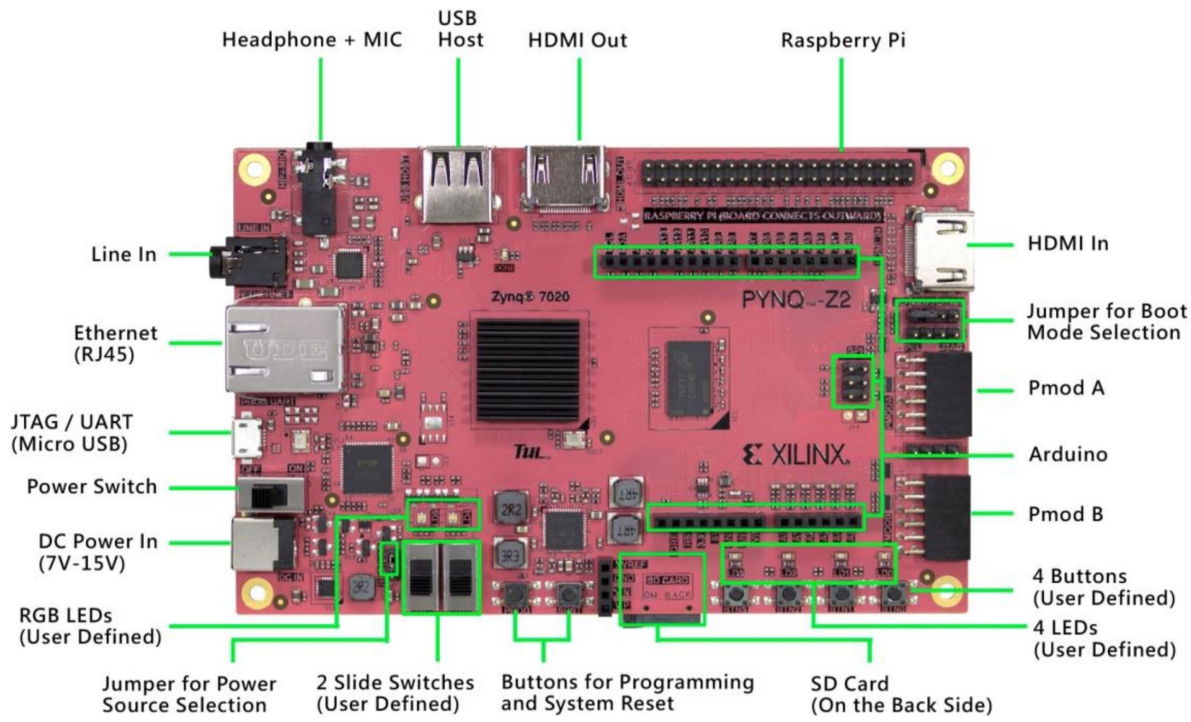


Figure 2

We will use the following:

1. Power switch
2. Ethernet port – to communicate with the board
3. JTAG / UART (micro USB) – to supply power to the board
4. SD Card – contains the Ubuntu linux that the board runs

The PYNQ board is relatively robust, but can be damaged if you don't handle it carefully. Starting or stopping the board incorrectly may lead to damage to the software (file system) on the SD card or the even the hardware. Some things to avoid:

- Switching off the PYNQ board without first shutting down Ubuntu with `sudo halt`. This happens when you unplug the USB cable (i.e. power), or switching off with the power button (before halting Ubuntu).
- Removing the SD card while the system is running. This can happen if you accidentally push the SD in — it will then pop out. This will crash the system, but worse, can corrupt the data on the SD card.
- Applying too much force when inserting or removing the cables. Note that the Ethernet cable has a little lip that you must push down to be able to pull it out of its socket.

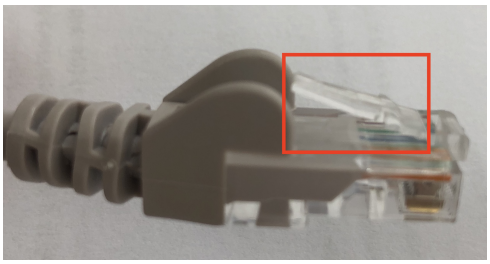


Figure 3

- Pushing the buttons too violently. At some point they'll break.
- Do not wash your board or spill water (drinks) on it.

Figure 4

If you damage the SD card then you have to download the image and reflash the cards. All data on the SD card will be lost. For this reason you should use shared folders (Section **??**). You have to buy another board if you damage the hardware.

We will discuss the following points in detail further below:

1. Connect the PYNQ board to your computer.
2. Install the PYNQ board (only once)
3. Start & use the PYNQ board with the virtual machine
4. Stop using the PYNQ board
5. Shared folders on the PYNQ board

3.1 Connecting the PYNQ Board

To use the PYNQ board you need to take the following steps, in the order shown:

1. **Ensure the power switch is OFF** (as indicated by the red power LED on the board).
2. **Insert the SD card** (only once, you can leave it in). The ARM processor on the PYNQ board runs the Ubuntu Linux operating system (like the virtual machine). The SD card contains the file system for Ubuntu. Insert the SD card in the SD card slot (the photo below shows the bottom of the board).

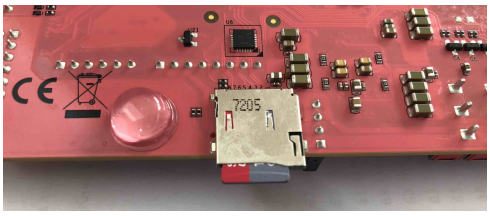


Figure 5

3. Check that the **Jumper for boot mode selection** is set to "SD". (This is the case for new boards, but for Computation II you may have changed this.)
4. **Connect the small end (microUSB) of the USB cable to the "JTAG / UART (micro USB)" port on the PYNQ** (see image below).

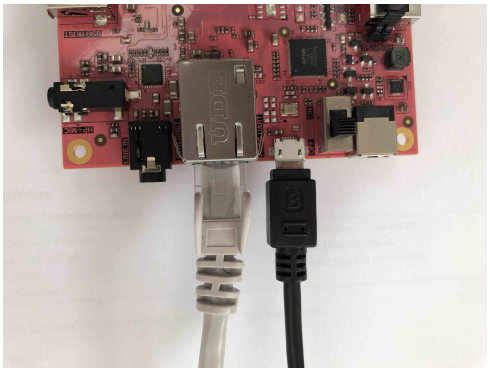


Figure 6

5. **Connect the Ethernet cable to the PYNQ** (see the image above).
6. **Connect the larger end of the USB cable to your computer.** If your computer has no USB ports (such as Macs) then you can use a USB to USB-C adapter.
7. **Connect the Ethernet cable to your computer.** If your computer has no Ethernet ports (such as the University Notebooks of 2019/20 and 2020/21 or Macs) then you must use a Ethernet to USB or USB-C adapter. See the next page for more details.

   Important: Never (re)start your 2020/21 university laptop with the HP Ethernet-to-USB-C plugged in. The virtual machine will no longer see `pynq wired connection` in the VM Network pull-down menu and you will not be able to use the PYNQ board. See Section 5 for a solution in case you do this.

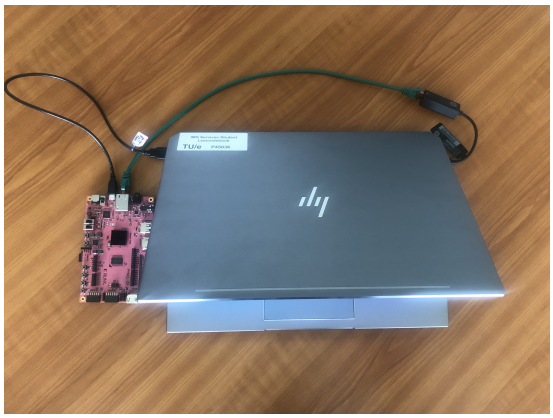


Figure 7: Set-up for the **2021/22 Lenovo** and **2020/21 HP** university laptops. Connect the USB cable from the PYNQ directly to the laptop. Connect the Ethernet cable from the PYNQ via the Lenovo/HP Ethernet-to-USB-C converter to a USB-C port on the laptop.

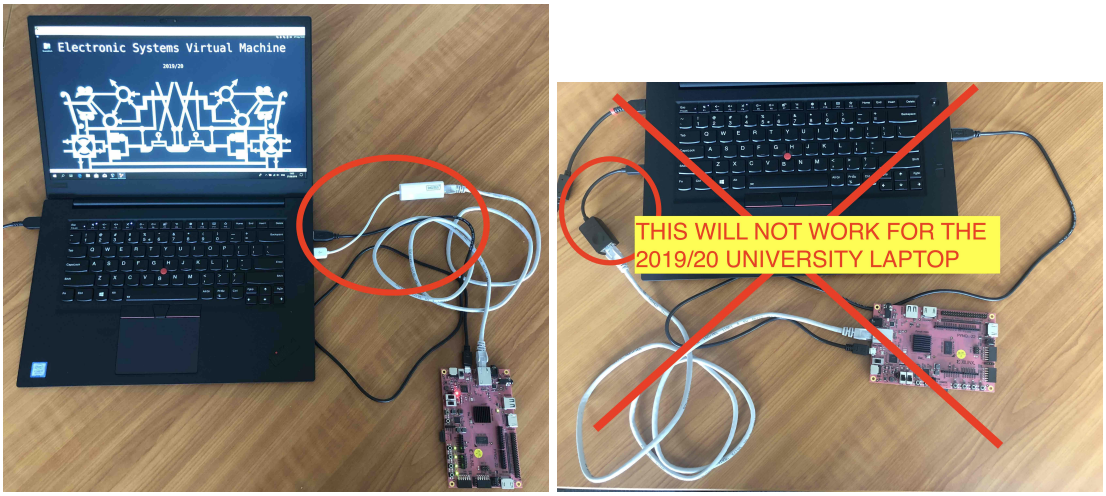


Figure 8: Set-up for the **2019/20** university laptop. Connect the USB cable from the PYNQ directly to the laptop. Connect the Ethernet cable from the PYNQ via an Ethernet-to-USB converter (e.g. Digitus or Edimax) to a USB port on the laptop. **Note that you cannot use the Lenovo Ethernet adapter that came with the university laptops**; it will not connect reliably to the virtual machine.

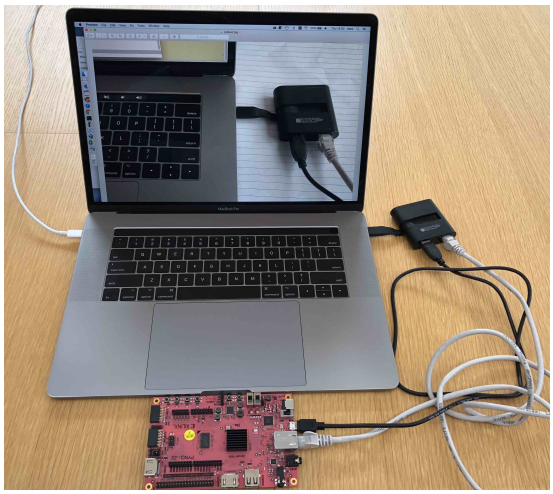


Figure 9: Example set-up for a Mac. Connect the USB and Ethernet cables from the PYNQ via a single converter to a USB-C port on the Mac. You can also use two separate converters. Note that only Intel-based Macs are supported.

For other computers: if your computer has an Ethernet port then use it. Otherwise use an Ethernet-to-USB adapter as described above.

8. **Do not yet switch on your PYNQ board.**

3.2 Installing the Ethernet Connection – First Time only

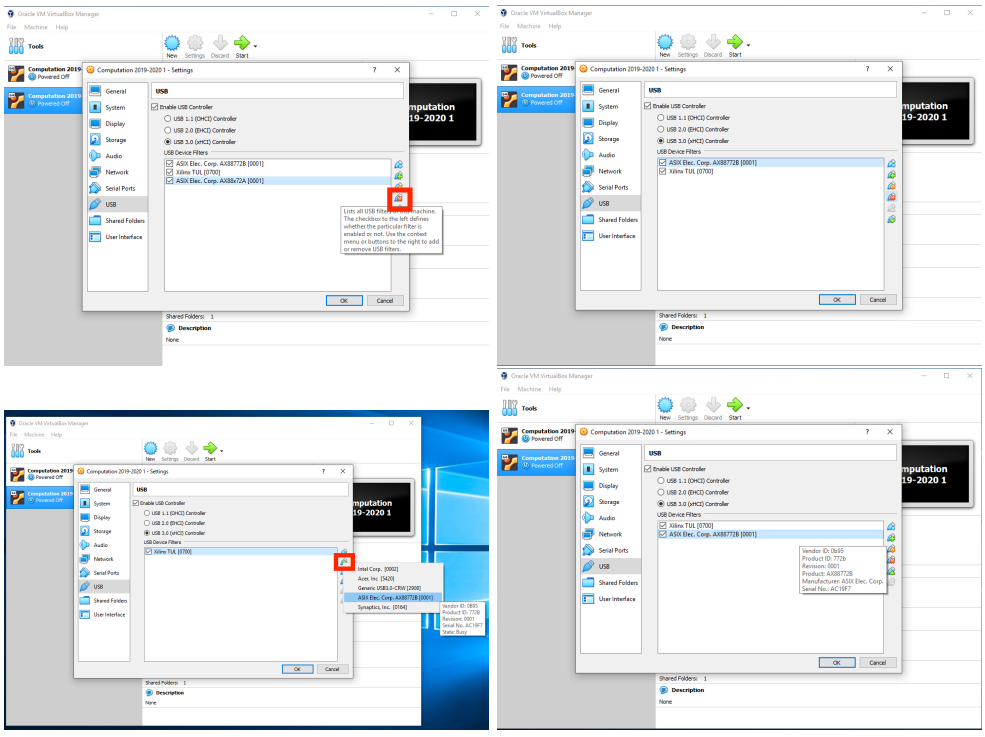
Skip this section and go to the next Subsection 3.3 if

1. you have a 2021/22 university laptop
2. you have a 2020/21 university laptop
3. you have a 2019/20 university laptop and a Digitus Ethernet-to-USB adapter (see image below) or an Edimax Ethernet-to-USB adapter

Figure 10

The steps in this section are required only the first time you use the board with the virtual machine, or if you change the Ethernet-to-USB adapter.
Connect the PYNQ board to the computer but do not yet switch it on. The virtual machine already knows about the PYNQ board on the USB cable, but you need to tell it about the Ethernet connection.

- **If you use an Ethernet-to-USB adapter** you need to register the USB adapter in the Settings USB pane. First remove the two existing ASIX adapters selecting them and clicking the small red "cross" icon, as shown in the top two figures. Then add your adapter by clicking the green "plus" icon and selecting your adapter, as shown in the bottom two figures. The screenshots show the Edimax adapter with the ASIX Elec. Corp., but the name of your adapter may be different.



Your Ethernet to USB-C connector can be listed as

1. `Realtek Semiconductor Corp. RTL8153 Gigabit Ethernet Adapter [3000]`
2. `Realtek USB 10/100/1000 LAN [3000]`

- **If you use an Ethernet port on your computer** then you need to register a new network port in the Settings Network pane. Select Adapter 2 and set it to "Bridged Adapter" and select the Ethernet port on your computer. On the 2018/19 university programme laptops this is something like `Intel(R) Ethernet Connection (2) I219-LM`.

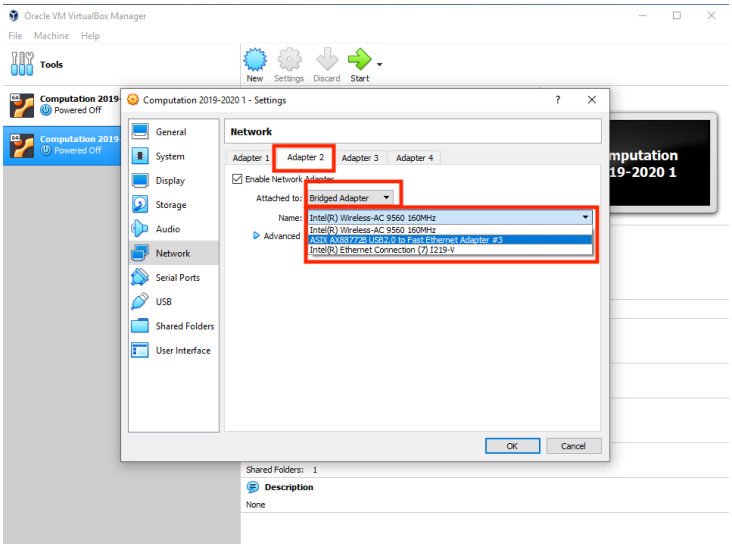


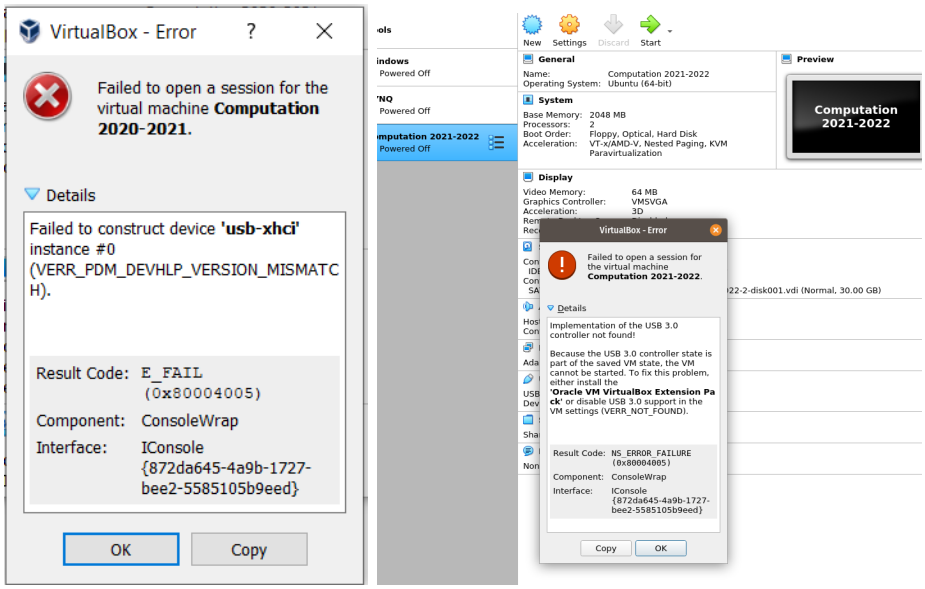
Figure 11

On the 2019/20 university laptops using Ethernet without Ethernet-to-USB adapter (as shown above) is very unreliable and we do not recommend it.

If for some reason you do not see `Xilinx TUL` in the list of USB devices then you can add it just like the USB adapter.

3.3 Installing the PYNQ Network Connection – First Time only

Start the VirtualBox application and start the Computation virtual machine.
If you get an error message about a broken shared folder, then fix this as described in the "Installing and Using the Computation Virtual Machine" document.
If you get the following error message then the Extension Pack has not been installed correctly, or the versions of the Extension Pack and VirtualBox are not compatible. Upgrade to or install the latest version of VirtualBox and Extension Packs.



Click on the Network pull-down menu (the "up/down arrow" symbol at the top-right of the Ubuntu task bar)

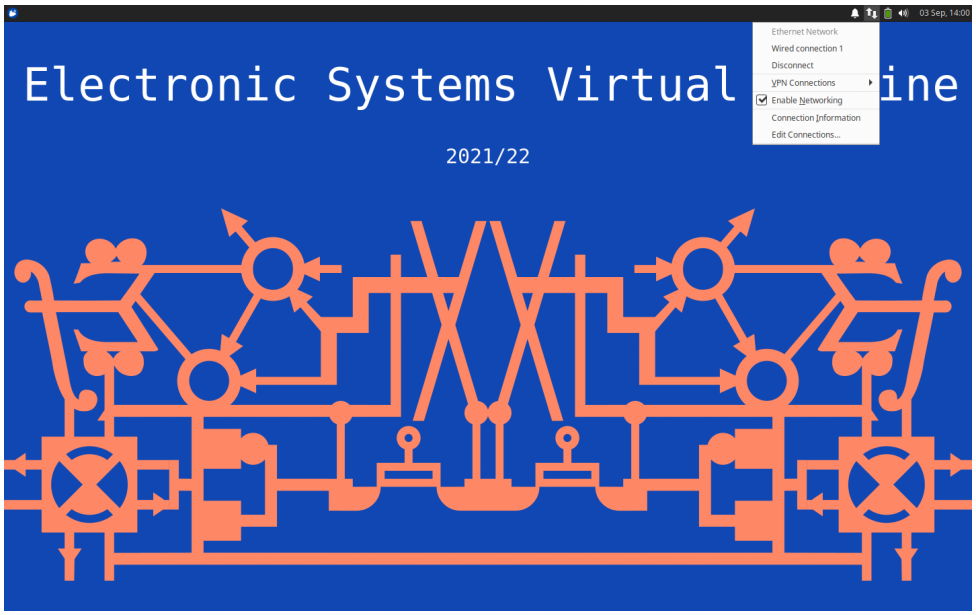


Figure 12

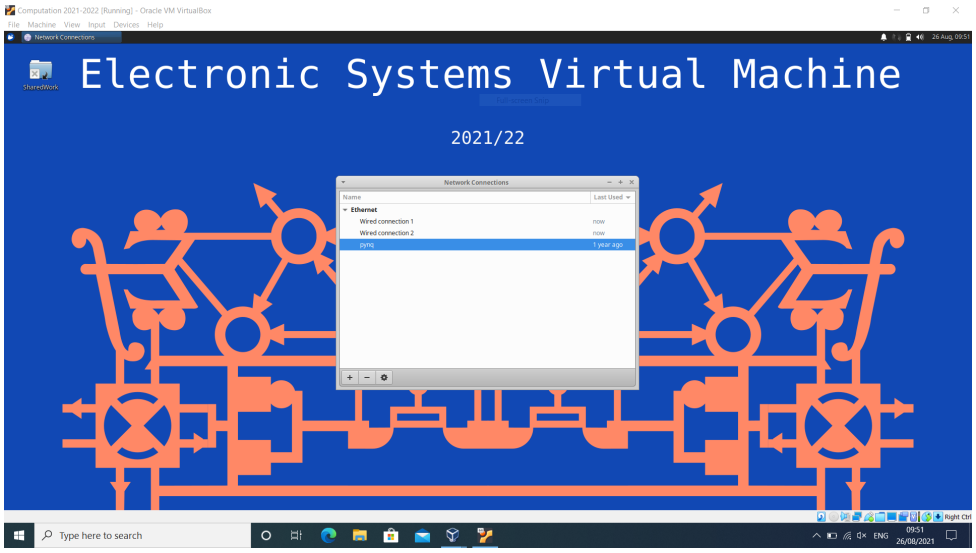


Figure 13

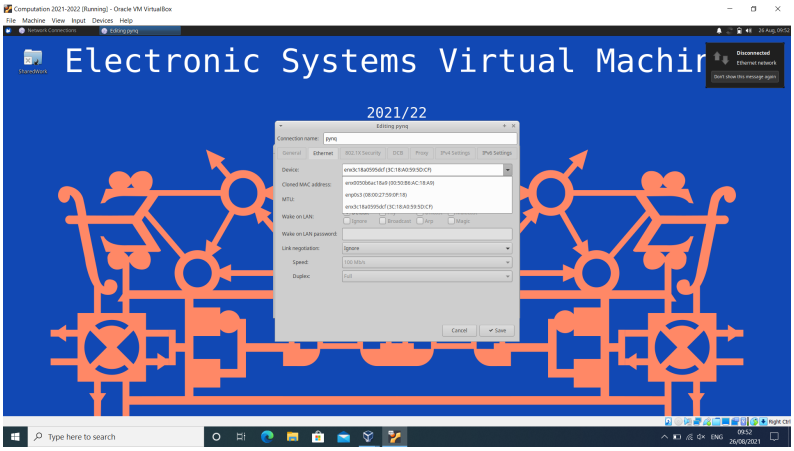


Figure 14

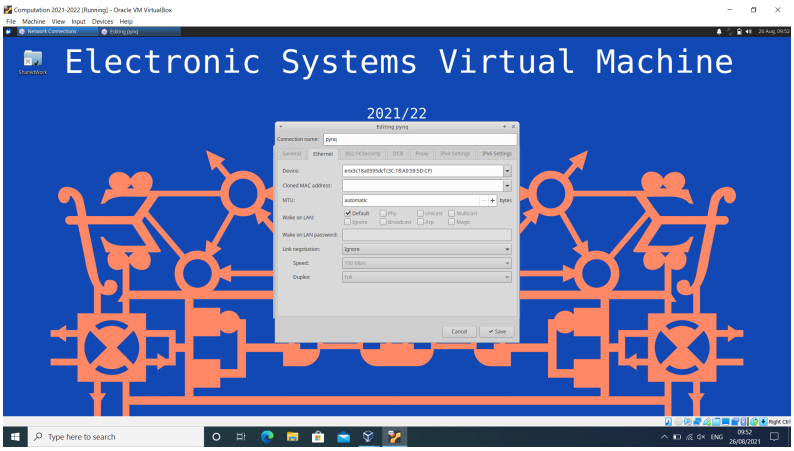


Figure 15

- **2021/22 university laptop** then select a MAC address starting with `enx3c`.
- **2020/21 university laptop** then select a MAC address starting with `enx3c`. If the Ethernet-to-USBC adapter of your 2020/21 university laptop is shown as "Realtek Semiconductor Corp. RTL8153 Gigabit Ethernet Adapter" and the adapter doesn't work in the VM then you have to uplug the adapter, restart the laptop, and then replug the adapter.
- **2019/20 university laptop with an Edimax Ethernet-to-USB adapter** then select a MAC address starting with `enx0`.
- **2019/20 university laptop with a Digitus Ethernet-to-USB adapter** (see image below) then select a MAC address starting with `enx3c`.

- **Otherwise** select the appropriate device.

4 Using the PYNQ board

1. **Set the power switch to ON.** The red LED (Figure 16) will turn on. If it does not, switch off the power, and check that you have pushed in the USB cable far enough in the computer USB port and the PYNQ microUSB port. Sometimes the 'Jumper for power source selection' (see Figure 1) is a bit loose and you may have to push it in further.

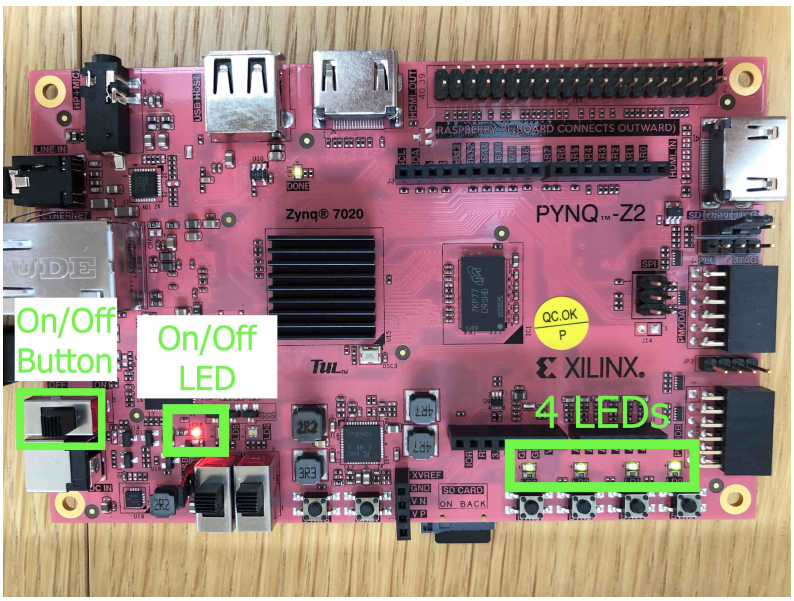


Figure 16

2. **Wait until the 4 green LEDs have turned on** (about 20 seconds). (The Ubuntu operating system boots the PYNQ board.)

   The first time that you use the SD card the lights may come on after 20 seconds but the board will not be operational yet. The board won't mount the shared folder in the virtual machine (see the screencast) and you may not be able to login for 3-4 minutes. The PYNQ Ubuntu is decompressing the file system and checking for operating sysystem updates. Do not switch off the power during this time because that will corrupt the SD card and you will have to reflash it. After the first time it takes only about 20 seconds. If it takes longer and only some of the LEDs are on, then this is also ok.

4.1 Logging in on the PYNQ board

Start a terminal.

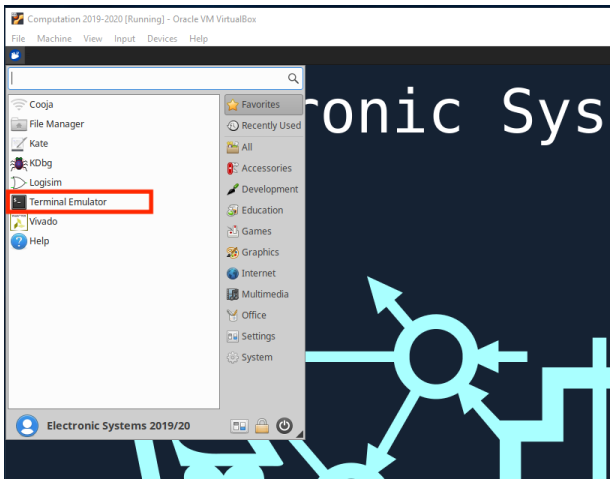


Figure 17

Login to PYNQ using `ssh` (secure shell) by typing `ssh student@pato-board.local`. The password of the `student` account is `student`. For security, `ssh` may ask (only once) if it's ok to connect. Say yes.

```
computation@computation-virtual-machine:~$ ssh student@pato-board.local
```

When you see the `student@pynq:~/` command prompt, you've logged in on the Ubuntu on the board!

4.2 Stop Using the PYNQ board

To stop using the PYNQ board you need to take the following steps, in the order shown:

1. **Shut down the PYNQ Ubuntu operating system** by executing `sudo halt` on the command line in the terminal. The password is `student`. After you press return, any X windows and shared folders that you may have in the Computation virtual machine will disappear.
2. **Set the power switch to OFF.**
3. **Disconnect all cables.**
4. You can leave the SD card in the board.
5. **Store the PYNQ such that it does not damage during transport.**

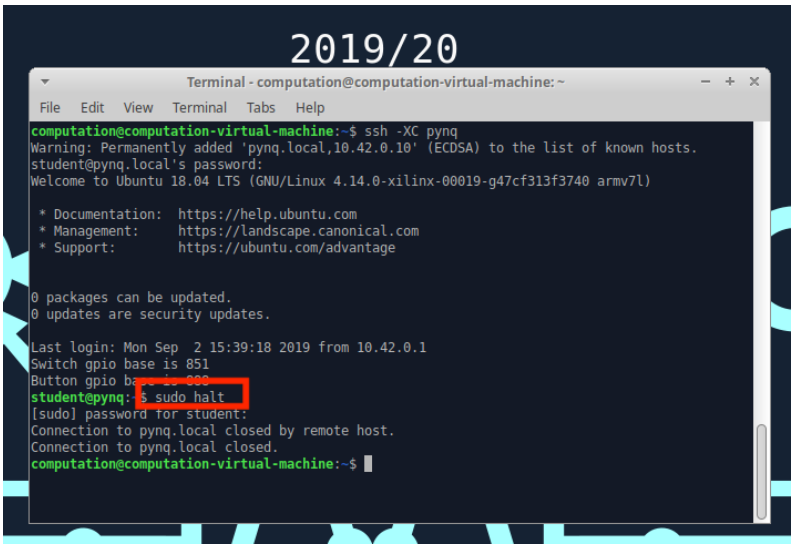


Figure 18

5 Recovering Missing PYNQ Connection in Virtual Machine

This section is relevant for 2020/21 university laptops only. If you (re)start your laptop with the HP Ethernet-to-USB-C converter then the virtual machine will lose that connection. The virtual machine will no longer see `pynq wired connection` in the "Network" pull-down menu (the up/down arrow in the menu bar) and you will not be able to use the PYNQ board. If this happens then you will have to stop the VM, switch off the PYNQ board, and reboot your laptop with the Ethernet adapter unplugged. Although the "Wired Connection 2" may be missing from the "Network Connections" menu, `pynq wired connection` should be visible in the "Network" pull-down menu again. To properly fix the problem you have to remove the virtual machine and re-import the original Computation `.ova` file. This is not really necessary though.

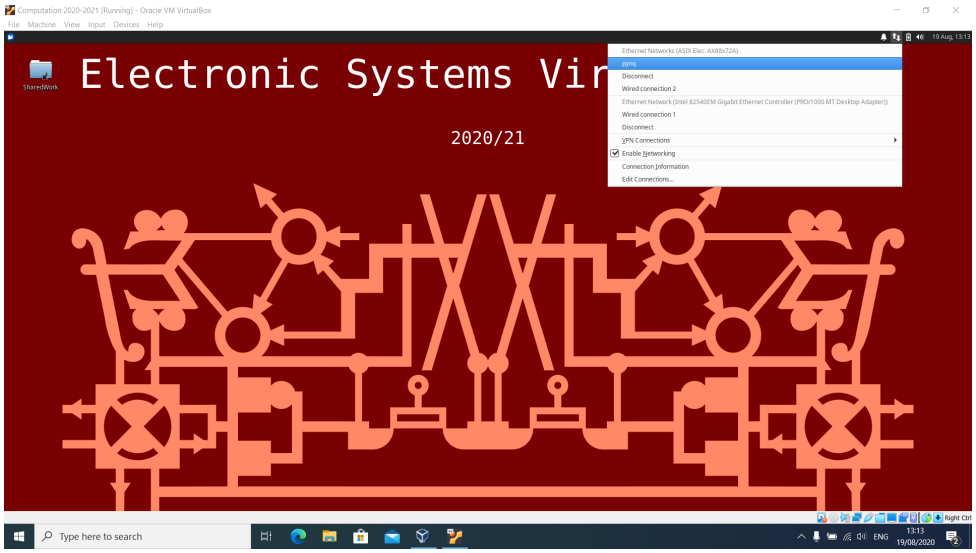


Figure 19: Correct connections menu, where pynq is visible in the Network pull-down menu.

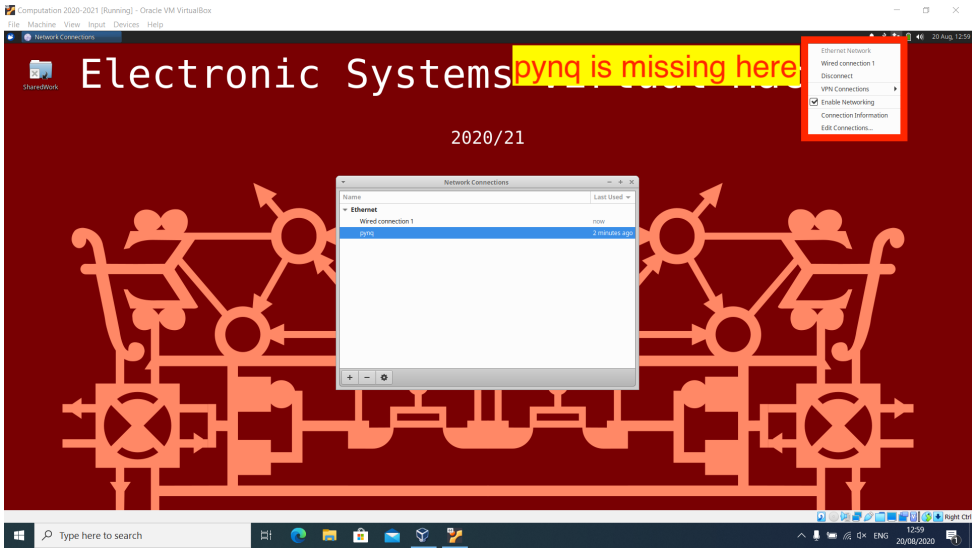


Figure 20: Missing pynq in the Network pull-down menu.

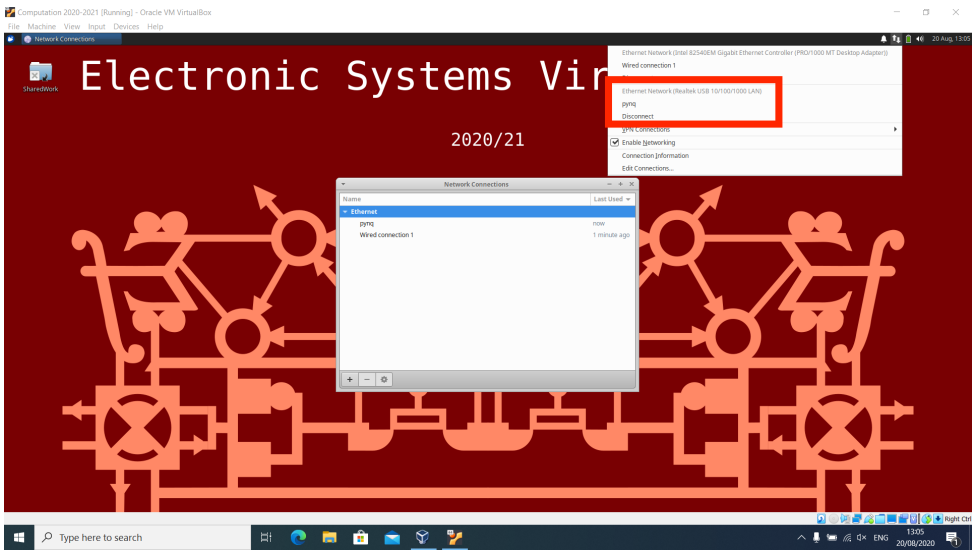


Figure 21: After rebooting with the Ethernet adapter unplugged and restarting the virtual machine.