

LINUX-BASED DEVELOPMENT PLATFORM

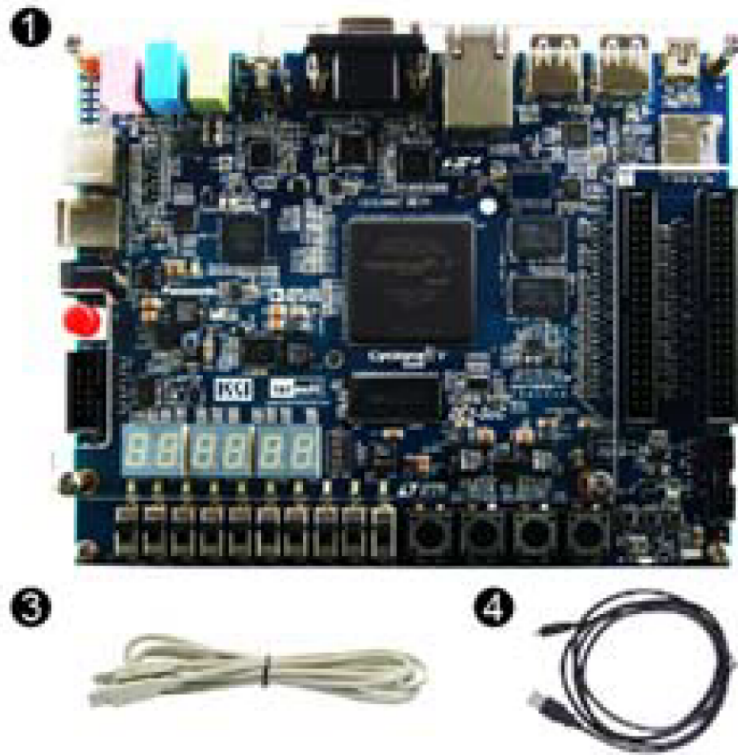
EMBEDDED SYSTEMS CLASS

Development Platform

- DE1-SoC board made by Terasic.
 - Based on Cyclone V SoC FPGA with a number of peripheral components.
 - You can see the details of the board by visiting <https://www.terasic.com.tw/cgi-bin/page/archive.pl?Language=English&CategoryNo=167&No=836&PartNo=1>

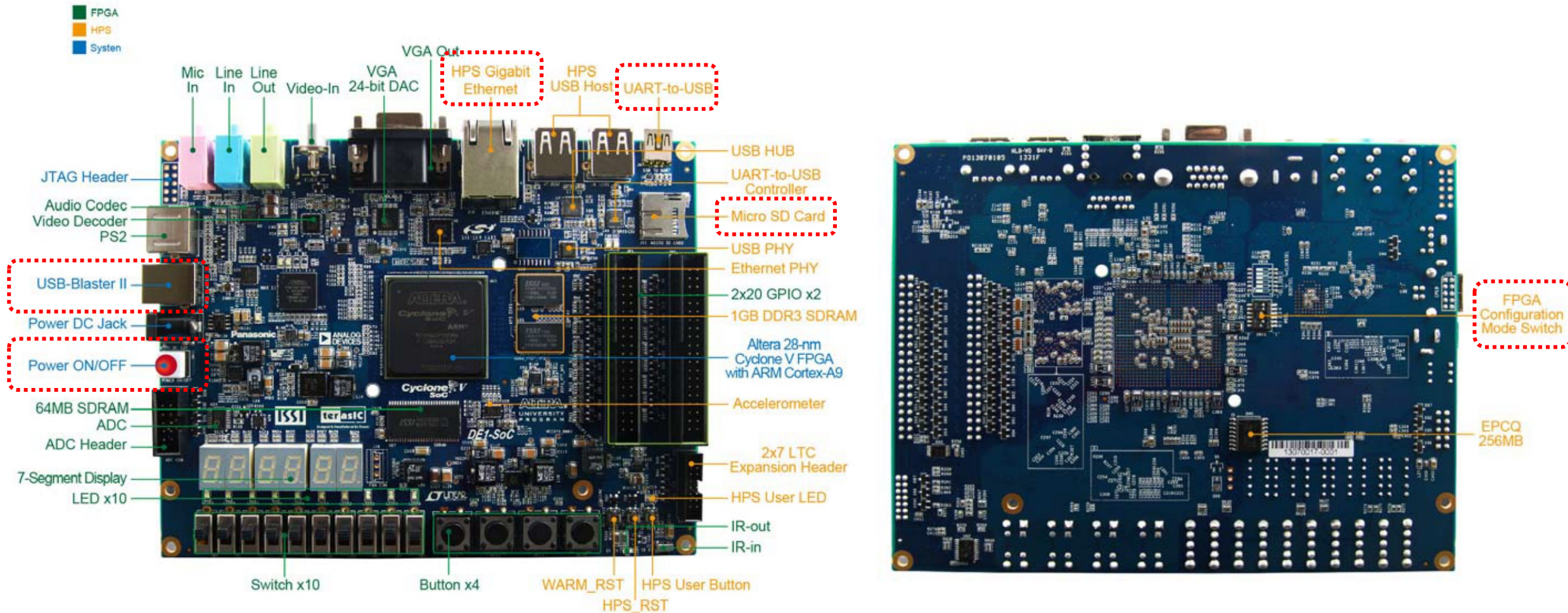
Development Platform, Cont'd

■ Board Package



- ① DE1-SoC Board
- ② DE1-SoC Quick Start Guide
- ③ Type A to B USB Cable
- ④ Type A to Mini-B USB Cable
- ⑤ Power DC Adapter (12V)

Development Platform, Cont'd



Development Platform, Cont'd

- Cyclone ® V SE 5CSEMA5F31C6N

- FPGA + HPS (Hard Proc. Sys.)

- FPGA

- ✓ 85K Programmable Logic Elem.
- ✓ 4450K bits On-Chip Mem.

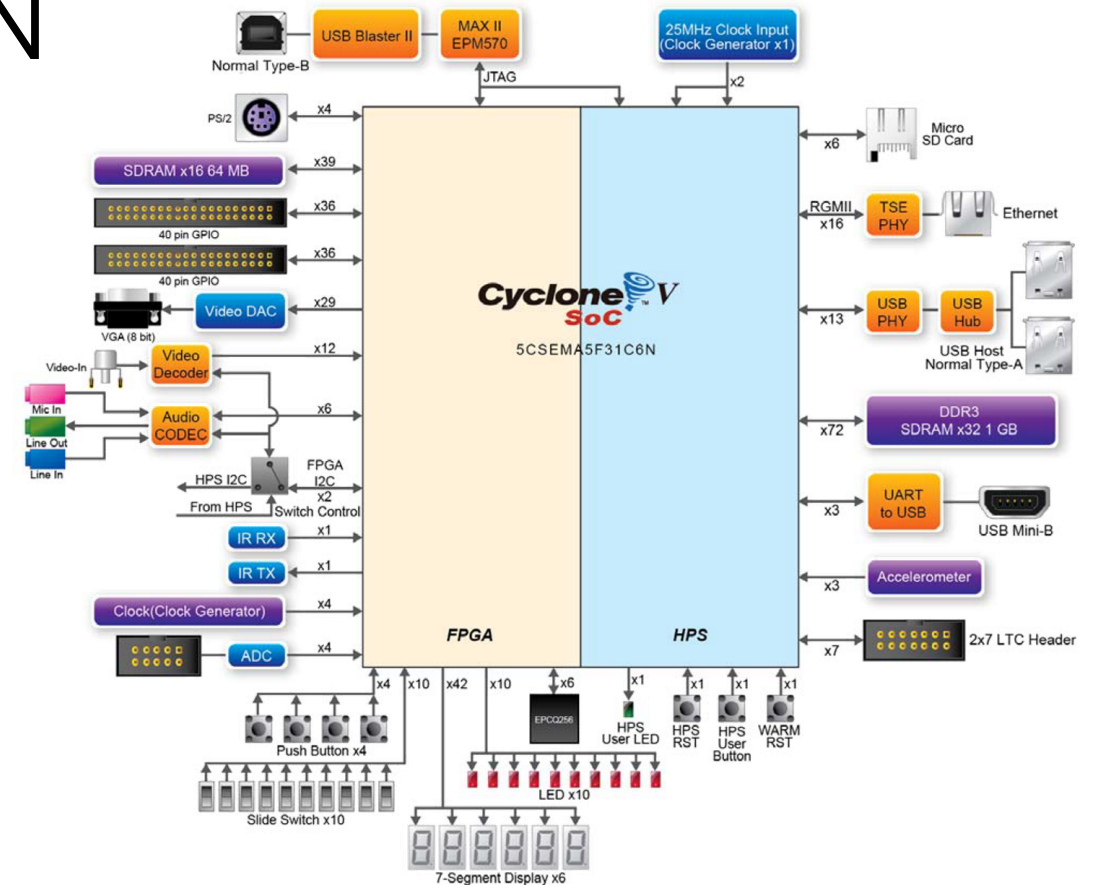
- HPS

- ✓ 800MHz Dual-Core ARM Cortex A9
- ✓ 1GB DDR3 SDRAM

- See the board manual

- Find the details of other components

- <https://www.terasic.com.tw/cgi-bin/page/archive.pl?Language=English&CategoryNo=167&No=836&PartNo=1>



Development Software

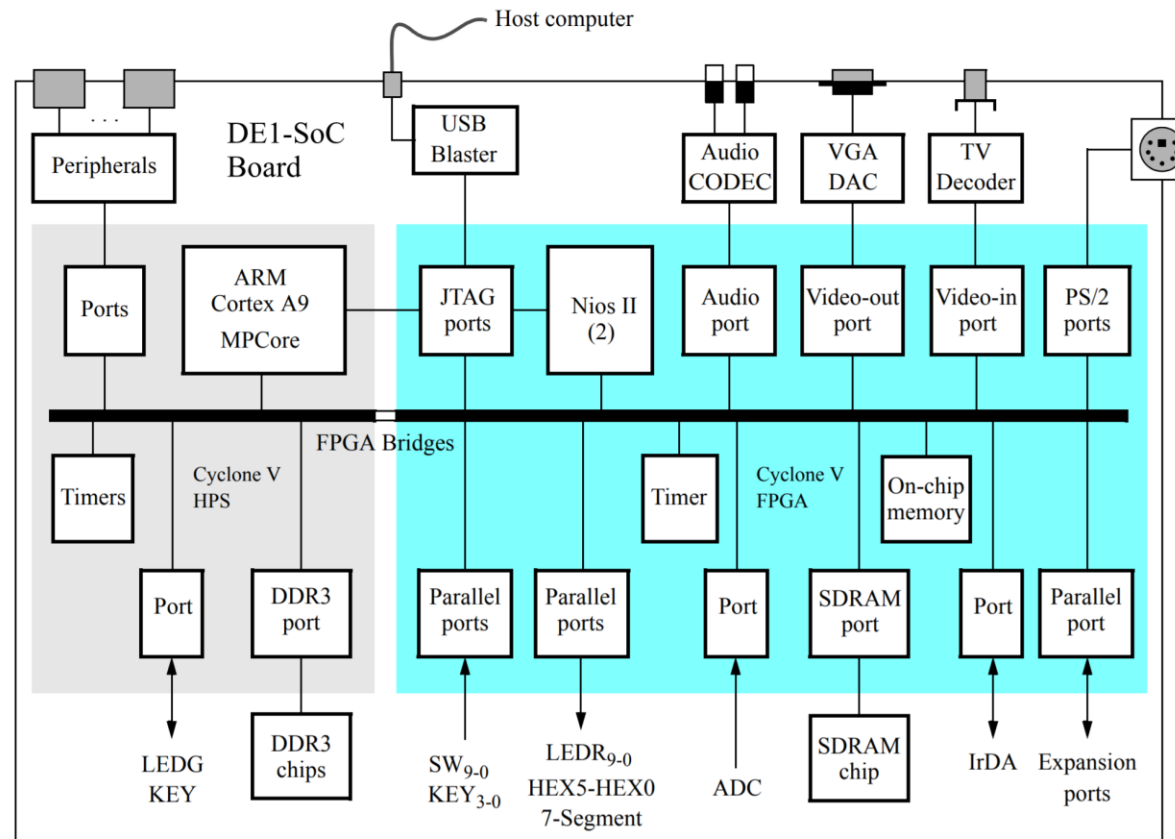
- Intel Quartus Prime Lite v18.1 (일부 Lab에서만 필요함)
 - This is a free edition.
 - Non-free editions, such as Standard and Pro, may be OK.
 - Need to support Cyclone V devices.
 - Can be downloaded by visiting <https://fpgasoftware.intel.com/18.1/?edition=lite>
 - You maybe make an account first for the download.
 - Download and install this tool in your laptop *before the lab*.
- Putty
 - A free SSH/serial comm. client.
 - Can be downloaded by visiting <https://www.putty.org>

SoC FPGA

- Cyclone V is an SoC FPGA, composed of an FPGA and HPS.
 - FPGA is a programmable logic device and HPS is an ARM-based CPU.
 - You can instantiate logic circuitry by using logic resources available in FPGA and control it by a software running on HPS.
 - This is, what we call, a *heterogeneous* multiprocessor system.
 - The software running on HPS can be developed under the ARM ecosystem.

SoC FPGA, Cont'd

- Example of HPS + FPGA

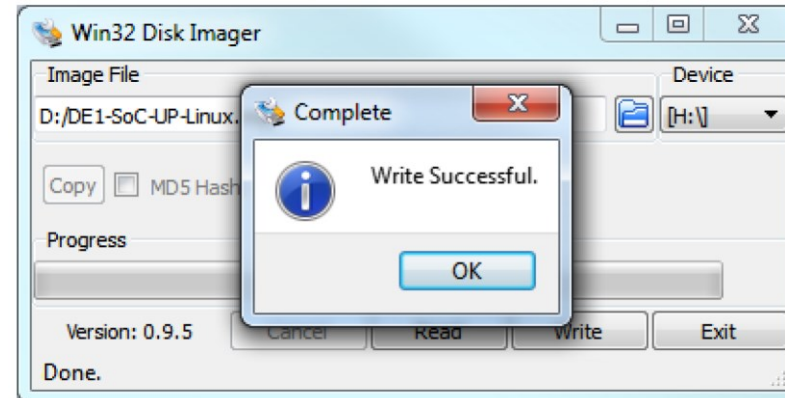
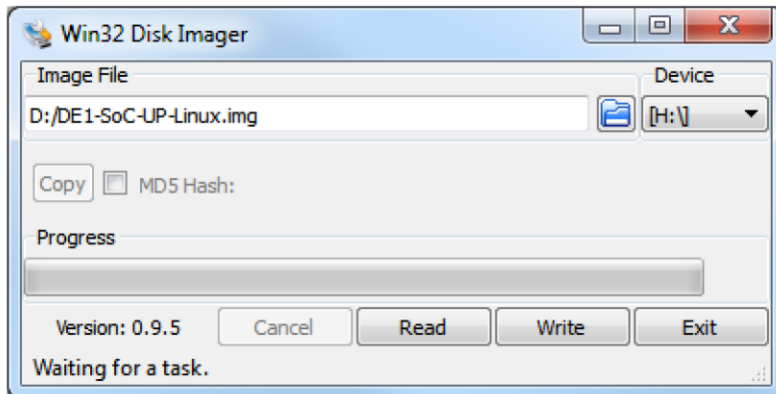


Preparing Linux Image

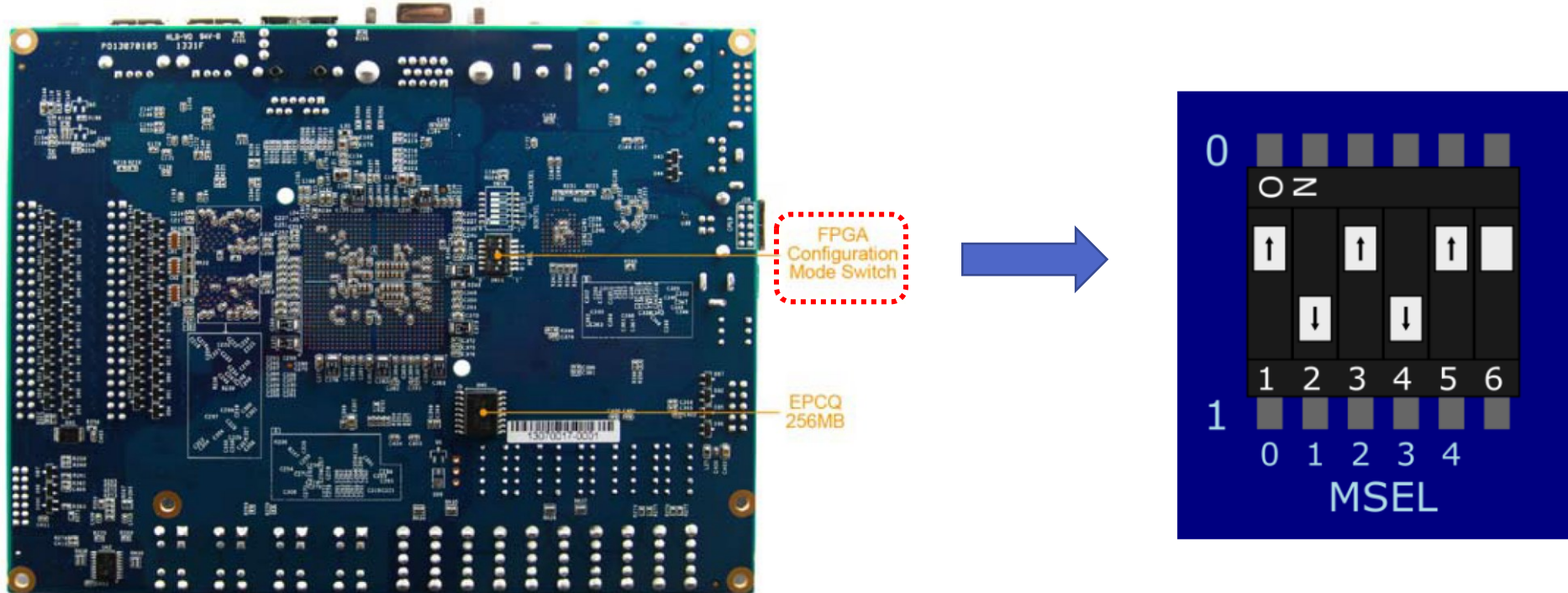
- Linux will be ran mainly on HPS, with some logics on FPGA to control the peripherals attached to it.
- For our lab, Linux image has been made by modifying Ubuntu so as to perform the optimization for the board.
 - Provided by an image file format (.img).
 - The image file need to be written into MicroSD card (>8GB) and the booted on the board.

Preparing Linux Image, Cont'd

- Prepare the MicroSD card with the Linux Image.
 - The image file can be downloaded by the class website.
 - The image file can be written into the MicroSD card by Win32 Disk Imager tool.
 - <https://sourceforge.net/projects/win32diskimager/>

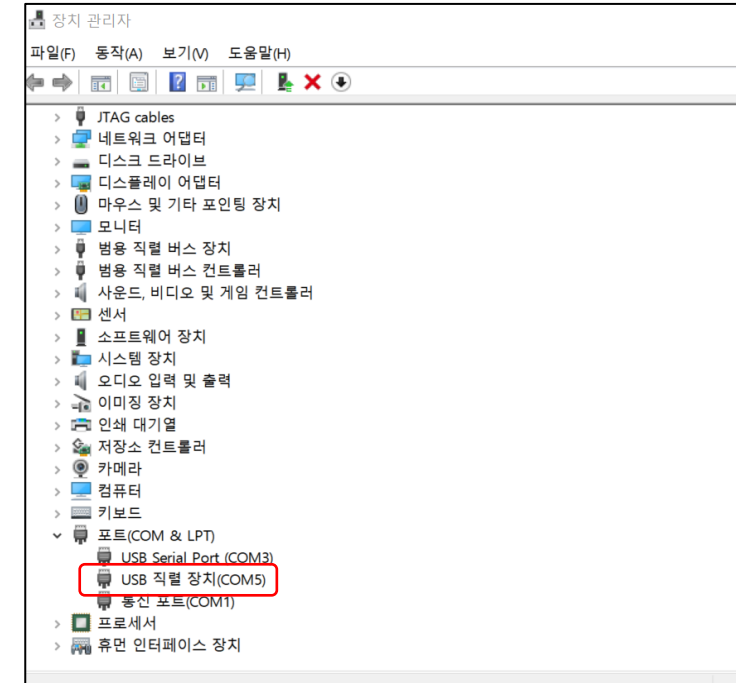


Board Setting for HPS + FPGA Working

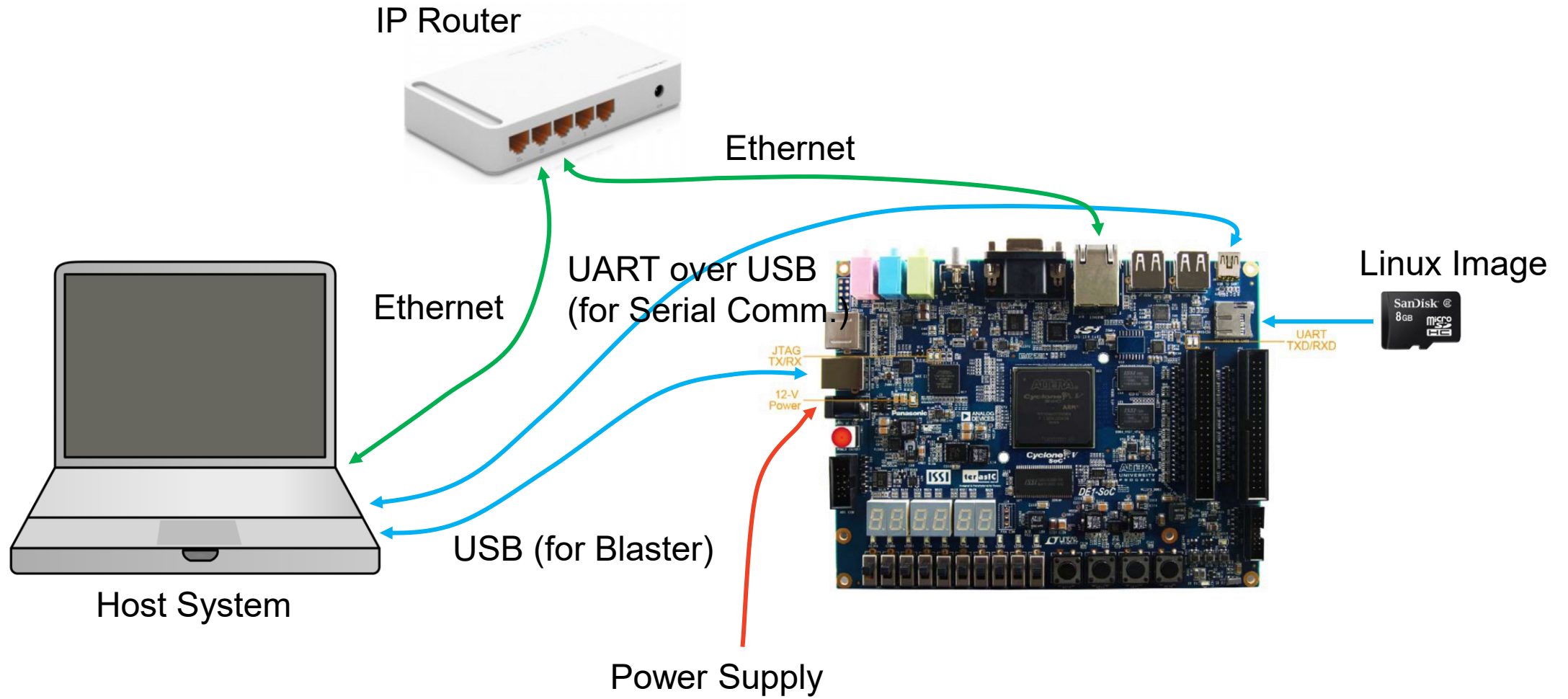


Board Connection

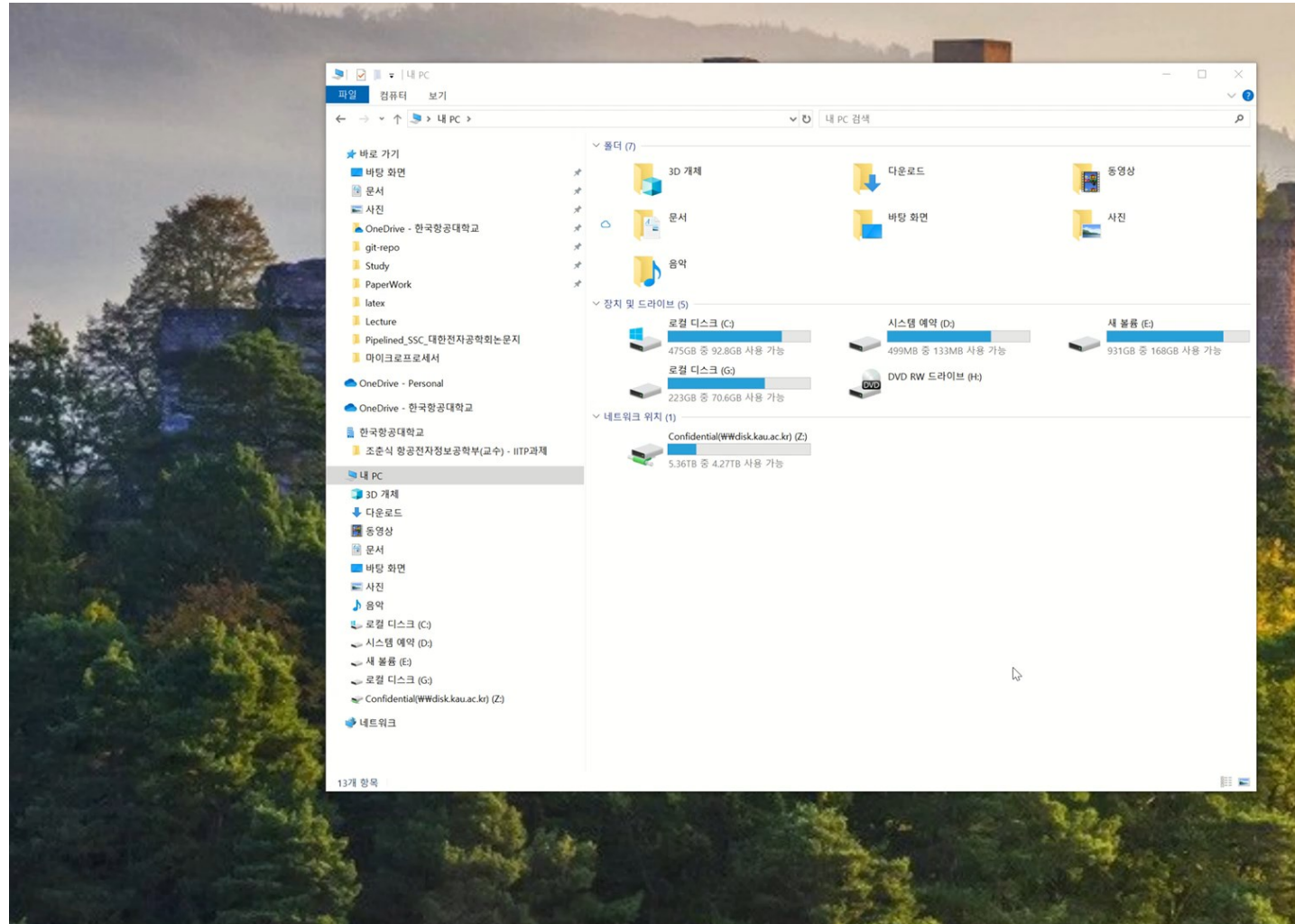
- UART is a primitive interface for the board.
 - You may need device driver for UART over USB in your host system.
 - FT232R UART USB Driver, <http://ftdichip.com>
- Ethernet provides the IP-based interface for the board.
 - Need to setup the interface manually.
 - In the board as well as the host system.
 - Some applications based on it will provide very convenient and useful features.
 - SSH, SFTP, VNC, etc.



Board Connection, Cont'd



Booting Linux



Lab Assignment

1. Set up your development environment using DE1-SoC board and your laptop computer. Test the simple “Hello World” program by connecting the board through serial communication.
 - Prepare the linux image in the micro SD card.
 - Code the program, compile it by using gcc, and run it.
2. Make your own multi-object C program. Compile the objects first and link them to make an executable object.
 - Find out the simple usage of gcc by yourself. (e.g. `gcc -c x.c -o x.o`)
- (Optional) try to setup the environment with IP network and perform #1 and #2 through ssh.

Study the simple usage of shell commands and editors (such as vim and nano) by yourself.