Joint ICTP-IAEA School on FPGA-based SoC and its Applications for Nuclear and Related Instrumentation | (smr 3562) 25 Jan – 19 Feb, 2021

Organizers:

Mladen Bogovac (IAEA)

Andres Cicuttin (ICTP)

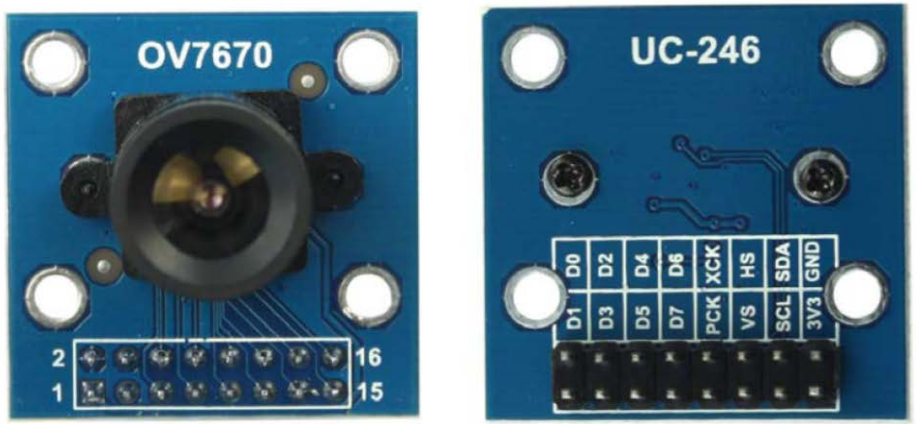
Local Organizer: Maria Liz Crespo (ICTP)

WebCam Development using Zynq SoC

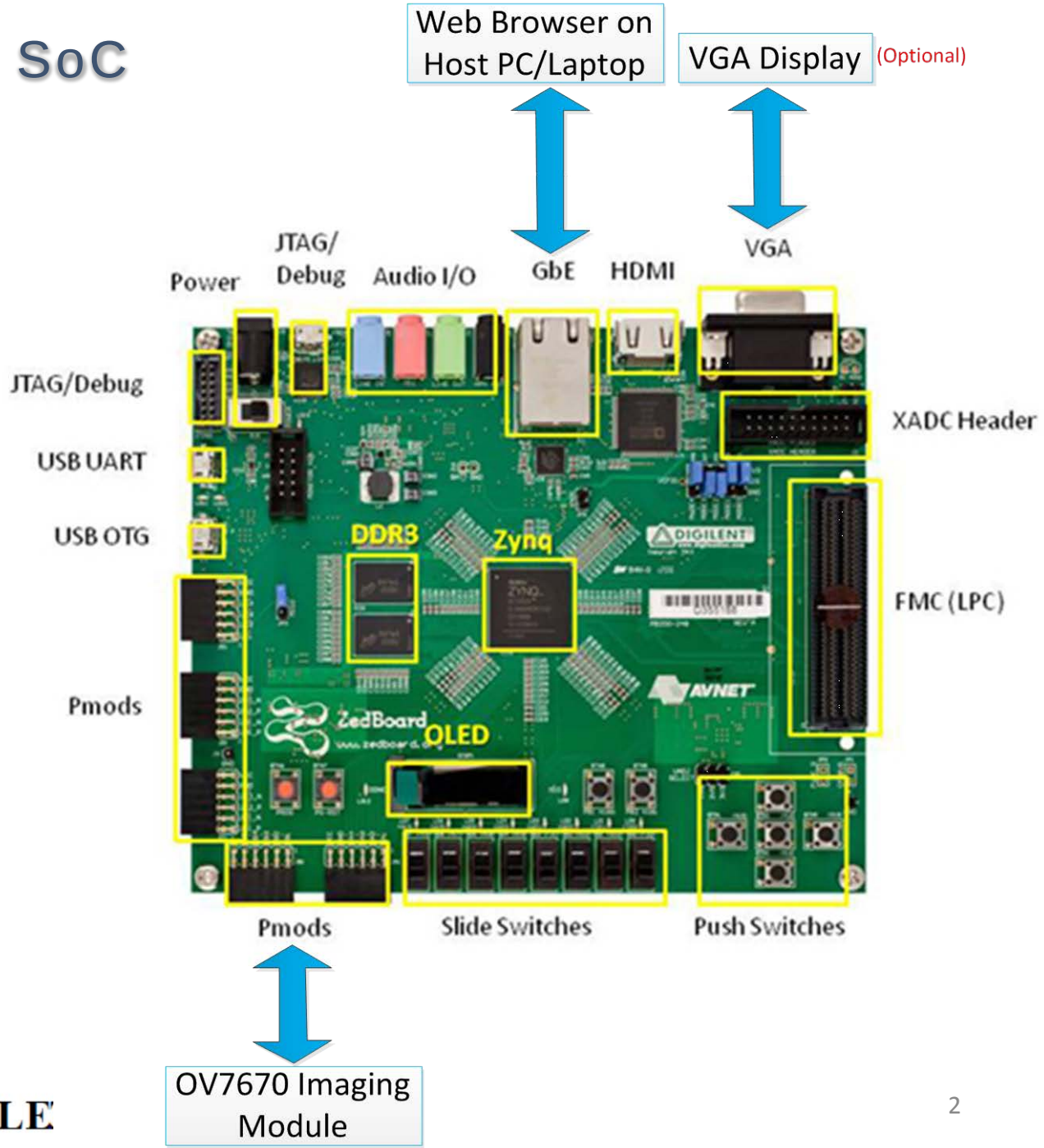
Presenter: Nasir Ahmed

Webcam Development using Zynq SoC

System Hardware

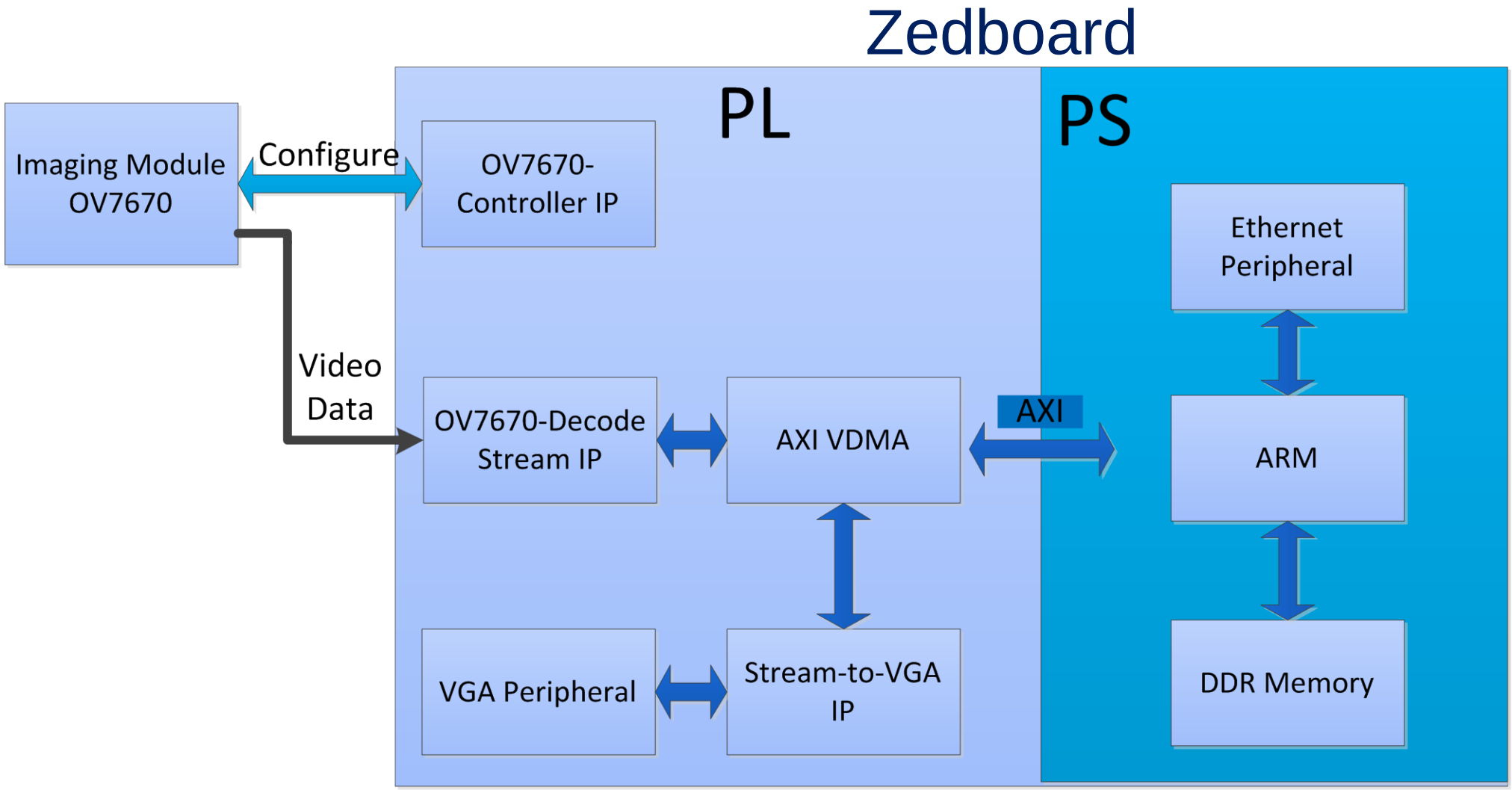


0.3M Pixels CMOS OV7670 CAMERA MODULE



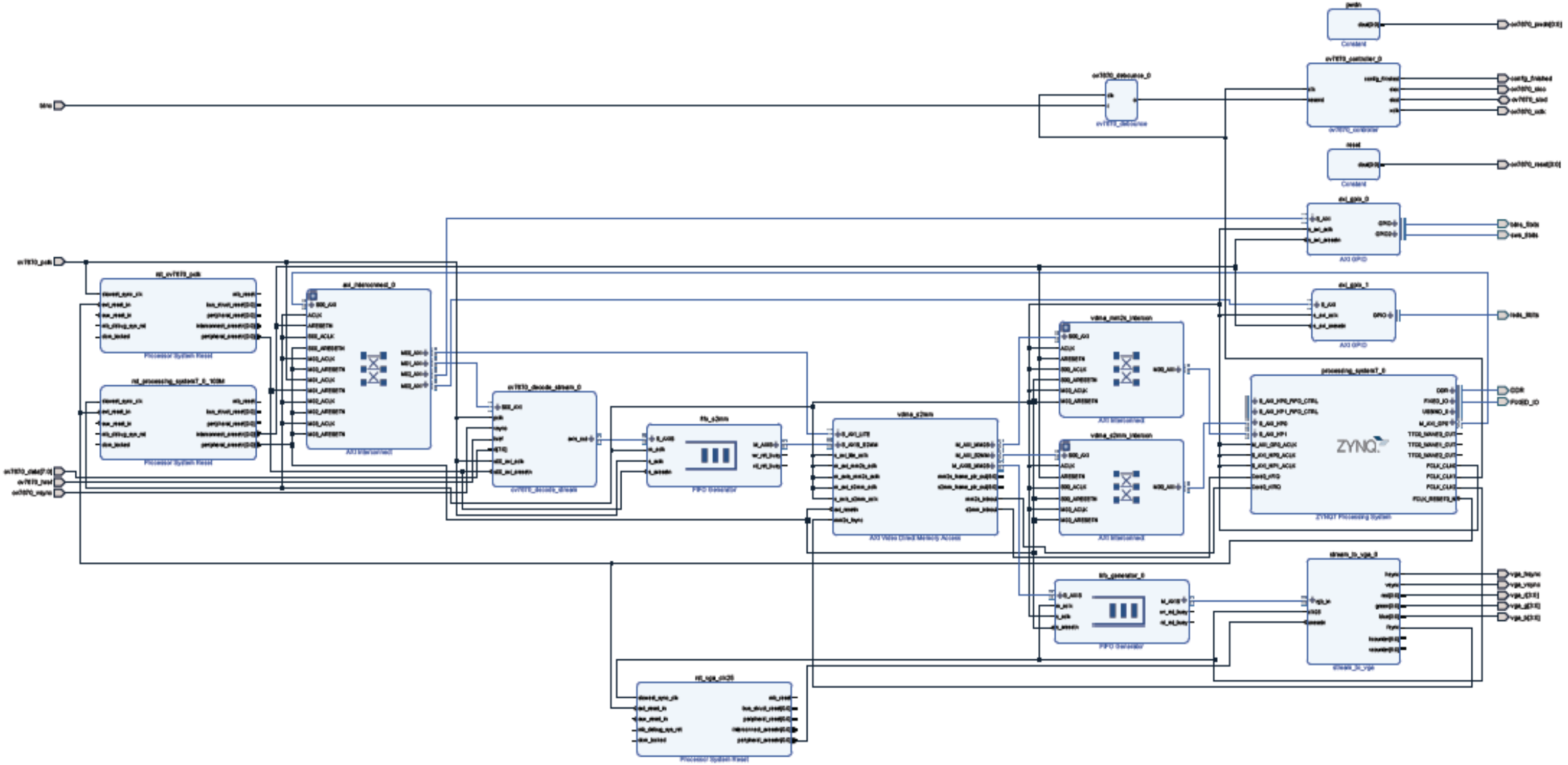
Webcam Development using Zynq SoC

Block Diagram



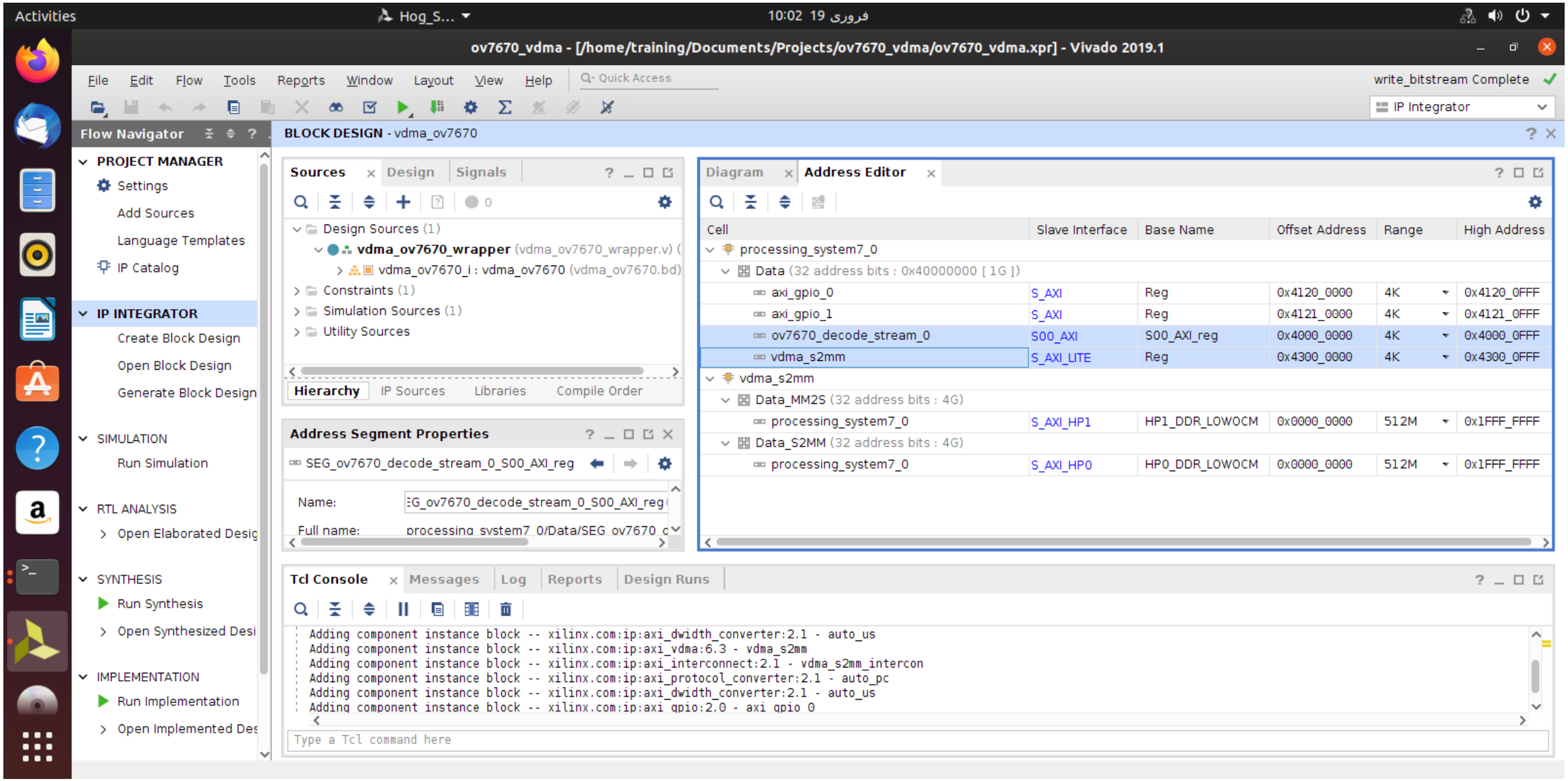
Webcam Development using Zynq SoC

Vivado Block Diagram



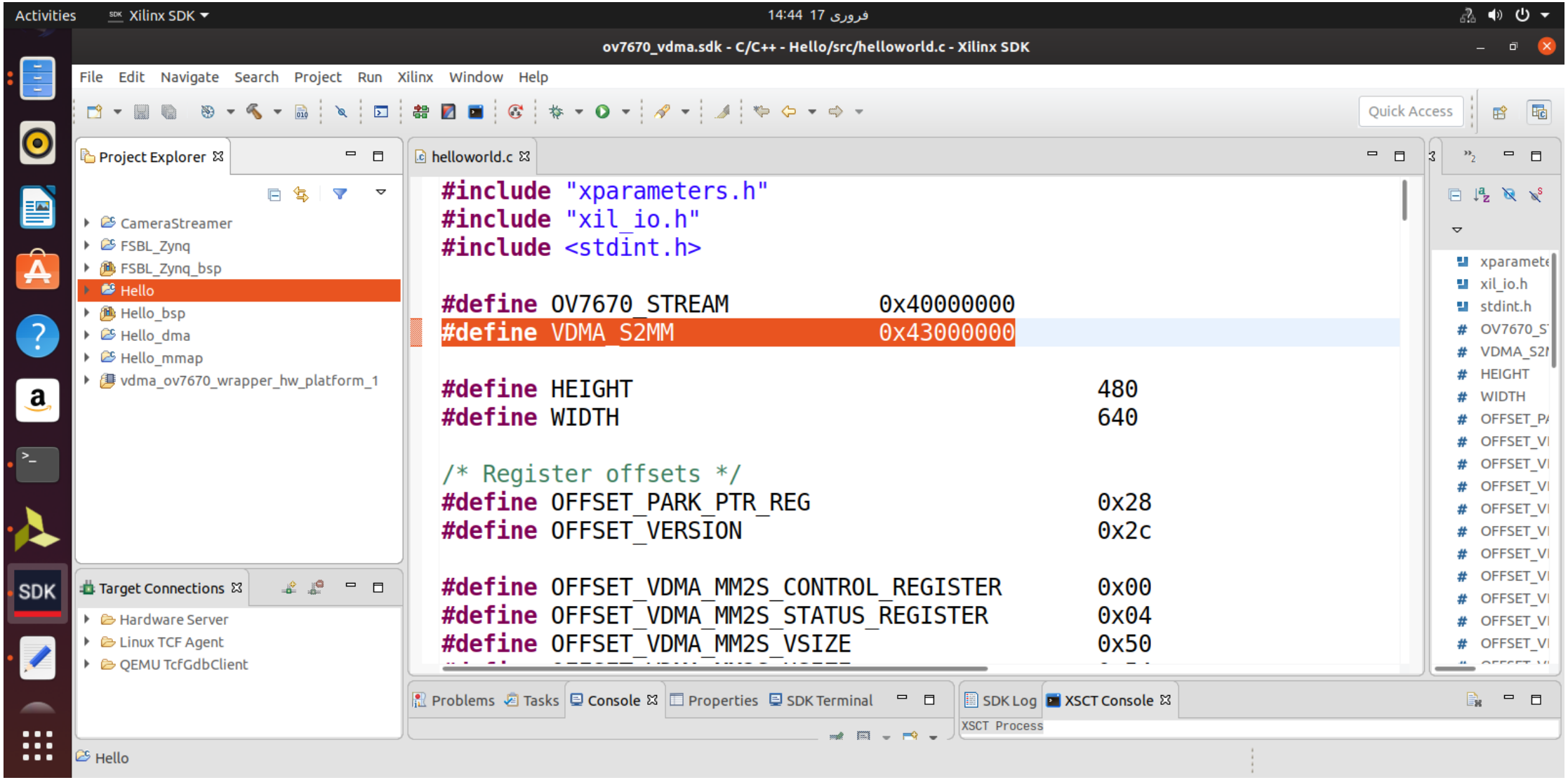
Webcam Development using Zynq SoC

Vivado Address Editor



Webcam Development using Zynq SoC

SDK2019.1: Standalone OS



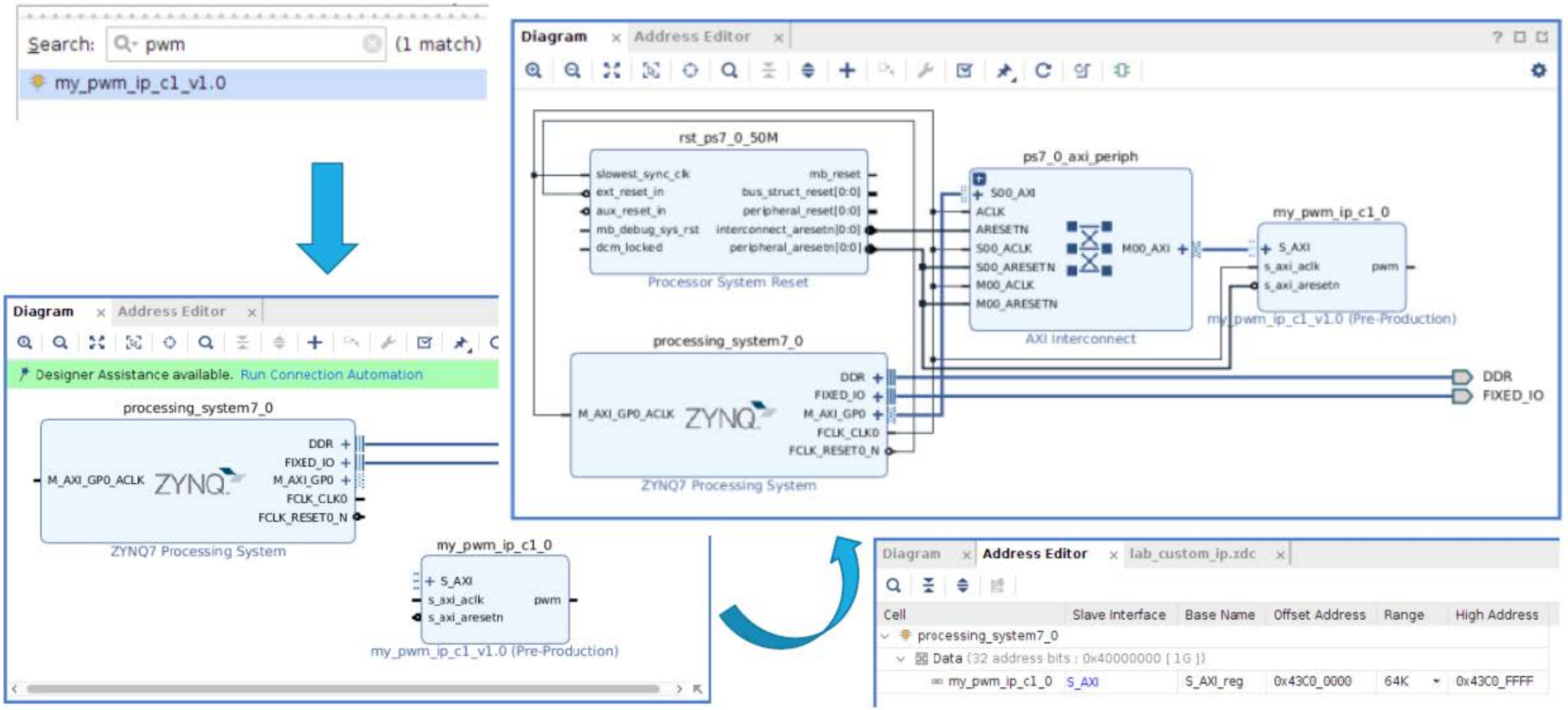
Labs at ITCP (Zedboard)

1. Hellow World
2. GPIO_IP
3. Interrupt SW/HW
4. DMA
5. Custom IP
6. Comblock

Lab5. Custom IP
Steps to Follow:

Webcam Development using Zynq SoC

ITCP Labs: Custom IP



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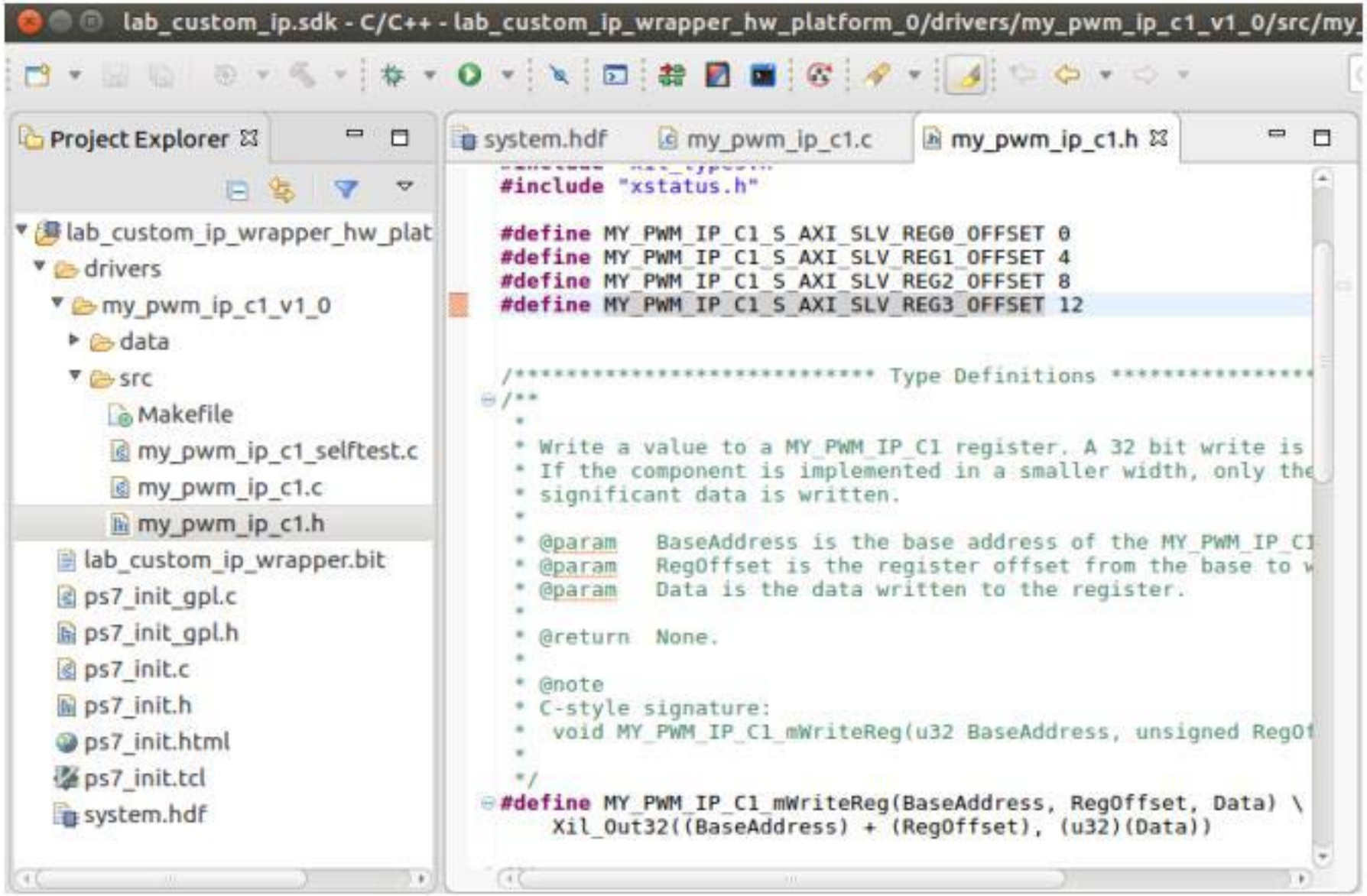
ITCP Labs: Custom IP



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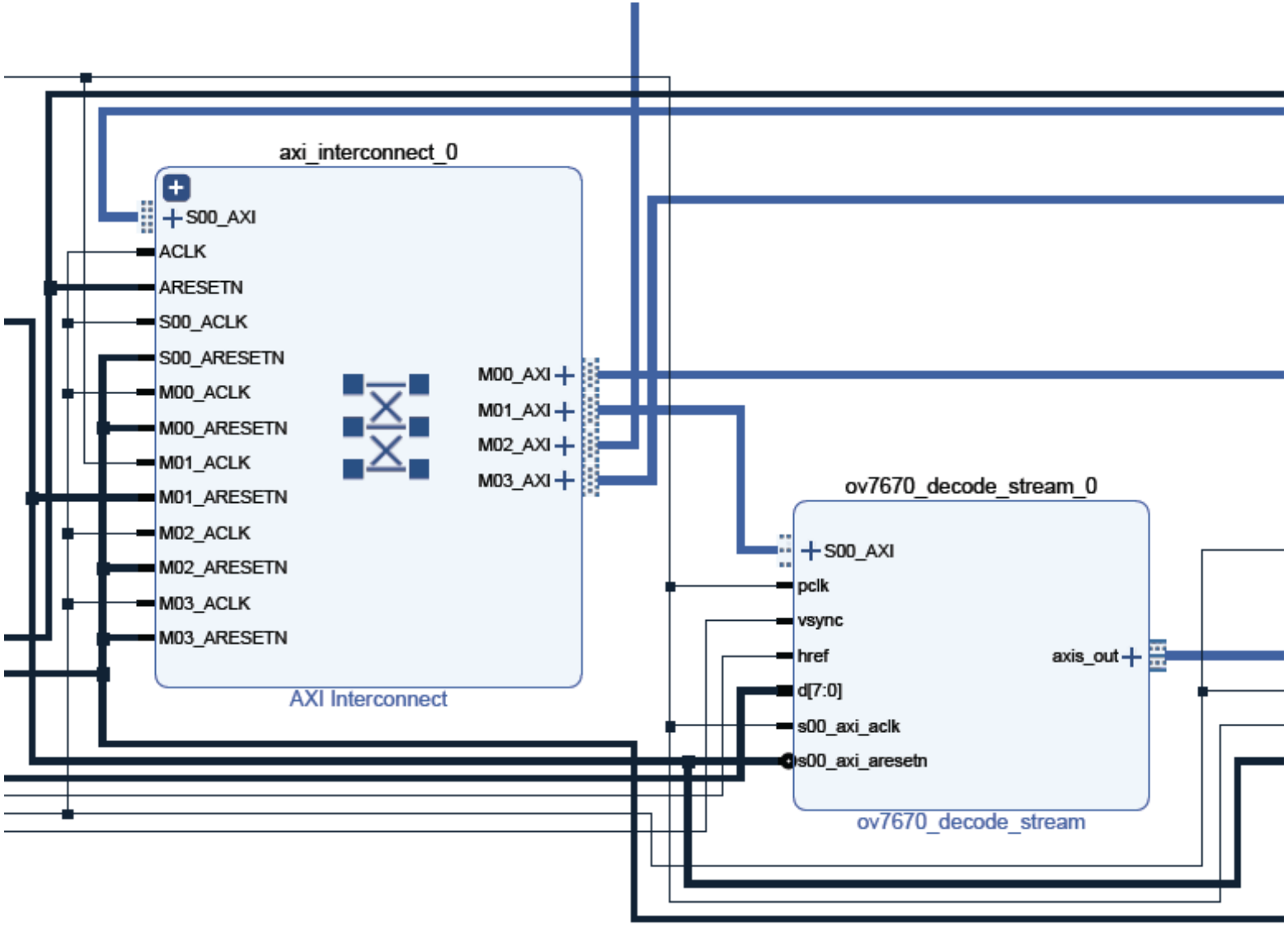
ITCP Labs: Custom IP



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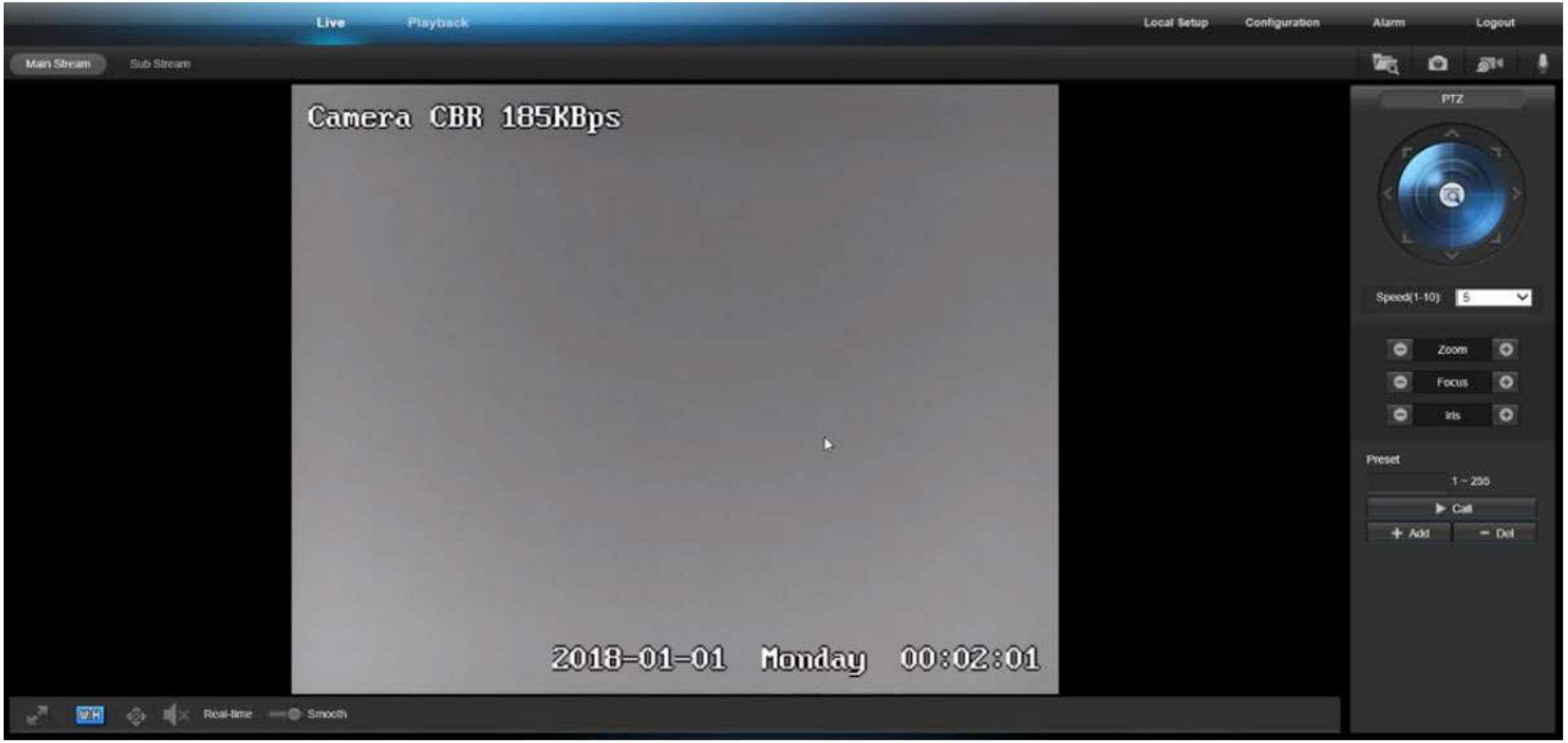
IP Camera Interface



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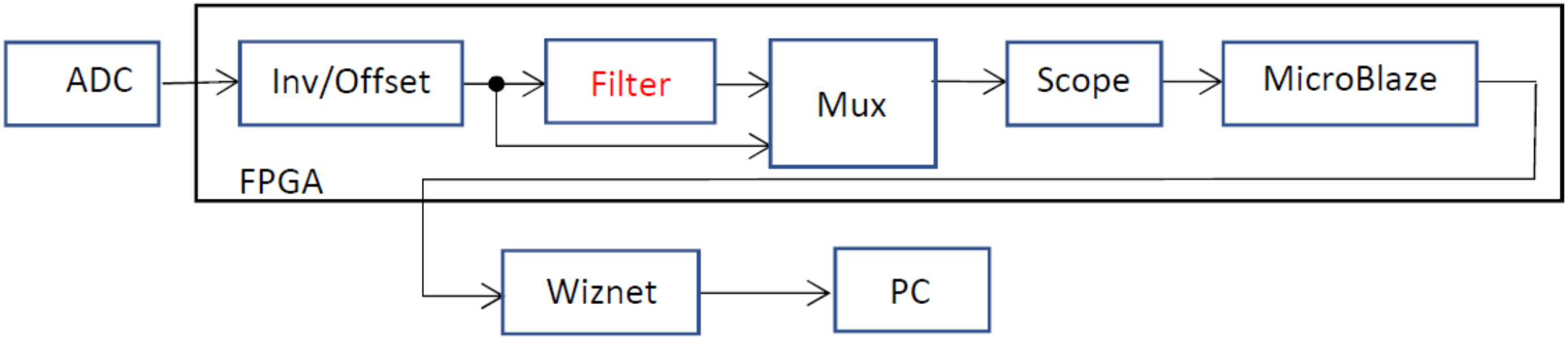
Labs IAEA

Main Labs at IAEA (CMOD-A7 and WIZned boards)

1. ADC data inversion and offset
2. Shaper
3. DC Stabilizer and base line restorer (BLR)
4. Pulse Height Analysis
5. Embedded Programming of WIZnet board



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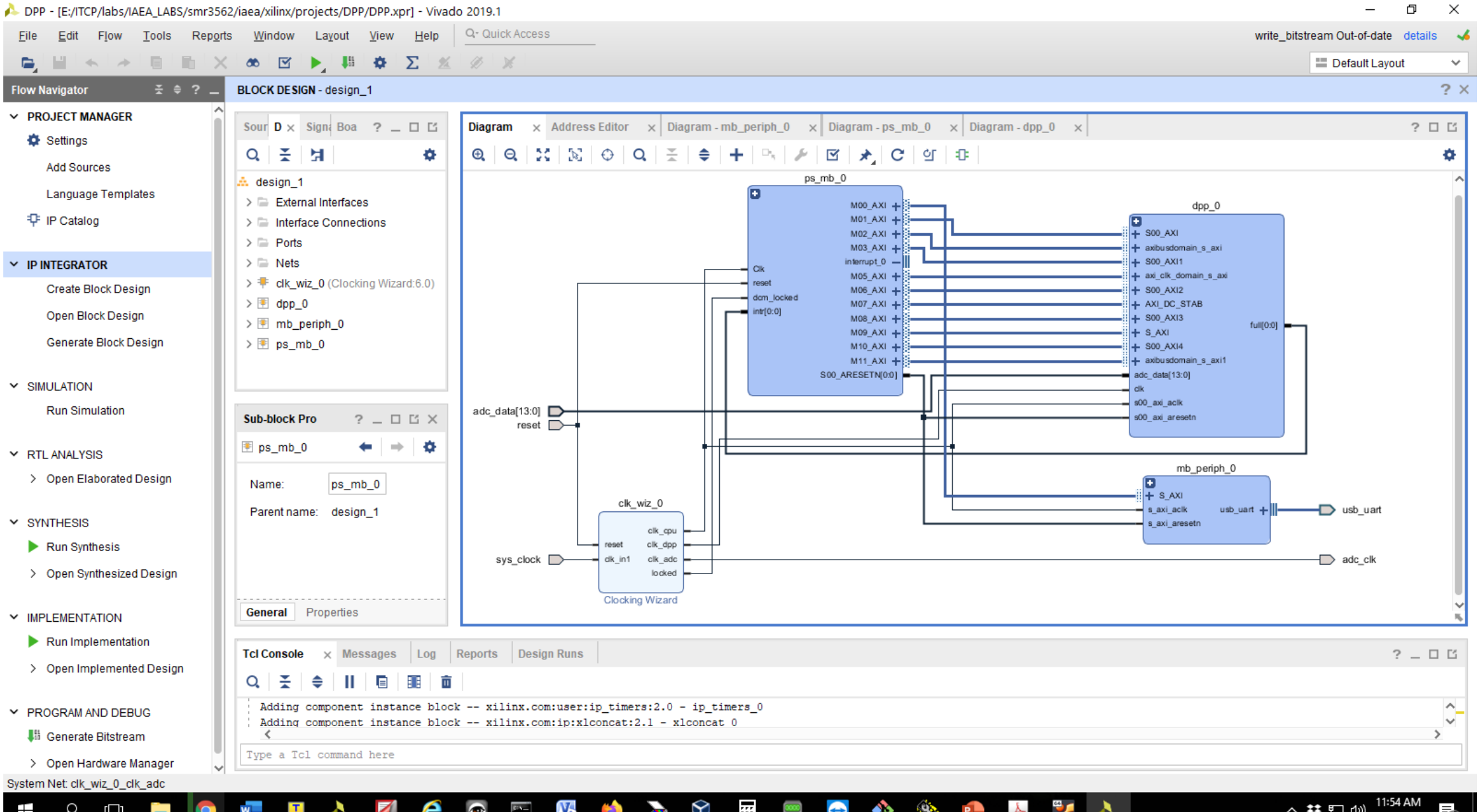
Labs IAEA: DPP (Hierarchal Design)



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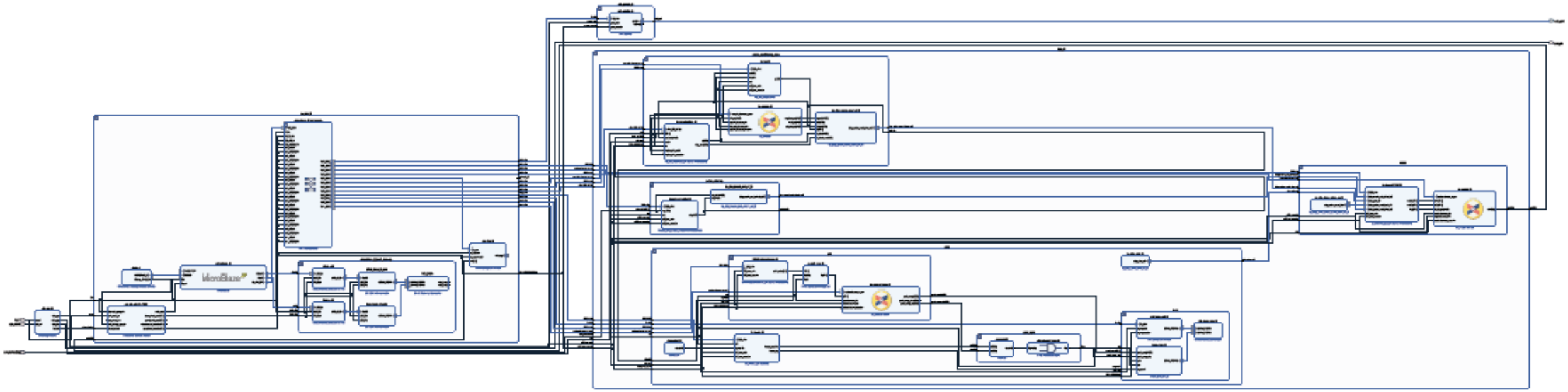
Labs IAEA: DPP (Complex Desing)



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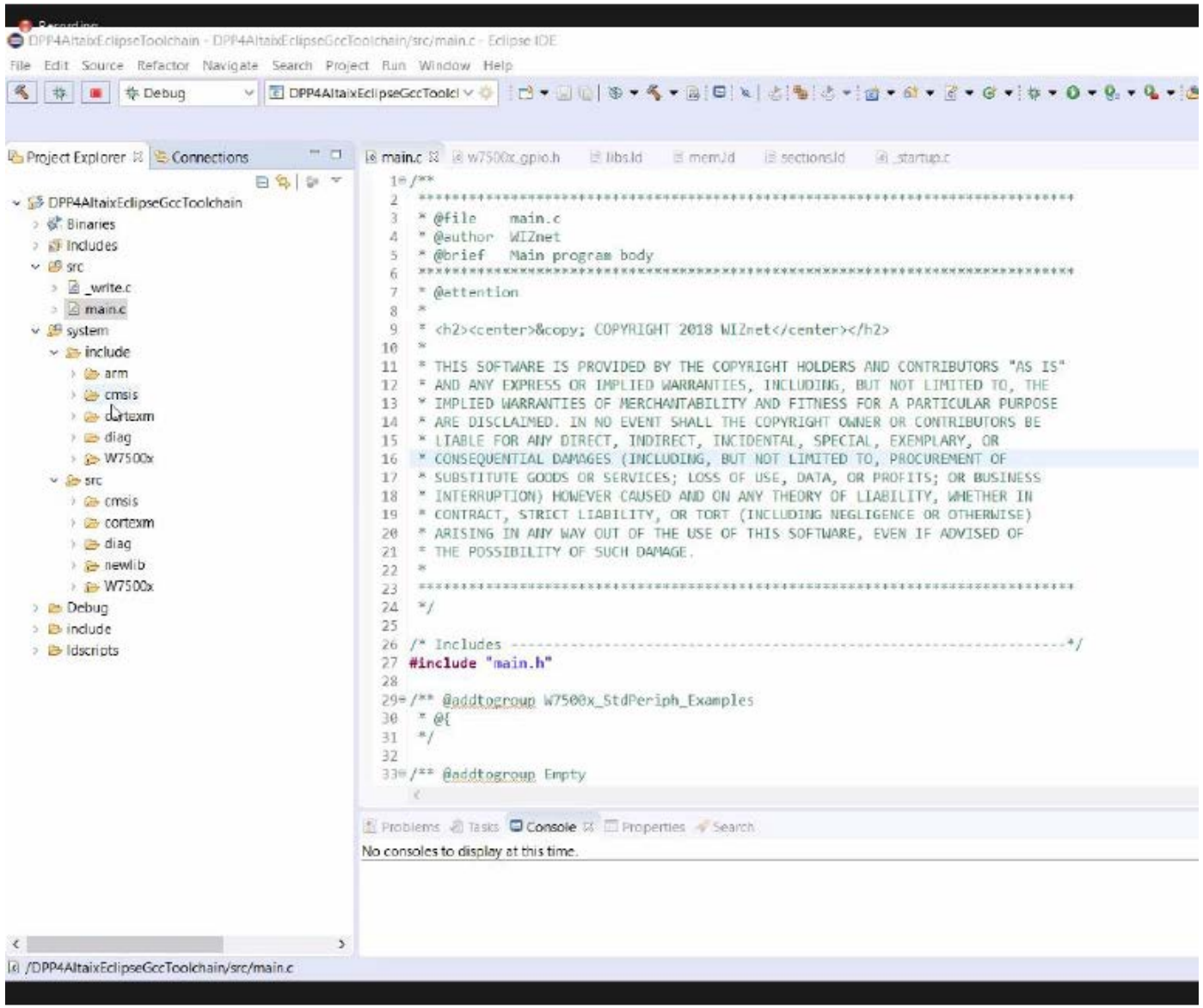
Labs IAEA: Embedded Development (Bare Metal)



Webcam Development using Zynq SoC

Embedded Linux SDK: PetaLinux

Introduction

PetaLinux is an embedded Linux software development kit (SDK) targeting Xilinx® FPGA-based System-on-Chip designs. This guide helps the reader to familiarize with the tool enabling overall usage of PetaLinux.

You are assumed to have basic Linux knowledge, such as how to run Linux commands. You should be aware of OS and host system features, such as OS version, Linux distribution, security privileges, and basic Yocto concepts.

The PetaLinux tool contains:

- Yocto Extensible SDK (eSDK)
- Minimal downloads
- XSCT and toolchains
- PetaLinux CLI tools

Note: Xilinx Software Development Kit (SDK) (XSDK) is the integrated design environment (IDE) for creating embedded applications on Xilinx microprocessors.

PetaLinux SDK is a Xilinx development tool that contains everything necessary to build, develop, test, and deploy embedded Linux systems.

Webcam Development using Zynq SoC

Embedded Linux SDK: PetaLinux

Table 5: **Design Flow Overview**

Design Flow Step	Tool / Workflow
Hardware Platform Creation (for custom hardware only)	Vivado® design tools
Create PetaLinux Project	`petalinux-create -t project`
Initialize PetaLinux Project (for custom hardware only)	`petalinux-config --get-hw-description`
Configure System-Level Options	`petalinux-config`
Create User Components	`petalinux-create -t COMPONENT`
Configure the Linux Kernel	`petalinux-config -c kernel`
Configure the Root Filesystem	`petalinux-config -c rootfs`
Build the System	`petalinux-build`
Package for Deploying the System	`petalinux-package`
Boot the System for Testing	`petalinux-boot`

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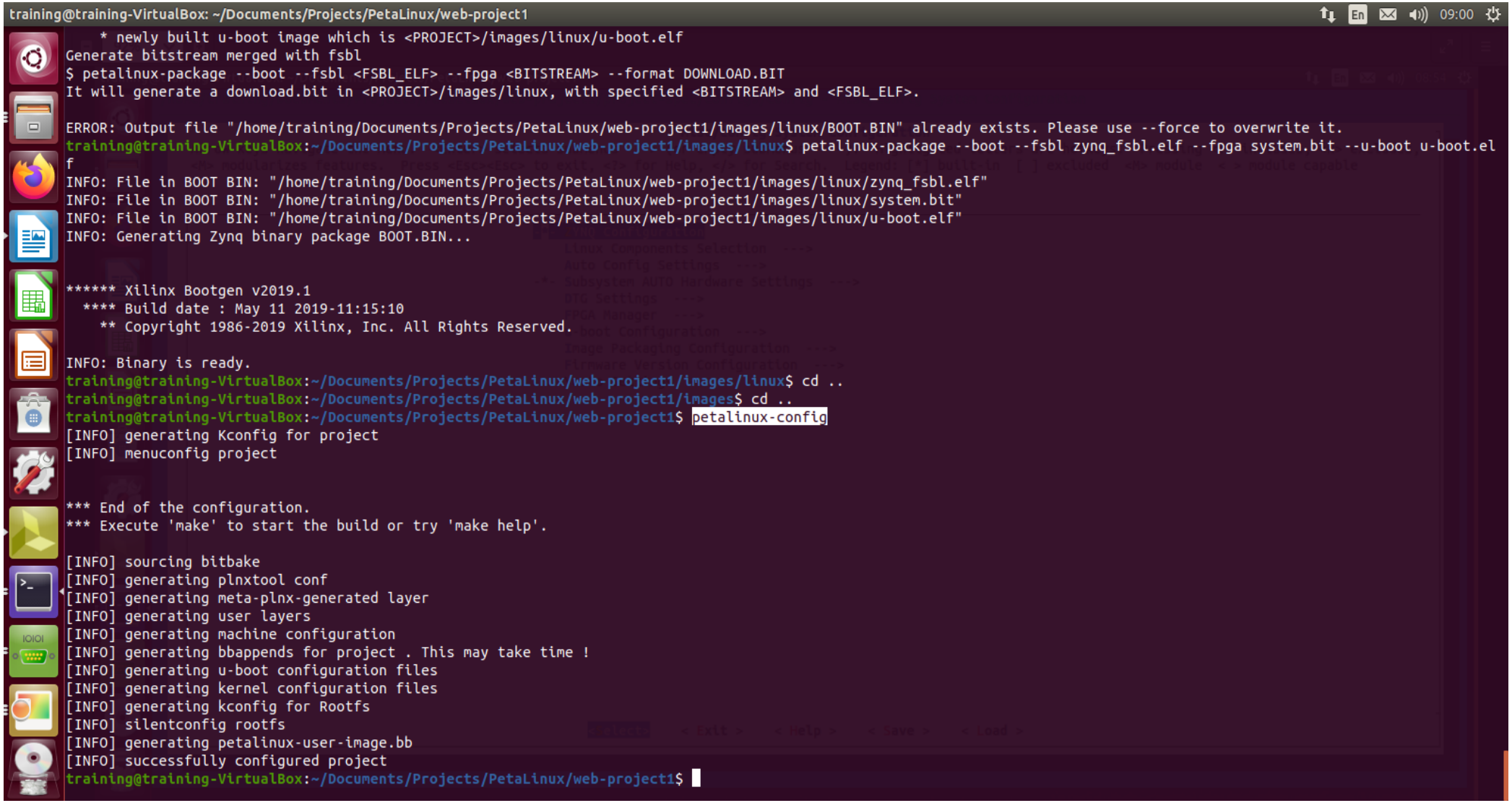
Embedded Linux SDK: PetaLinux



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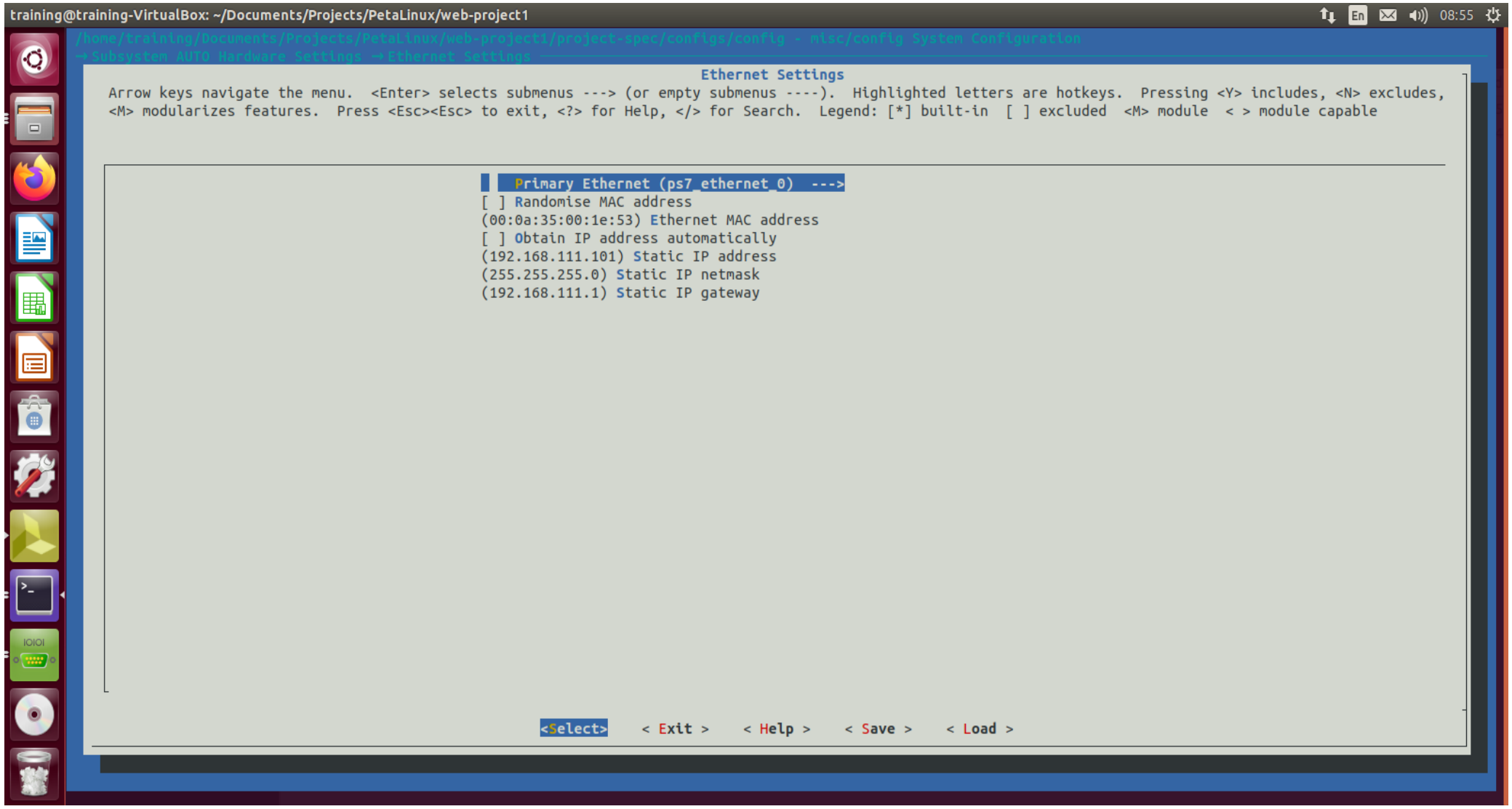
Embedded Linux SDK: Ethernet IP



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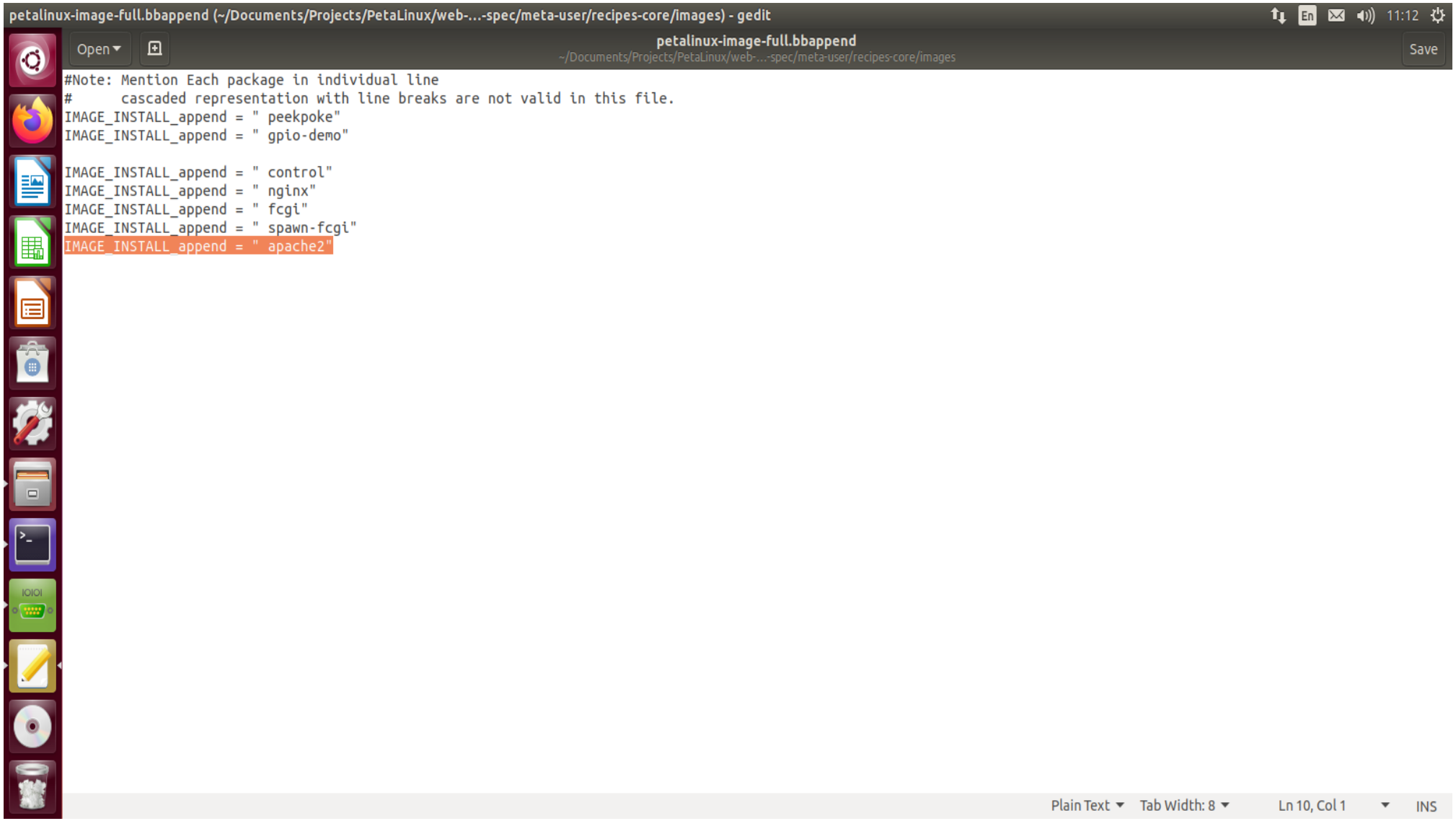
Embedded Linux SDK: Apache Web Server



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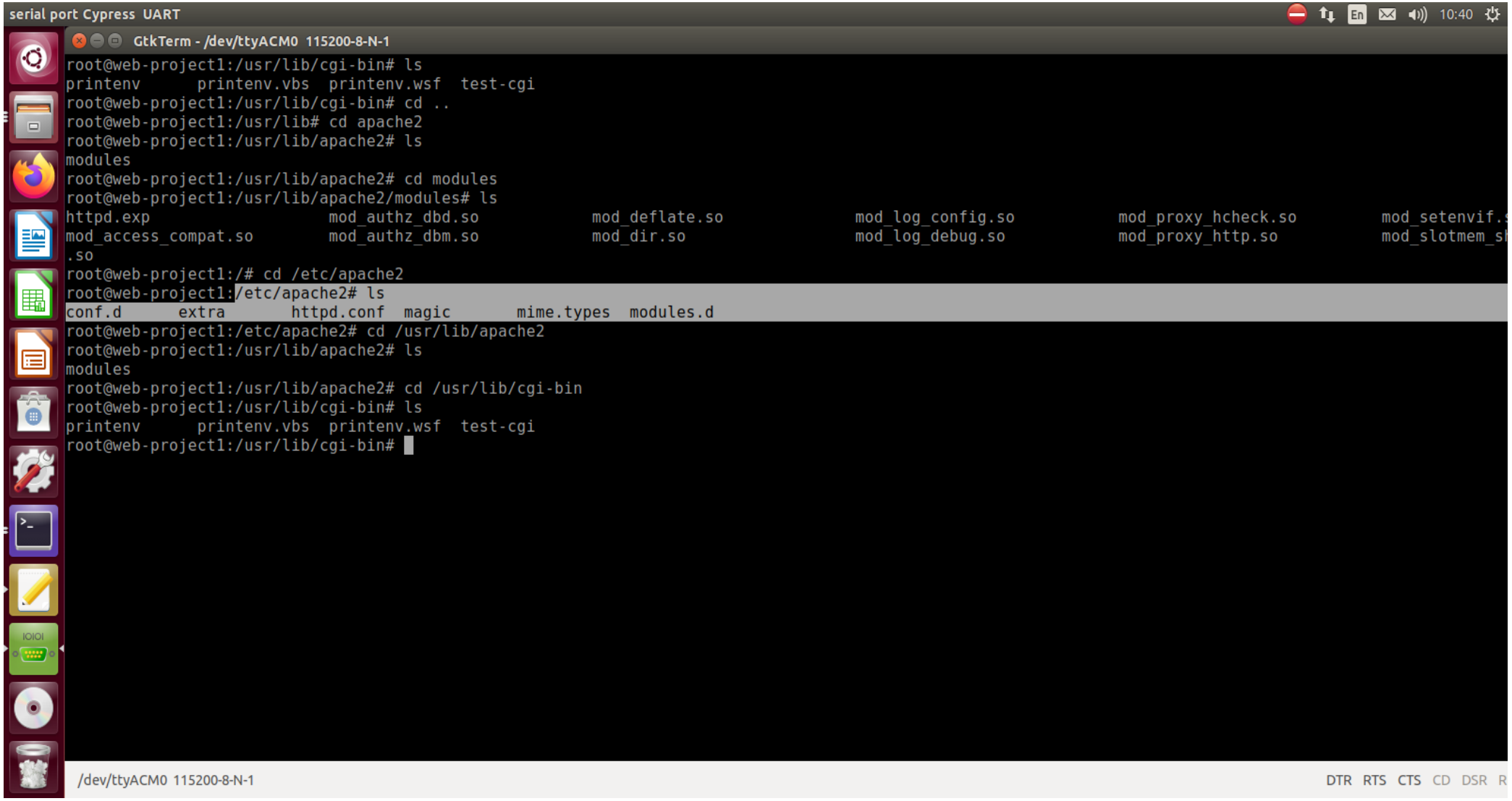
Embedded Linux SDK: Web Server Config. httpd.conf



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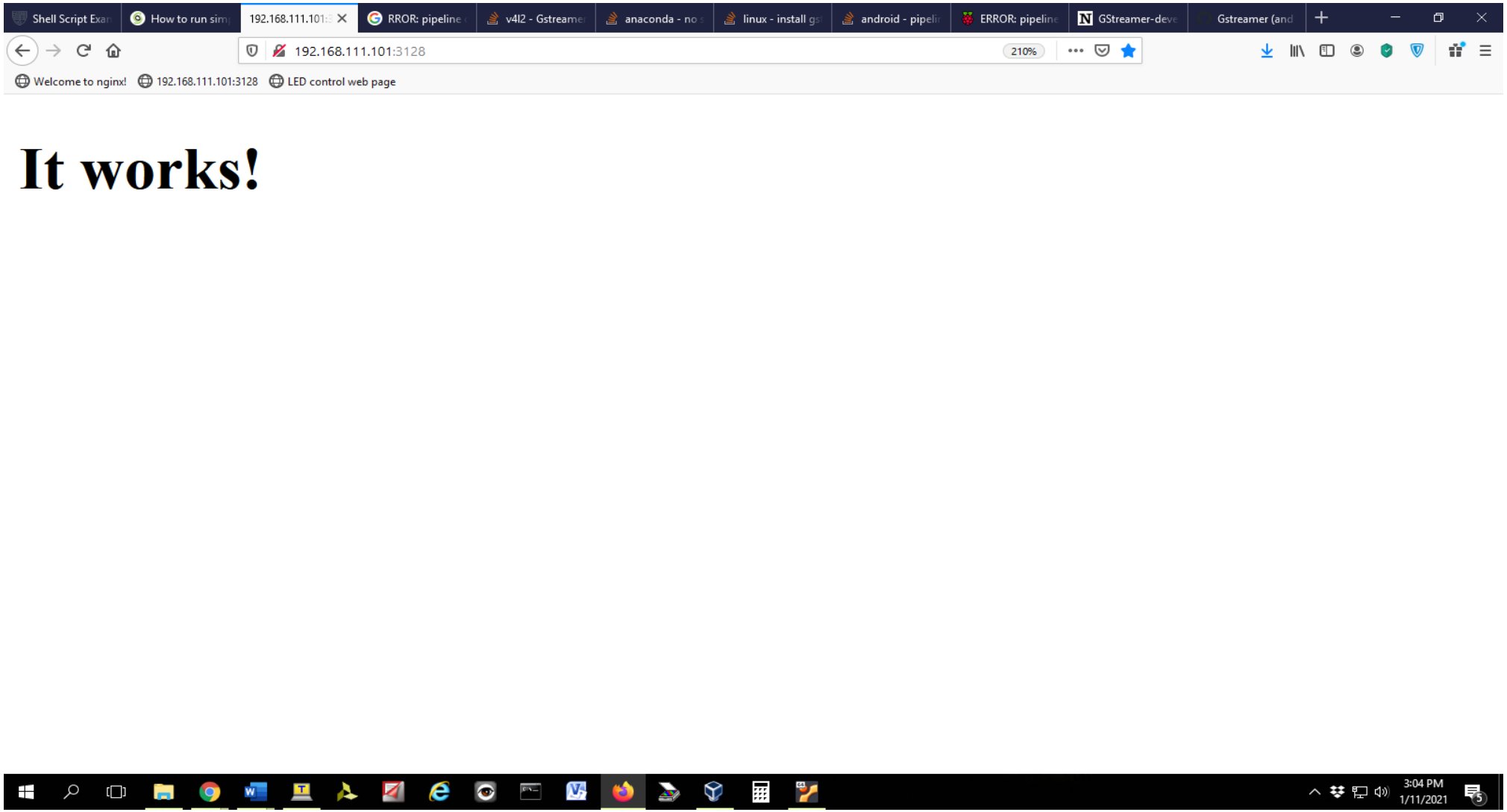
Host PC: Apache Web Server



Webcam Development using Zynq SoC

HTML Web Page Programming

HTML Web page

```
<html>
  <body>
     <h1>Hello there!</h1>
  </body>
</html>
```

Equivalent CGI script of HTML Web page

- Perl

```
#! /usr/bin/perl
print "Content-type: text/html\n\n";
print "<html><body><h1>Hello there!";
print "</h1></body></html>\n";
```

- C

```
#include <stdio.h>
Int main(){
     printf("Content-type: text/html\n\n");
     printf("<html>\n");
     printf("<body>\n");
     printf("<h1>Hello there!</h1>\n");
     printf("</body>\n");
     printf("</html>\n");
     return 0;
}
```

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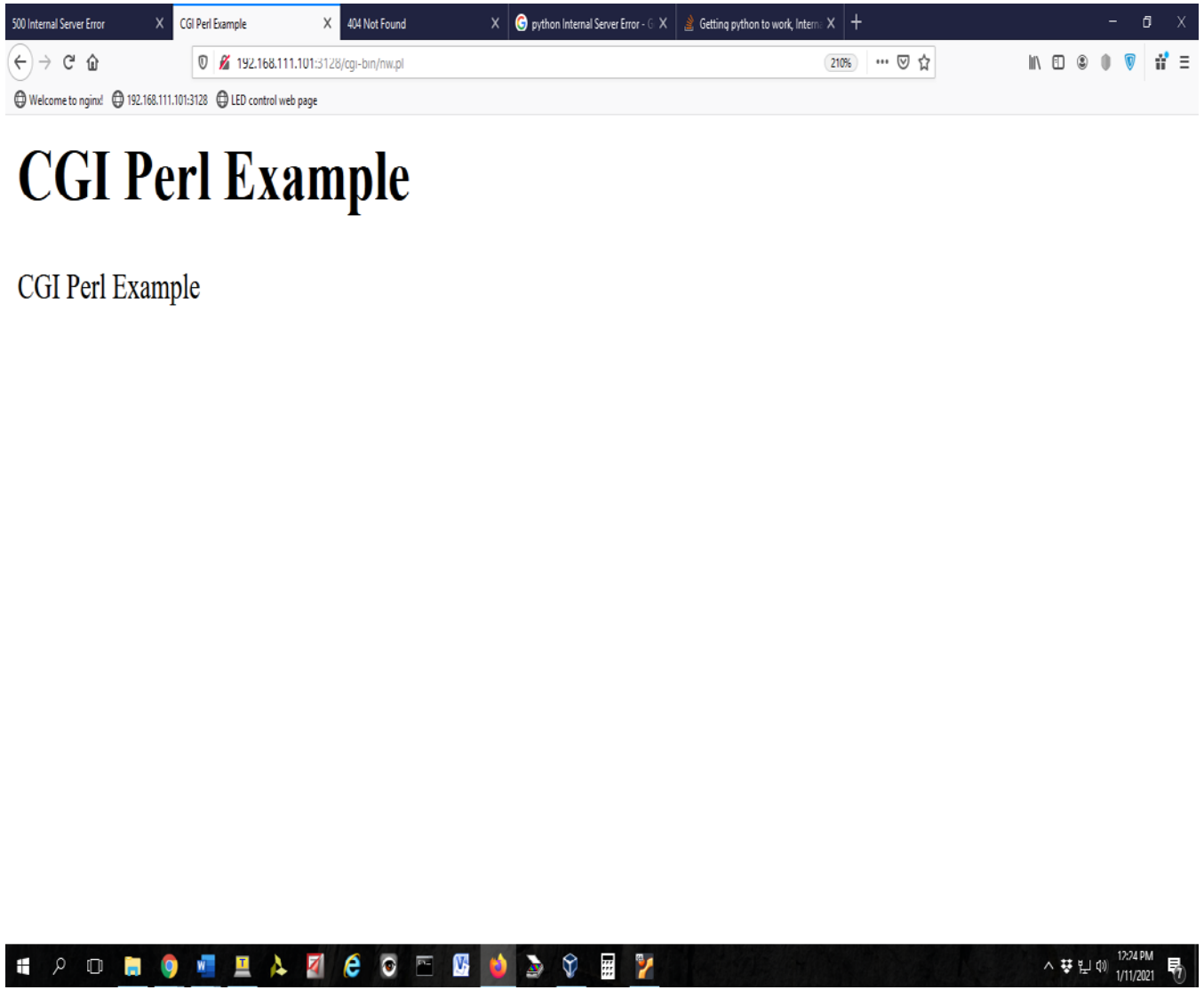
HTML Web Page Programming: Perl

Perl

```
#!/usr/bin/perl
print "Content-type: text/html\n\n";
print <<htmlcode;
<html>
<head>
<title>CGI Perl Example</title>
</head>
<body>
<h1>CGI Perl Example</h1>
<p>CGI Perl Example</p>
</body>
htmlcode
```



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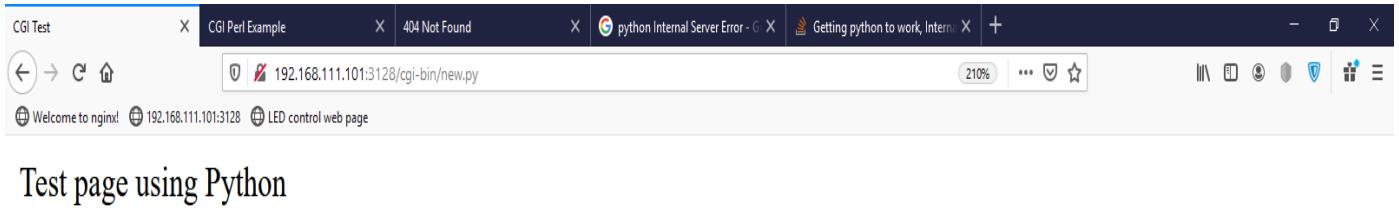
HTML Web Page Programming: Python

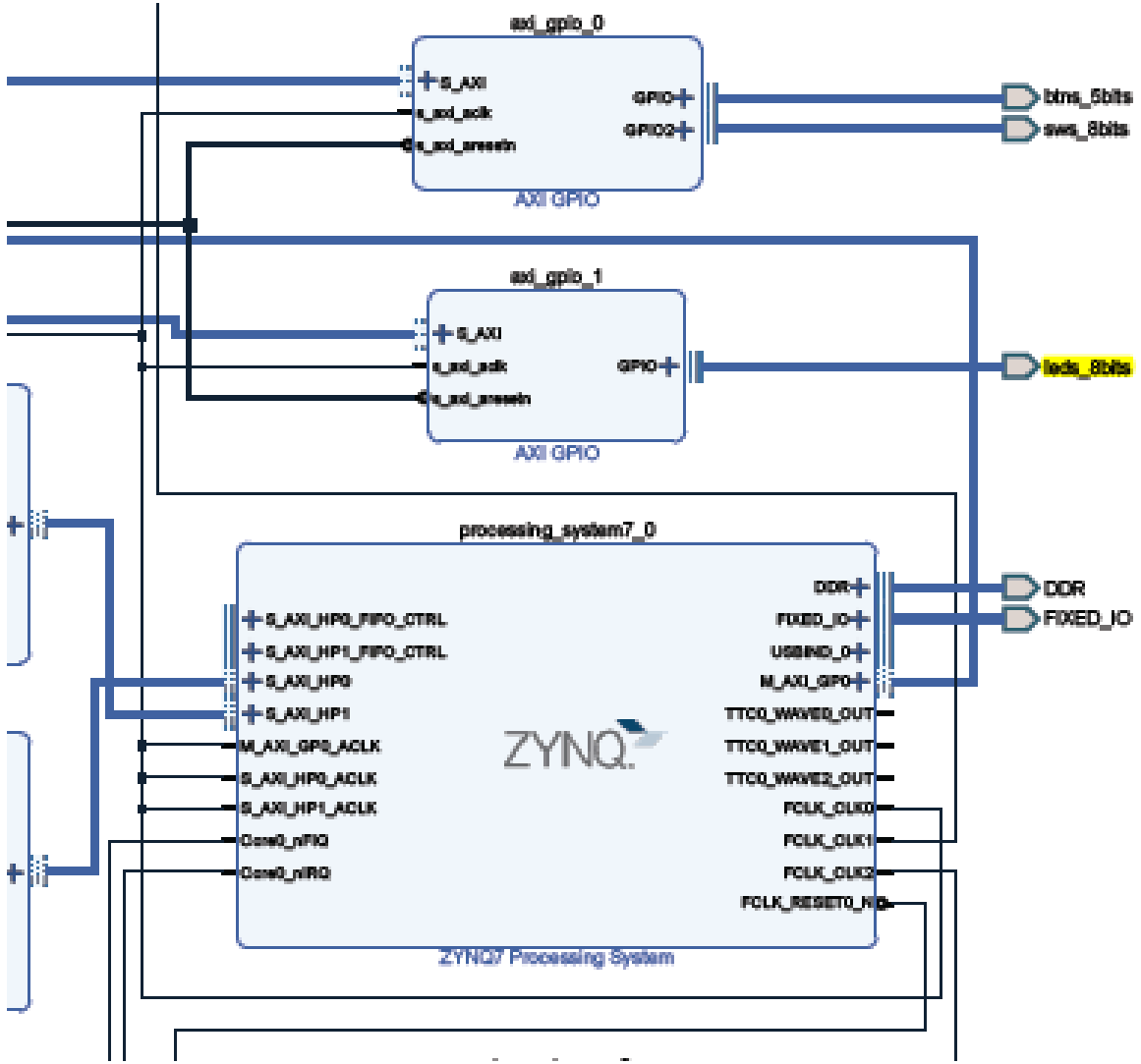
Python

```
#!/usr/bin/python2.7
print "Content-type: text/html\n\n";
print "<html><head>";
print "<title>CGI Test</title>";
print "</head><body>";
print "<p>Test page using Python</p>";
print "</body></html>";
```



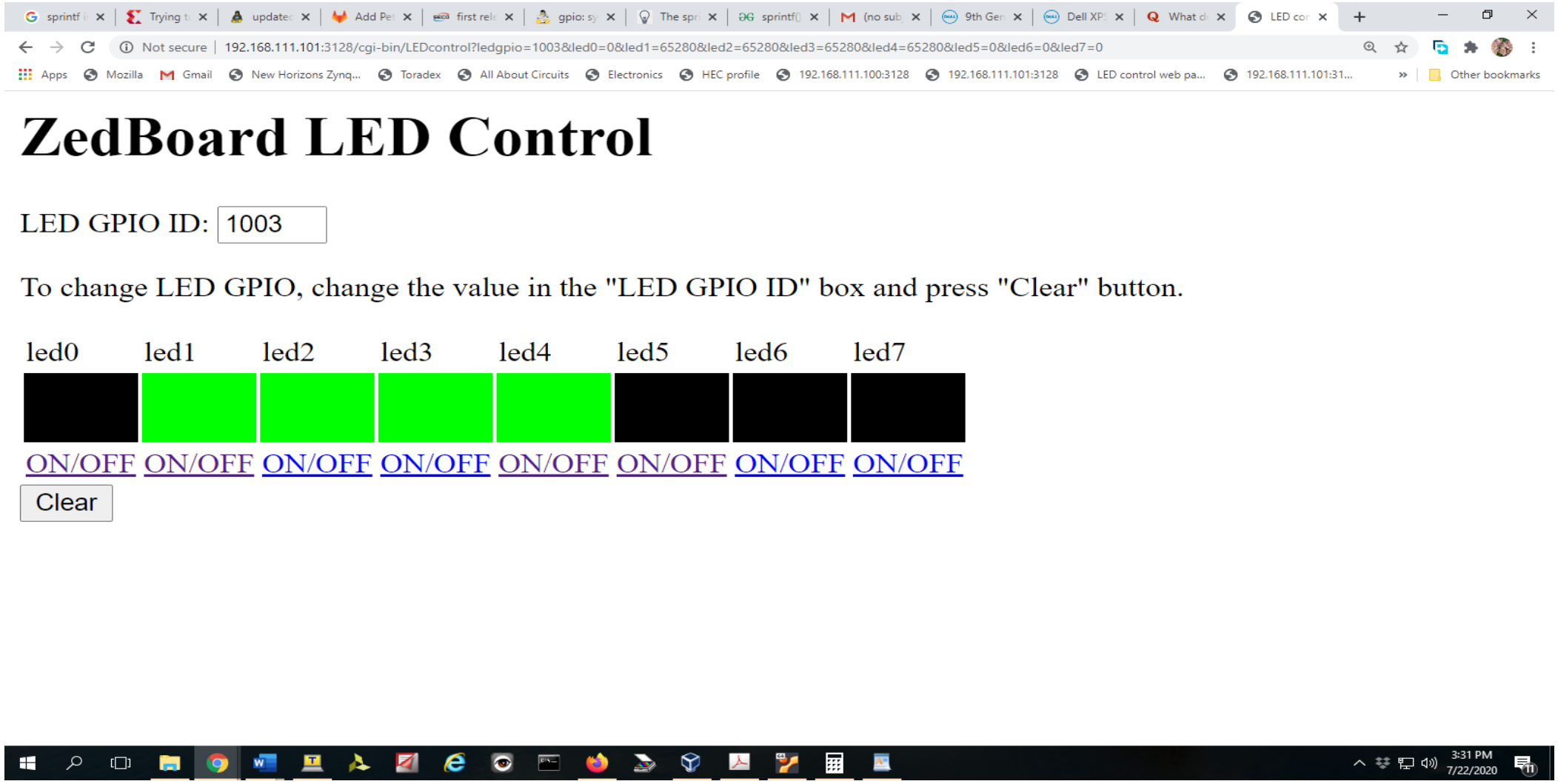
Webcam Development using Zynq SoC

Vivado Block Diagram: Zedboard LED



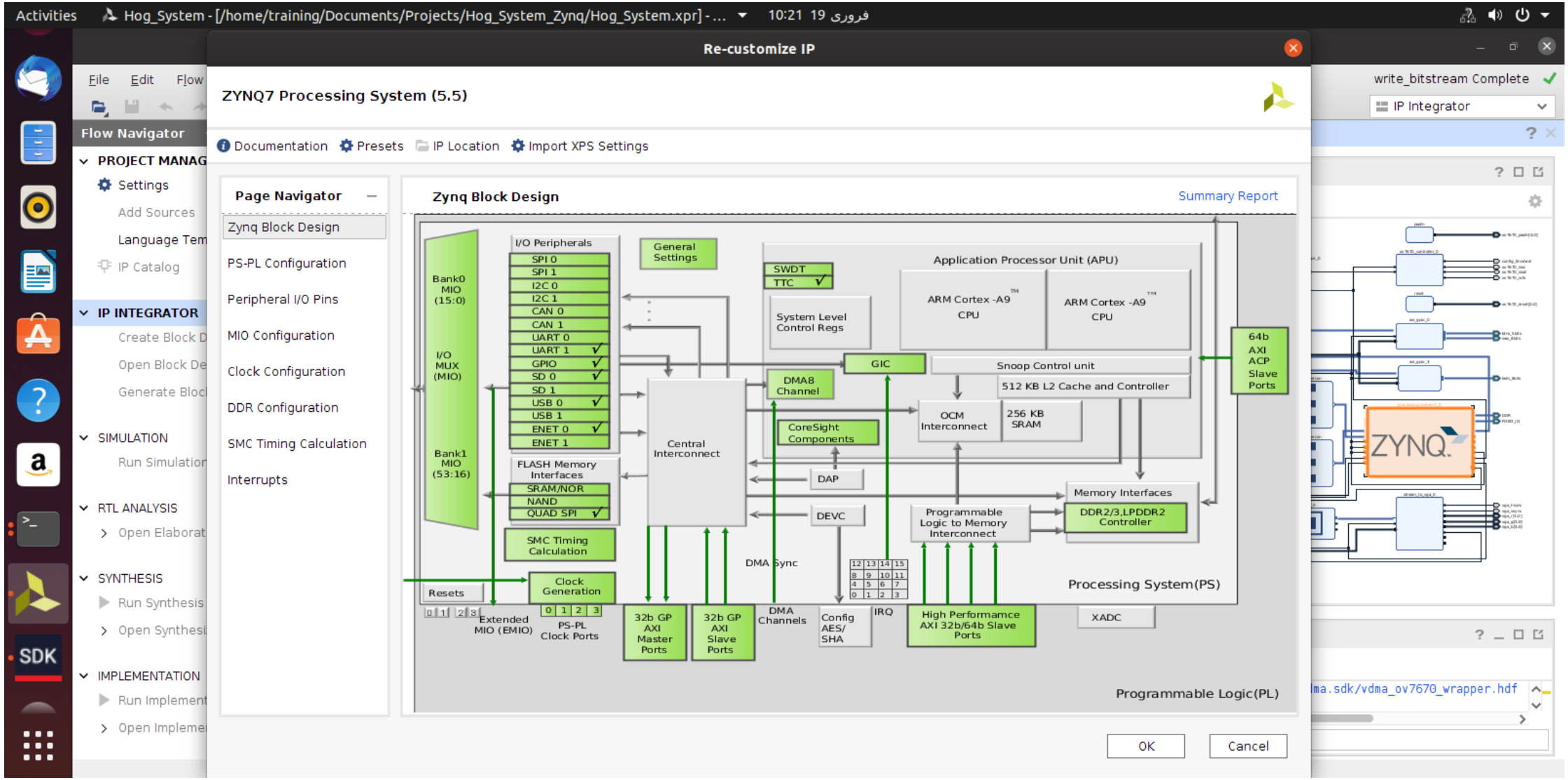
Webcam Development using Zynq SoC

Host PC: Zedboard LED Control



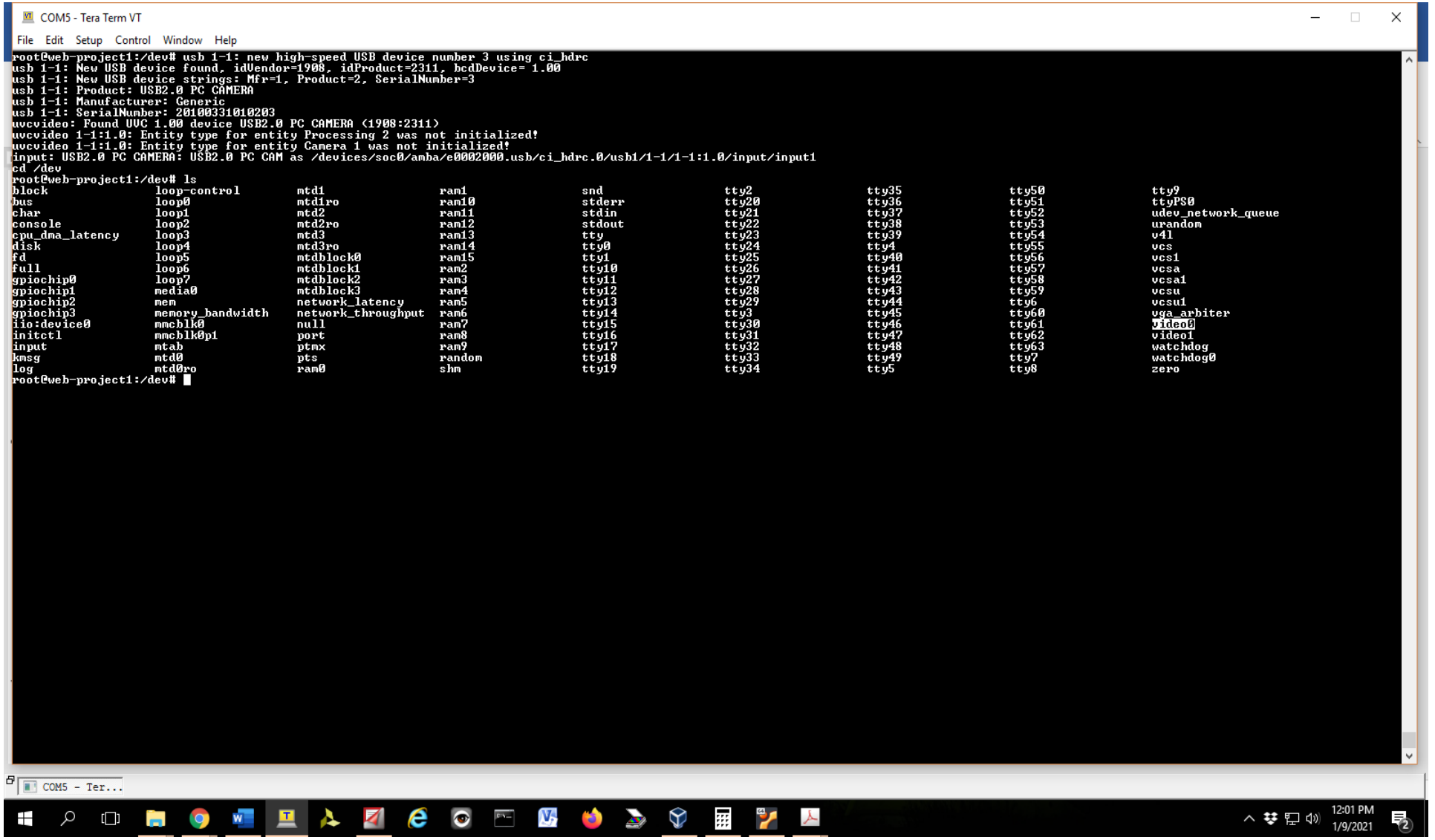
Webcam Development using Zynq SoC

Embedded Linux Drivers: Ethernet and USB



Webcam Development using Zynq SoC

Embedded Linux Drivers: USB Webcam



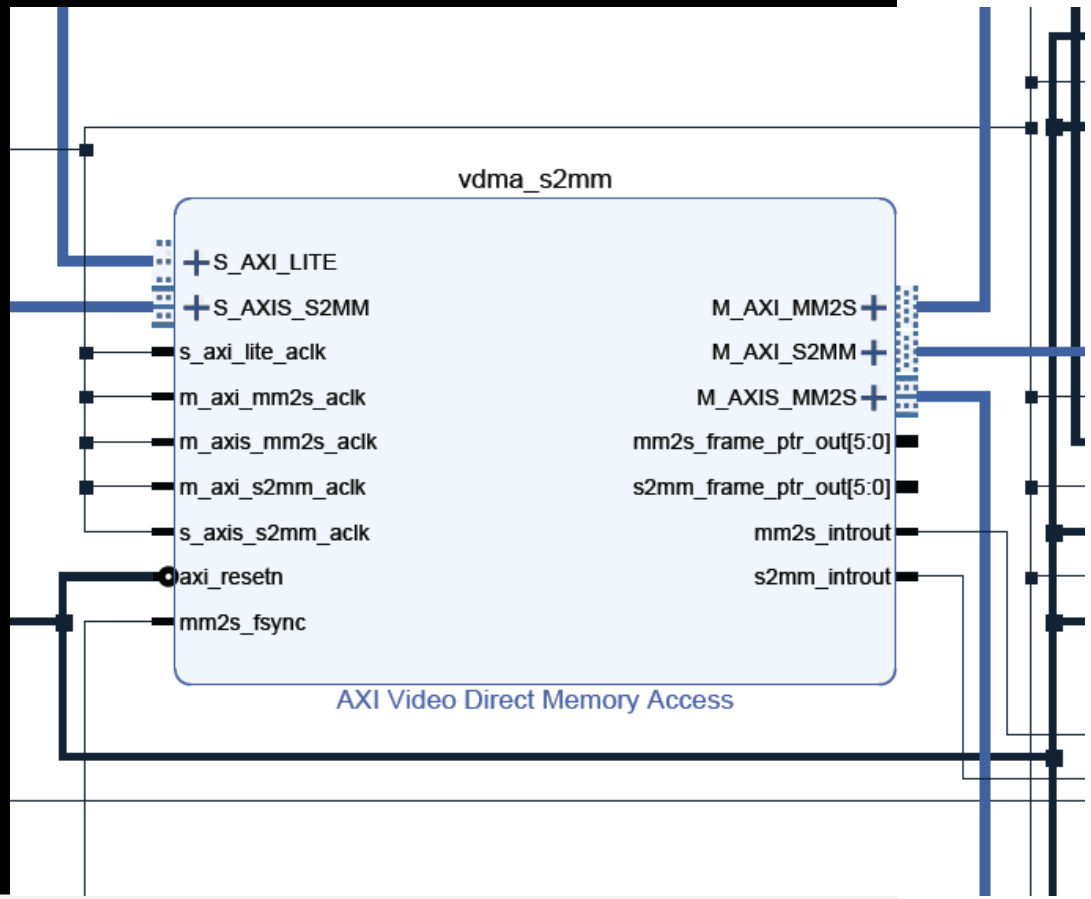
Webcam Development using Zynq SoC

Embedded Linux Drivers: AXI VDMA (Generic)

GtkTerm - /dev/ttyACM0 115200-8-N-1

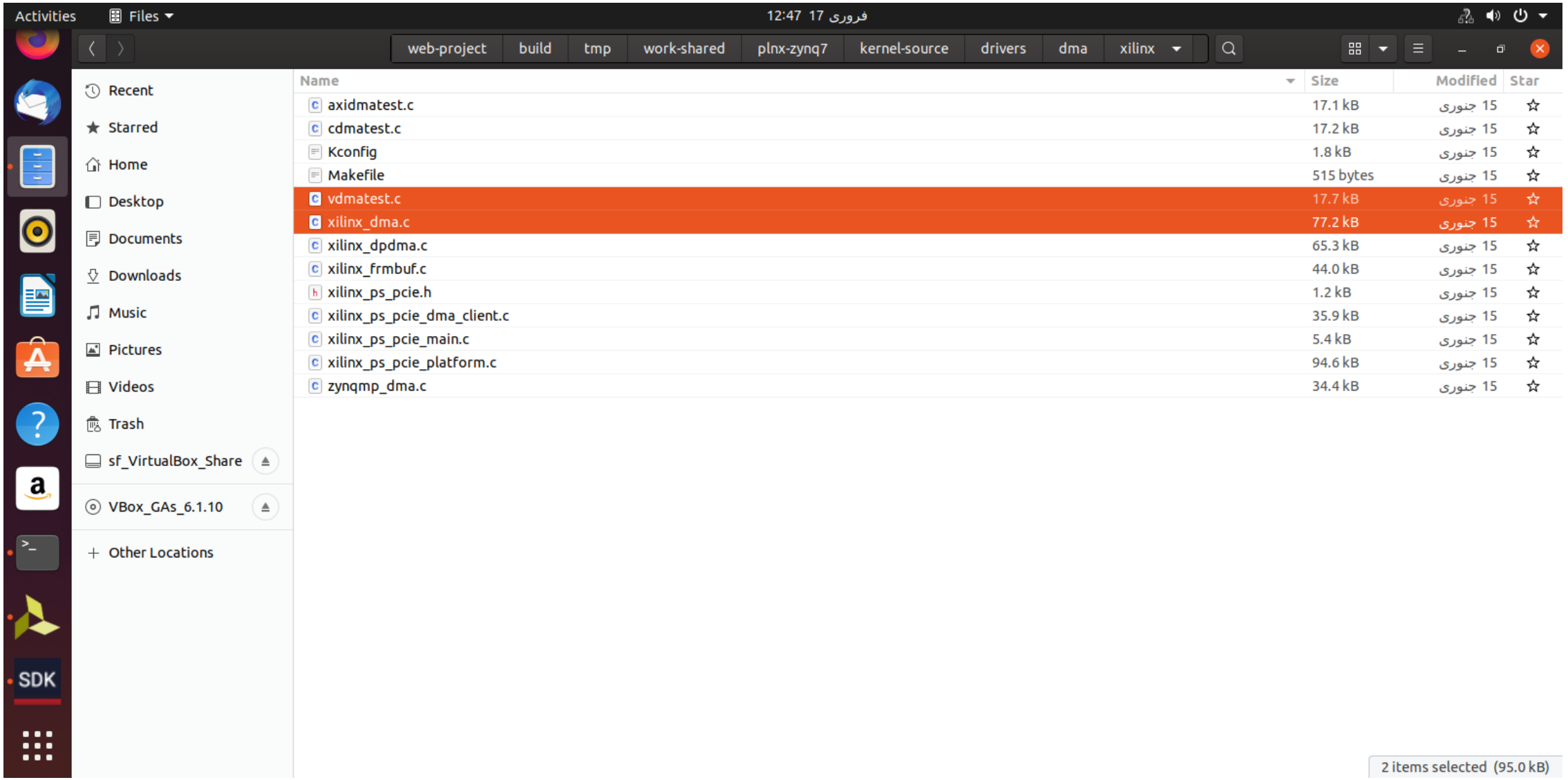
```
tcp_listen_portaddr_hash hash table entries: 512 (order: 0, 6144 bytes)
TCP established hash table entries: 4096 (order: 2, 16384 bytes)
TCP bind hash table entries: 4096 (order: 3, 32768 bytes)
TCP: Hash tables configured (established 4096 bind 4096)
UDP hash table entries: 256 (order: 1, 8192 bytes)
UDP-Lite hash table entries: 256 (order: 1, 8192 bytes)
NET: Registered protocol family 1
RPC: Registered named UNIX socket transport module.
RPC: Registered udp transport module.
RPC: Registered tcp transport module.
RPC: Registered tcp NFSv4.1 backchannel transport module.
PCI: CLS 0 bytes, default 64
Trying to unpack rootfs image as initramfs...
Freeing initrd memory: 53884K
hw perfevents: no interrupt-affinity property for /pmu@f8891000, guessing.
hw perfevents: enabled with armv7_cortex_a9 PMU driver, 7 counters available
workingset: timestamp_bits=30 max_order=17 bucket_order=0
jffs2: version 2.2. (NAND) (SUMMARY)  © 2001-2006 Red Hat, Inc.
io scheduler noop registered
io scheduler deadline registered
io scheduler cfq registered (default)
io scheduler mq-deadline registered
io scheduler kyber registered
dma-pl330 f8003000.dmac: Loaded driver for PL330 DMAC-241330
dma-pl330 f8003000.dmac:        DBUFF-128x8bytes Num_Chans-8 Num_Peri-4 Num_Events-16
xilinx-vdma 42000000.dma: Xilinx AXI VDMA Engine Driver Probed!!
xilinx-vdma 43000000.dma: Xilinx AXI VDMA Engine Driver Probed!!
brd: module loaded
loop: module loaded
m25p80 spi0.0: found s25fl256s1, expected n25q512a
m25p80 spi0.0: s25fl256s1 (32768 Kbytes)
4 fixed-partitions partitions found on MTD device spi0.0
Creating 4 MTD partitions on "spi0.0":
0x000000000000-0x000000500000 : "boot"
0x000000500000-0x000000520000 : "bootenv"
0x000nel"
0x000000fa0000-0x000002000000 : "spare"
libphy: Fixed MDIO Bus: probed
```

/dev/ttyACM0 115200-8-N-1 DTR RTS CTS CD DSR RI



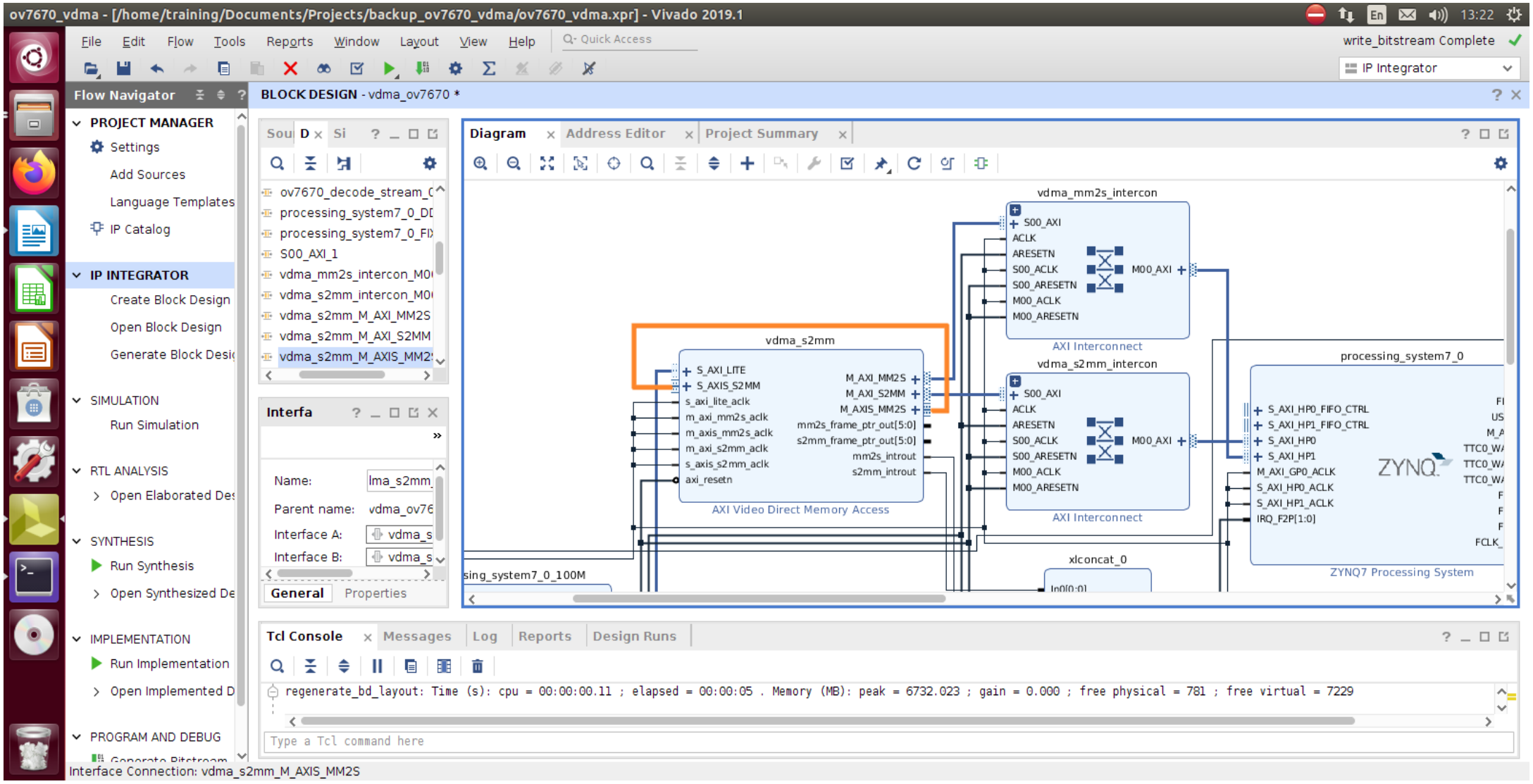
Webcam Development using Zynq SoC

Embedded Linux Drivers: AXI VDMA (Generic)



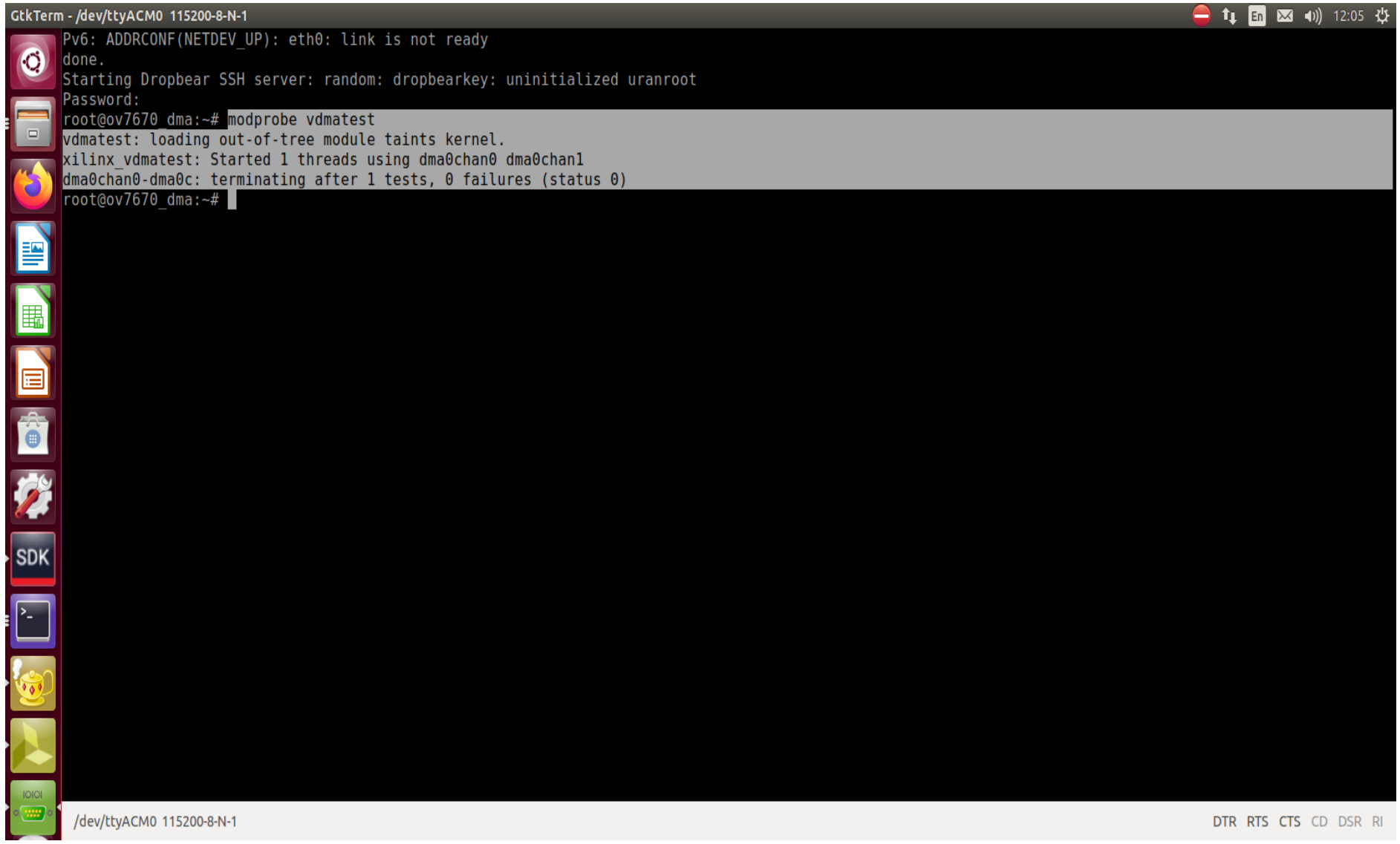
Webcam Development using Zynq SoC

AXI VDMA Driver: Self test



Webcam Development using Zynq SoC

Linux Kernel module: vdmatest.c



Thanks

- Organizers
- Faculty Members
- Lab Tutors

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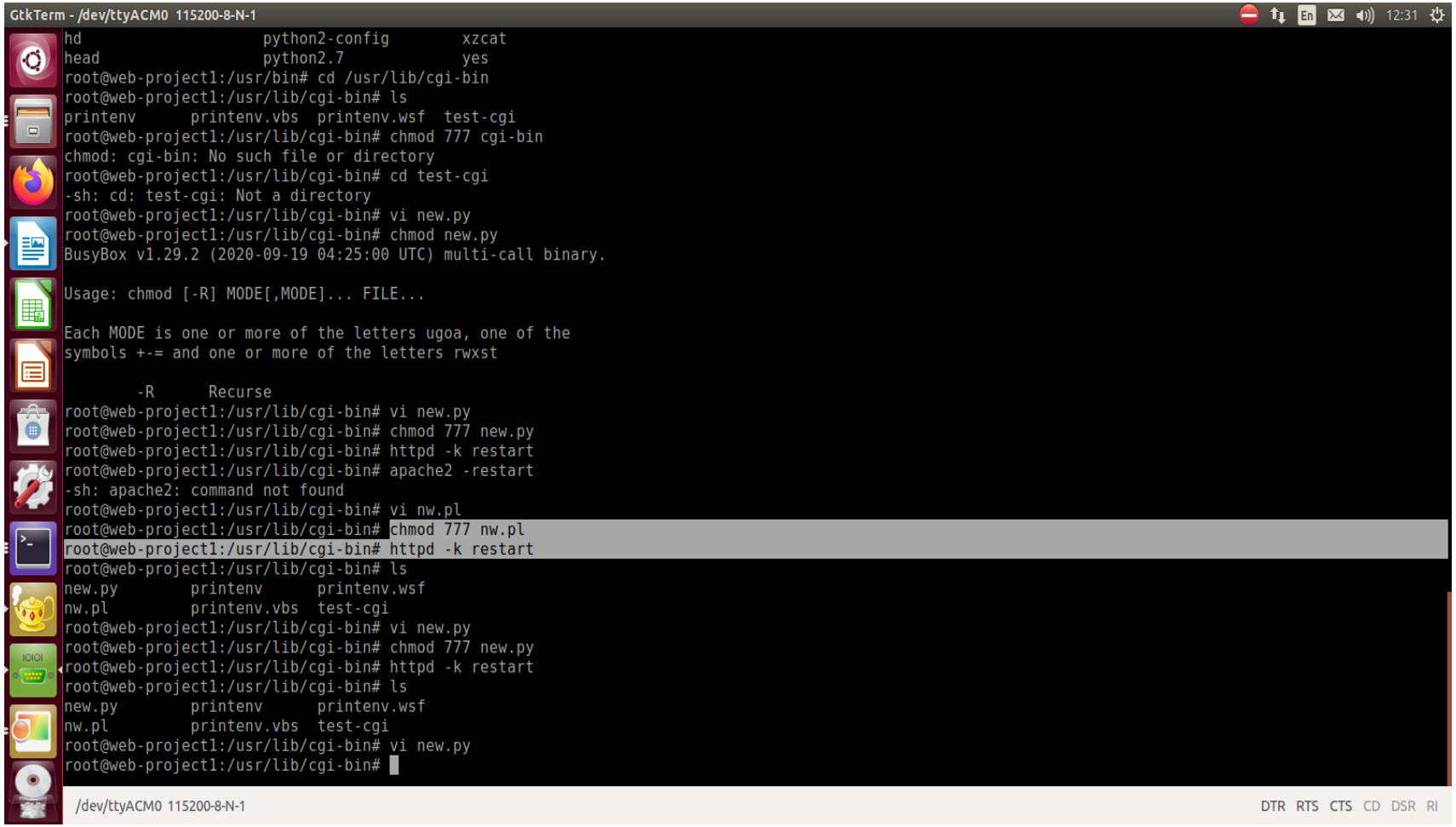
In the name of Allah, the Gracious, the Merciful.

Read [O Prophet] in the name of thy Lord Who created [96:1], Created man from a clot of blood [96:2]. Read, and your Lord is Most Honorable [96:3], Who taught with the pen [96:4], Taught man what he knew not [96:5].

Holy Quran [96:1-5]

Webcam Development using Zynq SoC

Embedded Linux: Web Page Programming

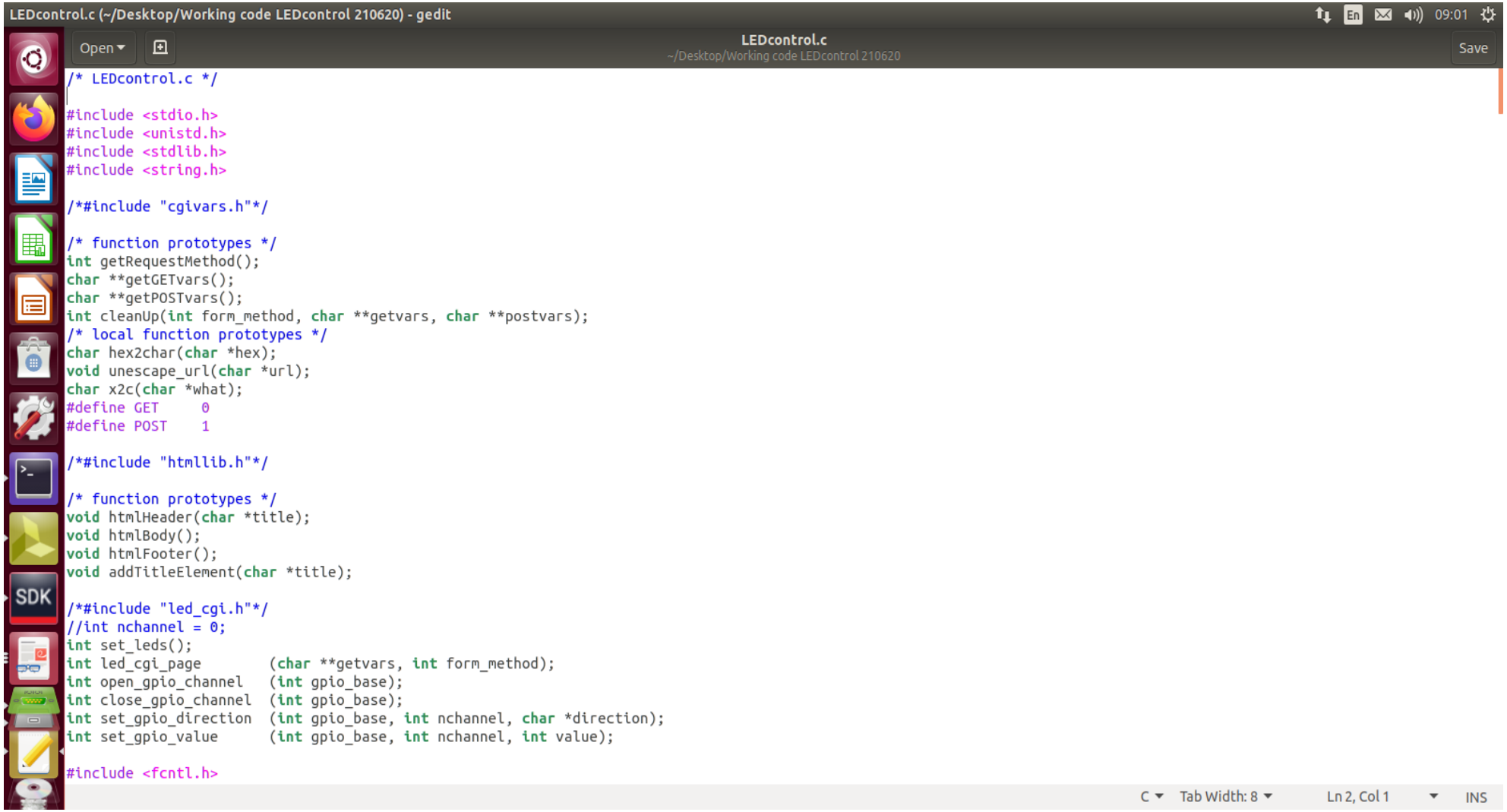


Perl

```
#!/usr/bin/perl
print "Content-type: text/html\n\n";
print <<htmlcode;
<html>
<head>
<title>CGI Perl Example</title>
</head>
<body>
<h1>CGI Perl Example</h1>
<p>CGI Perl Example</p>
</body>
htmlcode
```

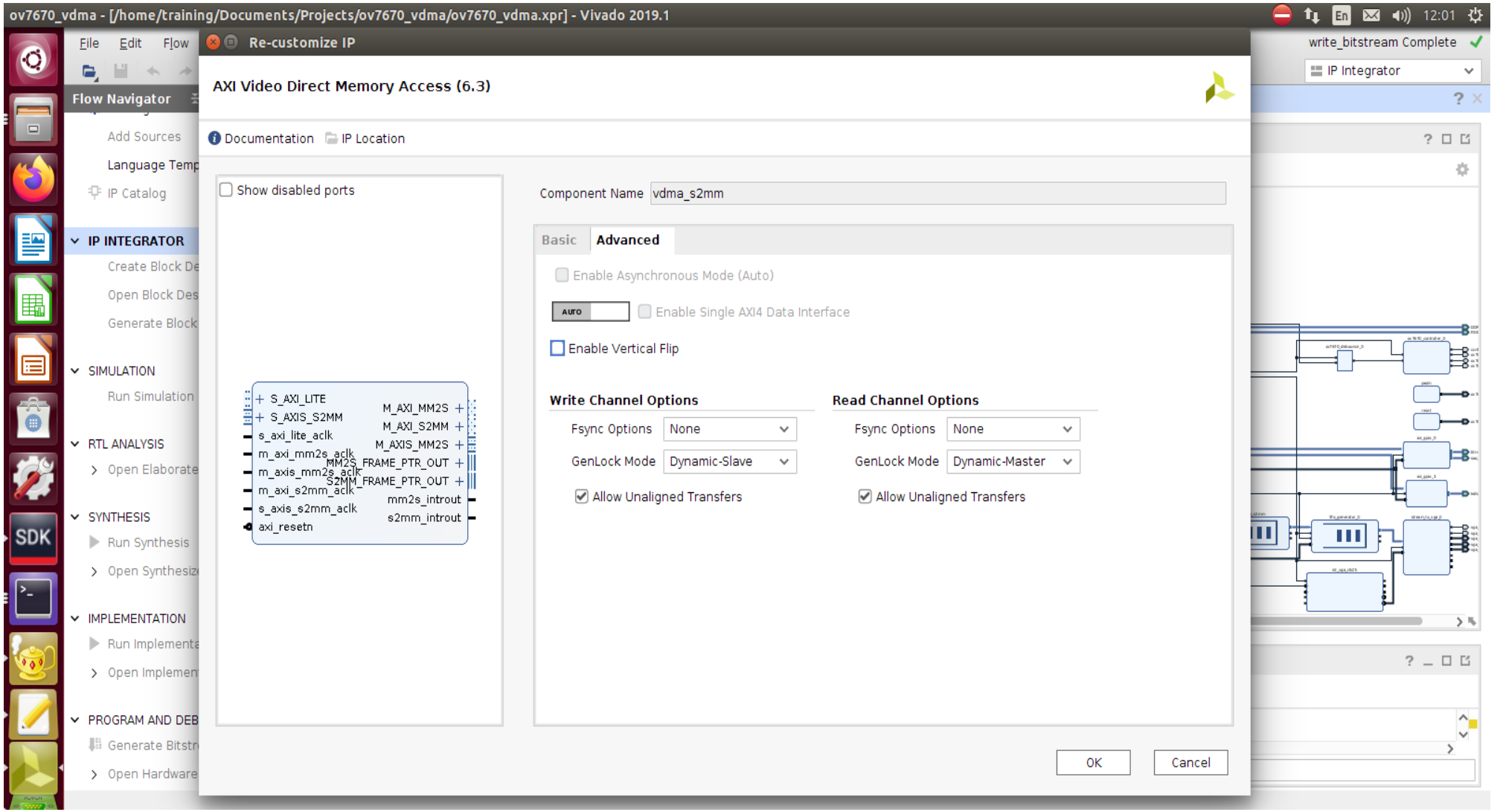
Webcam Development using Zynq SoC

HTML Web Page Programming: C (LED control)



Webcam Development using Zynq SoC

Vivado VDMA Self test setting



Webcam Development using Zynq SoC

VDMAtest.c