How to use
High-level synthesis

What’s High level synthesis?

- Convert software language to HDL
- VIVADO HLS offers platform that users can use C for FPGA implementation

What’s FPGA

- Field Programmable Gate Array
  - Users can reconfigure logic circuit by programming behavior
- Users can make any hardware as they like

Brief outline

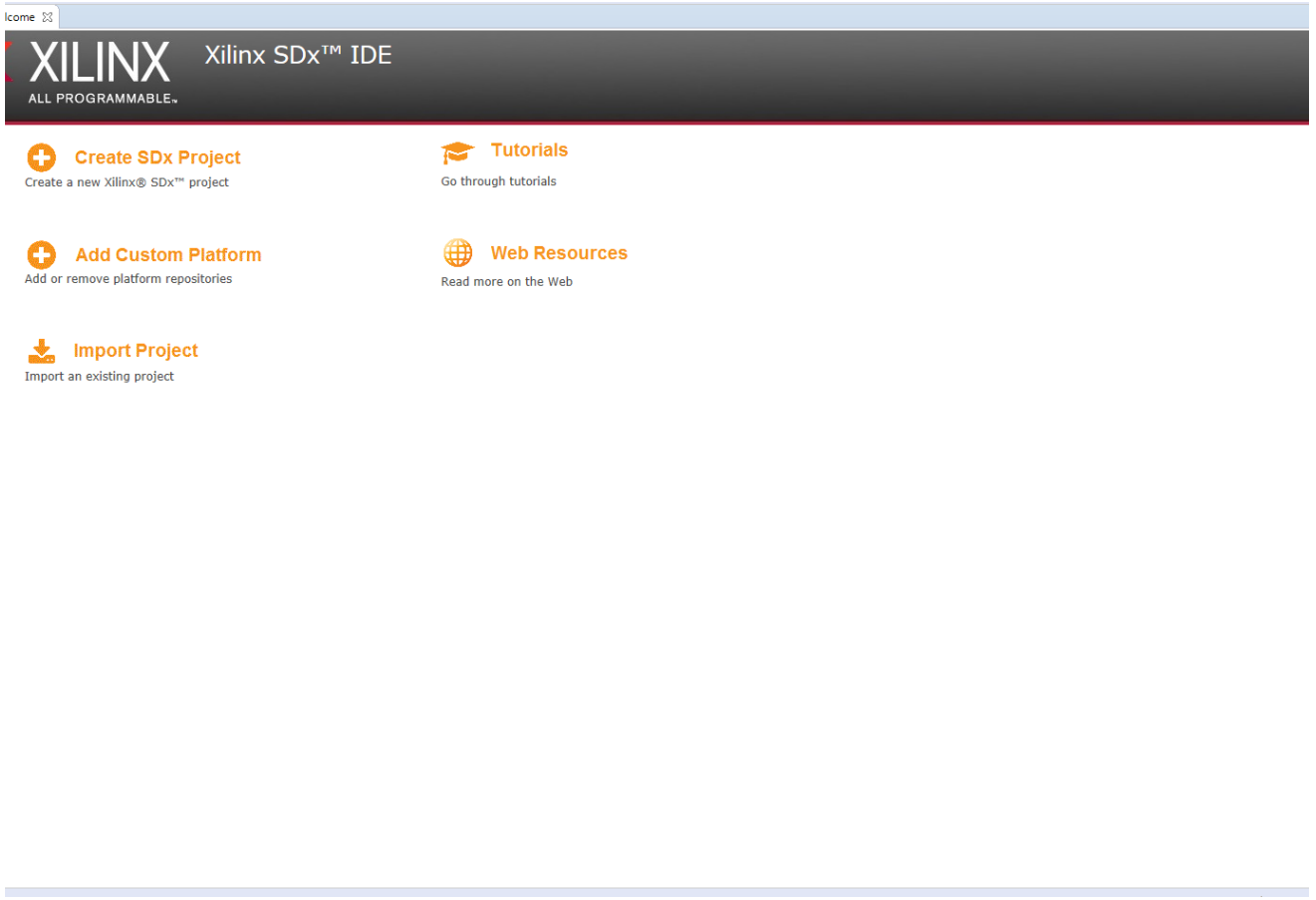
- Try high-level synthesize by using VIVADO HLS
  - Write Deep Learning code
  - Synthesize code and make bitstream file
  - Implement on FPGA

1. Run software

- Prepare FPGA “ZedBoard”
- Install “SDx IDE 2018.1”
- Run “SDx IDE 2018.1”

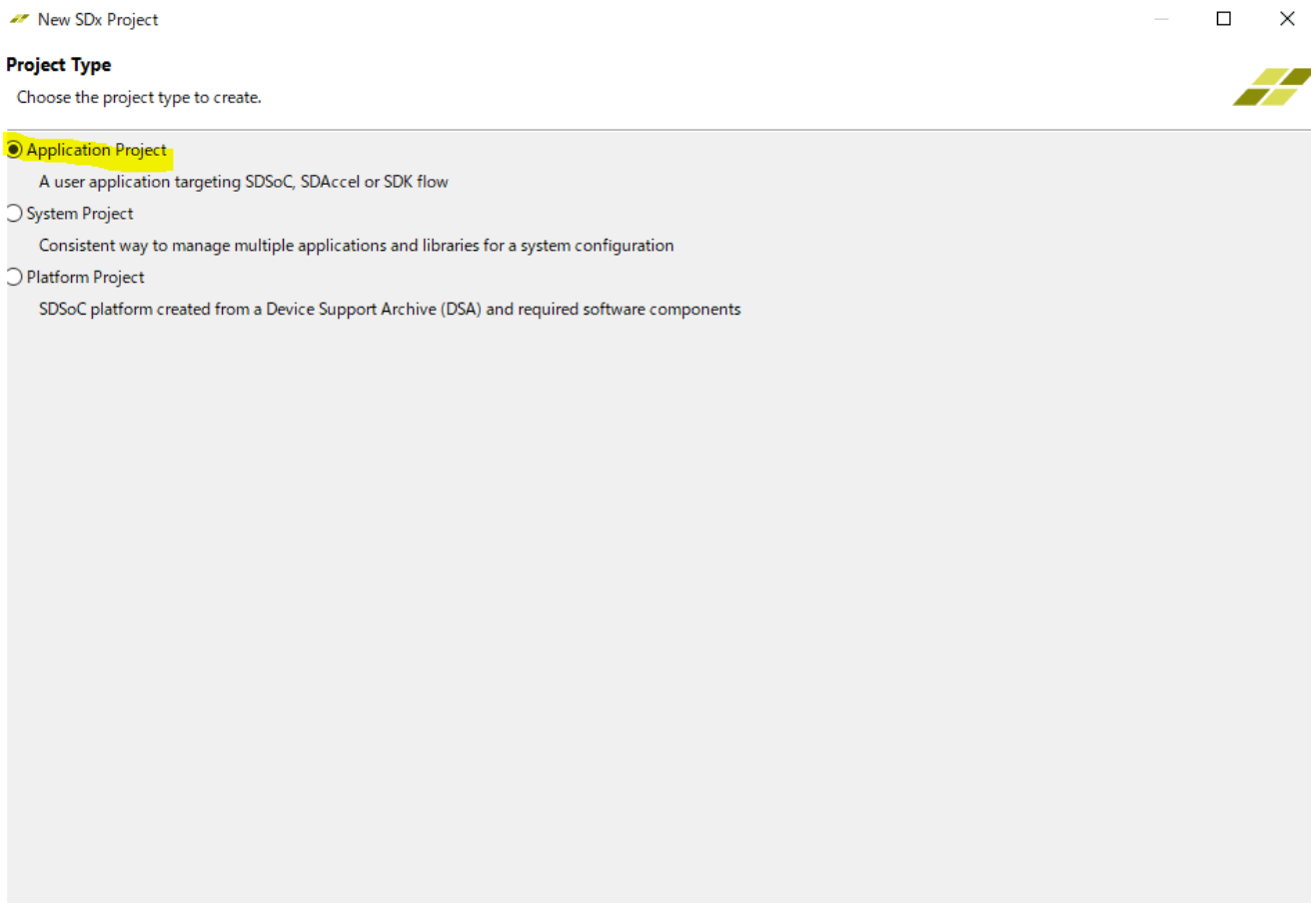
Create SDx Project

- Select “Create SDx Project”



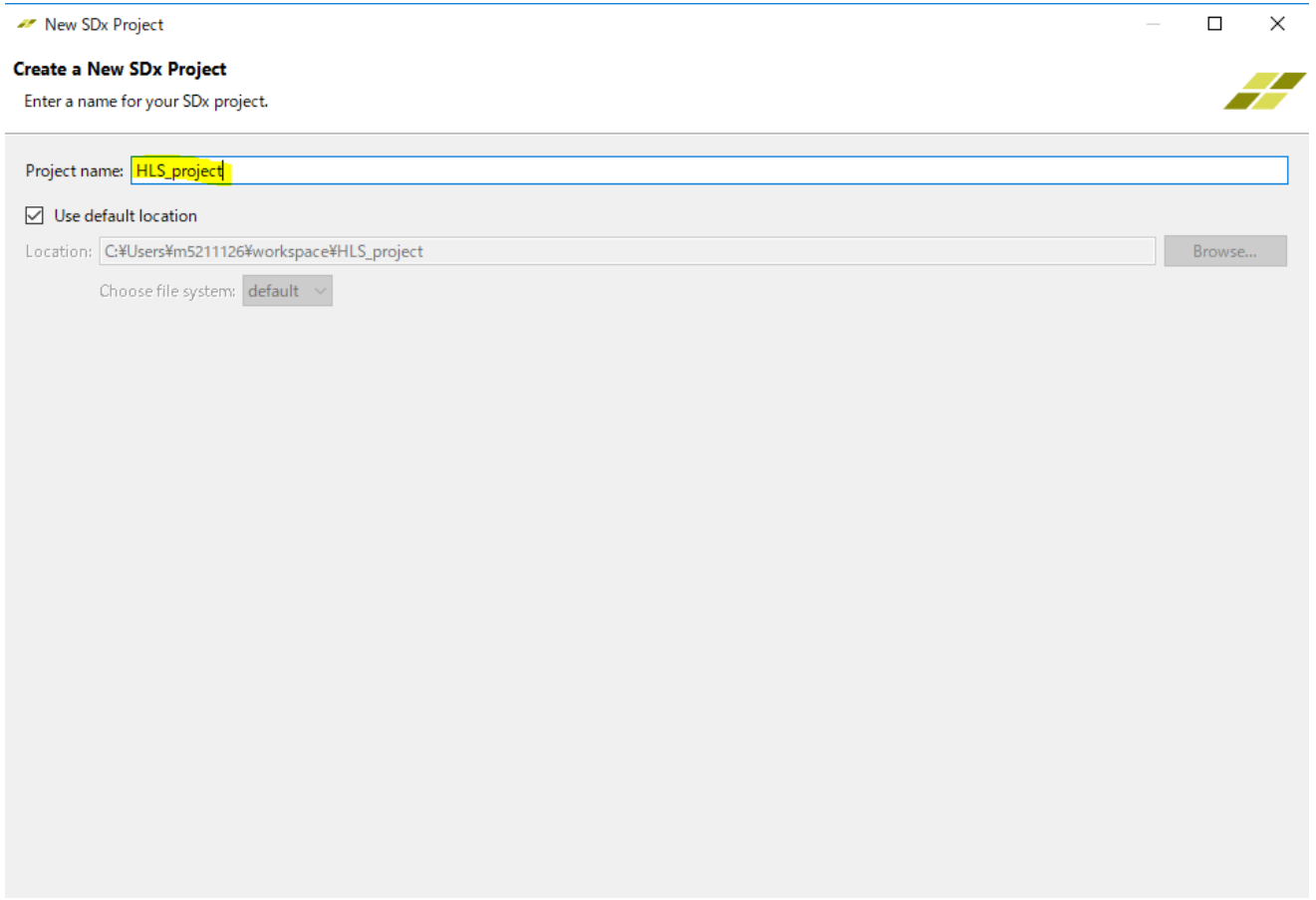
Project type

- Select “Application Project”



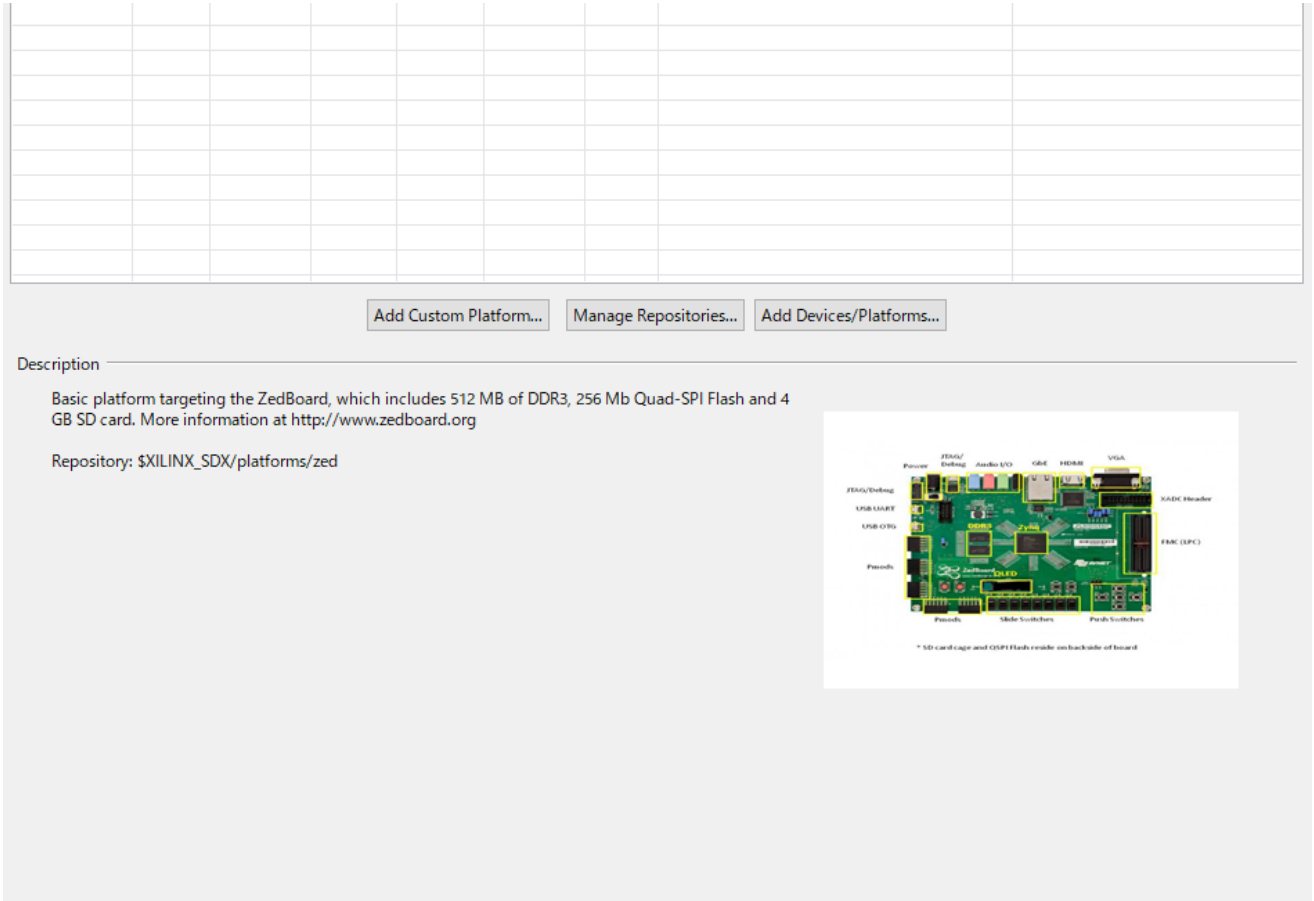
Enter project name

- Set “HLS_project”



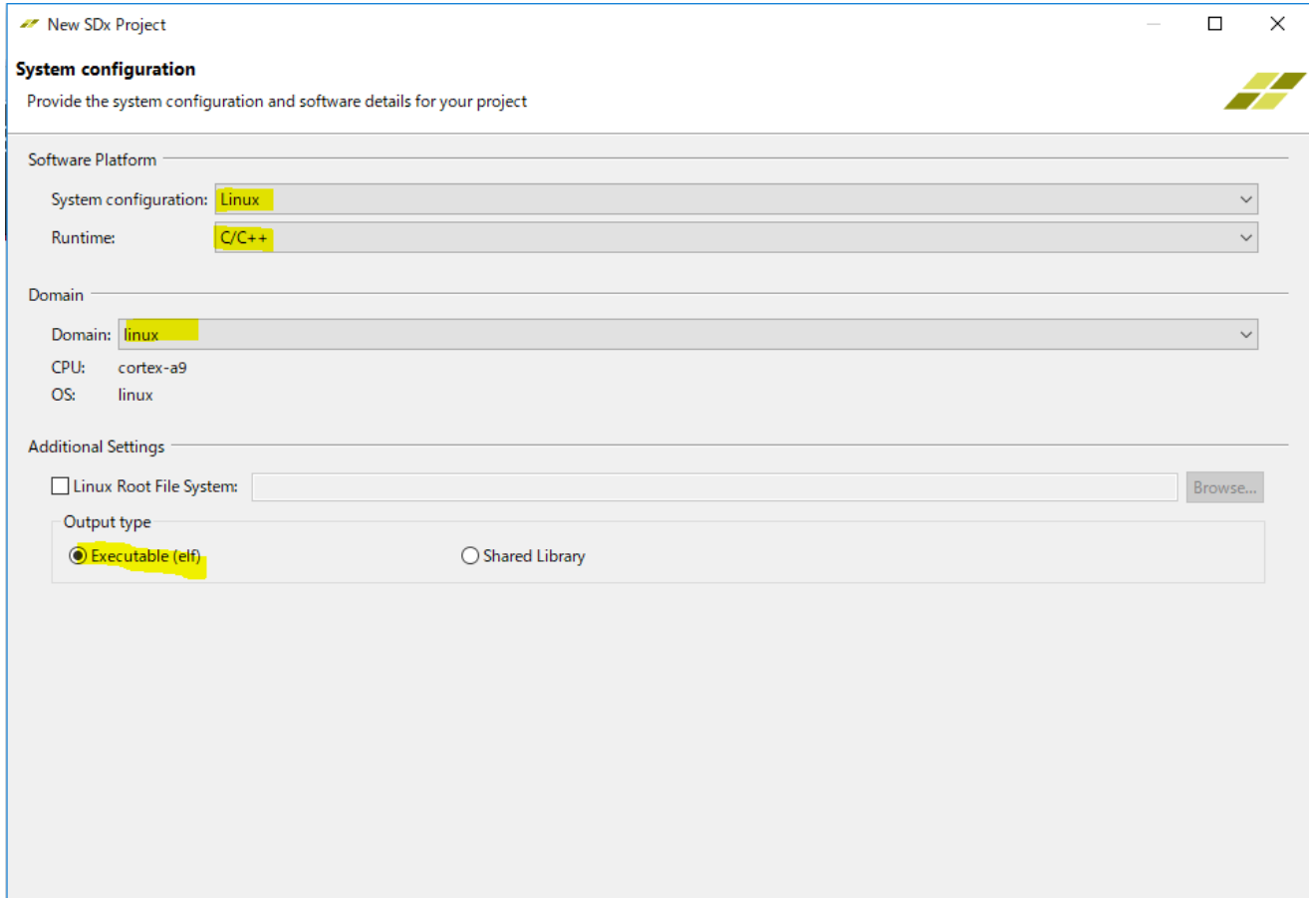
Platform

- Select “Zed Board”



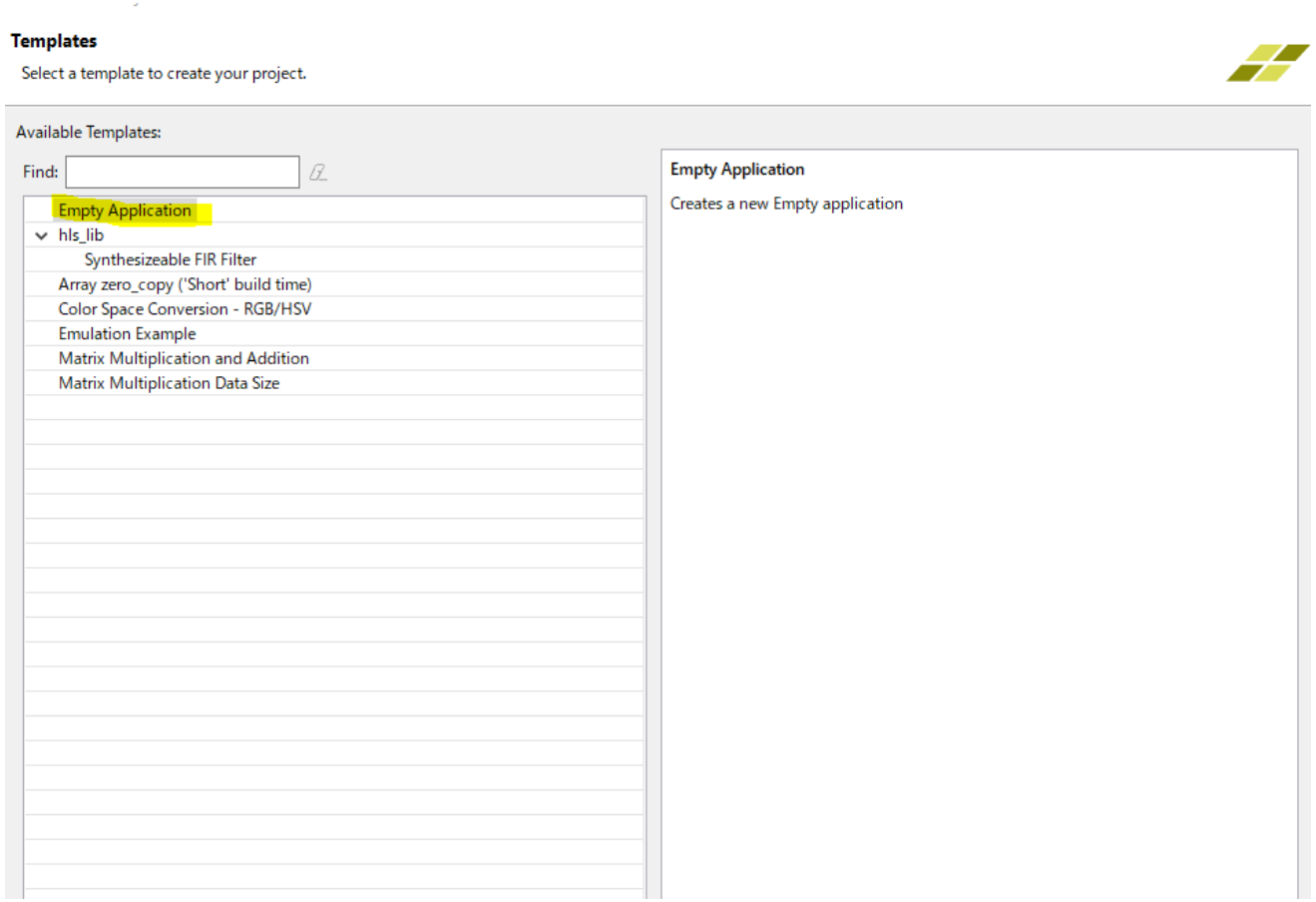
System configuration

- Set as like the image



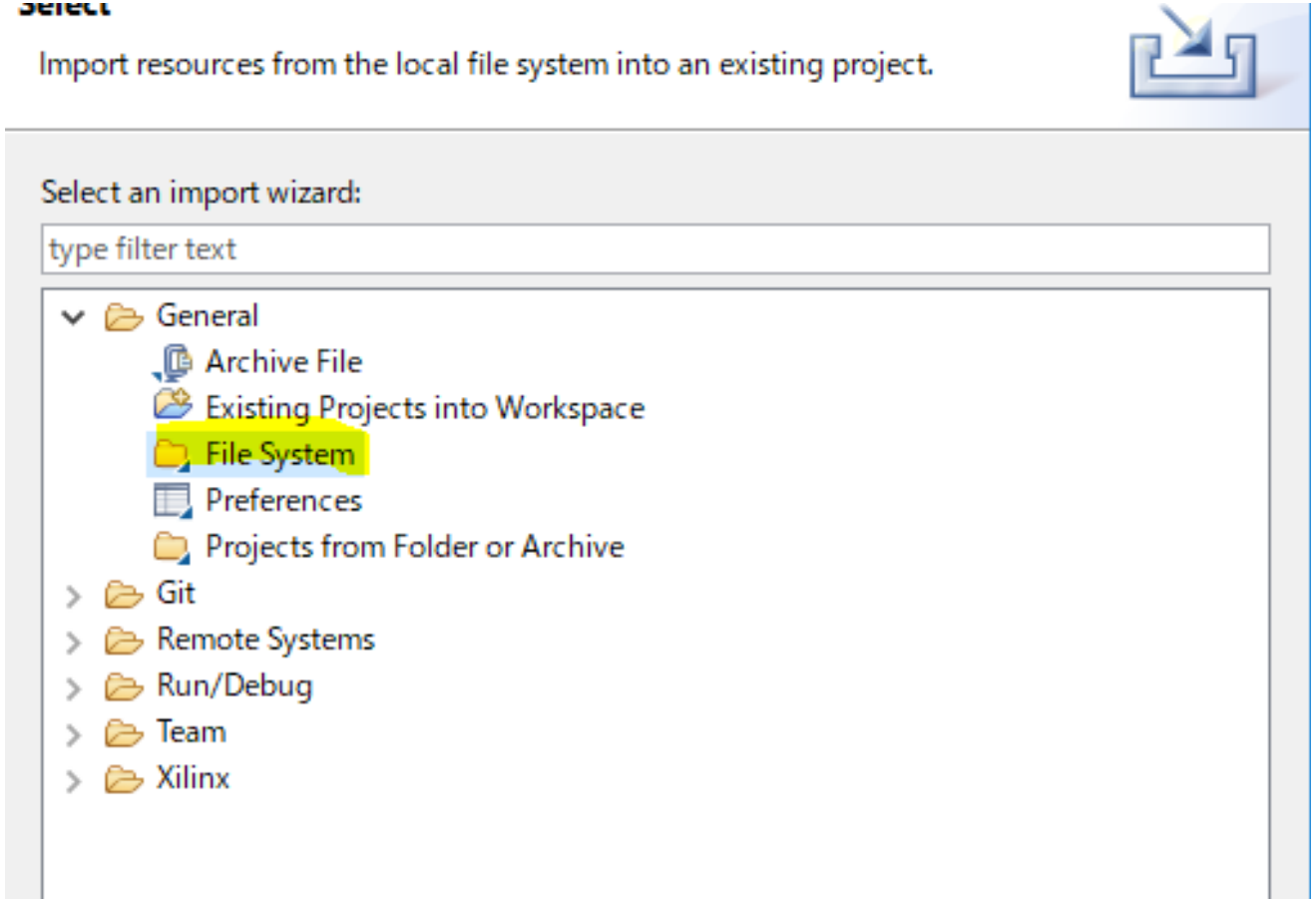
Templates

- Unnecessary -> Empty Application



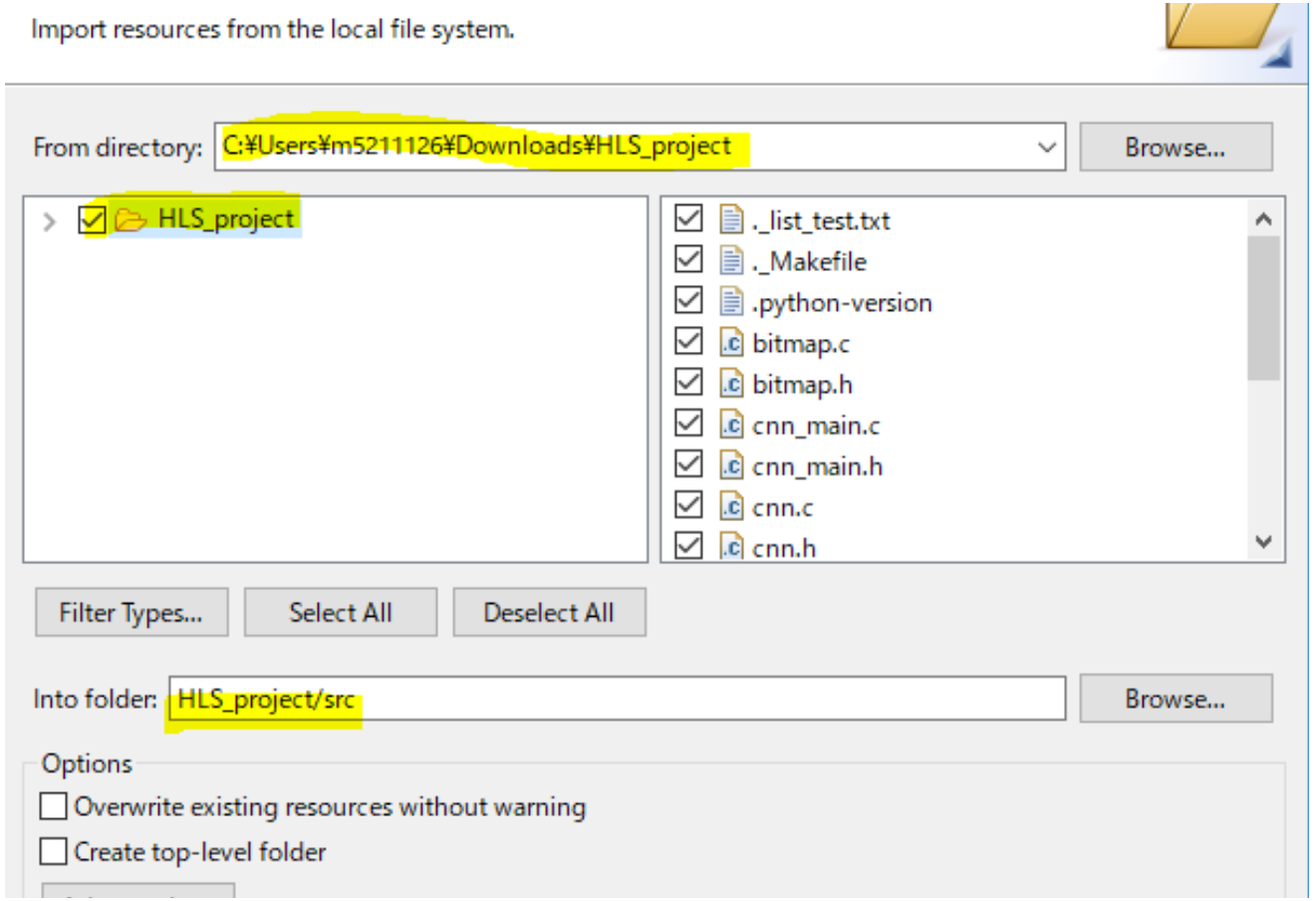
Import files

- Downloads file “HLS_project.zip”
- Select “File System”



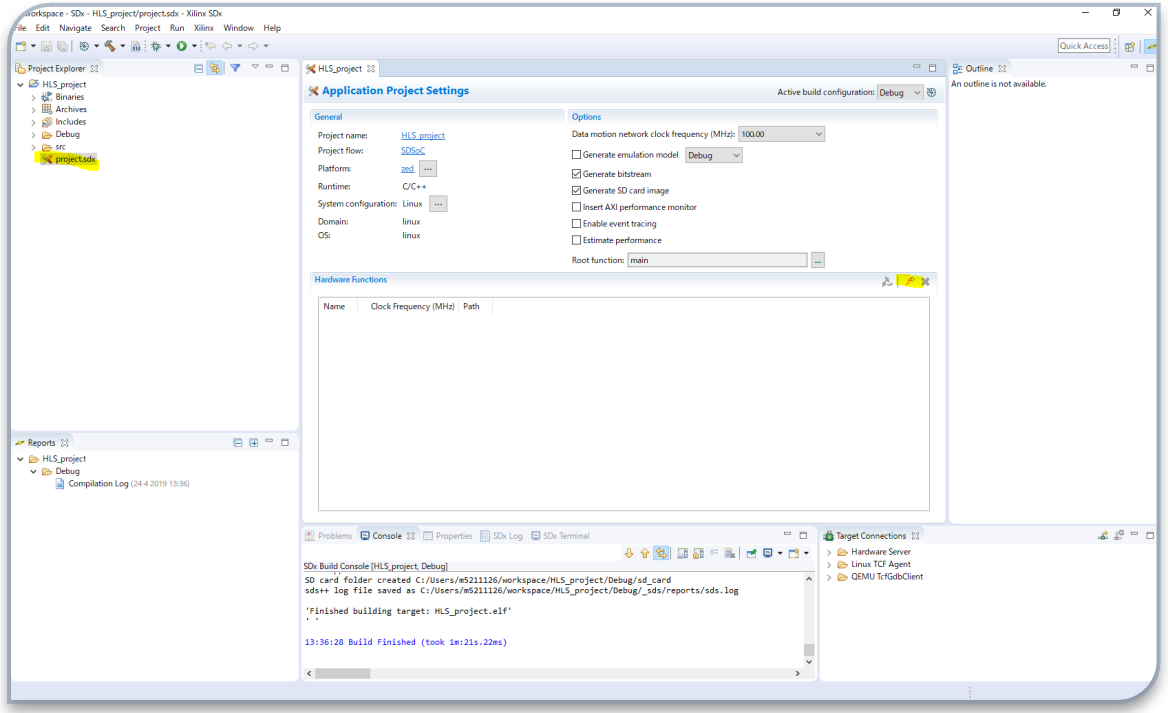
File system

- Select the files
- And “Finish”



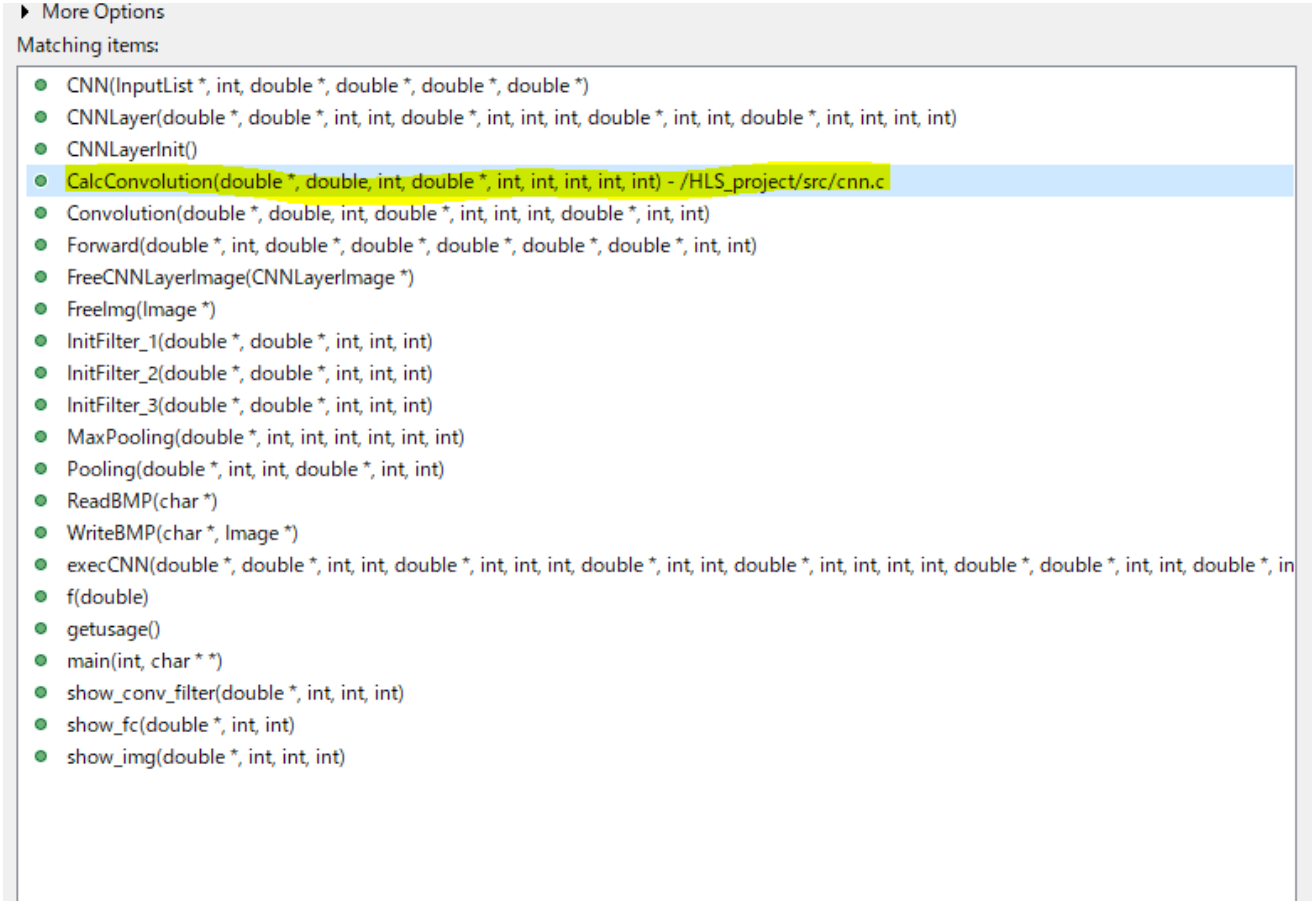
Project window

- “Project Explore” window shows the project files
- Click “project.sdx”
  - See “Application Project Settings”
- Click this mark
  -



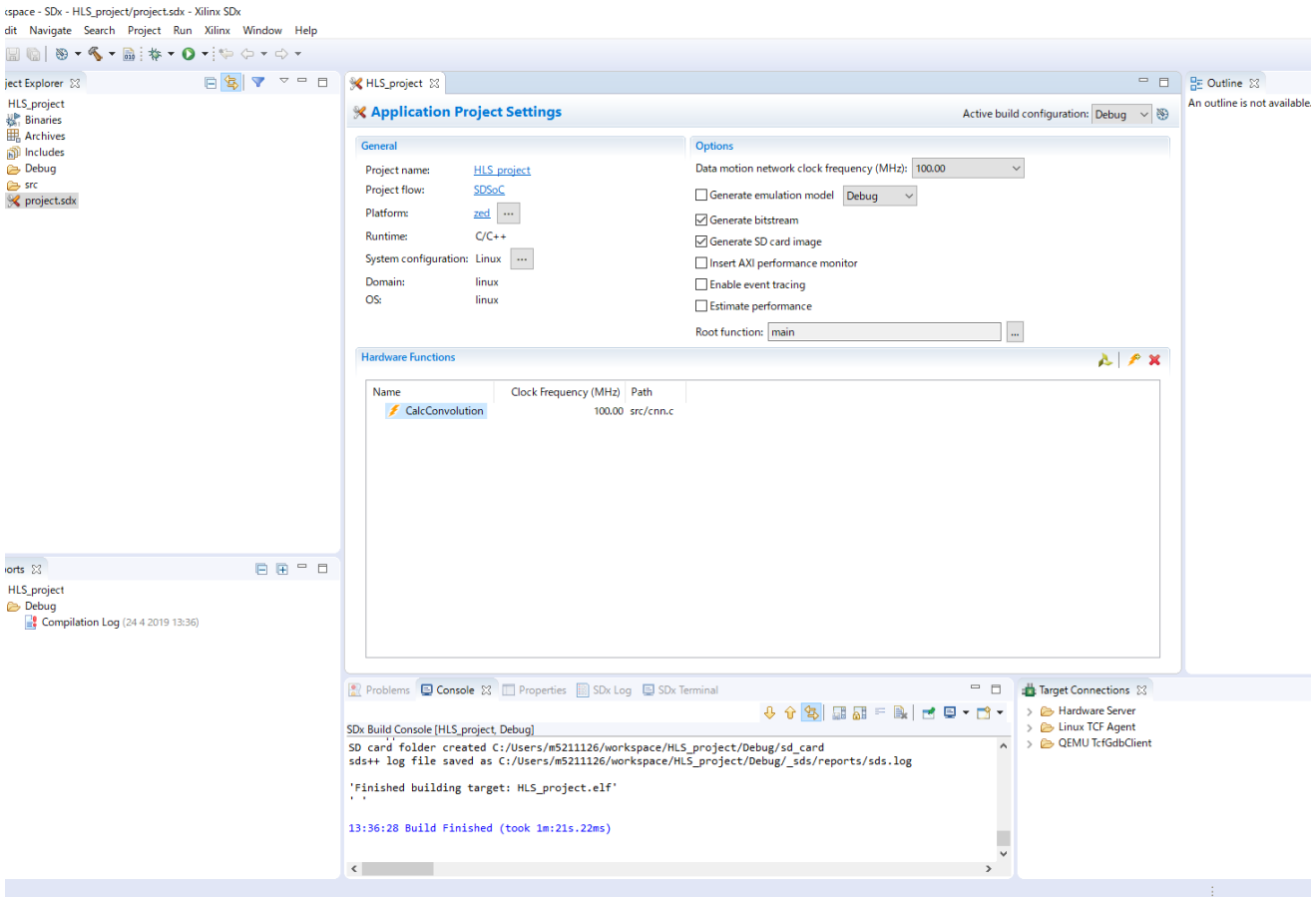
Add hardware functions

- Select “CalcConvolution”



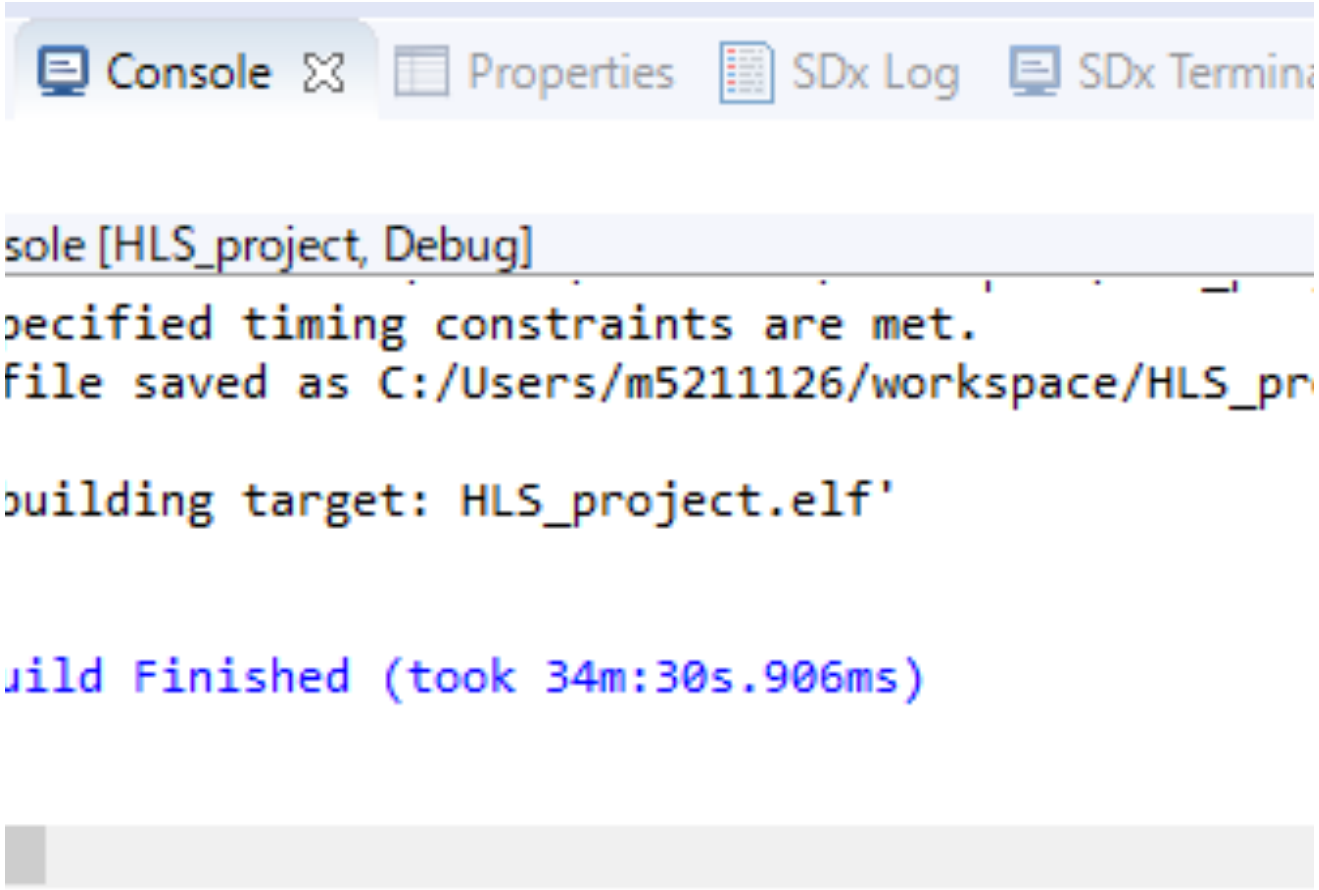
Hard ware function is selected

- Now the project should looks like this



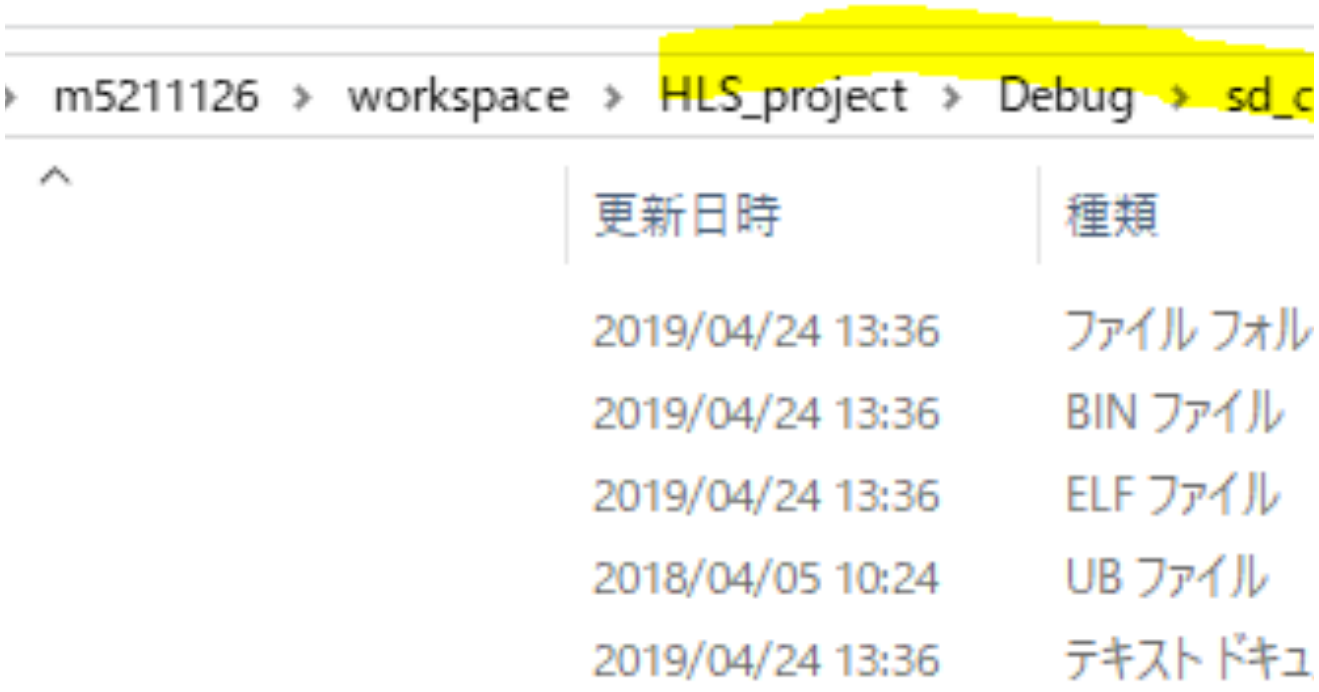
Build project

- On “Project Explore” window
  - Right click project folder “HLS_porject”
    - Select “Build Project”
- Build Completion takes about 34 minutes in my case
  - (It depends on machine spec)



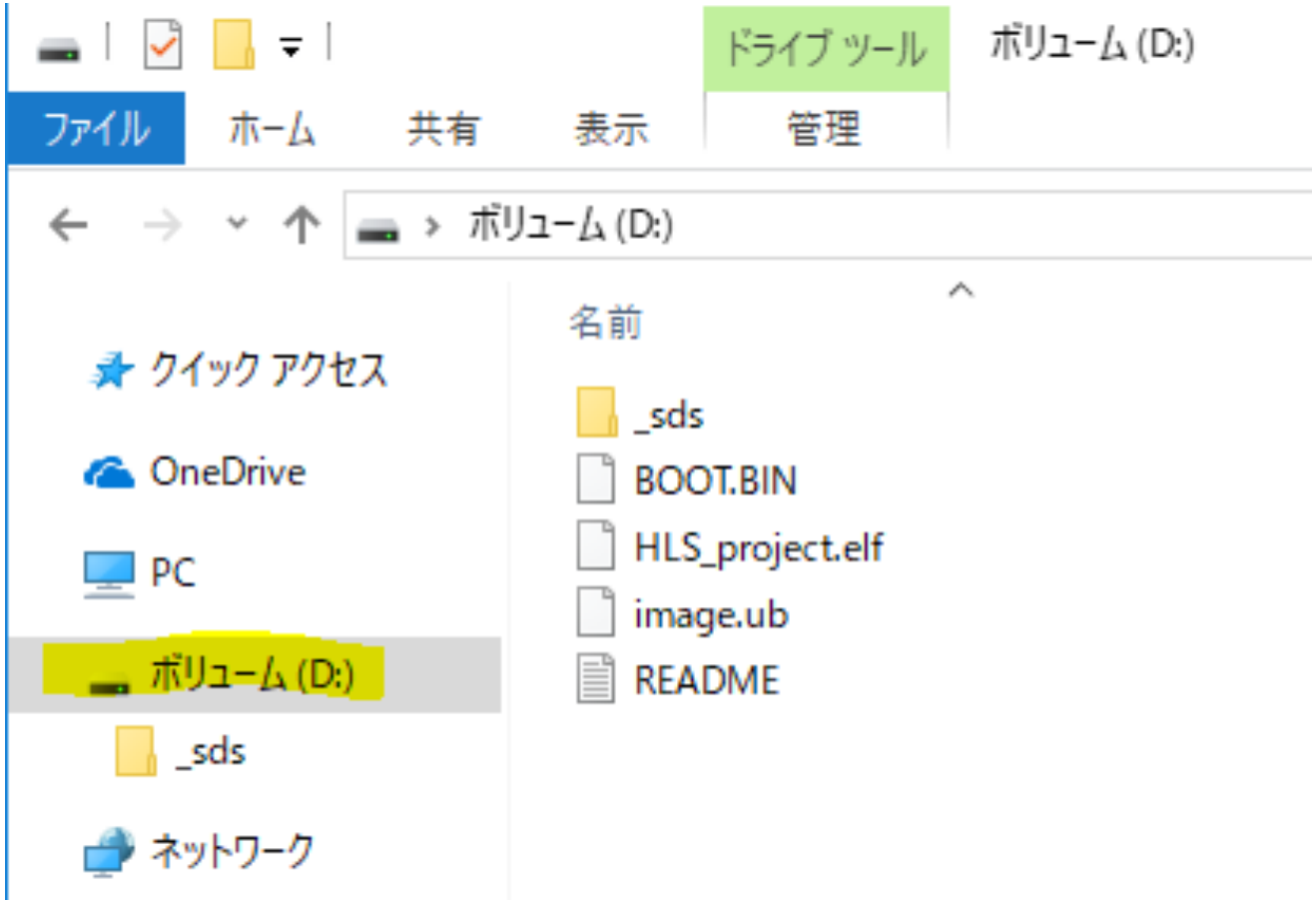
Store the synthesized files to SD card

- After the completion of build
- Open the directory “HLS_project/Debug/sc_card”



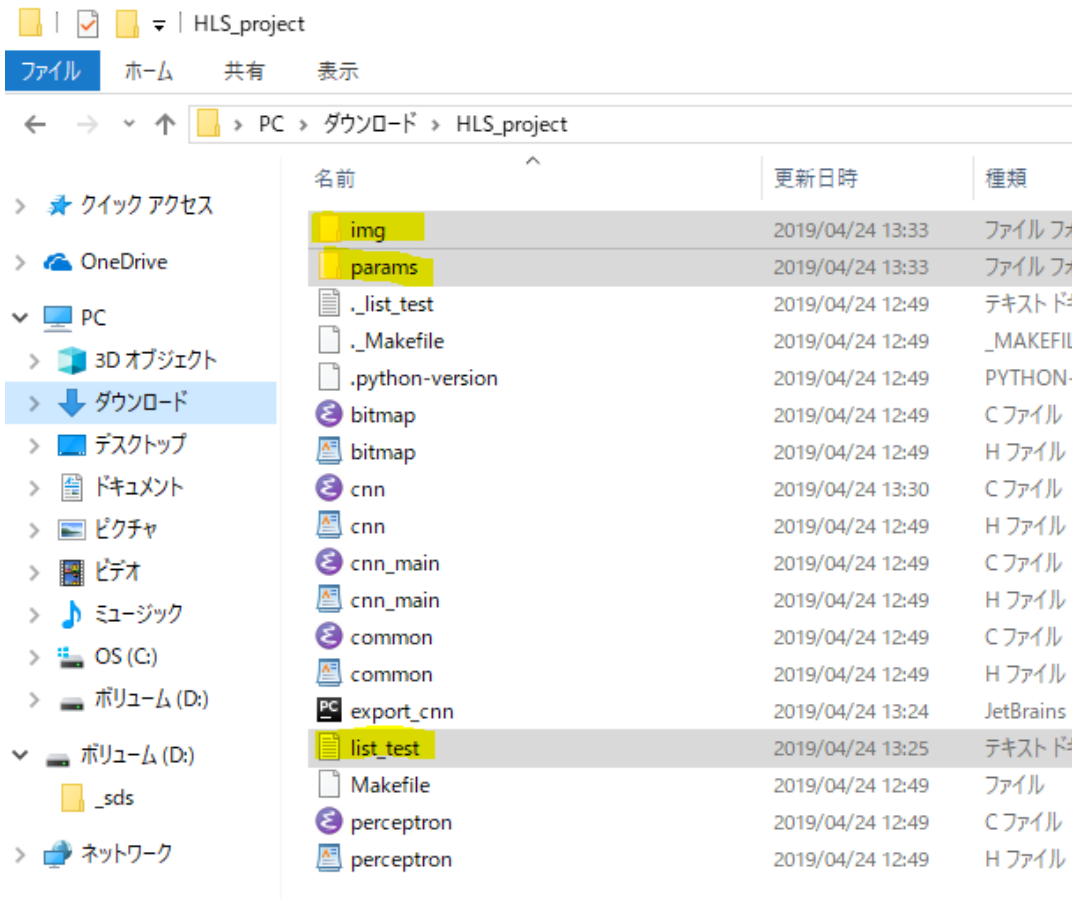
Sd card

- Store the all files in this directory to SD card



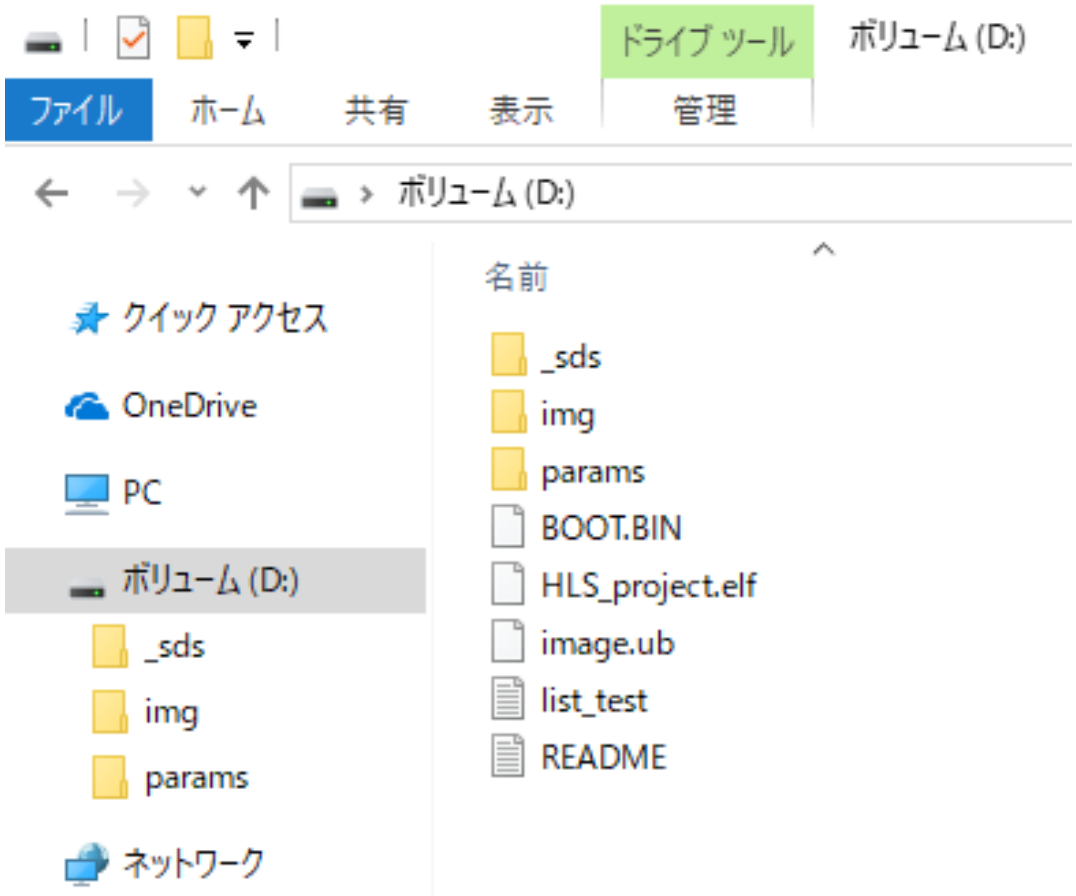
Presets files to SD card

- Also add image some files to SD card



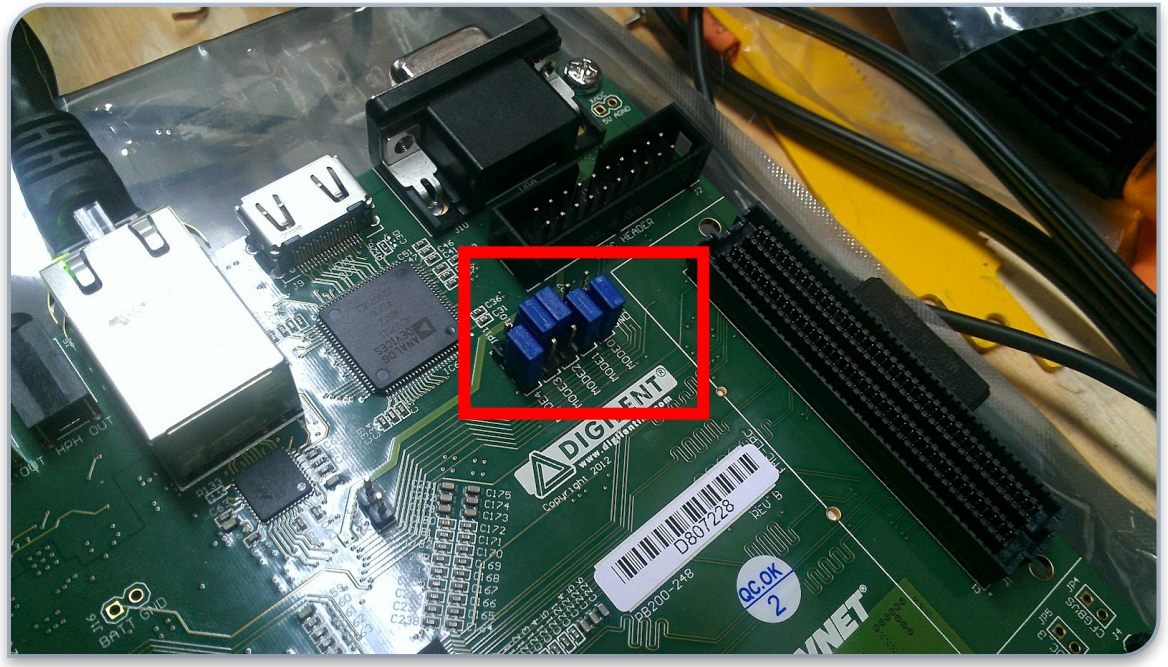
Check SD card

- Files in SD card should be like this



Set SD card into Zed board

- Set the boot mode as “SD boot” on Zed Board.
  - MIO6: GND
  - MIO5: 3V3
  - MIO4: 3V3
  - MIO3: GND
  - MIO2: GND

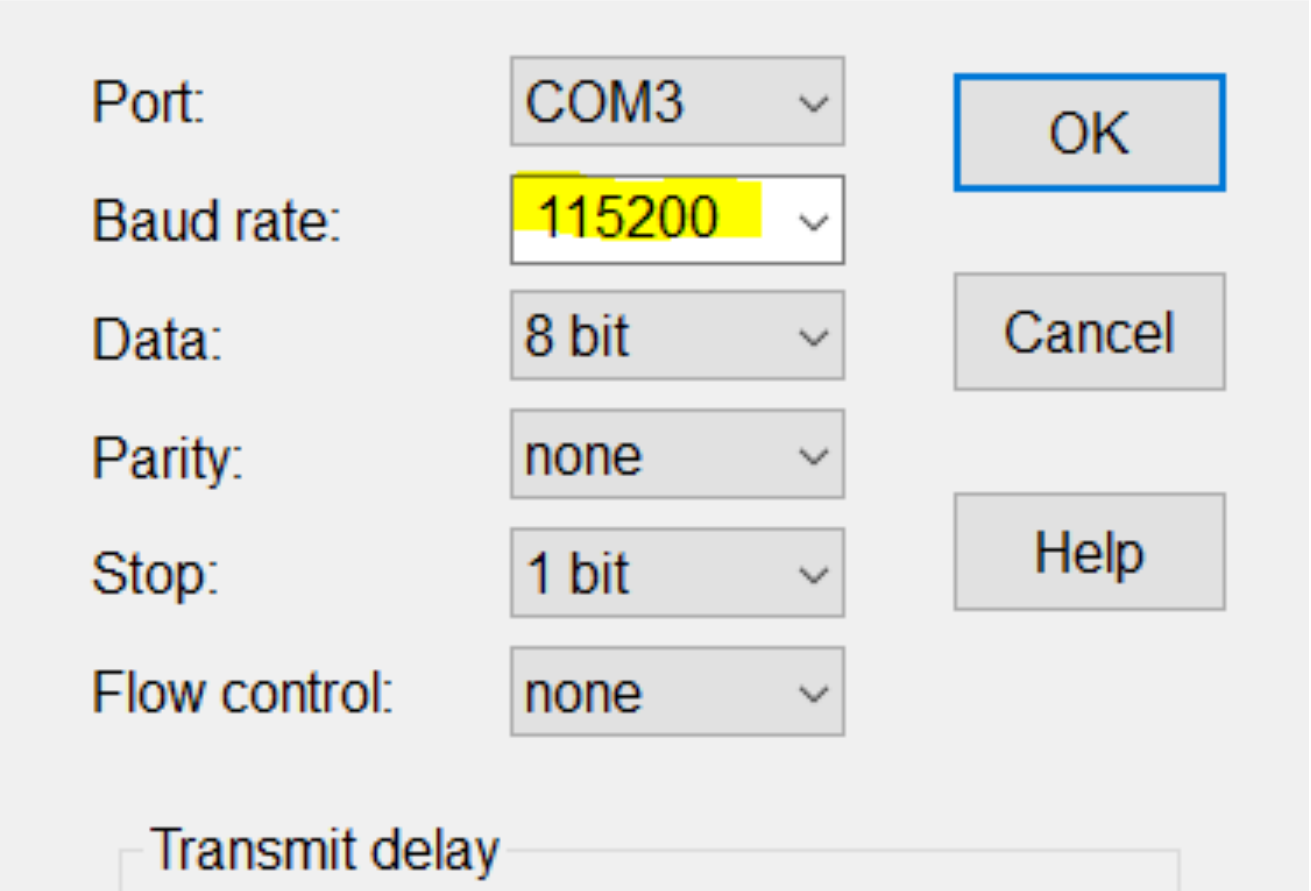


Turn on power on zed board

- Make sure the board is connected with “Prog” and “UART” port with USB connector

Run “tera term vt” for serial communication

- Set as figure



Linux kernel boot

- You can see linux console

```
NET: Registered protocol family 29
can: raw protocol (rev 20170425)
can: broadcast manager protocol (rev 20170425 t)
can: netlink gateway (rev 20170425) max_hops=1
Registering SWP/SWPB emulation handler
hctosys: unable to open rtc device (rtc0)
of_cfs_init
of_cfs_init: OK
ALSA device list:
  No soundcards found.
Freeing unused kernel memory: 1024K
mmc0: new high speed SDHC card at address 0007
mmcblk0: mmc0:0007 DDINC 3.71 GiB
INIT:  mmcblk0: p1
version 2.88 booting
Starting udev
udevd[765]: starting version 3.2.2
udevd[766]: starting eudev-3.2.2
hwclock: can't open '/dev/misc/rtc': No such file or directory
Mon Mar 19 21:56:25 UTC 2018
hwclock: can't open '/dev/misc/rtc': No such file or directory
Starting internet superserver: inetd.
Configuring packages on first boot....
 (This may take several minutes. Please do not power off the machine.)
Running postinst /etc/rpm-postinsts/100-sysvinit-inittab...
Running postinst /etc/rpm-postinsts/101-mnt-sd...
```

Move to SD card partition

```
root@zed:~# cd /mnt/
root@zed:/mnt# ls
BOOT.BIN                    System Volume Information  img
HLS_project.elf             _sds                       list_test.txt
README.txt                  image.ub                   params
root@zed:/mnt#
```

Run application

- Run “./HLS_project.elf”
- This time the hardware function is applied no optimization
- Test classification
  - Classify 10 images
    - 0: Cat
    - 1: Dog
- It took 1832.814 ms for classify each picture

```
root@zed:/mnt# ./HLS_project.elf
CNN - Start
Mode: Test
List File: list_test.txt
Num of Input Data: 10
File: /mnt/img/000.bmp(0)
[Answer] -0.664498
File: /mnt/img/001.bmp(0)
[Answer] 0.272151
File: /mnt/img/002.bmp(0)
[Answer] -0.948464
File: /mnt/img/003.bmp(0)
[Answer] -0.159920
File: /mnt/img/004.bmp(0)
[Answer] -0.216047
File: /mnt/img/005.bmp(1)
[Answer] 0.462996
File: /mnt/img/006.bmp(1)
[Answer] 0.362923
File: /mnt/img/007.bmp(1)
[Answer] 0.387195
File: /mnt/img/008.bmp(1)
[Answer] -0.109920
File: /mnt/img/009.bmp(1)
[Answer] 0.411720
UsageTIme: 1832.814[ms]
root@zed:/mnt#
```

Shutdown

- Type
  - Shutdown –h now
- System halted
  - You can power off Zed Board

```
ed:/mnt# shutdown -h now

ast message from root@zed (ttyPS0) (Mon Mar 19 22:04:41 2018):

stem is go ヨ虫[ヨッ]Yalt NOW!
 Sending processes the TERM signal
ed:/mnt# Stopping Dropbear SSH server: stopped /usr/sbin/dropbear (

ar.
k: can't open '/dev/misc/rtc': No such file or directory
ng syslogd/klogd: stopped syslogd (pid 1239)
d klogd (pid 1242)

ng tcf-agent: OK
 iguring network interfaces... done.
g all processes the TERM signal...
g all processes the KILL signal...
ting remote filesystems...
 vating swap...
ting local filesystems...
 : System halted
```

Summary

- How to use SDx IDE 2018.1 for HLS was demonstrated
- CNN circuit was designed