

# Application Note



## Compilation of Vitis AI 3.0 models for different configurations of AMD DPU

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### Revision history

Rev.	Date	Author	Description
v01	6.2.2024	J.K	Initial release
v02	14.2.2024	J.K	Fixed typos

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<https://zs.utia.cas.cz/index.php?ids=projects/eecone>

<https://eecone.com/eecone/home/>

# 1 Introduction

EECONE project <https://eecone.com/eecone/home/> work package 4, task 4.3 is investigating measures to support second life of electronics due to modular design.

Work package 4 task 4.4 is investigating measures to support extension of life of electronics due to methodology of support used custom platform to adapt for the in-time-evolving design tools and embedded Linux PetaLinux operating system.

UTIA AV CR, v.v.i. (Institute of Information Theory and Automation of the Czech Academy of Sciences, in short UTIA) is not-for profit research institute located in Prague, Czech Republic. UTIA is involved as partner in both tasks, T4.3 and T4.4.

Both EECONE tasks require specification of comparable reference systems which are based on modular HW with potential for “second life” by reuse of modules or use cost optimized PCB HW without modularity.

Systems (with HW modularity or low cost single PCB) should be capable to perform similar challenging tasks. Systems have to be capable to accelerate in HW AI inference algorithms with video camera input for edge application like person detection, face detection, car-make or car-type detection and graphical output to on X11 desktop of a remote PC connected by wired Ethernet in a local network.

Systems should also support remote monitoring and remote user control from a PC connected by wired Ethernet in a local network.

The investigated measures and methodologies to support “second life” of electronic modules (T4.3) and measures to support extension of life of electronics (T4.4) due to methodology of support used custom platform to adapt for the in-time-evolving design tools and embedded Linux PetaLinux operating system. We target developers designing the final commercial, AI inference based edge applications, mainly in the area of home automation.

Based on these requirements UTIA have selected two types of systems:

- Low cost systems. See [2], [3]
- Modul based systems. See [4] and [5].

Both compared types of systems use STMicroelectronic STM32H573I-DK board for:

- Local system control on small graphical touch screen display.
- Remote system control from www browser based on www-server or secure communication based on mqtt client. Board is supported by STMicroelectronic CubeMX SW framework and also by NetXDuo SW framework on top of ThreadX OS and FileX SW package.

The MCU used on STM32H573I-DK board is a 40 nm chip with 32 bit ARM M33 MCU operating with 250 MHz clock, 2 MBytes of program flash memory and 640 KBytes of RAM.

Compared systems use 16 nm AMD ZynqUltrascale+ device with 64 bit ARM A53 Microprocessor and programmable logic in the same device and Petalinux OS.

- Low-cost systems have an AMD ZynqUltrascale+ device and DDR4 with all peripheral interfaces soldered on a single, low cost PCB
- Module-based systems have an AMD ZynqUltrascale+ device and DDR4 soldered on an 4x5 cm module connected by connectors to a carrier board with all peripheral interfaces

## 1.1 Low cost systems used by UTIA in EECONE T4.3 and T4.4

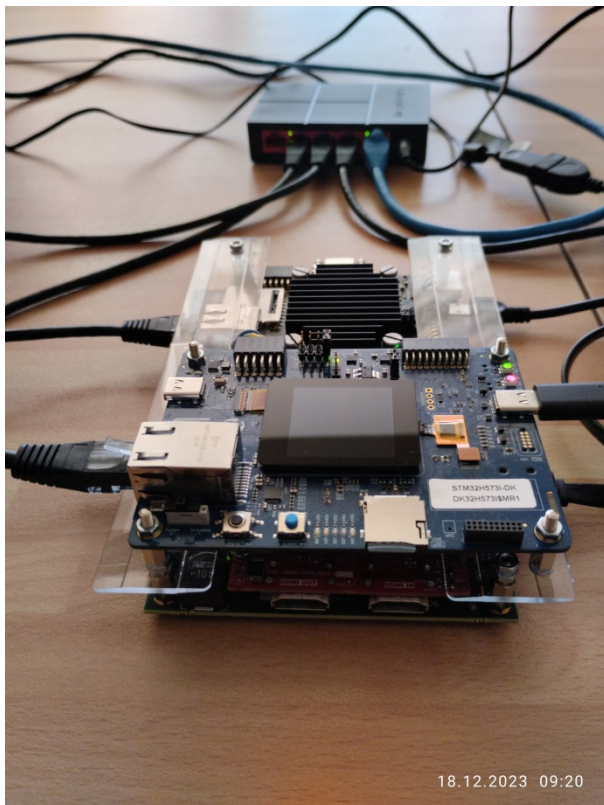
[1]	STM32H573I-DK	<a href="https://www.st.com/en/evaluation-tools/stm32h573i-dk.html">https://www.st.com/en/evaluation-tools/stm32h573i-dk.html</a>	Local or remote system control (www-server or secure mqtt client) for [2], [3]
[2]	TE0802-02-1BEV2-A	<a href="https://shop.trenz-electronic.de/en/TE0802-02-1BEV2-A-MPSoC-Development-Board-with-AMD-Zynq-UltraScale-ZU1EG-and-1-GB-LPDDR4?c=474">https://shop.trenz-electronic.de/en/TE0802-02-1BEV2-A-MPSoC-Development-Board-with-AMD-Zynq-UltraScale-ZU1EG-and-1-GB-LPDDR4?c=474</a>	AMD Vitis AI 3.0 AMD DPU in PL USB camera, remote X11 desktop
[3]	TE0802-02-2AEV2-A	<a href="https://shop.trenz-electronic.de/en/TE0802-02-2AEV2-A-MPSoC-Development-Board-with-AMD-Zynq-UltraScale-ZU2-and-1-GB-LPDDR4?c=474">MPSoC Development Board mit AMD Zynq™ UltraScale+™ ZU2 und 1 GB LPDDR4   Trenz Electronic GmbH Online Shop (EN) (trenz-electronic.de)</a>	AMD Vitis AI 3.0 AMD DPU in PL USB camera, remote X11 desktop



16.11.2023 16:29

## 1.2 Module based systems used by UTIA in EECONE T4.3 and T4.4

[1]	STM32H573I-DK  TE0701-06 Carrier Board for Trenez Electronic 4 x 5 Modules TE0821 or TE0820	<a href="https://www.st.com/en/evaluation-tools/stm32h573i-dk.html">https://www.st.com/en/evaluation-tools/stm32h573i-dk.html</a>  <a href="https://shop.trenz-electronic.de/en/TE0701-06-Carrier-Board-for-Trenz-Electronic-4-x-5-Modules?c=261">https://shop.trenz-electronic.de/en/TE0701-06-Carrier-Board-for-Trenz-Electronic-4-x-5-Modules?c=261</a>	Local or remote system control (www-server or secure mqtt client) for 2-1, 2-2 Carrier Board for range of 4x5 cm modules [3], [4].
[4]	TE0821 Module:  <b>17 module types</b> (to be supported)	<a href="https://shop.trenz-electronic.de/en/Products/Trenz-Electronic/TE08XX-Zynq-UltraScale/TE0821-Zynq-UltraScale/">https://shop.trenz-electronic.de/en/Products/Trenz-Electronic/TE08XX-Zynq-UltraScale/TE0821-Zynq-UltraScale/</a>	AMD Vitis AI 3.0 AMD DPU in PL USB camera FULL HD HDMI display or remote X11 desktop
[5]	TE0820 Module:  <b>100 module types</b> (to be supported)	<a href="https://shop.trenz-electronic.de/en/Products/Trenz-Electronic/TE08XX-Zynq-UltraScale/TE0821-Zynq-UltraScale/">https://shop.trenz-electronic.de/en/Products/Trenz-Electronic/TE08XX-Zynq-UltraScale/TE0821-Zynq-UltraScale/</a>	AMD Vitis AI 3.0 AMD DPU in PL USB camera FULL HD HDMI display or remote X11 desktop



This application note [6] and the accompanying evaluation package describe compilation of AI 3.0 models for different configurations of AMD DPUs for systems [2], [3], [4] and [5]. It is available for free public download from UTIA server dedicated to UTIA contributions to EECONE project:

<https://zs.utia.cas.cz/index.php?ids=projects/eecone>

This application note [6] and the accompanying evaluation package will be also available for free public download in format of wiki tutorial on Trenz-Electronic wiki server:

<https://wiki.trenz-electronic.de/display/PD/Vitis+AI+and+Vitis+Acceleration+Tutorials+with+Trenz+Electronic+Modules>

### 1.3 Objective of This Application Note and Evaluation Package

This application note [6] and the accompanying evaluation package describe compilation of AI 3.0 models for.

- Low-cost system [2] with zu1eg device: AMD DPU configuration B512.
- Low-cost system [3] with zu2cg device: AMD DPU configuration B512 or B1024.
- Module-based system [4]: AMD DPU configurations: B512, B1024, or B1600.
- Module-based system [5]: AMD DPU configurations: B512, B1024, B1600 and B4096.

## 2 Install packages

### 2.1 Install Vitis AI 3.0

Download the Vitis-AI 3.0 repository.  
In browser, open page:

<https://github.com/Xilinx/Vitis-AI/tree/3.0>

Click on green Code button and download Vitis-AI-3.0.zip file.

Unzip

Vitis-AI-3.0.zip

file to directory

~/Downloads/Vitis-AI

Copy

~/Downloads/Vitis-AI

to

~/work/Vitis-AI-3.0

The directory

~/work/Vitis-AI-3.0

contains the Vitis-AI 3.0 framework, now.

Starting point for exploration of these Vitis AI 3.0 examples is this Xilinx www page.

<https://xilinx.github.io/Vitis-AI/3.0/html/index.html>

Vitis AI 3.0 demos work in several modes:

## 2.2 Vitis AI 3.0 Images and Videos

Additional demos from the Vitis AI 3.0 library can be compiled on the test board and executed on the test board with the identical DPU HW.

Download the AI 3.0 support archive archive with images:

[https://www.xilinx.com/bin/public/openDownload?filename=vitis\\_ai\\_library\\_r3.0.0\\_images.tar.gz](https://www.xilinx.com/bin/public/openDownload?filename=vitis_ai_library_r3.0.0_images.tar.gz)

Download the AI 3.0 support archive with videos:

[https://www.xilinx.com/bin/public/openDownload?filename=vitis\\_ai\\_library\\_r3.0.0\\_video.tar.gz](https://www.xilinx.com/bin/public/openDownload?filename=vitis_ai_library_r3.0.0_video.tar.gz)

Unzip and untar content to:

```
~/apps
~/samples
~/samples_onnx
```

These directories contain support material for AI 3.0 examples. Move content to:

```
~/work/Vitis-AI-3.0/examples/vai_library/apps
~/work/Vitis-AI-3.0/examples/vai_library/samples
~/work/Vitis-AI-3.0/examples/vai_library/samples_onnx
```

## 2.3 Install Docker

In Ubuntu 20.04, install docker

```
sudo apt install docker.io
```

Test the docker instalation:

```
sudo docker run hello-world
```

## 2.4 Install Docker Images for Vitis AI 3.5

Install precompiled docker images

```
sudo docker pull xilinx/vitis-ai-tensorflow-cpu:latest
```

```
sudo docker pull xilinx/vitis-ai-tensorflow2-cpu:latest
```

```
sudo docker pull xilinx/vitis-ai-pytorch-cpu:latest
```

Version 3.5 is latest. It is suitable for compilation of models for the installed Vitis AI 3.0 DPUs present in [2], [3], [4], [5] systems.



## 3 Vitis AI 3.0 Model Downloads

### 3.1 Python Downloader

Vitis AI 3.0 models can be downloaded with python tool `downloader.py`

```
cd ~/work/Vitis-AI-3.0/model_zoo
```

Example:

Select pytorch model framework

input: pt

Select model (pt\_resnet50\_imagenet\_224\_224\_0.4\_4.9G\_3.0)

input num: 1

chose model (all)

Input num: 0

```
devel@ubuntu:~/work/Vitis-AI-3.0/model_zoo$ python3 downloader.py
```

Tip:

you need to input framework and model name, use space divide such as tf vgg16

tf:tensorflow1.x tf2:tensorflow2.x cf:caffe dk:darknet pt:pytorch

all: list all model

input:pt

chose model

0 : all

1 : pt\_resnet50\_imagenet\_224\_224\_0.4\_4.9G\_3.0

2 : pt\_face-mask-detection\_512\_512\_0.67G\_3.0

3 : pt\_inceptionv3\_imagenet\_299\_299\_0.5\_5.7G\_3.0

4 : pt\_yolov5-large\_coco\_640\_640\_109.6G\_3.0

5 : pt\_fadnet\_sceneflow\_576\_960\_0.65\_154G\_3.0

6 : pt\_psmnet\_sceneflow\_576\_960\_0.68\_696G\_3.0

7 : pt\_squeezenet\_imagenet\_224\_224\_1.12G\_3.0

8 : pt\_OFA-resnet50\_imagenet\_160\_160\_0.88\_1.8G\_3.0

9 : pt\_yolov6m\_coco\_640\_640\_82.4G\_3.0

10 : pt\_resnet50\_imagenet\_224\_224\_0.3\_5.8G\_3.0

11 : pt\_OFA-depthwise-res50\_imagenet\_176\_176\_1.29G\_3.0

12 : pt\_salsanext\_semantic-kitti\_64\_2048\_0.6\_20.4G\_3.0

13 : pt\_SOLO\_coco\_640\_640\_214G\_3.0

14 : pt\_resnet50\_imagenet\_224\_224\_0.5\_4.1G\_3.0

15 : pt\_vehicle-type-classification\_CarBodyStyle\_224\_224\_3.64G\_3.0  
16 : pt\_pmg\_grocerystore\_224\_224\_2.28G\_3.0  
17 : pt\_SemanticFPN-mobilenetv2\_cityscapes\_512\_1024\_10G\_3.0  
18 : pt\_bert-large\_SQuADv1.1\_384\_246.42G\_3.0  
19 : pt\_salsanextv2\_semantic-kitti\_64\_2048\_0.75\_33.27G\_3.0  
20 : pt\_inceptionv3\_imagenet\_299\_299\_0.6\_4.5G\_3.0  
21 : pt\_resnet50\_imagenet\_224\_224\_0.7\_2.5G\_3.0  
22 : pt\_vehicle-color-classification\_VCoR\_224\_224\_3.64G\_3.0  
23 : pt\_inceptionv3\_imagenet\_299\_299\_11.4G\_3.0  
24 : pt\_DRUNet\_Kvasir\_528\_608\_0.8G\_3.0  
25 : pt\_vehicle-make-classification\_VMMR\_224\_224\_3.64G\_3.0  
26 : pt\_OFA-yolo\_coco\_640\_640\_0.3\_34.72G\_3.0  
27 : pt\_MaskRCNN\_coco\_800\_800\_240G\_3.0  
28 : pt\_OFA-resnet50\_imagenet\_224\_224\_15.0G\_3.0  
29 : pt\_yolov5s6\_coco\_1280\_1280\_17G\_3.0  
30 : pt\_OFA-rcan\_DIV2K\_360\_640\_40.5G\_3.0  
31 : pt\_SESR-S\_DIV2K\_360\_640\_10.2G\_3.0  
32 : pt\_resnet50\_imagenet\_224\_224\_0.6\_3.3G\_3.0  
33 : pt\_resnet50\_imagenet\_224\_224\_8.2G\_3.0  
34 : pt\_CFLOW\_LIDC\_128\_128\_10.42G\_3.0  
35 : pt\_yolox-nano\_coco\_416\_416\_1G\_3.0  
36 : pt\_yolov4csp\_coco\_640\_640\_121G\_3.0  
37 : pt\_OFA-yolo\_coco\_640\_640\_48.88G\_3.0  
38 : pt\_OFA-resnet50\_imagenet\_192\_192\_0.74\_3.6G\_3.0  
39 : pt\_3D-UNET\_kits19\_128\_128\_128\_1065.44G\_3.0  
40 : pt\_bert-tiny\_SQuADv1.1\_384\_453M\_3.0  
41 : pt\_xilinxSR\_360\_640\_DIV2K\_364.88G\_3.0  
42 : pt\_OFA-resnet50\_imagenet\_224\_224\_0.45\_8.2G\_3.0  
43 : pt\_inceptionv3\_imagenet\_299\_299\_0.3\_8G\_3.0  
44 : pt\_OFA-yolo\_coco\_640\_640\_0.5\_24.62G\_3.0  
45 : pt\_inceptionv3\_imagenet\_299\_299\_0.4\_6.8G\_3.0  
46 : pt\_movenet\_coco\_192\_192\_0.5G\_3.0  
47 : pt\_fadnet\_sceneflow\_576\_960\_441G\_3.0

```

48 : pt_ENet_cityscapes_512_1024_11.3G_3.0
49 : pt_fadnetv2_sceneflow_576_960_412G_3.0
50 : pt_SemanticFPN_cityscapes_256_512_10.56G_3.0
51 : pt_fadnetv2_sceneflow_576_960_0.51_201G_3.0
52 : pt_pointpillars_kitti_12000_100_11.2G_3.0
53 : pt_OFA-resnet50_imagenet_224_224_0.60_6.0G_3.0
54 : pt_yolov5-nano_coco_640_640_4.6G_3.0
55 : pt_CLOCs_kitti_3.0
56 : pt_HRNet_cityscapes_1024_2048_378G_3.0
57 : pt_bert-base_SQuADv1.1_384_70.66G_3.0
input num:1
chose model type
0: all
1 : GPU
2 : zcu102 & zcu104 & kv260
3 : vck190
4 : vck5000-DPUCVDX8H-4pe
5 : vck5000-DPUCVDX8H-6pe-aieDWC
6 : vck5000-DPUCVDX8H-6pe-aieMISC
7 : vck5000-DPUCVDX8H-8pe
input num:0
pt_resnet50_imagenet_224_224_0.4_4.9G_3.0.zip
100.0%|100%
resnet50_pruned_0_4_pt-zcu102_zcu104_kv260-r3.0.0.tar.gz
100.0%|100%
resnet50_pruned_0_4_pt-vck190-r3.0.0.tar.gz
100.0%|100%
resnet50_pruned_0_4_pt-vck5000-DPUCVDX8H-4pe-r3.0.0.tar.gz
100.0%|100%
resnet50_pruned_0_4_pt-vck5000-DPUCVDX8H-6pe-aieDWC-r3.0.0.tar.gz
100.0%|100%
resnet50_pruned_0_4_pt-vck5000-DPUCVDX8H-6pe-aieMISC-r3.0.0.tar.gz
100.0%|100%

```

```
resnet50_pruned_0_4_pt-vck5000-DPUCVDX8H-8pe-r3.0.0.tar.gz
100.0%|100%
done
devel@ubuntu:~/work/Vitis-AI-3.0/model_zoo$
```

Delete model packages for other architectures:

```
./resnet50_pruned_0_4_pt-vck190-r3.0.0.tar.gz
./resnet50_pruned_0_4_pt-vck5000-DPUCVDX8H-4pe-r3.0.0.tar.gz
./resnet50_pruned_0_4_pt-vck5000-DPUCVDX8H-6pe-aieDWC-r3.0.0.tar.gz
./resnet50_pruned_0_4_pt-vck5000-DPUCVDX8H-6pe-aieMISC-r3.0.0.tar.gz
./resnet50_pruned_0_4_pt-vck5000-DPUCVDX8H-8pe-r3.0.0.tar.gz
```

Models for AMD DPU configuration B4096 are present in:

```
./resnet50_pruned_0_4_pt-zcu102_zcu104_kv260-r3.0.0.tar.gz
```

Models for other AMD DPU configurations have to be compiled from data present in zip archive:

```
./pt_resnet50_imagenet_224_224_0.4_4.9G_3.0.zip
```

unzip this archive to directory

```
./pt_resnet50_imagenet_224_224_0.4_4.9G_3.0
```

## 3.2 Arch.json File

An arch.json is produced by Vivado in the process of compilation of the AMD DPU.

In case of TE0821 system with ID=3, [4] the arch.json file describing the AMD DPU B1600 configuration has been created in:

```
~/work/te0821_3_240/test_board_dpu_trd/dpu_trd_system_hw_link/Hardware/
dpu.build/link/vivado/vpl/prj/prj.gen/sources_1/bd/zusys/ip/zusys_DPUCZ
DX8G_1_0/arch.json
```

Copy the arch.json file for the selected AMD DPU configuration to

```
~/work/Vitis-AI-3.0/model_zoo/arch.json
```

## 4 Compile Pytorch Models

Copy file compile\_model.sh from the repository associated to this application note to the directory

```
~/work/Vitis-AI-3.0/model_zoo/compile_model.sh
```

Change mode to executable for file compile\_model.sh

```
Chmod +x ~/work/Vitis-AI- 3.0/model_zoo/compile_model.sh
```

## 4.1 Compile First Pytorch Model for AMD DPU in B1600 Configuration

Change directory to

```
~/work/Vitis-AI-3.0
```

Start pytorch docker

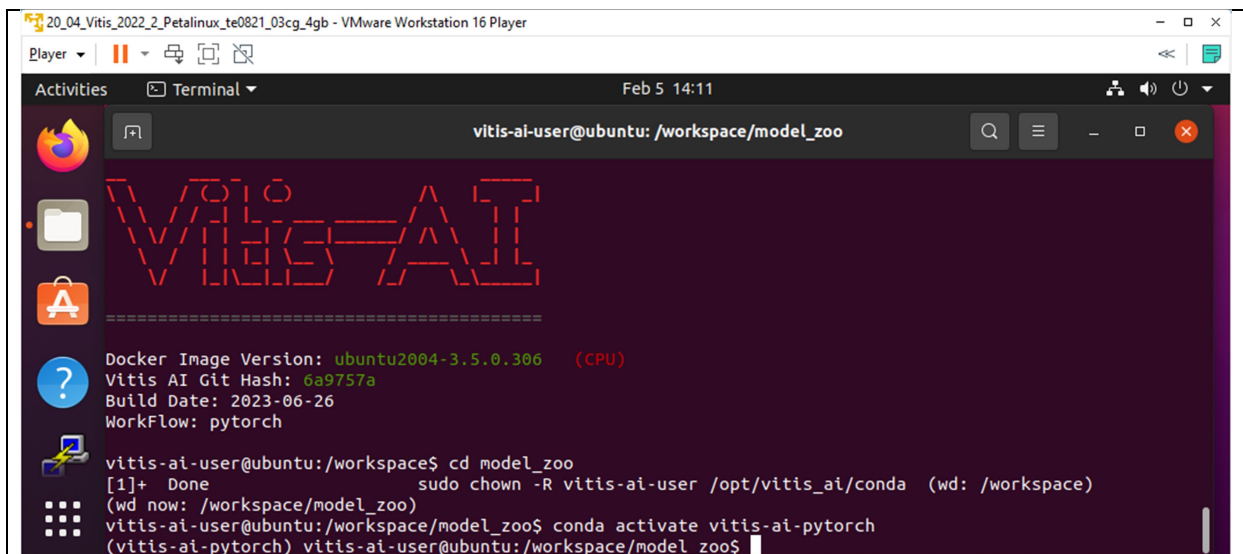
```
sudo ./docker_run.sh xilinx/vitis-ai-pytorch-cpu:latest
```

In pytorch docker WorkFlow, change directory to model\_zoo

```
cd model_zoo
```

Start pytorch compiler framework

```
conda activate vitis-ai-pytorch
```



Parameters for model compilation script compile\_model.sh :

- |  |                 |
|--|-----------------|
| 1. pt  | pytorch model   |
| 2. resnet50_pruned_0_4_pt                    | Model name      |
| 3. pt_resnet50_imagenet_224_224_0.4_4.9G_3.0 | Directory       |
| 4. ResNet_0_int.xmodel                       | Quantized model |

Pytorch model is indicated by pt

Model name can be found in the readme file in classification directory:

```
/home/devel/work/Vitis-AI-  
3.0/examples/vai_library/samples/classification/readme
```

## Part of classification/readme file content

```
Valid model name:  
...  
  resnet50_pruned_0_4_pt  
...
```

**Directory** is name of the unzipped directory associated to the model

**Quantized model** is name of file <name>.xmodel located in directory associated to the model in subdirectory quantized

```
/work/Vitis-AI-  
3.0/model_zoo/pt_resnet50_imagenet_224_224_0.4_4.9G_3.0/quantized/ResNet_0_int.xmodel
```

This file name <name> can be different for different models but the location always is in the subdirectory quantized and the extension is always .xmodel

**Command for compilation of pytorch model:**

```
./compile_model.sh pt resnet50_pruned_0_4_pt  
pt_resnet50_imagenet_224_224_0.4_4.9G_3.0 ResNet_0_int.xmodel
```

**Compilation listing:**

```
(vitis-ai-pytorch) vitis-ai-  
user@ubuntu:/workspace/model_zoo$ ./compile_model.sh pt  
resnet50_pruned_0_4_pt pt_resnet50_imagenet_224_224_0.4_4.9G_3.0  
ResNet_0_int.xmodel  
  
*****  
* VITIS_AI Compilation - Xilinx Inc.  
*****  
  
[UNILog][INFO] Compile mode: dpu  
[UNILog][INFO] Debug mode: null  
[UNILog][INFO] Target architecture: DPUCZDX8G_ISA1_B1600  
[UNILog][INFO] Graph name: ResNet_0, with op num: 417  
[UNILog][INFO] Begin to compile...  
[UNILog][INFO] Total device subgraph number 3, DPU subgraph number 1  
[UNILog][INFO] Compile done.  
  
[UNILog][INFO] The meta json is saved to  
"/workspace/model_zoo/./compiled_output_pt/resnet50_pruned_0_4_pt/meta.  
json"  
  
[UNILog][INFO] The compiled xmodel is saved to  
"/workspace/model_zoo/./compiled_output_pt/resnet50_pruned_0_4_pt/resne  
t50_pruned_0_4_pt.xmodel"  
  
[UNILog][INFO] The compiled xmodel's md5sum is  
8977ac80ac31133b9a957c20d55643d4, and has been saved to
```

```
"/workspace/model_zoo/./compiled_output_pt/resnet50_pruned_0_4_pt/md5sum.txt"
```

```
(vitis-ai-pytorch) vitis-ai-user@ubuntu:/workspace/model_zoo$
```

Directory `compiled_output_pt` is created. It contains compiled model files for the AMD DPU in configuration B1600 in the directory `resnet50_pruned_0_4_pt`

```
./compiled_output_pt/resnet50_pruned_0_4_pt
```

One file is needed in the compiled model. File is present in archive with precompiled model for the AMD DPU in B4096 configurations.

Open archive

```
resnet50_pruned_0_4_pt-zcu102_zcu104_kv260-r3.0.0.tar.gz
```

copy file

```
resnet50_pruned_0_4_pt/resnet50_pruned_0_4_pt.prototxt
```

to file

```
./compiled_output_pt/resnet50_pruned_0_4_pt/resnet50_pruned_0_4_pt.prototxt
```

General classification Model: `pt_resnet50_imagenet_224_224_0.4_4.9G_3.0` is compiled for AMD DPU in B1600 configuration. It contains 4 files:

```
~/work/Vitis-AI-3.0/model_zoo/compiled_output_pt/resnet50_pruned_0_4_pt/md5sum.txt
~/work/Vitis-AI-3.0/model_zoo/compiled_output_pt/resnet50_pruned_0_4_pt/meta.json
~/work/Vitis-AI-3.0/model_zoo/compiled_output_pt/resnet50_pruned_0_4_pt/resnet50_pruned_0_4_pt.xmodel
~/work/Vitis-AI-3.0/model_zoo/compiled_output_pt/resnet50_pruned_0_4_pt/resnet50_pruned_0_4_pt.prototxt
```

## 4.2 Compile Other Pytorch Models for AMD DPU in B1600 Configuration

Perform similar compilation steps for other 9 selected models:

```
Face detection Model:
pt_face-mask-detection_512_512_0.67G_3.0
```

```
Vehicle make Model:
pt_vehicle-make-classification_VMMR_224_224_3.64G_3.0
```

```
Vehicle type Model:
pt_vehicle-type-classification_CarBodyStyle_224_224_3.64G_3.0
```

```
Vehicle color Model:
pt_vehicle-color-classification_VCoR_224_224_3.64G_3.0
General classification Model:
pt_resnet50_imagenet_224_224_8.2G_3.0
General classification Model:
pt_resnet50_imagenet_224_224_0.3_5.8G_3.0
General classification Model:
pt_resnet50_imagenet_224_224_0.4_4.9G_3.0 (already compiled)
General classification Model:
pt_resnet50_imagenet_224_224_0.5_4.1G_3.0
General classification Model:
pt_resnet50_imagenet_224_224_0.6_3.3G_3.0
General classification Model:
pt_resnet50_imagenet_224_224_0.7_2.5G_3.0
```

Find the expected model names in sample application readme files:

```
~/work/Vitis-AI-3.0/examples/vai_library/samples/yolov4/readme
~/work/Vitis-AI-
3.0/examples/vai_library/samples/vehicleclassification/readme
~/work/Vitis-AI-3.0/examples/vai_library/samples/classification/readme
```

Result of compilations is folder (with all 10 model subfolders targeting the AMD DPU in B1600 configuration)

```
./compiled_output_pt/*
```

Compress it as .zip file. It will be used to target Vitis AI 3.0 demos on system [4] with AMD DPU configuration B1600

Copy this archive into directory indicating the AMD DPU configuration like:

```
~/work/B1600/compiled_output_pt.zip
```

Delete directory

```
~/work/Vitis-AI-3.0/model_zoo/compiled_output_pt/*
```

### 4.3 Compile Pytorch Models for other AMD DPU Configurations

To target other systems [2], [3] and [5], the arch.json describing the AMD DPU configuration has to be replaced.

Copy the arch.json file for the selected AMD DPU configuration to

```
~/work/Vitis-AI-3.0/model_zoo/arch.json
```

Repeat:

- Compilation for system [2], AMD DPU in B0512 configuration will be created.
- Compilation for system [3], AMD DPU in B1024 configuration will be created.



Already available:

- Compilation for system [4], AMD DPU in B1600 configuration will be created.
- In case of system [5], the AMD DPU in B4096 configuration all needed files are present in the download packages archives for zcu102\_zcu104\_kv260 targets.

To target tested systems [2], [3], [4] and [5] use these created .zip archives:

```
~/work/B0512/compiled_output_pt.zip
~/work/B1024/compiled_output_pt.zip
~/work/B1600/compiled_output_pt.zip
~/work/B4096/compiled_output_pt.zip
```

## 4.4 Sample Vitis AI 3.0 applications

Zip sample applications:

```
~/work/Vitis-AI-3.0/examples/vai_library/samples/yolov4
~/work/Vitis-AI-3.0/examples/vai_library/samples/vehicleclassification
~/work/Vitis-AI-3.0/examples/vai_library/samples/classification
```

to

```
~/work/yolov4.zip
~/work/vehicleclassification.zip
~/work/classification.zip
```

Archives to be moved to the target systems [2], [3], [4] and [5] are:

```
~/work/B0512/compiled_output_pt.zip
~/work/B1024/compiled_output_pt.zip
~/work/B1600/compiled_output_pt.zip
~/work/B4096/compiled_output_pt.zip
~/work/yolov4.zip
~/work/vehicleclassification.zip
~/work/classification.zip
```

## 4.5 Compile Tensorflow Models

Process of compilation models is similar to pytorch model. Change directory to:

```
~/work/Vitis-AI-3.0
```

Start tensorflow docker

```
sudo ./docker_run.sh xilinx/vitis-ai-tensorflow-cpu:latest
```

In tensorflow docker WorkFlow, change directory to model\_zoo

```
cd model_zoo
```

Start tensorflow compiler framework

```
conda activate vitis-ai-tensorflow
```

There are only 3 parameters for model compilation script `compile_model.sh` :

1. `tf tensorflow model`
2. Model name
3. Directory

The tensorflow model is indicated by `tf`

Model name can be found in the readme file in the sample application.

Directory is name of the unzipped directory associated to the model.

## 4.6 Compile Tensorflow2 Models

Process of compilation models is similar to pytorch model. Change directory to:

```
~/work/Vitis-AI-3.0
```

Start tensorflow docker

```
sudo ./docker_run.sh xilinx/vitis-ai-tensorflow2-cpu:latest
```

In tensorflow docker Workflow, change directory to `model_zoo`

```
cd model_zoo
```

Start tensorflow2 compiler framework

```
conda activate vitis-ai-tensorflow2
```

There are only 3 parameters for model compilation script `compile_model.sh` :

1. `tf2 tensorflow2 model`
2. Model name
3. Directory

Tensorflow2 model is indicated by `tf2`

Model name can be found in the readme file in the sample application.

Directory is name of the unzipped directory associated to the model.

## 5 Test Sample Vitis AI 3.0 Applications

### 5.1 Install Archives on Systems [2]-[5]

Use ssh to copy sample applications:

From:

```
~/work/yolov4.zip  
~/work/vehicleclassification.zip  
~/work/classification.zip
```

To:

```
~/yolov4.zip  
~/vehicleclassification.zip  
~/classification.zip
```

We target evaluation boards [2], [3], [4] or [5].

Use ssh to copy compiled model archives from:

From:

```
~/work/B0512/compiled_output_pt.zip  
~/work/B1024/compiled_output_pt.zip  
~/work/B1600/compiled_output_pt.zip  
~/work/B4096/compiled_output_pt.zip
```

To:

```
~/B0512/compiled_output_pt.zip  
~/B1024/compiled_output_pt.zip  
~/B1600/compiled_output_pt.zip  
~/B4096/compiled_output_pt.zip
```

On target board, unzip sample applications:

From

```
~/yolov4.zip  
~/vehicleclassification.zip  
~/classification.zip
```

To:

```
~/yolov4  
~/vehicleclassification  
~/classification
```

On target board, copy models from the relevant directory (for [2], [3], [4] or [5] target):

<config> = [B0512|B1024|B1600|B4096]

From:

```
~/<config>/compiled_output_pt/face_mask_detection_pt
```

To:

```
~/yolov4/face_mask_detection_pt
```

From:

```
~/<config>/compiled_output_pt/vehicle_make_resnet18_pt  
~/<config>/compiled_output_pt/vehicle_type_resnet18_pt
```

To:

```
~/vehicleclassification/vehicle_make_resnet18_pt  
~/vehicleclassification/vehicle_type_resnet18_pt
```

From:

```
~/<config>/compiled_output_pt/chen_color_resnet18_pt  
~/<config>/compiled_output_pt/resnet50_pt  
~/<config>/compiled_output_pt/resnet50_pruned_0_3_pt  
~/<config>/compiled_output_pt/resnet50_pruned_0_4_pt  
~/<config>/compiled_output_pt/resnet50_pruned_0_5_pt  
~/<config>/compiled_output_pt/resnet50_pruned_0_6_pt  
~/<config>/compiled_output_pt/resnet50_pruned_0_7_pt
```

To:

```
~/classification/chen_color_resnet18_pt  
~/classification/resnet50_pt  
~/classification/resnet50_pruned_0_3_pt  
~/classification/resnet50_pruned_0_4_pt
```

```
~/classification/resnet50_pruned_0_5_pt
~/classification/resnet50_pruned_0_6_pt
~/classification/resnet50_pruned_0_7_pt
```

## 5.2 Compile Vitis AI 3.0 Applications on Systems [2]-[5]

On target board, compile all sample applications:

```
cd ~/yolov4
chmod +x build.sh
./build.sh

cd ~/vehicleclassification
chmod +x build.sh
./build.sh

cd ~/classification
chmod +x build.sh
./build.sh
```

## 5.3 Export Path to the DPU

On low-cost systems TE0802 [2] or TE0802 [3], use export command:

```
export XLNX_VART_FIRMWARE=/run/media/mmcblk0p1/dpu.xclbin
```

On module-based systems supporting modules TE0821 [4] or modules TE0820 [5], use export command:

```
export XLNX_VART_FIRMWARE=/run/media/mmcblk1p1/dpu.xclbin
```

## 5.4 Test Vitis AI 3.0 Application on Systems [2]-[5]

Test Vitis AI 3.0 applications with commands described in sample application readme files:

```
~/work/Vitis-AI-3.0/examples/vai_library/samples/yolov4/readme
~/work/Vitis-AI-
3.0/examples/vai_library/samples/vehicleclassification/readme
~/work/Vitis-AI-3.0/examples/vai_library/samples/classification/readme
```

Change directory to

```
~/yolov4
```

**Test face mask detection** with input from file `sample_face_mask.jpg`

```
./test_jpeg_yolov4 face_mask_detection_pt sample_face_mask.jpg
```

Output: face mask detection coordinates on terminal.

**Test performance of face mask detection** with input from files listed in `test_performance_face_mask.list` file.

```
./test_performance_yolov4 face_mask_detection_pt
test_performance_face_mask.list -s 60 -t 3
```

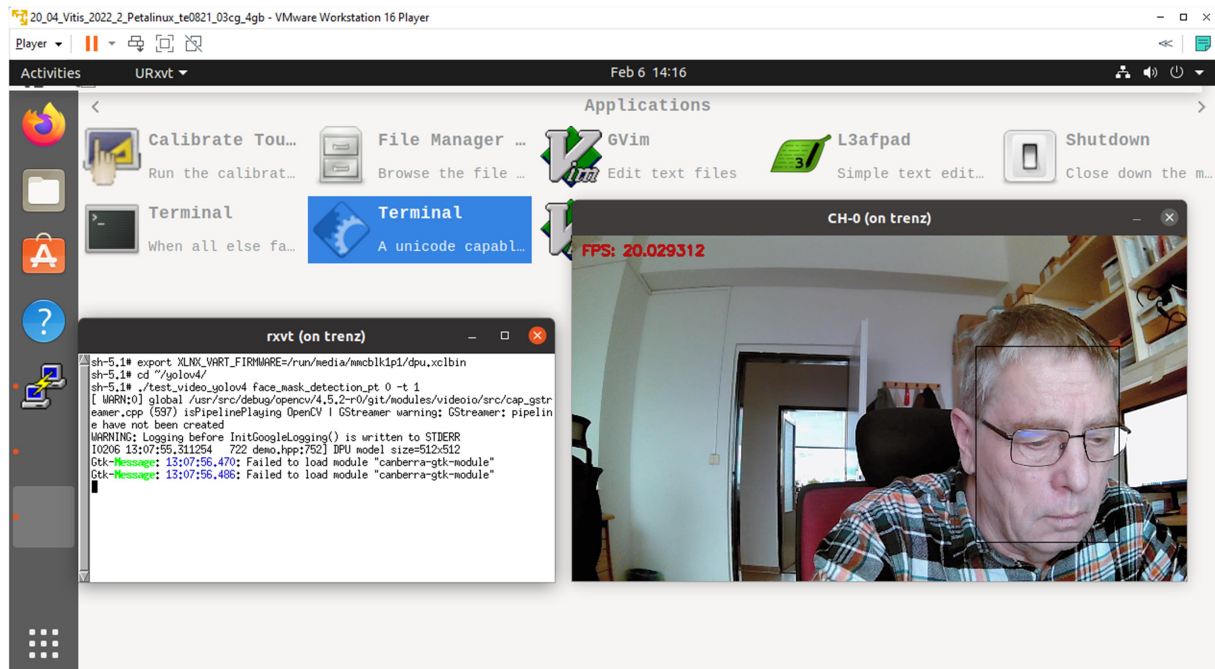
Output: data about performance (in FPS) of face mask detection on terminal.

-s 60 defines length of benchmark in seconds.

-t 3 defines use of 3 SW threads (with one AMD DPU)

### Test face mask detection with USB www camera input

```
./test_video_yolov4 face_mask_detection_pt 0 -t 1
```



Face mask detection Vitis AI 3.0 application with camera input, DPU: B1600, system [4].

Output: Video output with face mask coordinates in video and performance (in FPS) displayed as text in video.

0 defines USB www camera device number

-t 1 defines use of 1 SW thread (with one AMD DPU)

Face mask detection Vitis AI 3.0 application can be stopped by pointing mouse to the X11 window with video output and typing Esc key on the keyboard.

## 5.5 Other Vitis AI 3.0 Applications on Systems [2]-[5]

Vitis AI 3.0 sample test applications located in the directory ~/vehicleclassification have analogical format for calling and parameters.

Two different AI models can be used to classify make or type of the vehicle.

Vitis AI 3.0 sample test applications located in the directory ~/classification have analogic format.

Several different AI models can be used to

- Classify color of vehicle,
- Classify objects with original model

- Classify objects with model, pruned by factor of 0.3, 0.4, 0.5, 0.6 or 0.7, have gradually reduced complexity and potentially reduced classification quality.

## 5.6 Measured Vitis AI 3.0 Performance on Systems [2]-[5]

Measured performance indicators are summarized in sections 5.8, 5.9 and 5.10, 5.11 for low-cost systems [2], [3] and for module-based systems [4], [5]:

- Performance in frames per second [FPS],
- Power consumption in [W],
- End to end performance in (int8) Giga operations per second [GOPs].

## 5.7 TE0802-02-1BEV2-A board [2], ID=4, 1EG Device, DPU: B512

Vitis AI 3.0 examples	Performance with input from camera e2e [FPS]	Power with camera and VGA [W]	Performance with input from file e2e [FPS]	Power with input from file [W]	GigaOps with input from file e2e [Gops]
<b>Face detection</b> Model: pt_face-mask-detection_512_512_0.67G_3.0	17.3	6.9	30.9	6.2	20.7
<b>Vehicle make</b> Model: pt_vehicle-make-classification_VMMR_224_224_3.64G_3.0	18.9	7.4	22.3	6.7	81.1
<b>Vehicle type</b> Model: pt_vehicle-type-classification_CarBodyStyle_224_224_3.64G_3.0	19.1	7.4	22.3	6.7	81.1
<b>Vehicle color</b> Model: pt_vehicle-color-classification_VCoR_224_224_3.64G_3.0	18.9	7.4	22.3	6.7	81.1
<b>General classification</b> Model: pt_resnet50_imagenet_224_224_8.2G_3.0	8.1	7.2	9.3	6.5	76.2
<b>General classification</b> Model: pt_resnet50_imagenet_224_224_0.3_5.8G_3.0	9.2	7.1	11.1	6.5	64.3
<b>General classification</b> Model: pt_resnet50_imagenet_224_224_0.4_4.9G_3.0	9.8	7.1	12.2	6.5	59.7
<b>General classification</b> Model: pt_resnet50_imagenet_224_224_0.5_4.1G_3.0	10.2	7.0	12.9	6.4	52.8
<b>General classification</b> Model: pt_resnet50_imagenet_224_224_0.6_3.3G_3.0	11.4	7.0	14.9	6.4	49,1
<b>General classification</b> Model: pt_resnet50_imagenet_224_224_0.7_2.5G_3.0	11.8	6.9	16.2	6.3	40.5

Measurement conditions:

- TE0802-02-1BEV2-A board with ZU01EG device 1 GB DDR4
- DPU in B512 configuration
- USB WWW camera ETERNICO with sensor JX\_F23, 1920x1080, max 20 FPS
- Keyboard RPi
- Mouse RPi
- VGA display (1280x720p60)
- Power supply 5V/4A
- Power measured at the 230V power plug

## 5.8 TE0802-02-2AEV2-A board [3], ID=1, 2CG Device, DPU: B1024

Vitis AI 3.0 examples	Performance with input from camera e2e [FPS]	Power with camera and VGA [W]	Performance with input from file e2e [FPS]	Power with input from file [W]	GigaOps with input from file e2e [Gops]
<b>Yolov4 face mask detection</b> Model: pt_face-mask-detection_512_512_0.67G_3.0	17.3	7.2	43.9	6.9	29.4
<b>Vehicleclassification vehicle make</b> Model: pt_vehicle-make-classification_VMMR_224_224_3.64G_3.0	18.1	7.7	39.8	7.6	144.8
<b>Vehicleclassification vehicle type</b> Model: pt_vehicle-type-classification_CarBodyStyle_224_224_3.64G_3.0	18.1	7.7	39.8	7.6	144.8
<b>Classification vehicle color</b> Model: pt_vehicle-color-classification_VCoR_224_224_3.64G_3.0	18.0	7.8	39.8	7.7	144.8
<b>Classification</b> Model: pt_resnet50_imagenet_224_224_8.2G_3.0	10.0	7.8	15.0	6.7	123.0
<b>Classification</b> Model: pt_resnet50_imagenet_224_224_0.3_5.8G_3.0	10.5	7.8	16.9	6.6	98.0
<b>Classification</b> Model: pt_resnet50_imagenet_224_224_0.4_4.9G_3.0	10.7	7.7	18.1	6.5	88.7
<b>Classification</b> Model: pt_resnet50_imagenet_224_224_0.5_4.1G_3.0	11.5	7.7	19.3	6.4	79.1
<b>Classification</b> Model: pt_resnet50_imagenet_224_224_0.6_3.3G_3.0	12.0	6.7	20.6	6.2	68.0
<b>Classification</b> Model: pt_resnet50_imagenet_224_224_0.7_2.5G_3.0	12.5	6.5	23.4	6.2	58.5

Measurement conditions:

- TE0802-02-2AEV2-A board with ZU02CG device 1 GB DDR4
- DPU in B1024 configuration
- USB WWW camera ETERNICO ET201 Full HD, sensor JX\_F23, 1920x1080, 20 FPS
- Keyboard RPi
- Mouse RPi
- VGA display (1280x720p60)
- Power supply 5V/4A
- Power measured at the 230V power plug



## 5.9 TE0821-01-3AE31KA module, ID=3, TE0701-06 [4], DPU: B1600

Vitis AI 3.0 examples	Performance input from camera e2e (-t 1) [FPS]	Power with camera e2e (-t 1) [W]	Performance input from file e2e (-t 3) [FPS]	Power with input from file e2e (-t 3) [W]	GigaOps input from file e2e (-t 3) [Gops]
<b>Yolov4 face mask detection</b> Model: pt_face-mask-detection_512_512_0.67G_3.0	20.0	7.7	76.1	7.6	50.9
<b>Vehicleclassification vehicle make</b> Model: pt_vehicle-make-classification_VMMR_224_224_3.64G_3.0	20.0	7.9	61.2	8.4	222.7
<b>Vehicleclassification vehicle type</b> Model: pt_vehicle-type-classification_CarBodyStyle_224_224_3.64G_3.0	20.0	7.9	61.2	8.4	222.7
<b>Classification vehicle color</b> Model: pt_vehicle-color-classification_VCoR_224_224_3.64G_3.0	20.0	7.9	61.2	8.4	222.7
<b>Classification</b> Model: pt_resnet50_imagenet_224_224_8.2G_3.0	20.0	8.8	27.5	8.6	225.5
<b>Classification</b> Model: pt_resnet50_imagenet_224_224_0.3_5.8G_3.0	20.0	8.5	36.0	8.6	208.8
<b>Classification</b> Model: pt_resnet50_imagenet_224_224_0.4_4.9G_3.0	20.0	8.4	39.7	8.5	194.5
<b>Classification</b> Model: pt_resnet50_imagenet_224_224_0.5_4.1G_3.0	20.0	8.3	44.1	8.5	180.8
<b>Classification</b> Model: pt_resnet50_imagenet_224_224_0.6_3.3G_3.0	20.0	8.2	45.4	8.4	149.8
<b>Classification</b> Model: pt_resnet50_imagenet_224_224_0.7_2.5G_3.0	20.0	8.0	58.3	8.4	145.7

Measurement conditions:

- TE0821-01-3AE31KA module 3cg-1e, 4GB DDR4, TE0701-06 carrier board
- DPU in B1024 configuration
- USB WWW camera ETERNICO ET201 Full HD, sensor JX\_F23, 1920x1080, 20 FPS
- Keyboard RPi
- Mouse RPi
- Remote X11 desktop
- Power supply 12V/5A
- Power measured at the 230V power plug

## 5.10 TE0820-03-04EV-1E-2GB module, ID=84, TE0701-06 [5], DPU: B4096

Vitis AI 3.0 examples	Performance with input from camera e2e [FPS]	Power with camera and VGA [W]	Performance input from file e2e (-t 3) [FPS]	Power with input from file e2e (-t 3) [W]	GigaOps input from file e2e (-t 3) [Gops]
<b>Face detection</b> Model: pt_face-mask-detection_512_512_0.67G_3.0	30.0	10.0	113	9.8	75.7
<b>Vehicle make</b> Model: pt_vehicle-make-classification_VMMR_224_224_3.64G_3.0	30.0	10.5	167	13.6	607.9
<b>Vehicle type</b> Model: pt_vehicle-type-classification_CarBodyStyle_224_224_3.64G_3.0	30.0	10.5	167	13.6	607.9
<b>Vehicle color</b> Model: pt_vehicle-color-classification_VCoR_224_224_3.64G_3.0	30.0	10.5	167	13.6	607.9
<b>General classification</b> Model: pt_resnet50_imagenet_224_224_8.2G_3.0	30.0	11.9	59.6	13.0	488.7
<b>General classification</b> Model: pt_resnet50_imagenet_224_224_0.3_5.8G_3.0	30.0	11.5	69.2	12.7	401.3
<b>General classification</b> Model: pt_resnet50_imagenet_224_224_0.4_4.9G_3.0	30.0	11.2	73.8	12.4	361.6
<b>General classification</b> Model: pt_resnet50_imagenet_224_224_0.5_4.1G_3.0	30.0	11.0	81.1	12.2	332.5
<b>General classification</b> Model: pt_resnet50_imagenet_224_224_0.6_3.3G_3.0	30.0	10.7	91.1	11.9	300.6
<b>General classification</b> Model: pt_resnet50_imagenet_224_224_0.7_2.5G_3.0	30.0	10.6	99.6	11.5	249.0

Measurement conditions:

- TE0820-03-04EV-1EA 2GB module with 12V FAN on TE0701-06 carrier board
- DPU in B4096 configuration
- USB WWW colour camera logi 720p, Logitech, 1280x720p30, 30 FPS
- Keyboard RPi
- Mouse RPi
- Remote X11 desktop
- Power supply 12V/5A
- Power measured at the 230V power plug

## 6 References

- [1] Support for STM32H573I-DK web server. (Application note, with evaluation package, UTIA). Not published, yet. To be published for public access from:  
<https://zs.utia.cas.cz/index.php?ids=projects/eecone>  
This application and evaluation package will be based on the STM32CubeH5 Firmware Examples for STM32H5xx Series Application based on NetXDuo: **Nx\_WebServer**. This STM application provides an example of Azure RTOS NetX Duo stack usage on STM32H573G-DK board, it shows how to develop Web HTTP server based application.  
<https://htmlpreview.github.io/?https://raw.githubusercontent.com/STMicroelectronics/STM32CubeH5/master/Projects/STM32CubeProjectsList.html>
- [2] Lukáš Kohout, Jiří Kadlec, Zdeněk Pohl: Support for TE0802-02-1BEV2-A board with Vitis AI 3.0 DPU and VGA display (Application note with evaluation package, UTIA). Draft has been provided to partners for review 14.1.2024. **To be published 15.2.2024** for public free access from:  
<https://zs.utia.cas.cz/index.php?ids=projects/eecone>
- [3] Lukáš Kohout, Jiří Kadlec, Zdeněk Pohl: Support for TE0802-02-2AEV2-A board with Vitis AI 3.0 DPU and VGA display (Application note, with evaluation package, UTIA). Draft has been provided to partners for review 14.1.2024. **To be published 15.2.2024** for public access from:  
<https://zs.utia.cas.cz/index.php?ids=projects/eecone>
- [4] Support for module-based systems with TE0821 modules on TE0701 carrier board with Vitis AI 3.0 DPU (Application note, with evaluation package, UTIA). Not published, yet. To be published for free public access from:  
<https://zs.utia.cas.cz/index.php?ids=projects/eecone>
- [5] Support for TE0820 modules with Vitis AI 3.0 DPU (Application note, with evaluation package, UTIA). Not published, yet. To be published for free public access from:  
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- [6] Compilation of Vitis AI 3.0 models for different configurations of AMD DPUs, (Application note, with evaluation package, UTIA). Not published, yet. To be published for free public access from:  
<https://zs.utia.cas.cz/index.php?ids=projects/eecone>
- [7] TE0802-02-1AEV2-A test board Vitis AI Tutorial (Vitis 2021.2.1, Vitis AI 2.0, no VGA display support)  
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