

# Edge Computing with DSP Acceleration

## Lab 4

Department of Electronic and Computer Engineering  
National Taiwan University of Science and Technology



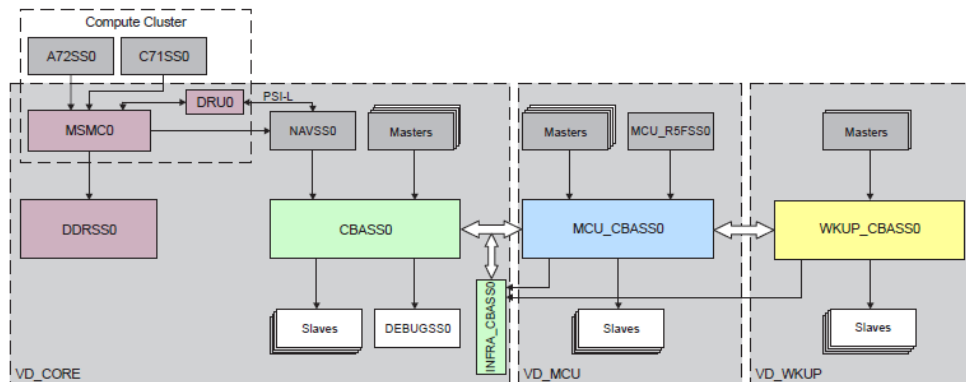


# Interprocessor Communication

## ■ Compute Cluster

SDK:

<https://www.ti.com/tool/download/PROCESSOR-SDK-LINUX-SK-TDA4VM>



Legend:  
 MAIN domain  
 MCU domain  
 WKUP domain

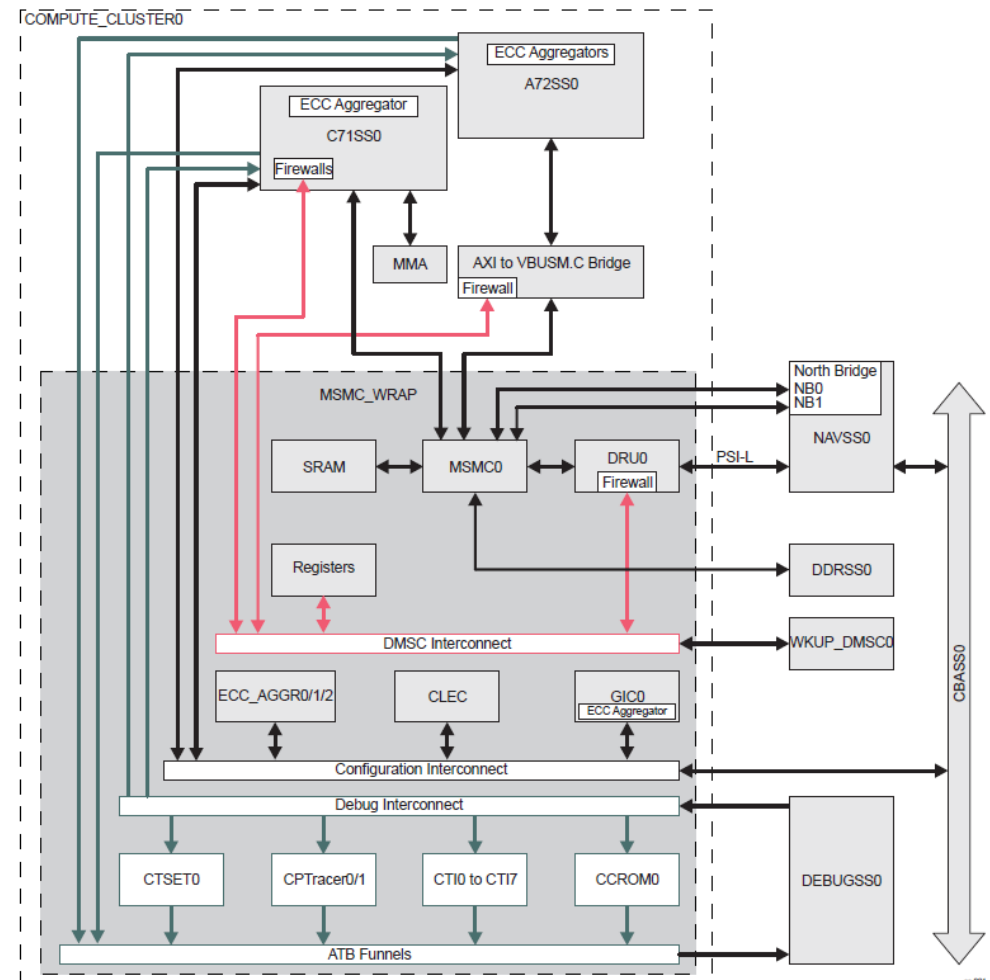


Figure 6-1. COMPUTE\_CLUSTER0 Overview

# SK-TDA4VM Embedded Main Component

## ■ Dual-A72 MPU Subsystem

SDK:

<https://www.ti.com/tool/download/PROCESSOR-SDK-LINUX-SK-TDA4VM>

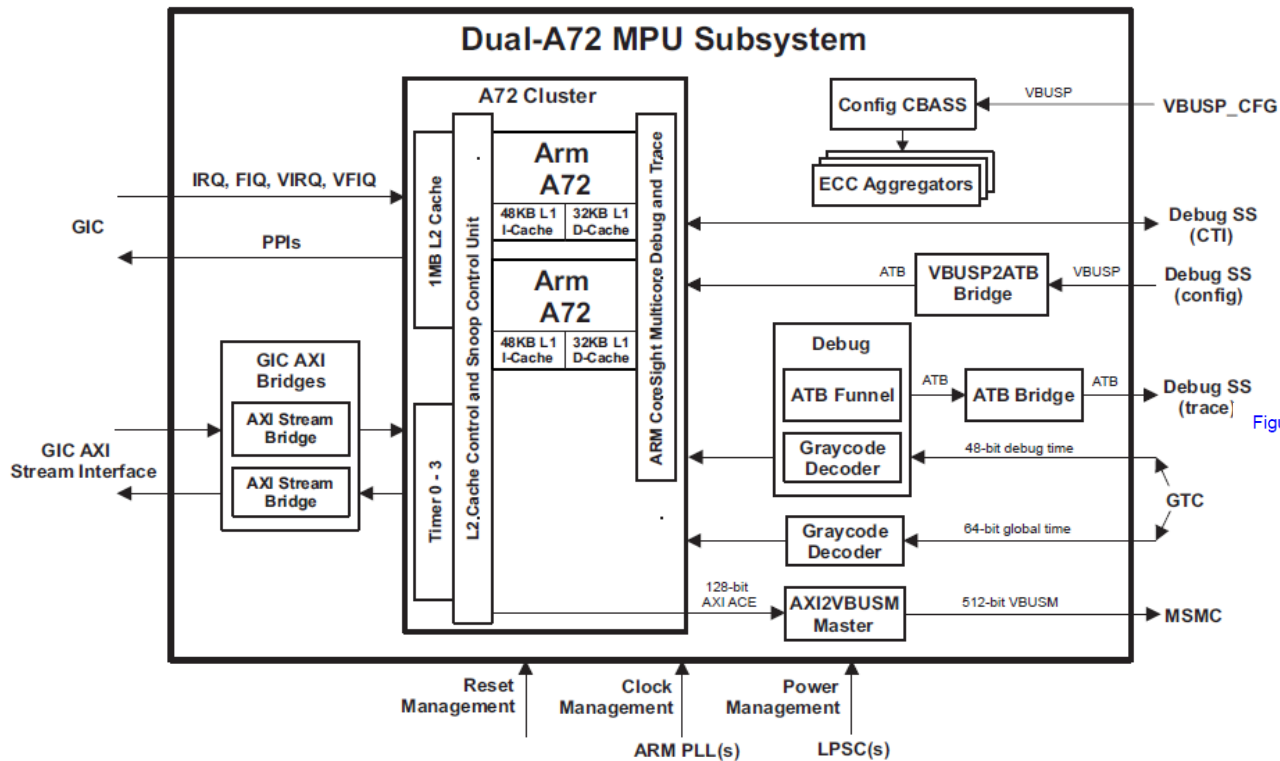


Figure 6-3. A72SS Block Diagram

Figure 6-13 shows the available SRAM/cache configurations for L1D.

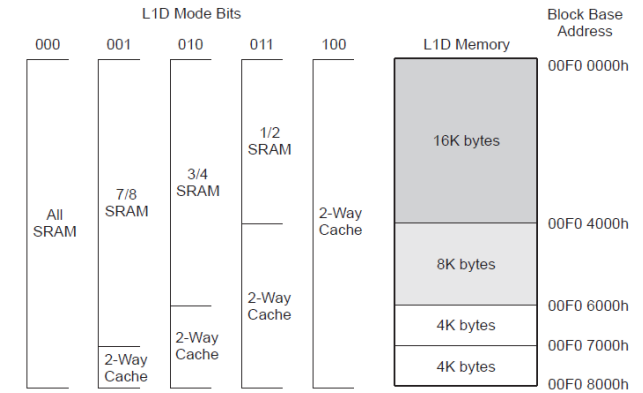


Figure 6-13. L1D Memory Configurations

Figure 6-12 shows the available SRAM/cache configurations for L1P.

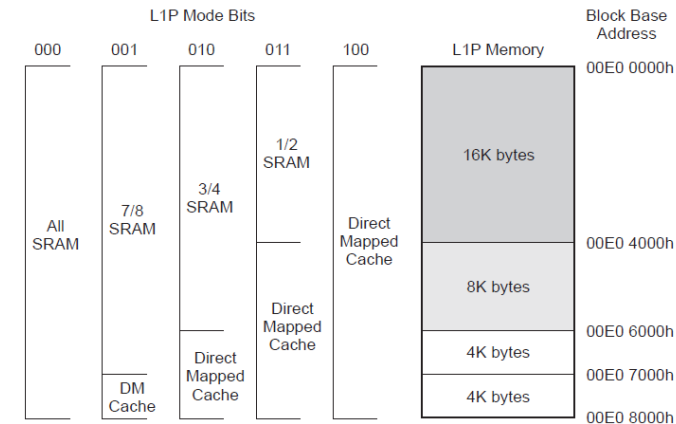
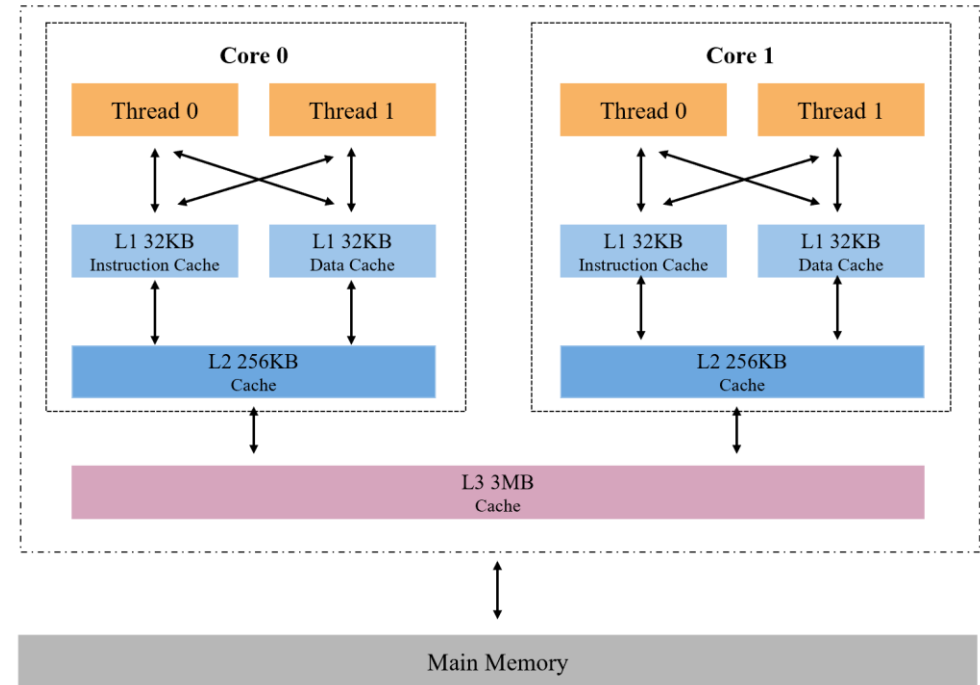
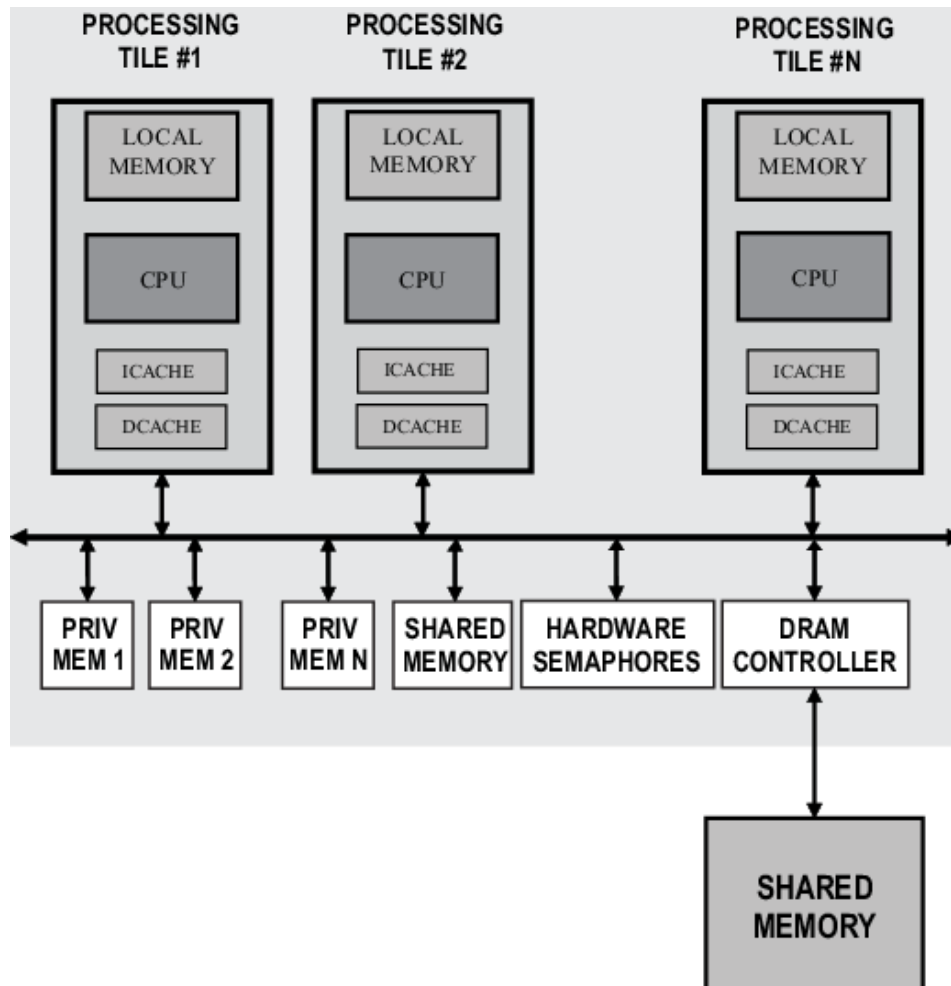


Figure 6-12. L1P Memory Configurations

# SK-TDA4VM Embedded Memory Component

## ■ Memory Share Architecture



# SK-TDA4VM Embedded Memory Component

## ■ Multi-Core Memory Share(MCMS)

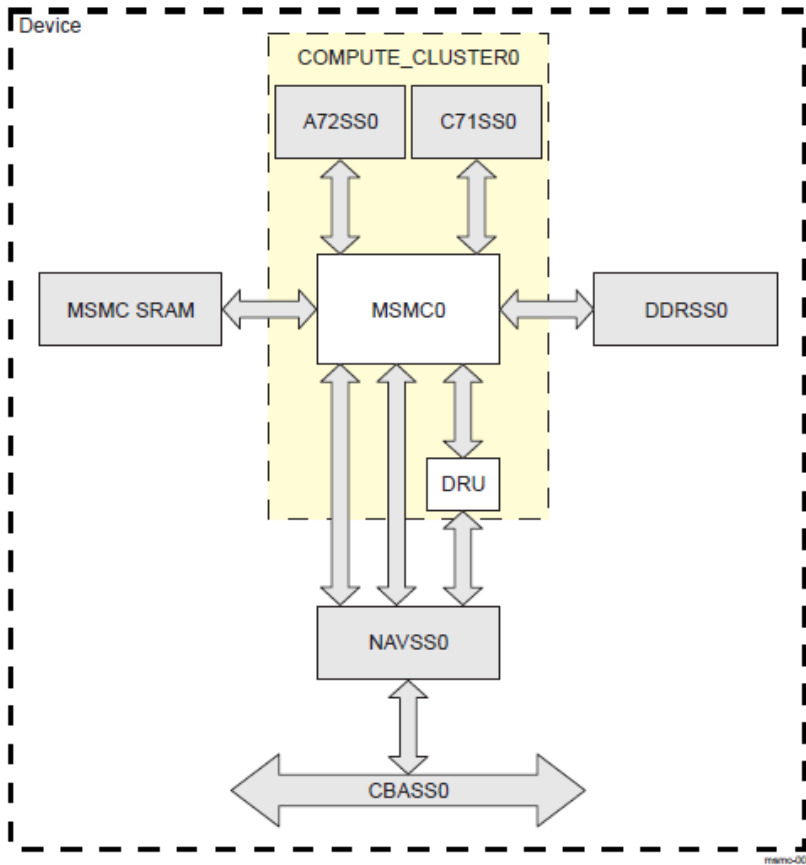


Figure 8-1. MSMC Overview

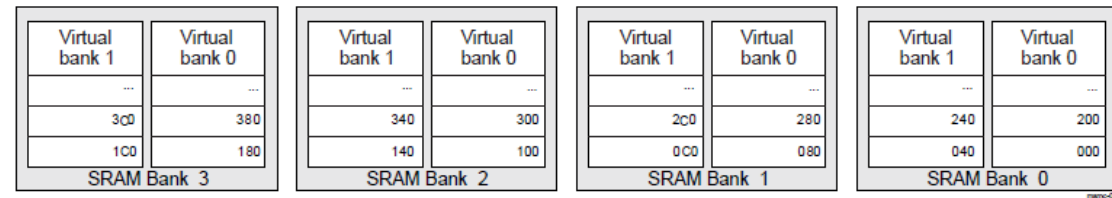
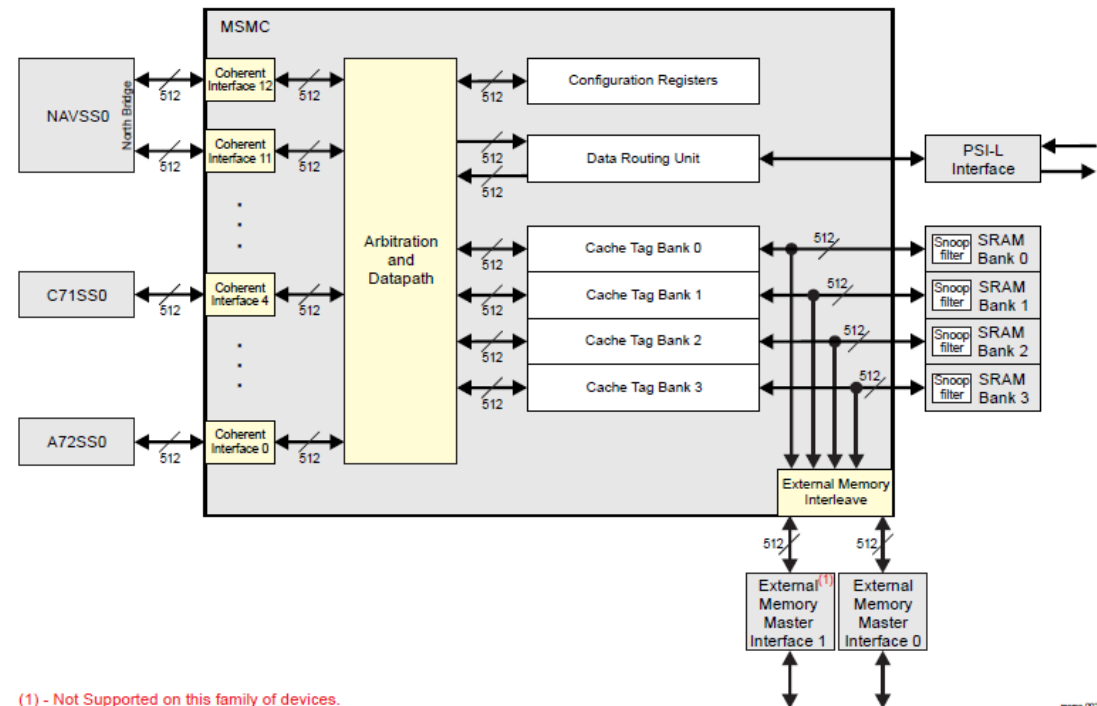


Figure 8-4. MSMC Memory Organization



(1) - Not Supported on this family of devices.

Figure 8-3. MSMC Functional Block Diagram

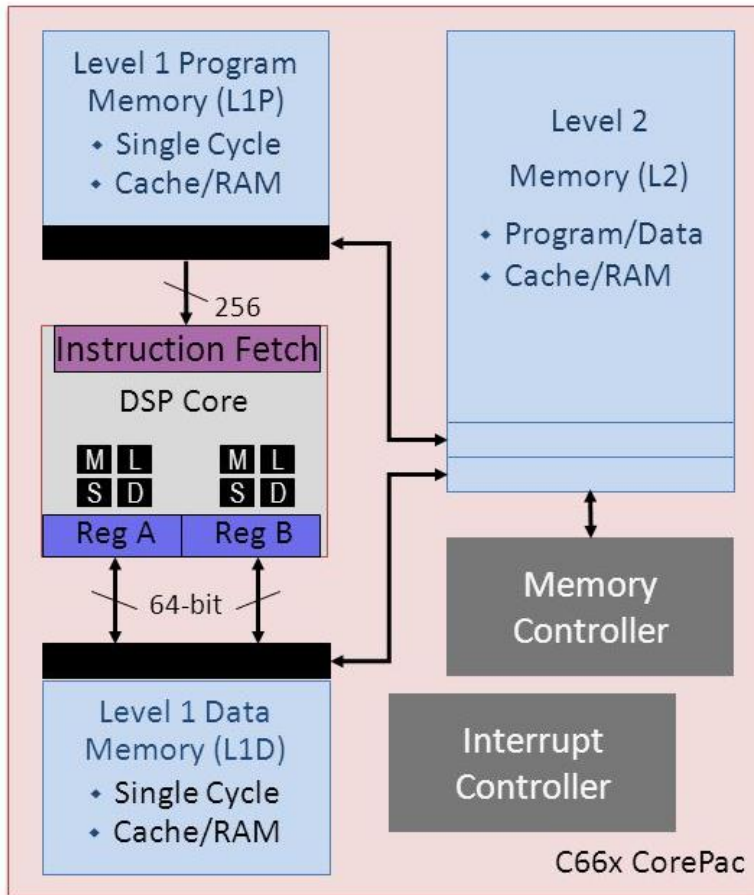


# SK-TDA4VM Embedded Accelerator Component

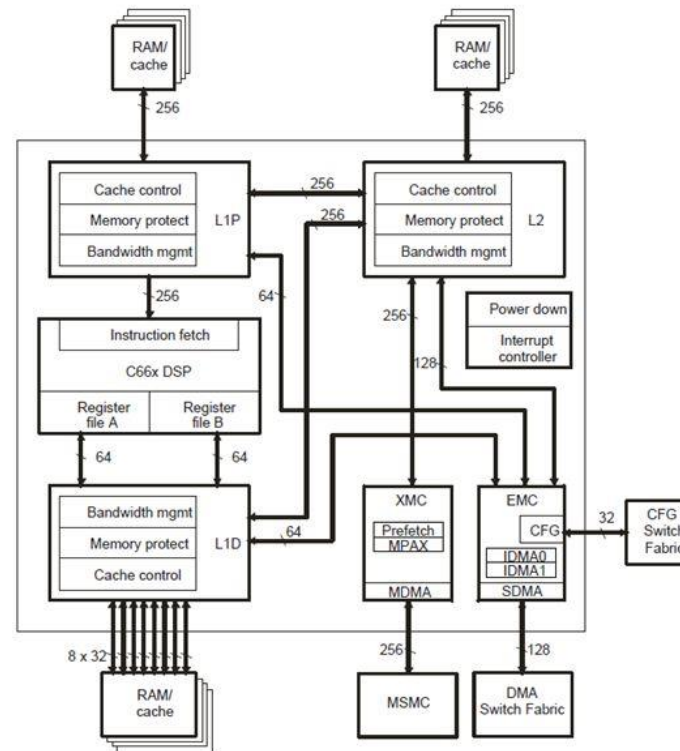
## ■ C66SS DSP Subsystem

SDK:

<https://www.ti.com/tool/download/PROCESSOR-SDK-LINUX-SK-TDA4VM>



## C66x Core Access Summary



- Master port into the MSMC
- Slave port from the TeraNet (Switched Central Resource)
- Interface to the configuration bus
- MSMC arbitrates between all cores and TeraNet requests, MSM memory, and DDR(s)

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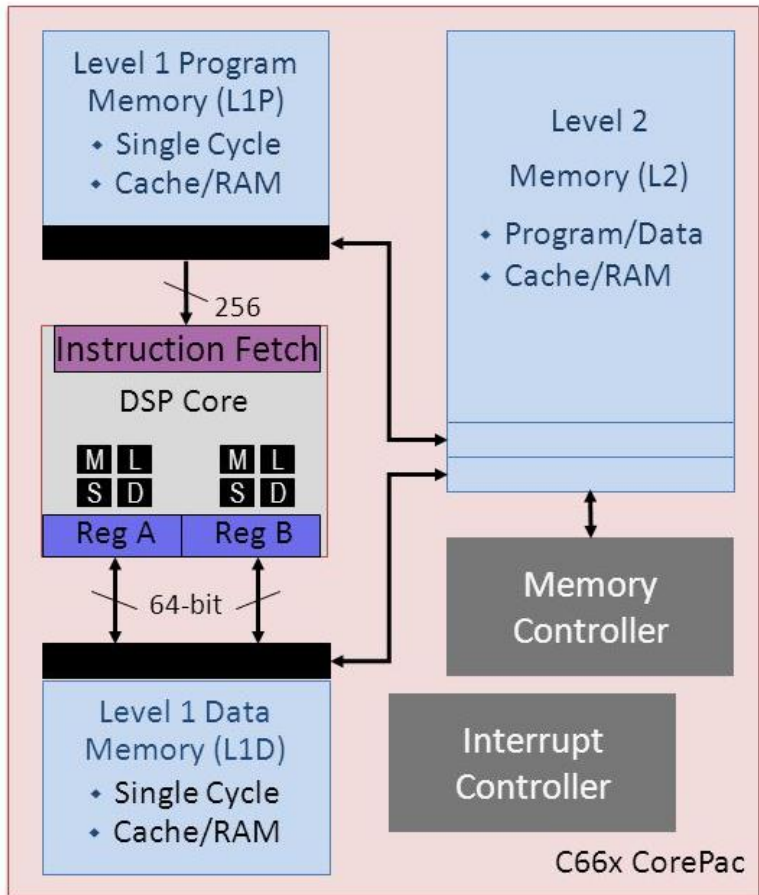


# SK-TDA4VM Embedded Accelerator Component

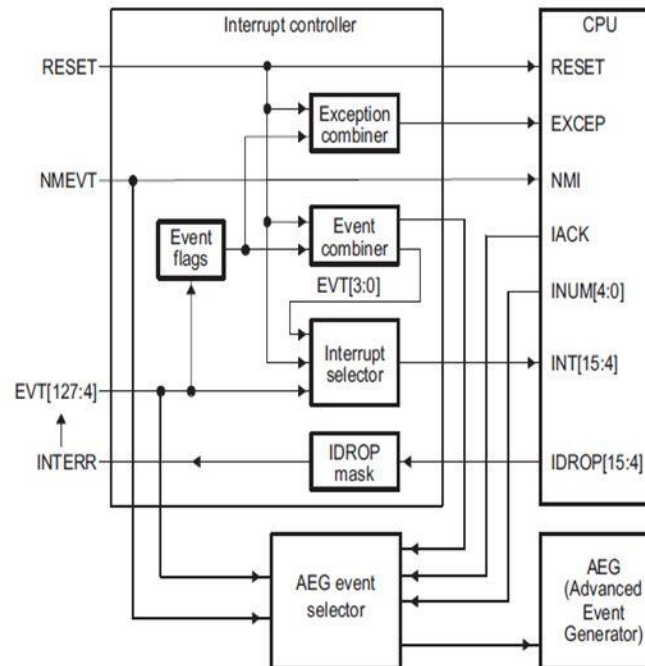
## ■ C66SS DSP Subsystem

SDK:

<https://www.ti.com/tool/download/PROCESSOR-SDK-LINUX-SK-TDA4VM>



## C66 Core Interrupt Controller



- 12 maskable hardware interrupts
- NMI
- Reset
- Exception signal
- 128 input events
- **Interrupt controller maps 128 signals into 12 interrupts**

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# SK-TDA4VM Embedded Accelerator Component

## ■ C66SS DSP Subsystem

SDK:

<https://www.ti.com/tool/download/PROCESSOR-SDK-LINUX-SK-TDA4VM>

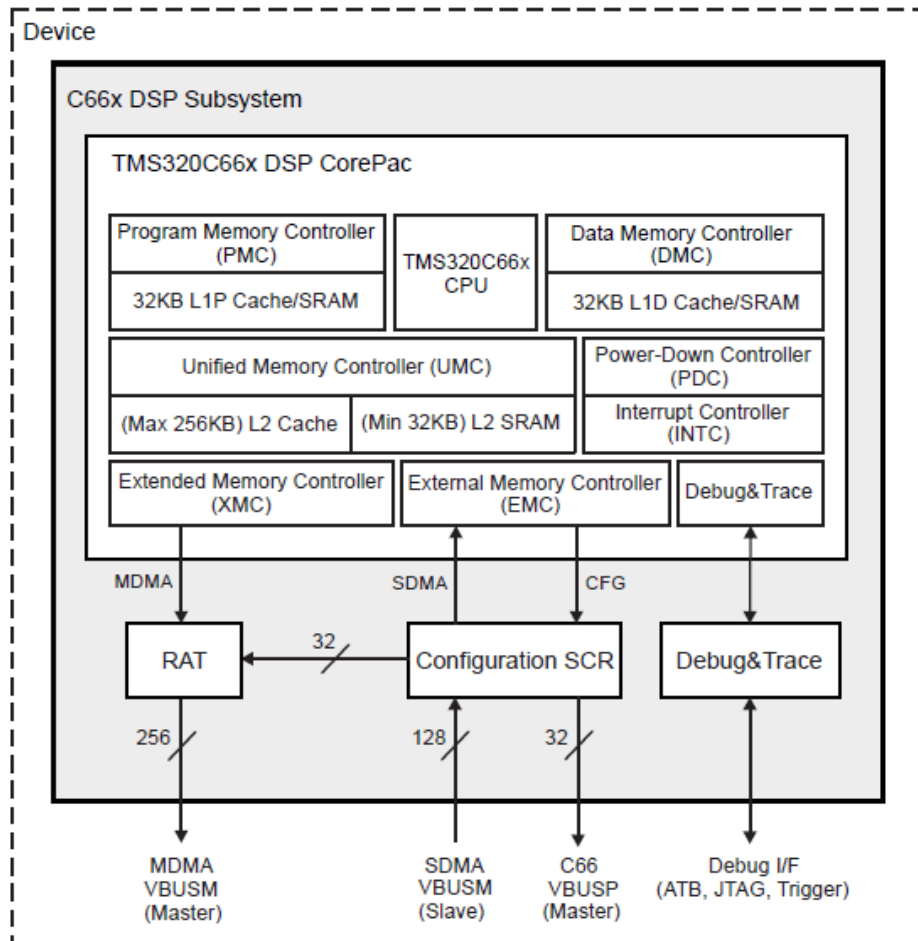


Figure 6-9. C66SS Overview

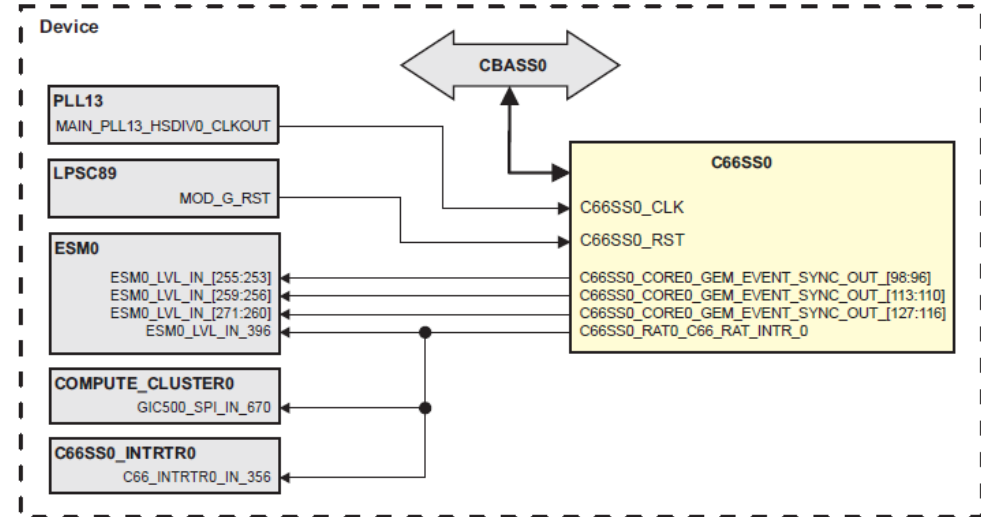
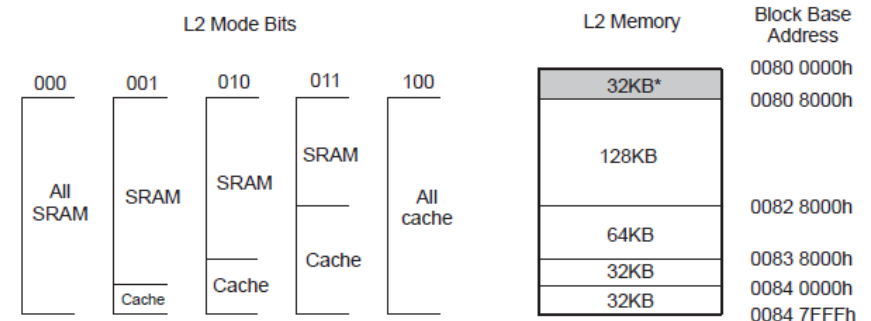


Figure 6-10. C66SS0 Integration



\*Note: The 32KB gray-shaded block is all SRAM, non-cacheable, non-configurable by L2MODE

Figure 6-14. L2 Memory Configurations

# SK-TDA4VM Embedded Accelerator Component

## C66SS DSP Register Map

### 6.4.24 C66x RAT Registers

Table 6-44 lists the memory-mapped registers for the C66x RAT registers. All register offset addresses not listed in Table 6-44 should be considered as reserved locations and the register contents should not be modified.

Table 6-43. C66x RAT Instances

Instance	Base Address
Table 6-44	07FF 0000h <sup>(1)</sup>

- (1) C66SS0/1 private memory-mapped register space. This region is only accessible by its associated C66x core; it is not accessible by any other SoC master. The base address is the same for each C66x memory view.

Table 6-44. C66x RAT Registers

Offset	Acronym	Register Name	C66_COREPAC_C66_RATCFG Physical Address
0h	Section 6.4.25	Revision Register	07FF 0000h
4h	Section 6.4.26	Config Register	07FF 0004h
20h + formula	Section 6.4.27	Region Control Register	07FF 0020h + formula
24h + formula	Section 6.4.28	Region Base Register	07FF 0024h + formula
28h + formula	Section 6.4.29	Region Translated Lower Address	07FF 0028h + formula
2Ch + formula	Section 6.4.30	Region Translated Upper Address	07FF 002Ch + formula
804h	Section 6.4.31	Destination ID Register	07FF 0804h
820h	Section 6.4.32	Exception Logging Control Register	07FF 0820h
824h	Section 6.4.33	Exception Logging Header 0 Register	07FF 0824h
828h	Section 6.4.34	Exception Logging Header 1 Register	07FF 0828h
82Ch	Section 6.4.35	Exception Logging Data 0 Register	07FF 082Ch
830h	Section 6.4.36	Exception Logging Data 1 Register	07FF 0830h
834h	Section 6.4.37	Exception Logging Data 2 Register	07FF 0834h
838h	Section 6.4.38	Exception Logging Data 3 Register	07FF 0838h
840h	Section 6.4.39	Exception Logging Interrupt Pending Set Register	07FF 0840h
844h	Section 6.4.40	Exception Logging Interrupt Pending Clear Register	07FF 0844h
848h	Section 6.4.41	Exception Logging Interrupt Enable Set Register	07FF 0848h
84Ch	Section 6.4.42	Exception Logging Interrupt Enable Clear Register	07FF 084Ch
850h	Section 6.4.43	EOI Register	07FF 0850h

### 6.4.26 C66\_RAT\_CONFIG Register (Offset = 4h) [reset = 300210h]

Section 6.4.26 is shown in Figure 6-16 and described in Table 6-49.

Return to Table 6-44.

This register contains the configuration values for the module.

Table 6-48. C66\_RAT\_CONFIG Instances

Instance	Physical Address
C66_COREPAC_C66_RATCFG	07FF 0004h

Figure 6-16. C66\_RAT\_CONFIG Register

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
RESERVED								ADDR_WIDTH							
R-0h								R-30h							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ADDRS								REGIONS							
R-1h								R-10h							

LEGEND: R = Read Only; -n = value after reset

Table 6-49. C66\_RAT\_CONFIG Register Field Descriptions

Bit	Field	Type	Reset	Description
31-24	RESERVED	R	0h	Reserved.
23-16	ADDR_WIDTH	R	30h	Number of address bits.
15-8	ADDRS	R	2h	Number of addresses.
7-0	REGIONS	R	10h	Number of regions.

Table 6-81. C66\_RAT\_EXCEPTION\_LOGGING\_DATA2 Instances

Instance	Physical Address
C66_COREPAC_C66_RATCFG	07FF 0834h

Figure 6-27. C66\_RAT\_EXCEPTION\_LOGGING\_DATA2 Register

31	30	29	28	27	26	25	24
RESERVED				ROUTEID			
R-0h				R-0h			
23	22	21	20	19	18	17	16
ROUTEID							
R-0h							
15	14	13	12	11	10	9	8
RESERVED		WRITE	READ	DEBUG	CACHEABLE	PRIV	SECURE
R-0h		R-0h	R-0h	R-0h	R-0h	R-0h	R-0h
7	6	5	4	3	2	1	0
PRIV_ID							
R-0h							

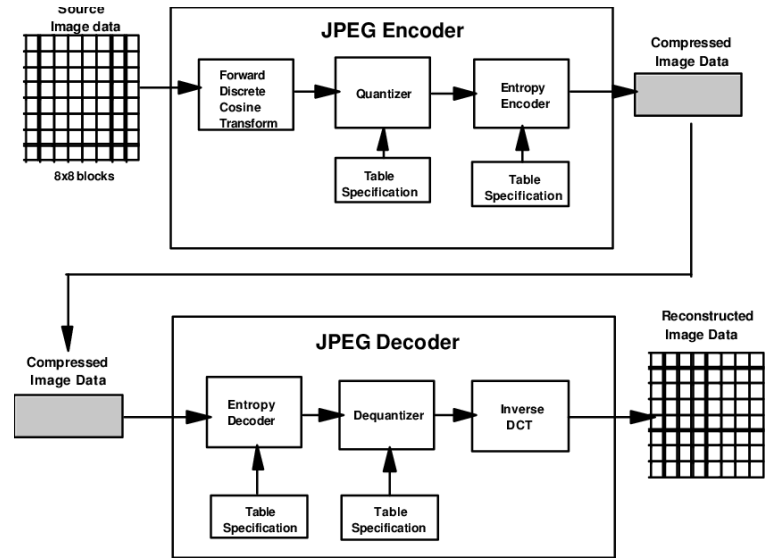
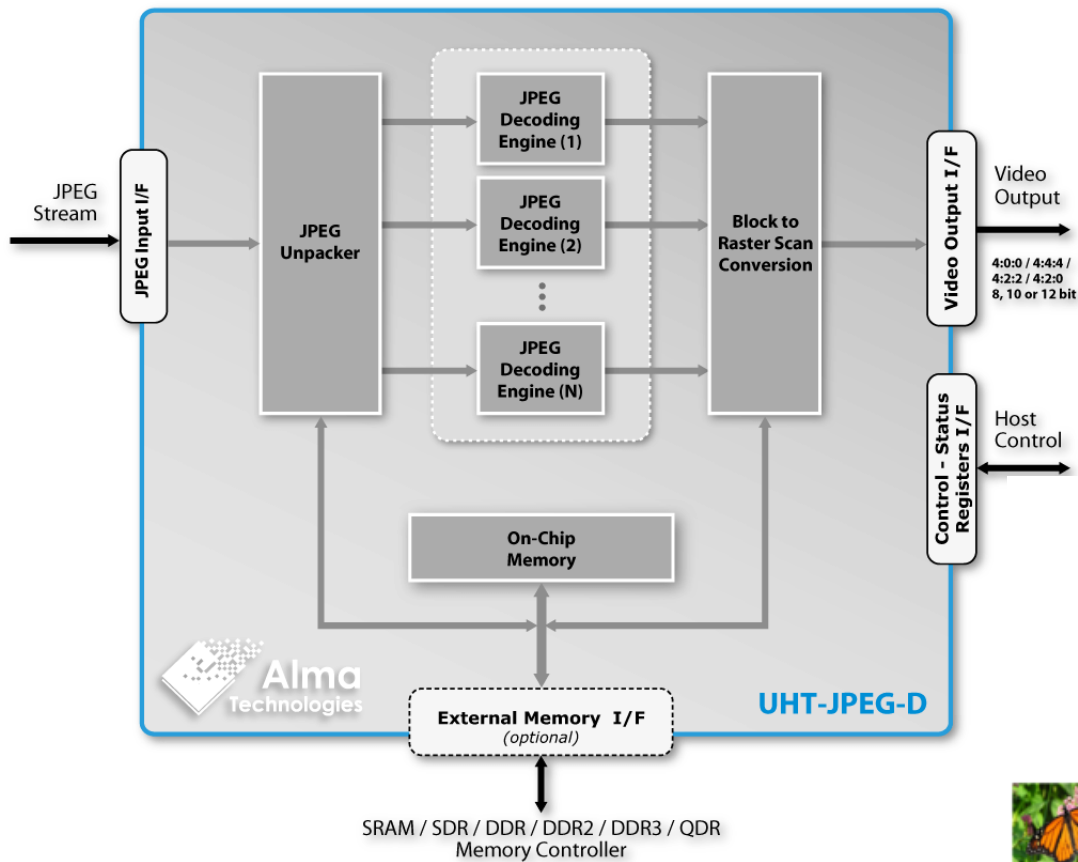
LEGEND: R = Read Only; -n = value after reset

Table 6-82. C66\_RAT\_EXCEPTION\_LOGGING\_DATA2 Register Field Descriptions

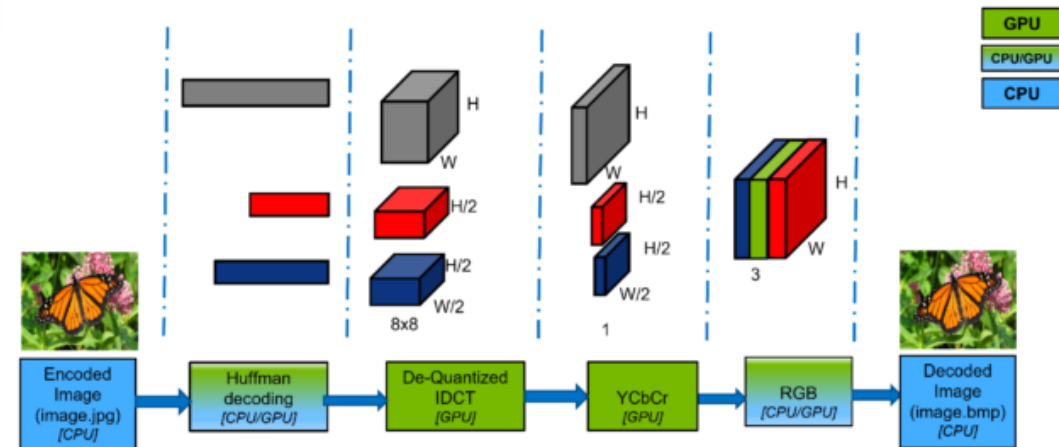
Bit	Field	Type	Reset	Description
31-28	RESERVED	R	0h	Reserved.
27-16	ROUTEID	R	0h	Route ID.
15-14	RESERVED	R	0h	Reserved.
13	WRITE	R	0h	Write.
12	READ	R	0h	Read.
11	DEBUG	R	0h	Debug.
10	CACHEABLE	R	0h	Cacheable.
9	PRIV	R	0h	Priv.
8	SECURE	R	0h	Secure.
7-0	PRIV_ID	R	0h	Priv ID.

# SK-TDA4VM Embedded Accelerator Component

## ■ JPEG Decoder Block Diagram



## nvJPEG Decoder (SW)



# SK-TDA4VM Embedded Accelerator Component

## Decoder Block Diagram

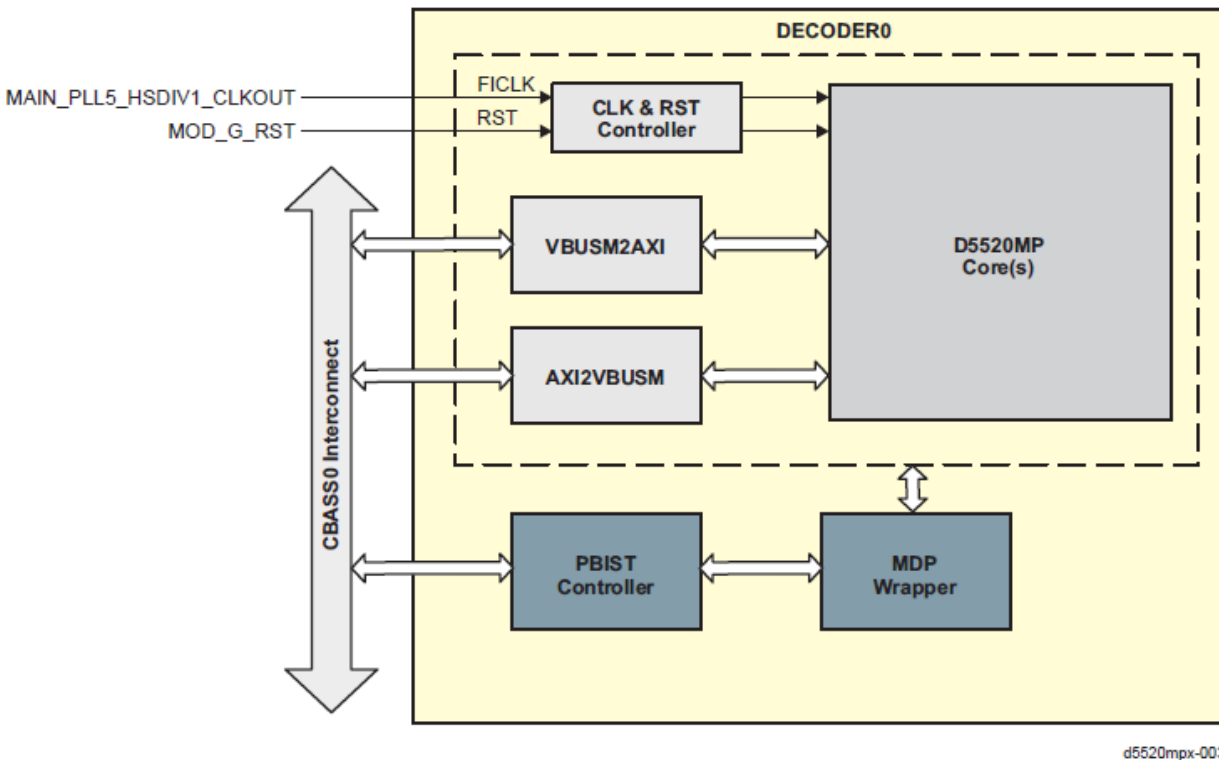


Figure 6-41. DECODER Functional Block Diagram

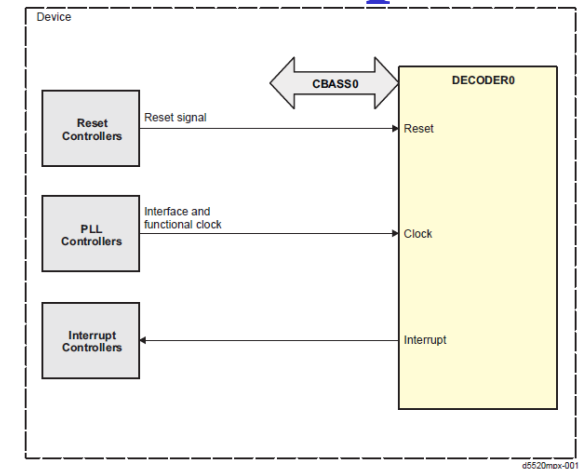


Figure 6-39. DECODER Module Overview

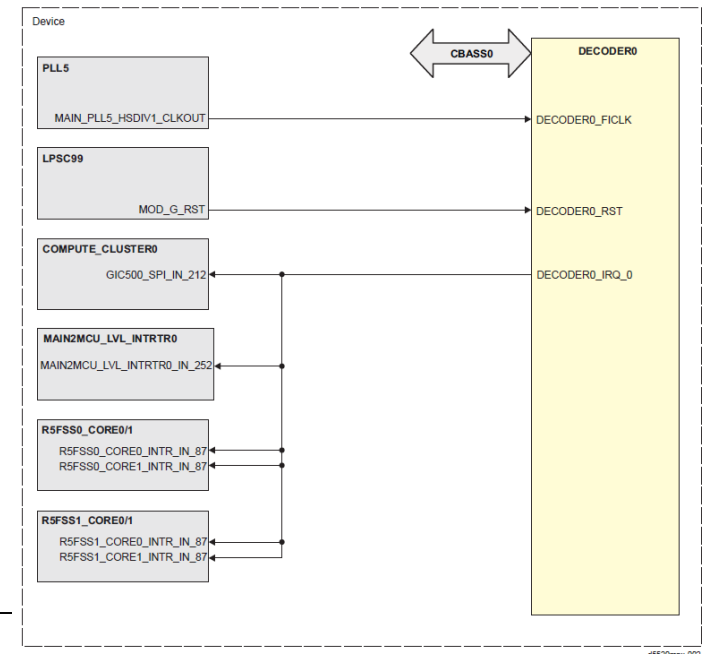
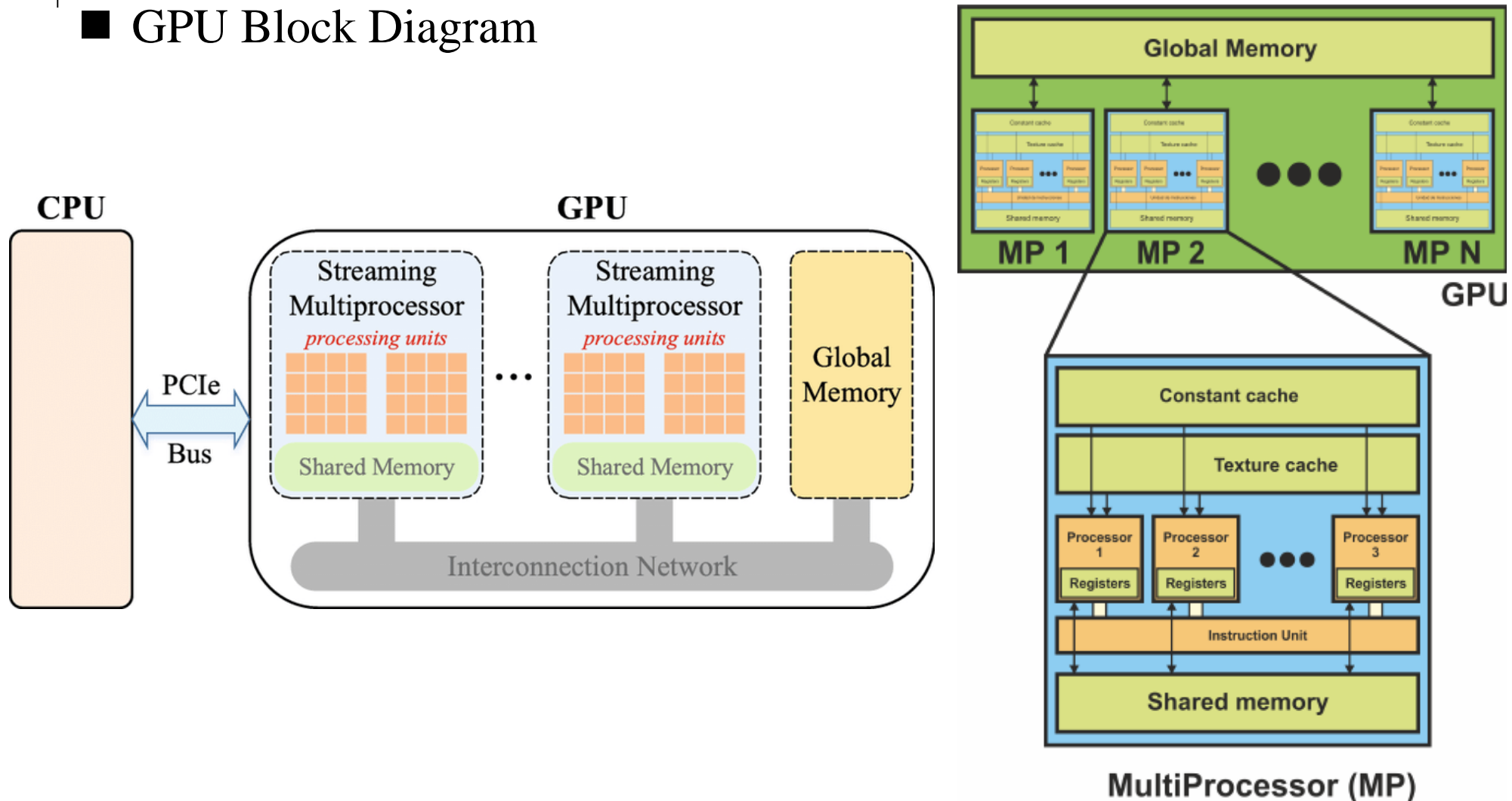


Figure 6-40. DECODER Integration

# Hardware Architecture of a Modern GPU

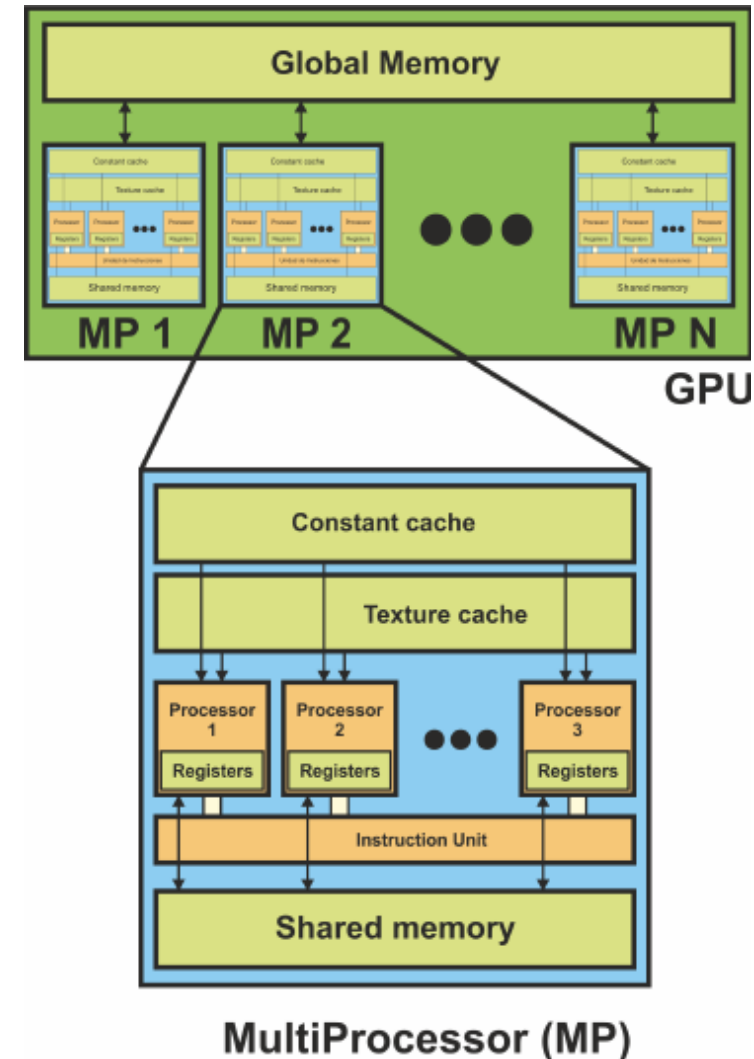
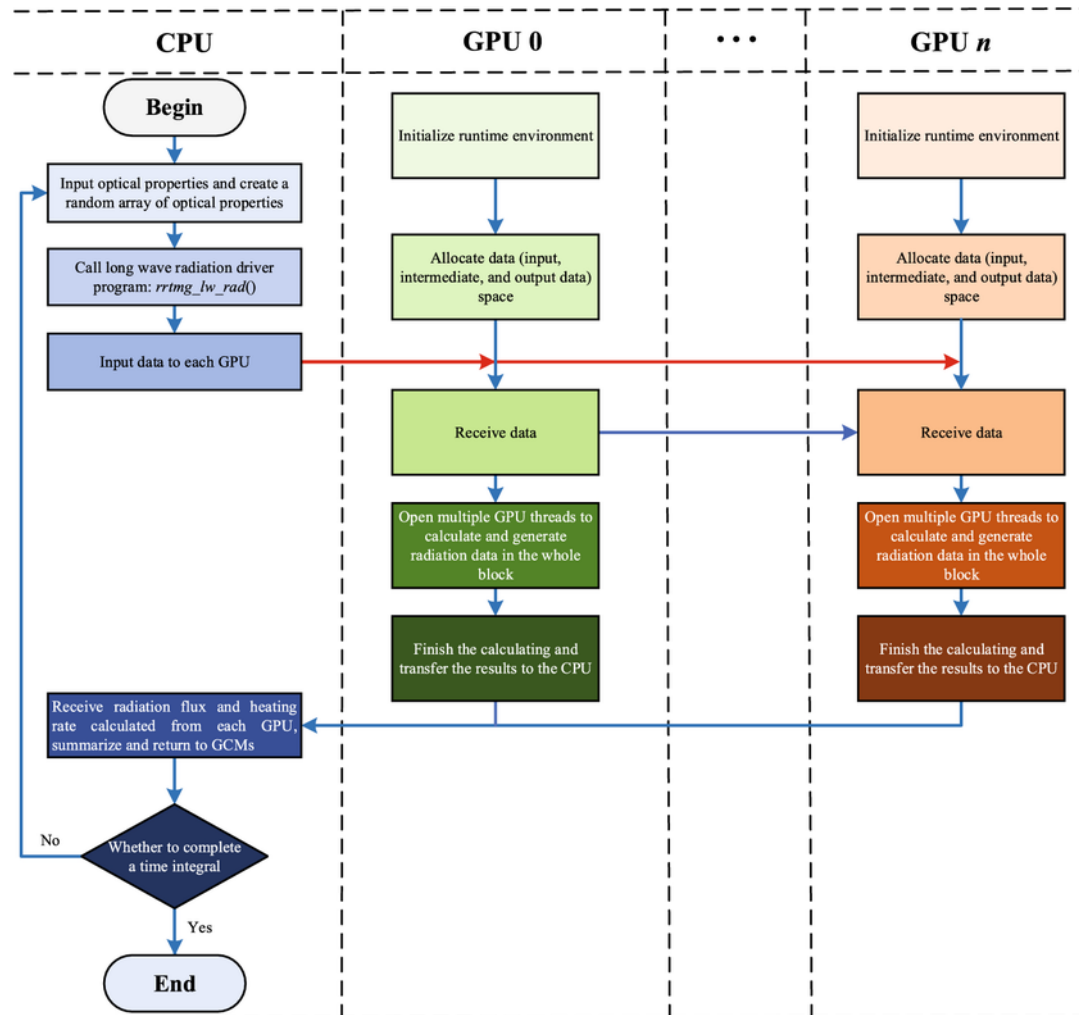
## ■ GPU Block Diagram





# Hardware Architecture of a Modern GPU

## ■ GPU Block Diagram



# SK-TDA4VM Embedded Accelerator Component

## ■ GPU Block Diagram

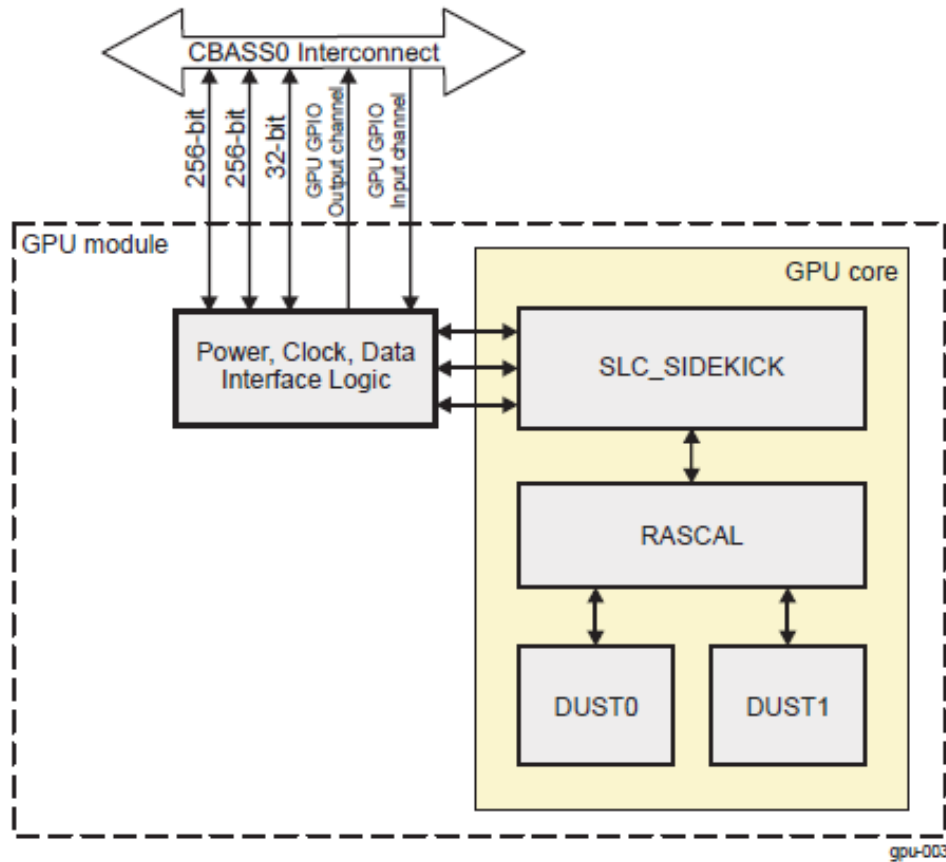


Figure 6-38. GPU Block Diagram

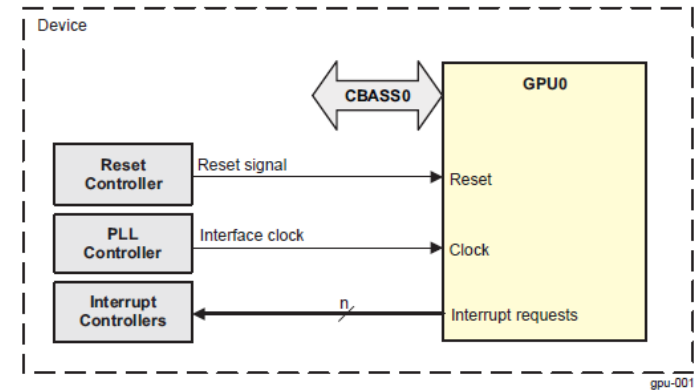


Figure 6-36. GPU Module Overview

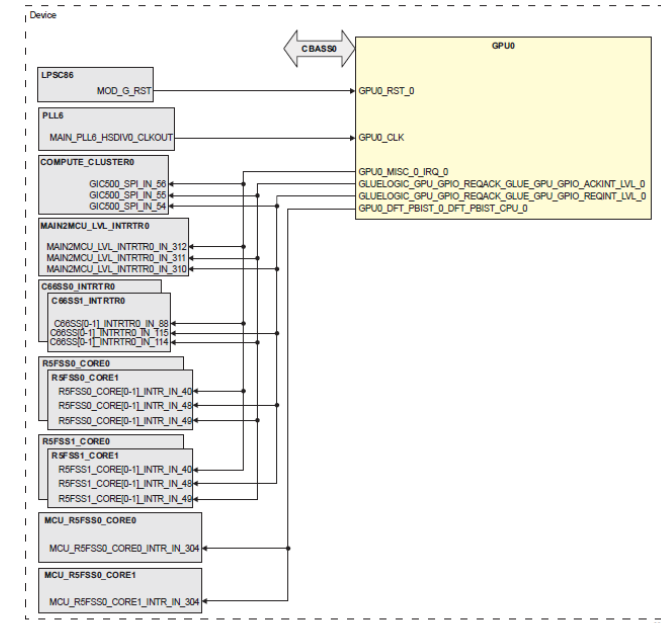


Figure 6-37. GPU0 Integration

# 學習基於TDA4VM輕量化Model訓練流程與環境建置

- ❖ 利用Lab2之模型參數知識完成Model Maker工具  
並完成訓練
- ❖ 根據客製化Dataset學習屬於自己的模型
- ❖ 完成期末專題模型實現



# SK-TDA4VM Embedded Environment Platform

SDK:

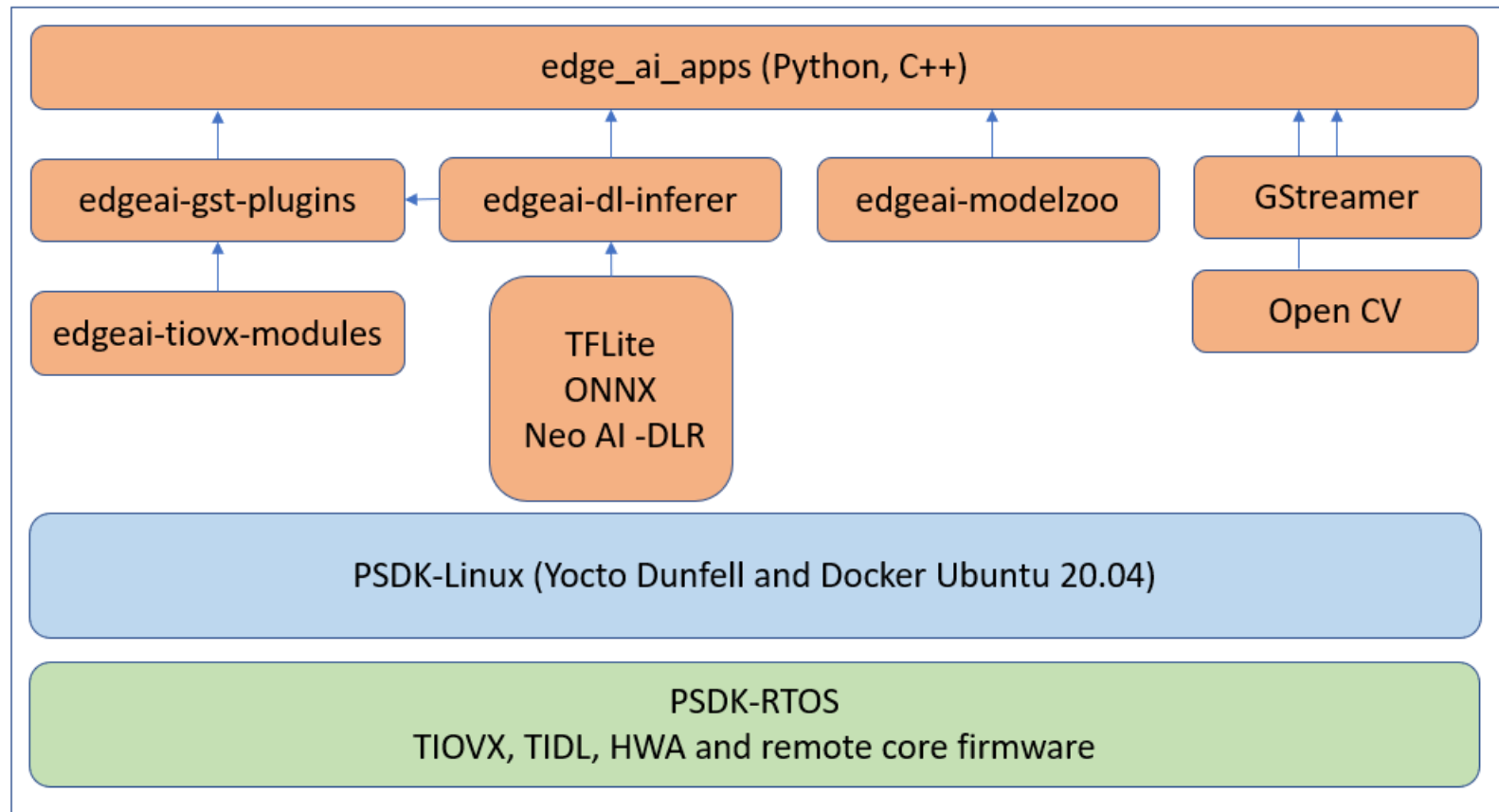
<https://www.ti.com/tool/download/PROCESSOR-SDK-LINUX-SK-TDA4VM>

Fetching software:

<https://www.balena.io/etcher>

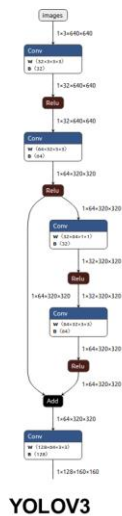
## ■ TDA4VM Development Kit

### ➤ Processor SDK Linux for Edge AI components

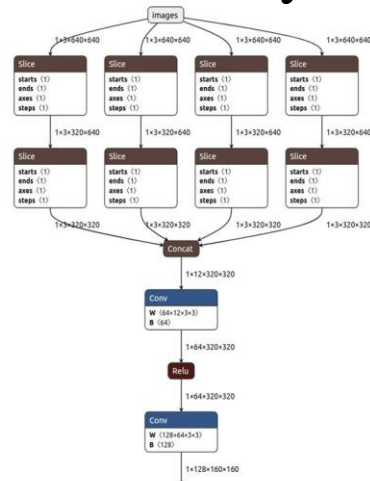


## DSP硬體加速元件流程

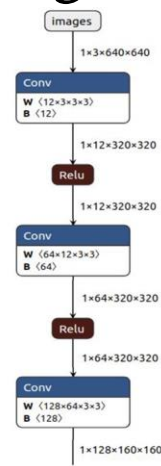
- A72 Core ARM CPU Process (Before Acceleration Original Data Flow)
- Edge AI TI-Lite Model Transfer
- C66x DSP Image Process Acceleration
- C7x DSP Neural Network Acceleration
- DMA Cache Memory Handling



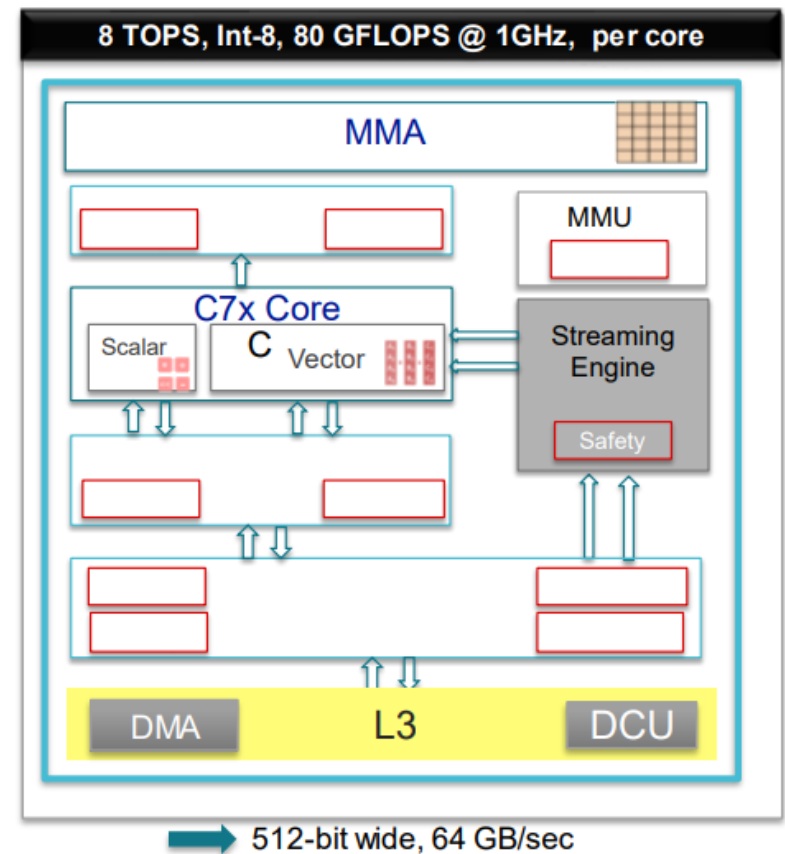
## YOLOV3



YOLOV5 official



## YOLOV5-ti-lite



# EdgeAI-ModelMaker 環境setup

參考自 [edgeai-modelmaker\(github\)](https://github.com/edgeai-modelmaker)

## ❖ 建立隔離環境

輸入以下指令安裝python3.10並建立名為” py3.10” 的隔離環境：

```
pyenv install 3.10
pyenv virtualenv 3.10 py310
pyenv rehash
pyenv activate py310
pip install --upgrade pip setuptools
```

```
wsl@jeffPC:~$ pyenv install 3.10
pyenv virtualenv 3.10 py310
pyenv rehash
pyenv activate py310
pip install --upgrade pip setuptools
Downloading Python-3.10.13.tar.xz...
-> https://www.python.org/ftp/python/3.10.13/Python-3.10.13.tar.xz
Installing Python-3.10.13...
Installed Python-3.10.13 to /home/wsl/.pyenv/versions/3.10.13
Requirement already satisfied: pip in ./pyenv/versions/3.10.13/envs/py310/lib/python3.10/site-packages (23.0.1)
Collecting pip
  Downloading pip-24.0-py3-none-any.whl (2.1 MB)
    2.1/2.1 MB 5.6 MB/s eta 0:00:00
Requirement already satisfied: setuptools in ./pyenv/versions/3.10.13/envs/py310/lib/python3.10/site-packages (65.5.0)
Collecting setuptools
  Downloading setuptools-69.1.1-py3-none-any.whl (819 kB)
    819.3/819.3 kB 37.3 MB/s eta 0:00:00
Installing collected packages: setuptools, pip
Attempting uninstall: setuptools
  Found existing installation: setuptools 65.5.0
  Uninstalling setuptools-65.5.0:
    Successfully uninstalled setuptools-65.5.0
Attempting uninstall: pip
  Found existing installation: pip 23.0.1
  Uninstalling pip-23.0.1:
    Successfully uninstalled pip-23.0.1
Successfully installed pip-24.0 setuptools-69.1.1
```



# EdgeAI-ModelMaker 環境setup

## ❖ 下載Github Model maker工具

輸入以下指令複製modelmaker的存儲庫並簽出到r9.0分支:

```
git clone https://github.com/TexasInstruments/edgeai-modelmaker.git
cd edgeai-modelmaker/
git checkout r9.0
```

```
(py310) wsl@jeffPC:~$ git clone https://github.com/TexasInstruments/edgeai-modelmaker.git
Cloning into 'edgeai-modelmaker'...
remote: Enumerating objects: 3390, done.
remote: Counting objects: 100% (131/131), done.
remote: Compressing objects: 100% (57/57), done.
remote: Total 3390 (delta 99), reused 91 (delta 74), pack-reused 3259
Receiving objects: 100% (3390/3390), 586.27 KiB | 1.61 MiB/s, done.
Resolving deltas: 100% (2308/2308), done.
(py310) wsl@jeffPC:~$ cd edgeai-modelmaker/
(py310) wsl@jeffPC:~/edgeai-modelmaker$ git checkout r9.0
Branch 'r9.0' set up to track remote branch 'r9.0' from 'origin'.
Switched to a new branch 'r9.0'
(py310) wsl@jeffPC:~/edgeai-modelmaker$
```

確定有切換到r9.0之後輸入以下指令開始初始化modelmaker:

```
./setup_all.sh
```

這個過程會持續數分鐘到數十分鐘，直到看到如下輸出:

```
Successfully installed pillow-simd-9.0.0.post1
../edgeai-benchmark    ../edgeai-modelmaker  ../edgeai-torchvision
../edgeai-mmdetection  ../edgeai-modelzoo
installation done.
(py310) wsl@jeffPC:~/edgeai-modelmaker$ |
```

# EdgeAI-ModelMaker 環境setup

## ❖ 下載Github Model maker工具

因為新版本有一些破壞性更動，我們需要將python套件的版本降級  
輸入以下指令強制安裝舊版本yapf：

```
pip install yapf==0.40.1
```

不用理會此錯誤，因為我們已經在上一步安裝Pillow-SIMD了

```
(py310) wsl@jeffPC:~/edgeai-modelmaker$ pip install yapf==0.40.1
Collecting yapf==0.40.1
  Downloading yapf-0.40.1-py3-none-any.whl.metadata (35 kB)
Requirement already satisfied: importlib-metadata>=6.6.0 in /home/wsl/.pyenv/versions/3.10.13/envs/py310/lib/python3.10/site-packages (from yapf==0.40.1) (7.0.1)
Requirement already satisfied: platformdirs>=3.5.1 in /home/wsl/.pyenv/versions/3.10.13/envs/py310/lib/python3.10/site-packages (from yapf==0.40.1) (4.2.0)
Requirement already satisfied: tomli>=2.0.1 in /home/wsl/.pyenv/versions/3.10.13/envs/py310/lib/python3.10/site-packages (from yapf==0.40.1) (2.0.1)
Requirement already satisfied: zipp>=0.5 in /home/wsl/.pyenv/versions/3.10.13/envs/py310/lib/python3.10/site-packages (from importlib-metadata>=6.6.0->yapf==0.40.1) (3.17.0)
Downloading yapf-0.40.1-py3-none-any.whl (250 kB)
250.3/250.3 kB 1.7 MB/s eta 0:00:00
Installing collected packages: yapf
  Attempting uninstall: yapf
    Found existing installation: yapf 0.40.2
    Uninstalling yapf-0.40.2:
      Successfully uninstalled yapf-0.40.2
ERROR: pip's dependency resolver does not currently take into account all the packages that are installed. This behaviour is the source of the following dependency conflicts.
mncv-full 1.4.8 requires Pillow, which is not installed.
Successfully installed yapf-0.40.1
(py310) wsl@jeffPC:~/edgeai-modelmaker$ |
```

# EdgeAI-ModelMaker 環境setup

## ❖ 下載Github Model maker工具

因為TI的編譯工具對CPU有要求，因此我們要停用模型編譯：

輸入 `vi config_detection.yaml` 編輯設定檔：

將compilation中的enable改為False後保存並離開

```
# 'http://software-dl.ti.com/jacinto7/esd/modelzoo/08_06_00_01/datasets/animal_detection.zip'
# -----
# Example 3, give image folders with annotation files (require list with values for both train and val splits)
# dataset_name: coco_detection
# input_data_path: ["/data/projects/coco_detection/dataset/train2017",
#                  "/data/projects/coco_detection/dataset/val2017"]
# input_annotation_path: ["/data/projects/coco_detection/dataset/annotations/instances_train2017.json",
#                          "/data/projects/coco_detection/dataset/annotations/instances_val2017.json"]
# -----
dataset_name: tiscapes2017_driving
input_data_path: 'http://software-dl.ti.com/jacinto7/esd/modelzoo/08_06_00_01/datasets/tiscapes2017_driving.zip'

training:
# enable/disable training
enable: True #False

# Object Detection model chosen can be changed here if needed
# options are: 'yolox_s_lite', 'yolox_tiny_lite', 'yolox_nano_lite', 'yolox_pico_lite', 'yolox_femto_lite'
model_name: 'yolox_nano_lite'

training_epochs: 2 #30
batch_size: 16 #32
# learning_rate: 0.005
# num_gpus: 0 #1 #4

compilation:
# enable/disable compilation
enable: False #False
# tensor_bits: 8 #16 #32
```

Epoch自行設定

53,1

Bot

## 完成下載訓練集與模型訓練成功

## 最後執行設定與執行黨：

```
./run modelmaker.sh TDA4VM config detection.yaml
```

```
(py310) wsl@jefFPC:~/edgeai-modelmaker$ ./run_modelmaker.sh TDA4VM config_detection.yaml
Number of AVX cores detected in PC: 12
AVX compilation speedup in PC : 1
Target device : TDA4VM
PYTHONPATH : .
TIDL_TOOLS_PATH : ../edgeai-benchmark/tools/TDA4VM/tidl_tools
LD_LIBRARY_PATH : ../edgeai-benchmark/tools/TDA4VM/tidl_tools
argv: ['./scripts/run_modelmaker.py', 'config_detection.yaml', '--target_device', 'TDA4VM']

-----
Run Name: 20240306-012627/yolox_nano_lite
- Model: yolox_nano_lite
- TargetDevices & Estimated Inference Times (ms): {'TDA4VM': 3.74, 'AM62A': 8.87, 'AM68A': 3.73, 'AM69A': '3.64 (with 1/4th device capability)', 'AM62': 516.15}
- This model can be compiled for the above device(s).

-----
downloading from https://software-dl.ti.com/jacinto7/esd/modelzoo/08_06_00_01/models/vision/detection/coco/edgeai-mmdet/yolox_nano_lite_416x416_20220214_checkpoint.pth to ./data/downloads/pretrained/yolox_nano_lite/yolox_nano_lite_416x416_20220214_checkpoint.pth
100%|██████████████████████████████████████████████████████████████████████████████| 27605950/27605950 [00:00<00:00, 37449535.29B/s]
downloading from http://software-dl.ti.com/jacinto7/esd/modelzoo/08_06_00_01/datasets/tiscapes2017_driving.zip to ./data/downloads/datasets/tiscapes2017_driving.zip
52%|██████████████████████████████████████████████████████████████████████████████| 58693632/113880250 [00:01<00:01, 38863876.10B/s]
```

如果你過程中沒有出現問題  
那你應該會看到這樣的輸出-->  
到這裡就完成了環境的初始化

```
2024-03-06 01:28:26.397 - mmdet - INFO - Exp name: yolox_nano_lite.py
2024-03-06 01:28:26.397 - mmdet - INFO - Epoch(val) [2][107] - bbox_mAP: 0.1250, bbox_map_50: 0.2360,
bbox_map_75: 0.1180, bbox_mAP_s: 0.0030, bbox_mAP_m: 0.0920, bbox_mAP_l: 0.4740, bbox_mAP_copypaste:
0.125 0.236 0.118 0.003 0.092 0.474
/home/wsl/.pyenv/versions/py310/lib/python3.10/site-packages/mmcv/onnx/info.py:20: UserWarning: DeprecationWarning: This function will be deprecated in future. Welcome to use the unified model deployment toolbox MMDeploy: https://github.com/open-mmlab/mmdelay
warnings.warn(msg)
/home/wsl/.pyenv/versions/py310/lib/python3.10/site-packages/mmcv/tensorrt/init_plugins.py:51: UserWarning: DeprecationWarning: This function will be deprecated in future. Welcome to use the unified model deployment toolbox MMDeploy: https://github.com/open-mmlab/mmdelay
warnings.warn(msg)
/home/wsl/.pyenv/versions/py310/lib/python3.10/site-packages/torch/onnx/symbolic_opset9.py:1248: UserWarning: This model contains a squeeze operation on dimension 1. If the model is intended to be used with dynamic input shapes, please use opset version 11 to export the model.
warnings.warn(
===== Diagnostic Run torch.onnx.export version 2.0.1+cpu =====
verbose: False, log level: Level.ERROR
===== 0 NONE 0 NOTE 0 WARNING 0 ERROR =====

Successfully exported ONNX model: /home/wsl/edgeai-modelmaker/data/projects/tiscapes2017_driving/run/20240306-012627/yolox_nano_lite/training-model.onnx
Trained model is at: /home/wsl/edgeai-modelmaker/data/projects/tiscapes2017_driving/run/20240306-012627/yolox_nano_lite/training

SUCCESS: ModelMaker - Training completed.
(py310) wsl@jeffPC:~/edgeai-modelmaker$
```

# 模型參數調整

## ❖ 所有可調參數

參考自<https://github.com/TexasInstruments/edgeai-modelmaker>

edgeai-modelmaker / edgeai\_modelmaker / ai\_modules / vision / params.py

Code Blame 132 lines (129 loc) · 5.69 KB

```
37 def init_params(*args, **kwargs):
73     training=dict(
74         enable=True,
75         model_name=None,
76         model_training_id=None,
77         training_backend=None,
78         pretrained_checkpoint_path=None,
79         target_devices={},
80         project_path=None,
81         dataset_path=None,
82         training_path=None,
83         log_file_path=None,
84         log_summary_regex=None,
85         summary_file_path=None,
86         model_checkpoint_path=None,
87         model_export_path=None,
88         model_proto_path=None,
89         model_packaged_path=None,
90         training_epochs=15,
91         warmup_epochs=1,
92         num_last_epochs=5,
93         batch_size=8,
94         learning_rate=2e-3,
95         num_classes=None,
96         weight_decay=1e-4,
97         input_resize=(512, 512),
98         input_cropsizes=(512, 512),
99         training_device=None, # 'cpu', 'cuda'
100         num_gpus=0, # 0,1..4
101         distributed=True,
102         training_master_port=29500,
103         with_background_class=None
104     ),
```



# Lab4成果目標

參考自<https://github.com/TexasInstruments/edgeai-modelmaker>

## ❖ 準確率評分標準

模型Yolox-nano-lite限制(可修改模型內部但不可置換整個模型)

限制Epoch 200以下

分數標準: Precision AP等比較與Loss大小

提供佐證相關資料

```
2024-03-06 01:28:26,397 - mmdet - INFO - Exp name: yolox_nano_lite.py
2024-03-06 01:28:26,397 - mmdet - INFO - Epoch(val) [2][107] bbox_mAP: 0.1250, bbox_mAP_50: 0.2360,
bbox_mAP_75: 0.1180, bbox_mAP_s: 0.0030, bbox_mAP_m: 0.0920, bbox_mAP_l: 0.4740, bbox_mAP_copypaste:
0.125 0.236 0.118 0.003 0.092 0.474
/home/wsl/.pyenv/versions/py310/lib/python3.10/site-packages/mmcv/onnx/info.py:20: UserWarning: Deprec
ationWarning: This function will be deprecated in future. Welcome to use the unified model deployment
toolbox MMDeploy: https://github.com/open-mmlab/mmdelay
warnings.warn(msg)
/home/wsl/.pyenv/versions/py310/lib/python3.10/site-packages/mmcv/tensorrt/init_plugins.py:51: UserWar
ning: DeprecationWarning: This function will be deprecated in future. Welcome to use the unified model
deployment toolbox MMDeploy: https://github.com/open-mmlab/mmdelay
warnings.warn(msg)
/home/wsl/.pyenv/versions/py310/lib/python3.10/site-packages/torch/onnx/symbolic_opset9.py:1248: UserW
arning: This model contains a squeeze operation on dimension 1. If the model is intended to be used wi
th dynamic input shapes, please use opset version 11 to export the model.
warnings.warn(
===== Diagnostic Run torch.onnx.export version 2.0.1+cpu =====
verbose: False, log level: Level.ERROR
===== 0 NONE 0 NOTE 0 WARNING 0 ERROR =====

Successfully exported ONNX model: /home/wsl/edgeai-modelmaker/data/projects/tiscapes2017_driving/run/2
0240306-012627/yolox_nano_lite/training/model.onnx
Trained model is at: /home/wsl/edgeai-modelmaker/data/projects/tiscapes2017_driving/run/20240306-01262
7/yolox_nano_lite/training

SUCCESS: ModelMaker - Training completed.
(py310) wsl@jeffPC:~/edgeai-modelmaker$ |
```



# 提供相關佐證訓練結果

## ❖ Log訊息與模型訓練截圖

參考自<https://github.com/TexasInstruments/edgeai-modelmaker>

```
20240129_050440
檔案 編輯 檢視
Average Precision (AP) @ [l=0.50:0.95] area= all maxDets=1000 ] = 0.166
Average Recall (AR) @ [l=0.50:0.95] area= all maxDets=100 ] = 0.060
Average Recall (AR) @ [l=0.50:0.95] area= all maxDets=300 ] = 0.060
Average Recall (AR) @ [l=0.50:0.95] area= all maxDets=1000 ] = 0.060
Average Recall (AR) @ [l=0.50:0.95] area= small maxDets=1000 ] = 0.000
Average Recall (AR) @ [l=0.50:0.95] area= medium maxDets=1000 ] = 0.023
Average Recall (AR) @ [l=0.50:0.95] area= large maxDets=1000 ] = 0.338

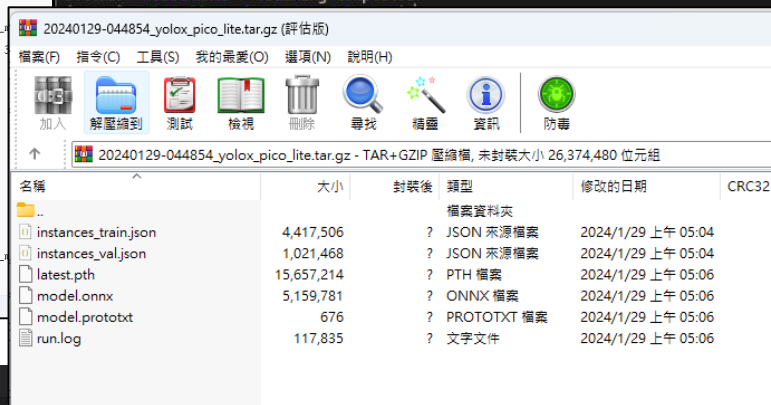
2024-01-29 05:05:17.188 - mmdet - INFO - Exp name: yolox_pico_lite.py
2024-01-29 05:05:17.188 - mmdet - INFO - Epoch(val) [1][107] bbox_mAP: 0.0260, bbox_mAP_50: 0.0680, bbox_mAP_75: 0.0150, bbox_mAP_s: 0.0000, bbox_mAP_m: 0.0050, 0.005 0.153
2024-01-29 05:05:34.652 - mmdet - INFO - Epoch [2][100/197] lr: 1.000e-04, eta: 0:00:33, time: 0.175, data_time: 0.030, loss_cls: 0.8125, loss_bbox: 3.2911, 0.005 0.153
2024-01-29 05:05:50.857 - mmdet - INFO - Evaluating bbox...
2024-01-29 05:05:51.799 - mmdet - INFO -
Average Precision (AP) @ [l=0.50:0.95] area= all maxDets=1000 ] = 0.076
Average Precision (AP) @ [l=0.50:0.95] area= all maxDets=1000 ] = 0.160
Average Precision (AP) @ [l=0.75:0.95] area= all maxDets=1000 ] = 0.064
Average Precision (AP) @ [l=0.50:0.95] area= small maxDets=1000 ] = 0.000
Average Precision (AP) @ [l=0.50:0.95] area= medium maxDets=1000 ] = 0.041
Average Precision (AP) @ [l=0.50:0.95] area= large maxDets=1000 ] = 0.346
Average Recall (AR) @ [l=0.50:0.95] area= all maxDets=100 ] = 0.116
Average Recall (AR) @ [l=0.50:0.95] area= all maxDets=300 ] = 0.116
Average Recall (AR) @ [l=0.50:0.95] area= all maxDets=1000 ] = 0.116
Average Recall (AR) @ [l=0.50:0.95] area= small maxDets=1000 ] = 0.000
Average Recall (AR) @ [l=0.50:0.95] area= medium maxDets=1000 ] = 0.009
Average Recall (AR) @ [l=0.50:0.95] area= large maxDets=1000 ] = 0.496

2024-01-29 05:05:51.804 - mmdet - INFO - Exp name: yolox_pico_lite.py
2024-01-29 05:05:51.804 - mmdet - INFO - Epoch(val) [2][107] bbox_mAP: 0.0760, bbox_mAP_50: 0.1600, bbox_mAP_75: 0.0640, bbox_mAP_s: 0.0000, bbox_mAP_m: 0.041 0.346
2024-01-29 05:06:11.013 - mmdet - INFO - Epoch [3][100/197] lr: 1.000e-04, eta: 0:00:10, time: 0.192, data_time: 0.027, loss_cls: 0.7838, loss_bbox: 3.2911, 0.041 0.346
2024-01-29 05:06:25.093 - mmdet - INFO - Saving checkpoint at 3 epochs
2024-01-29 05:06:27.550 - mmdet - INFO - Evaluating bbox...
2024-01-29 05:06:28.395 - mmdet - INFO -
Average Precision (AP) @ [l=0.50:0.95] area= all maxDets=100 ] = 0.074
Average Precision (AP) @ [l=0.50:0.95] area= all maxDets=1000 ] = 0.166
Average Precision (AP) @ [l=0.75:0.95] area= all maxDets=1000 ] = 0.063
Average Precision (AP) @ [l=0.50:0.95] area= small maxDets=1000 ] = 0.000
Average Precision (AP) @ [l=0.50:0.95] area= medium maxDets=1000 ] = 0.041
Average Precision (AP) @ [l=0.50:0.95] area= large maxDets=1000 ] = 0.331
Average Recall (AR) @ [l=0.50:0.95] area= all maxDets=100 ] = 0.115
Average Recall (AR) @ [l=0.50:0.95] area= all maxDets=300 ] = 0.115
Average Recall (AR) @ [l=0.50:0.95] area= all maxDets=1000 ] = 0.115
Average Recall (AR) @ [l=0.50:0.95] area= small maxDets=1000 ] = 0.000
Average Recall (AR) @ [l=0.50:0.95] area= medium maxDets=1000 ] = 0.093
Average Recall (AR) @ [l=0.50:0.95] area= large maxDets=1000 ] = 0.503

2024-01-29 05:06:28.401 - mmdet - INFO - Exp name: yolox_pico_lite.py
2024-01-29 05:06:28.401 - mmdet - INFO - Epoch(val) [3][107] bbox_mAP: 0.0740, bbox_mAP_50: 0.1600, bbox_mAP_75: 0.0630, bbox_mAP_s: 0.0000, bbox_mAP_m: 0.041 0.331
SUCCESS: ModelMaker - Training completed.
第 1494 行 / 共 113,329 個字元
```

```
2024-03-06 01:28:26,397 - mmdet - INFO - Exp name: yolox_nano_lite.py
2024-03-06 01:28:26,397 - mmdet - INFO - Epoch(val) [2][107] bbox_mAP: 0.1250, bbox_mAP_50: 0.2360, bbox_mAP_75: 0.1180, bbox_mAP_s: 0.0030, bbox_mAP_m: 0.0920, bbox_mAP_l: 0.4740, bbox_mAP_copypaste: 0.125 0.236 0.118 0.003 0.092 0.474
/home/wsl/.pyenv/versions/py310/lib/python3.10/site-packages/mmcv/onnx/info.py:20: UserWarning: DeprecationWarning: This function will be deprecated in future. Welcome to use the unified model deployment toolbox MMDeploy: https://github.com/open-mmlab/mmdelay
warnings.warn(msg)
/home/wsl/.pyenv/versions/py310/lib/python3.10/site-packages/mmcv/tensorrt/init_plugins.py:51: UserWarning: DeprecationWarning: This function will be deprecated in future. Welcome to use the unified model deployment toolbox MMDeploy: https://github.com/open-mmlab/mmdelay
warnings.warn(msg)
/home/wsl/.pyenv/versions/py310/lib/python3.10/site-packages/torch/onnx/symbolic_opset9.py:1248: UserWarning: This model contains a squeeze operation on dimension 1. If the model is intended to be used with dynamic input shapes, please use opset version 11 to export the model.
warnings.warn(
===== Diagnostic Run torch.onnx.export version 2.0.1+cpu =====
verbose: False, log level: Level.ERROR
===== 0 NONE 0 NOTE 0 WARNING 0 ERROR =====

Successfully exported ONNX model: /home/wsl/edgeai-modelmaker/data/projects/tiscapes2017_driving/run/20240306-012627/yolox_nano_lite/training/model.onnx
Trained model is at: /home/wsl/edgeai-modelmaker/data/projects/tiscapes2017_driving/run/20240306-012627/yolox_nano_lite/training
SUCCESS: ModelMaker - Training completed.
```



```
{ } 20240129_050440.log.json | x  run.log  #ifdef ENABLE_TIDL Untitled-2  timescale 1ns / 1ps Untitled-1
Ubuntu-22.04 > home > wsl > edgeai-modelmaker > data > projects > tiscapes2017_driving > run > 20240129-044854 > yolox_pico_lite > training > { } 20240129_050440.log.json | x  run.log  #ifdef ENABLE_TIDL Untitled-2  timescale 1ns / 1ps Untitled-1
1 {"env_info": "sys.platform: linux\nPython: 3.10.13 (main, Jan 25 2024, 17:41:46) [GCC 11.4.0]\nCUDA available: False\nGCC: (Ubuntu 11.4.0-1ubuntu1~22.04) 11.4.0\n\nPyTorch:
2 {"mode": "train", "epoch": 1, "iter": 100, "lr": 0.00052, "data_time": 0.02811, "loss_cls": 1.73538, "loss_bbox": 3.16204, "loss_obj": 2.9099, "loss": 7.80732, "time": 0.16874
3 {"mode": "val", "epoch": 1, "iter": 107, "lr": 0.002, "bbox_mAP": 0.026, "bbox_mAP_50": 0.068, "bbox_mAP_75": 0.015, "bbox_mAP_s": 0.0, "bbox_mAP_m": 0.005, "bbox_mAP_l": 0.15
4 {"mode": "train", "epoch": 2, "iter": 100, "lr": 0.0001, "data_time": 0.03, "loss_cls": 0.81249, "loss_bbox": 3.29108, "loss_obj": 2.51849, "loss": 6.62206, "time": 0.17456}
5 {"mode": "val", "epoch": 2, "iter": 107, "lr": 0.0001, "bbox_mAP": 0.076, "bbox_mAP_50": 0.16, "bbox_mAP_75": 0.064, "bbox_mAP_s": 0.0, "bbox_mAP_m": 0.041, "bbox_mAP_l": 0.34
6 {"mode": "train", "epoch": 3, "iter": 100, "lr": 0.0001, "data_time": 0.02655, "loss_cls": 0.78377, "loss_bbox": 3.09365, "loss_obj": 2.2302, "loss": 6.10762, "time": 0.19196}
7 {"mode": "val", "epoch": 3, "iter": 107, "lr": 0.0001, "bbox_mAP": 0.074, "bbox_mAP_50": 0.166, "bbox_mAP_75": 0.063, "bbox_mAP_s": 0.0, "bbox_mAP_m": 0.041, "bbox_mAP_l": 0.3
8 }
```

# GPU CUDA加速

## ❖ 可提供詳細流程

參考自<https://github.com/TexasInstruments/edgeai-modelmaker>

### Step 6: Accelerated Training using GPUs (Optional)

Note: This section is for advanced users only. Familiarity with NVIDIA GPU and CUDA driver installation is assumed.

This tool can train models either on CPU or on GPUs. By default, CPU based training is used.

It is possible to speedup model training significantly using GPUs (with CUDA support) - if you have those GPUs in the PC. The PyTorch version that we install by default is not capable of supporting CUDA GPUs. There are additional steps to be followed to enable GPU support in training.

- In the file setup\_all.sh, we are using setup\_cpu.sh for several of the repositories that we are using. These will have to be changed to setup.sh before running setup\_all.sh
- Install GPU driver and other tools as described in the sections below.
- In the config file, set a value for num\_gpus to a value greater than 0 (should not exceed the number of GPUs in the system) to enable GPU based training.

#### Option 1: When using Native Ubuntu Environment

The user has to install an appropriate NVIDIA GPU driver that supports the GPU being used.

The user also has to install CUDA Toolkit. See the [CUDA download instructions](#). The CUDA version that is installed must match the CUDA version used in the PyTorch installer - see [our edgeai-torchvision setup script](#) to understand the CUDA version used.

#### Option 2: When using docker environment

Enabling CUDA GPU support inside a docker environment requires several additional steps. Please follow the instructions given in: <https://docs.nvidia.com/datacenter/cloud-native/container-toolkit/install-guide.html>

Once CUDA is installed, you will be able to model training much faster.

# 參考資料與文獻

- [1] [TDA4VM Processors datasheet \(Rev. K\)](#)
- [2] [J721E DRA829/TDA4VM Processors Silicon Revision 1.1/1.0 \(Rev. D\)](#)
- [3] [DRA829/TDA4VM Technical Reference Manual \(Rev. C\)](#)
- [4] [Jacinto7 AM6x, TDA4x, and DRA8x High-Speed Interface Design Guidelines \(Rev. A\)](#)
- [5] [TMS320C6652 and TMS320C6654 Fixed and Floating-Point Digital Signal Processor datasheet \(Rev. E\)](#)
- [6] [TMS320C6652/54/55/57 Multicore Fixed and Floating-Point DSP SR1.0 \(Rev. C\)](#)
- [7] [SK-TDA4VM User's Guide \(Rev. D\)](#)
- [8] [J721EXSKG01EVM EU Declaration of Conformity \(DoC\) \(Rev. A\)](#)
- [9] [DMA Controller Module \(Chapter Excerpt From MSP430x5xx Family, SLAU208\) \(Rev. F\)](#)
- [10] [AM437x Sitara™ Processors datasheet \(Rev. E\)](#)
- [11] [AM437x and AMIC120 ARM® Cortex™-A9 Processors Technical Reference Manual \(Rev. I\)](#)
- [12] [TMS320C6000 DSP Cache User's Guide \(Rev. A\)](#)