112 上學期
系統晶片設計
SOC Design Laboratory LAB1

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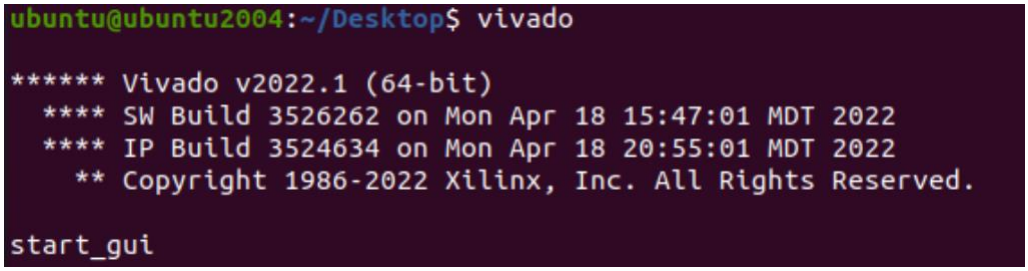
學系: 電控專

1. Tool Installation

The screenshot of Xilinx tools(Check your tool version)

- Vitis

- Vivado

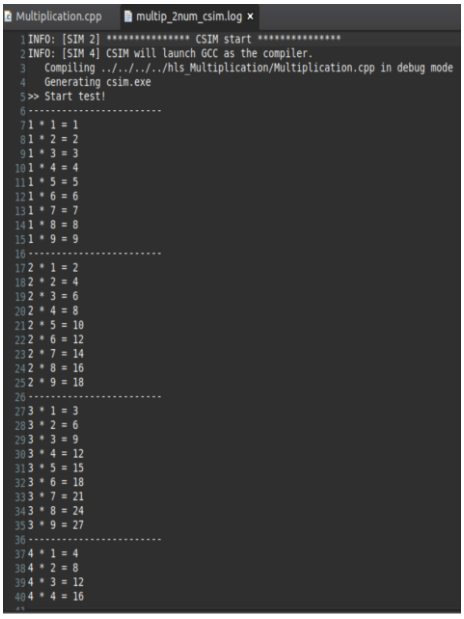


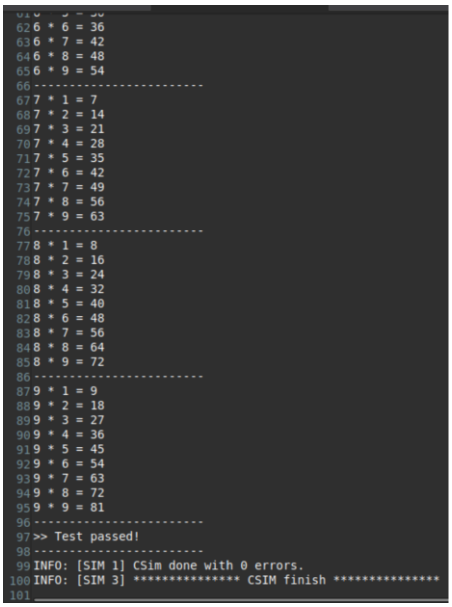
- Vitis_HLS

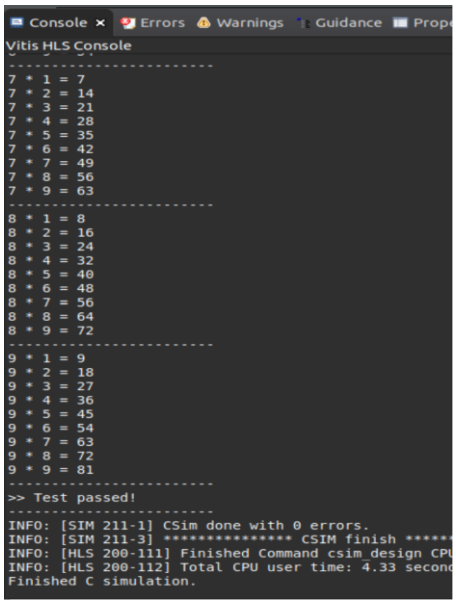
2. Co-Simulation Log

Co-simulation log(Usually located at VitisHLSProjectName/solution1/csim/report)

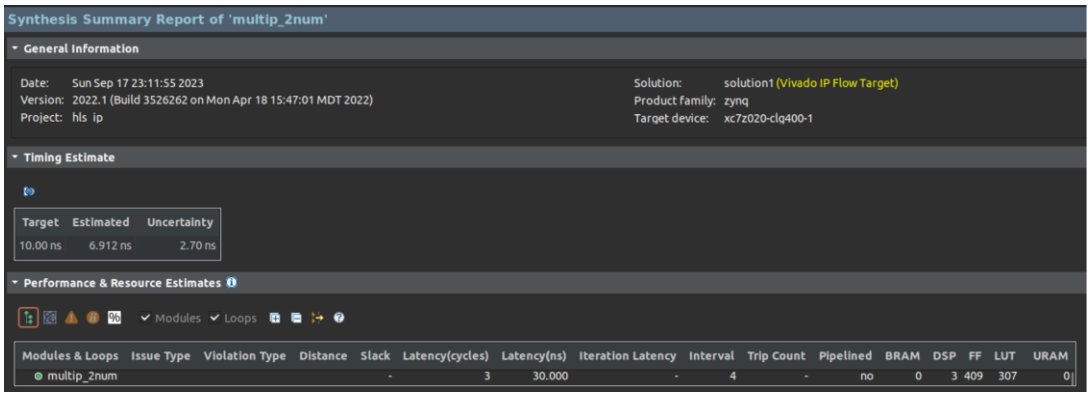
- C simulation



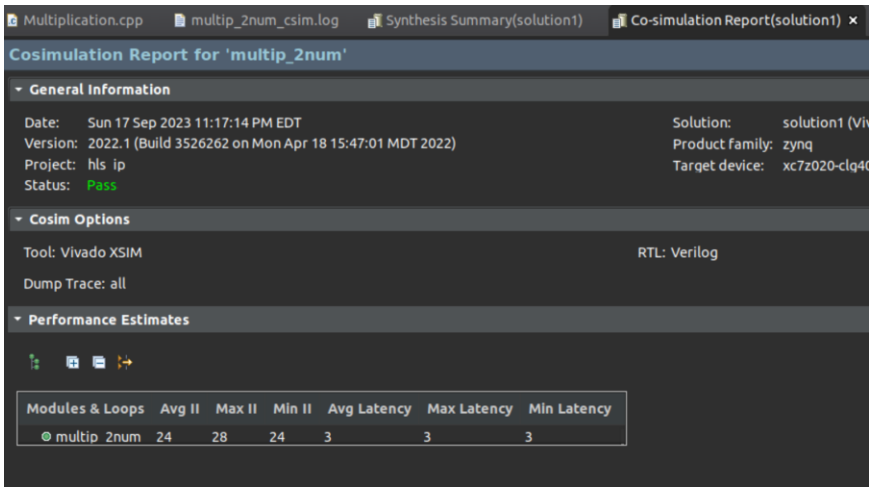




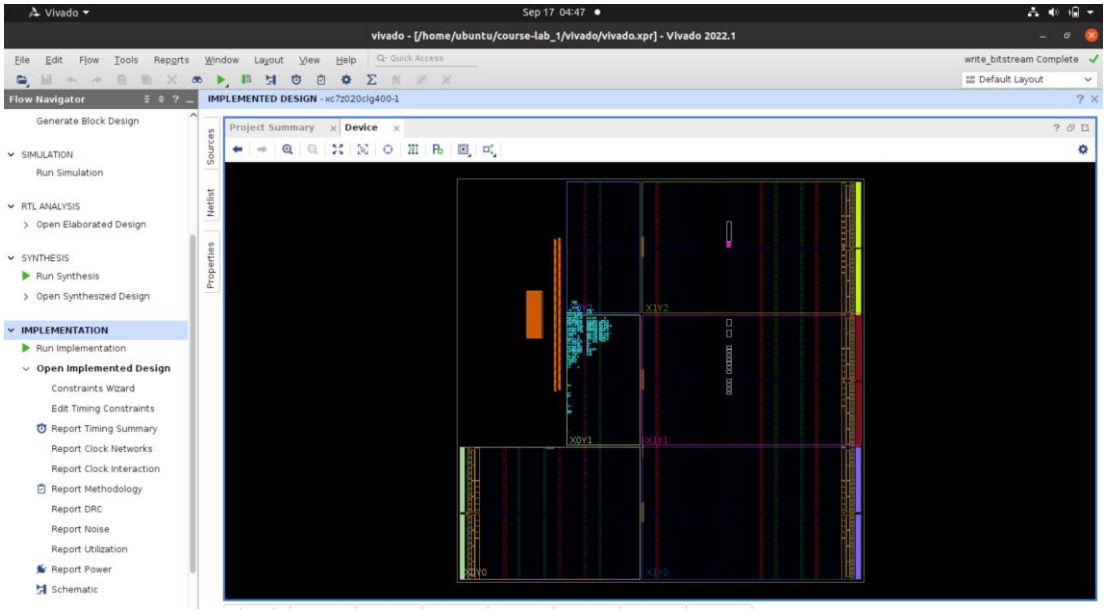
- C synthesis



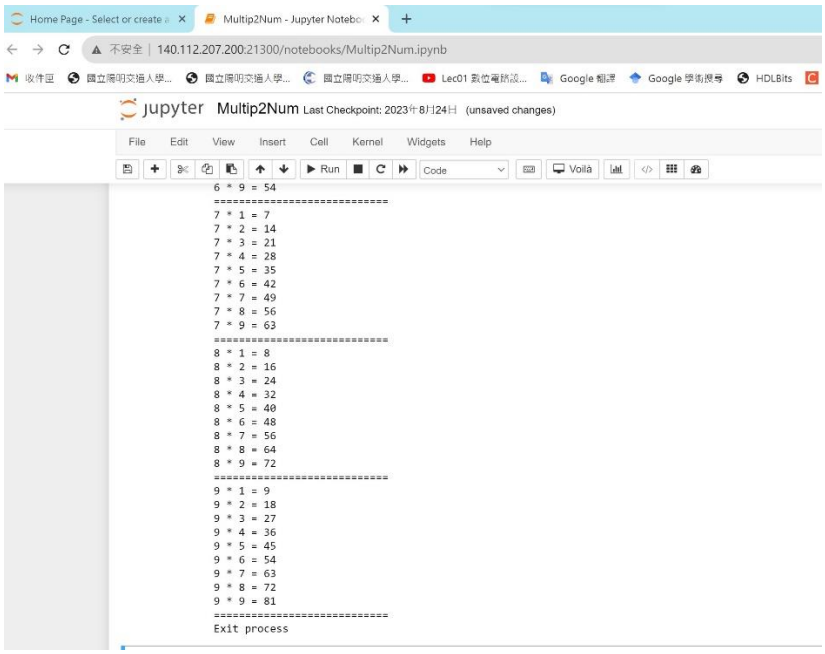
- Cosimulation



➢ Generate bitstream



➢ Jupyter notebook



3. Brief introduction about the overall system

用 HLS 的方式設計乘法器(Multip2Num)，最後燒錄 FPGA 做驗證

實驗步驟: (lab1 主要為讓學生了解如果操作，並無 coding)

1. vitis_hls 建置 Multip2Num IP (匯出 RTL)
2. vivado 使用 Multip2Num IP 並與其他電路連接，最後產生 BITSTREAM
3. 使用租借的 FPGA 燒錄
4. 用 PYTHON 對燒錄後的電路驗證

4. What is observed & learned

- Ubuntu 安裝困難

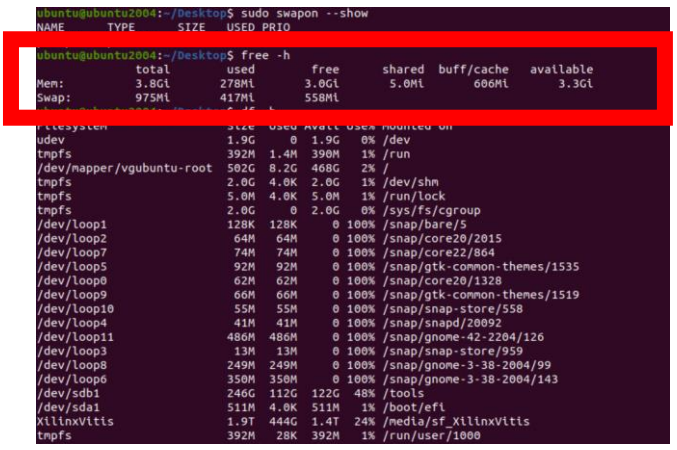
  筆電容量如下圖剩下不多，因此需要外接硬碟(如 E 槽)，剩餘的部分就按照說明做

- Vivado 閃退問題

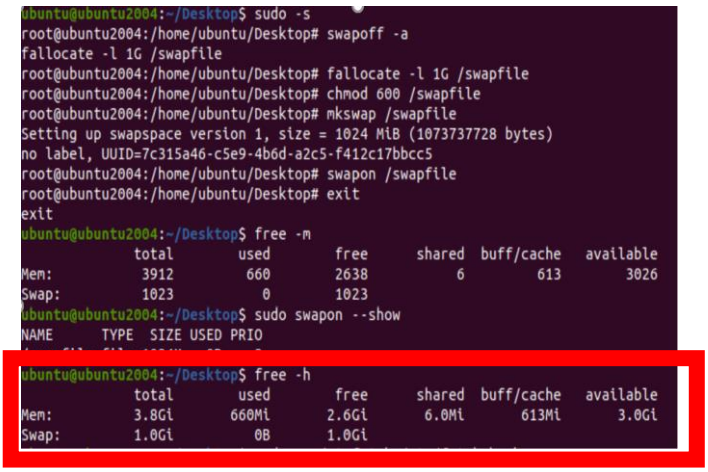
  如下圖只要開始執行 BITSTREAM 這個步驟，就會發生閃退問題，畫面顯示 "RDI_PROG"

```
ubuntu@ubuntu2004:~/Desktop$ vivado

****** Vivado v2022.1 (64-bit)
  **** SW Build 3526262 on Mon Apr 18 15:47:01 MDT 2022
  **** IP Build 3524634 on Mon Apr 18 20:55:01 MDT 2022
    ** Copyright 1986-2022 Xilinx, Inc. All Rights Reserved.

start_gui
/tools/Xilinx/Vivado/2022.1/bin/rdiArgs.sh: line 312:  2026 Killed                  "$RDI_PROG" "$@"
```

而後查證問題為內存不足(圖左)，因此需要 SWAP 擴充，步驟如(圖右)



```
ubuntu@ubuntu2004:~/Desktop$ sudo swapon --show
NAME      TYPE      SIZE   USED PRIO

ubuntu@ubuntu2004:~/Desktop$ free -h
               total        used        free      shared  buff/cache   available
Mem:           3.8Gi       278Mi       3.0Gi       5.0Mi       606Mi       3.3Gi
Swap:          975Mi       417Mi       558Mi
Filesystem                Size  Used Avail Use% Mounted on
udev                      1.9G     0  1.9G   0% /dev
tmpfs                     392M  1.4M  390M   1% /run
/dev/mapper/vgubuntu-root  502G  8.2G  468G   2% /
tmpfs                     2.0G  4.0K  2.0G   1% /dev/shm
tmpfs                     5.0M  4.0K  5.0M   1% /run/lock
tmpfs                     2.0G     0  2.0G   0% /sys/fs/cgroup
/dev/loop1                128K  128K     0 100% /snap/bare/5
/dev/loop2                 64M   64M     0 100% /snap/core20/2015
/dev/loop7                 74M   74M     0 100% /snap/core22/864
/dev/loop5                 92M   92M     0 100% /snap/gtk-common-themes/1535
/dev/loop0                 62M   62M     0 100% /snap/core20/1328
/dev/loop9                 66M   66M     0 100% /snap/gtk-common-themes/1519
/dev/loop10                55M   55M     0 100% /snap/snap-store/558
/dev/loop4                 41M   41M     0 100% /snap/snapd/20092
/dev/loop11               486M  486M     0 100% /snap/gnome-42-2204/126
/dev/loop3                 13M   13M     0 100% /snap/snap-store/959
/dev/loop8                249M  249M     0 100% /snap/gnome-3-38-2004/99
/dev/loop6                350M  350M     0 100% /snap/gnome-3-38-2004/143
/dev/sdb1                 246G  112G  122G  48% /tools
/dev/sda1                 511M  4.0K  511M   1% /boot/efi
XilinxVitis               1.9T  444G  1.4T  24% /media/sf_XilinxVitis
tmpfs                     392M   28K  392M   1% /run/user/1000
```



```
ubuntu@ubuntu2004:~/Desktop$ sudo -s
root@ubuntu2004:/home/ubuntu/Desktop# swapoff -a
fallocate -l 1G /swapfile
root@ubuntu2004:/home/ubuntu/Desktop# fallocate -l 1G /swapfile
root@ubuntu2004:/home/ubuntu/Desktop# chmod 600 /swapfile
root@ubuntu2004:/home/ubuntu/Desktop# mkswap /swapfile
Setting up swapspace version 1, size = 1024 MiB (1073737728 bytes)
no label, UUID=7c315a46-c5e9-4b6d-a2c5-f412c17bbcc5
root@ubuntu2004:/home/ubuntu/Desktop# swapon /swapfile
root@ubuntu2004:/home/ubuntu/Desktop# exit
exit
ubuntu@ubuntu2004:~/Desktop$ free -m
               total        used        free      shared  buff/cache   available
Mem:           3912         660        2638           6         613        3026
Swap:          1023           0        1023
ubuntu@ubuntu2004:~/Desktop$ sudo swapon --show
NAME      TYPE  SIZE USED PRIO

ubuntu@ubuntu2004:~/Desktop$ free -h
               total        used        free      shared  buff/cache   available
Mem:           3.8Gi       660Mi       2.6Gi       6.0Mi       613Mi       3.0Gi
Swap:          1.0Gi          0B       1.0Gi
```

參考網址:

https://medium.com/@ihsanalhafiz28/how-to-solve-vivado-crash-on-ubuntu-while-running-4b445d609fa5

- 心得:

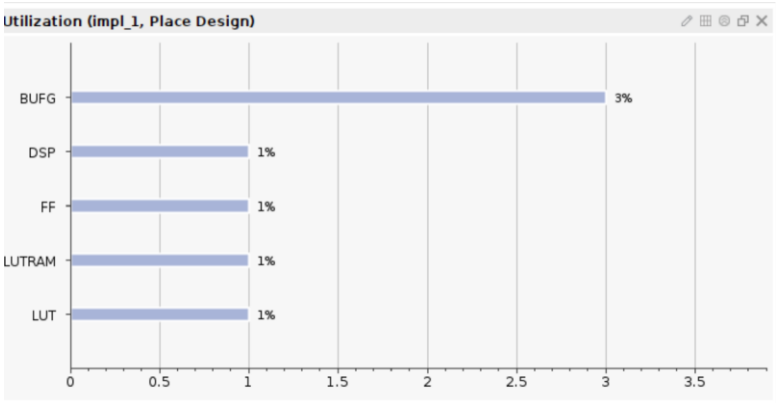
安裝與軟體熟悉比較麻煩，因為 LAB1 不需要 CODING 主要是解決硬體安裝上的問題~

5. SCREEN DUMPS

- PERFORMANCE

```
================================================================
== Vitis HLS Report for 'multip_2num'
================================================================
* Date:           Fri Sep 15 20:43:58 2023

* Version:        2022.1 (Build 3526262 on Mon Apr 18 15:47:01 MDT 2022)
* Project:        hls_ip
* Solution:       solution1 (Vivado IP Flow Target)
* Product family: zynq
* Target device:  xc7z020-clg400-1


================================================================
== Performance Estimates
================================================================
+ Timing:
    * Summary:
    +--------+----------+----------+------------+
    |  Clock |  Target  | Estimated| Uncertainty|
    +--------+----------+----------+------------+
    |ap_clk  |  10.00 ns|  6.912 ns|     2.70 ns|
    +--------+----------+----------+------------+

+ Latency:
    * Summary:
    +---------+---------+-----------+-----------+-----+-----+---------+
    |  Latency (cycles) |   Latency (absolute)  |  Interval | Pipeline|
    |   min   |   max   |    min    |    max    | min | max |   Type  |
    +---------+---------+-----------+-----------+-----+-----+---------+
    |        3|        3|  30.000 ns|  30.000 ns|    4|    4|       no|
    +---------+---------+-----------+-----------+-----+-----+---------+
```

- UTILIZATION



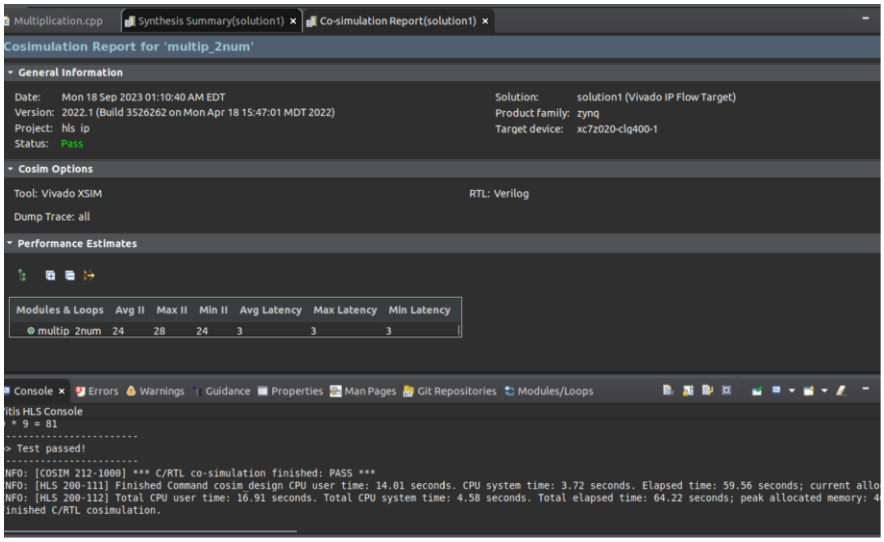

```
================================================================
== Utilization Estimates
================================================================
* Summary:
+-----------------+---------+-----+--------+-------+-----+
|       Name      | BRAM_18K| DSP |   FF   |  LUT  | URAM|
+-----------------+---------+-----+--------+-------+-----+
|DSP              |        -|    -|       -|      -|    -|
|Expression       |        -|    -|       -|      -|    -|
|FIFO             |        -|    -|       -|      -|    -|
|Instance         |        0|    3|     309|    282|    -|
|Memory           |        -|    -|       -|      -|    -|
|Multiplexer      |        -|    -|       -|     25|    -|
|Register         |        -|    -|     100|      -|    -|
+-----------------+---------+-----+--------+-------+-----+
|Total            |        0|    3|     409|    307|    0|
+-----------------+---------+-----+--------+-------+-----+
|Available        |      280|  220|  106400|  53200|    0|
+-----------------+---------+-----+--------+-------+-----+
|Utilization (%)  |        0|    1|      ~0|     ~0|    0|
+-----------------+---------+-----+--------+-------+-----+

+ Detail:
    * Instance:
    +----------------------+--------------------+---------+----+-----+-----+-----+
    |       Instance       |       Module       | BRAM_18K| DSP|  FF | LUT | URAM|
    +----------------------+--------------------+---------+----+-----+-----+-----+
    |control_s_axi_U       |control_s_axi       |        0|   0|  144|  232|    0|
    |mul_32s_32s_32_2_1_U1 |mul_32s_32s_32_2_1  |        0|   3|  165|   50|    0|
    +----------------------+--------------------+---------+----+-----+-----+-----+
    |Total                 |                    |        0|   3|  309|  282|    0|
    +----------------------+--------------------+---------+----+-----+-----+-----+
```

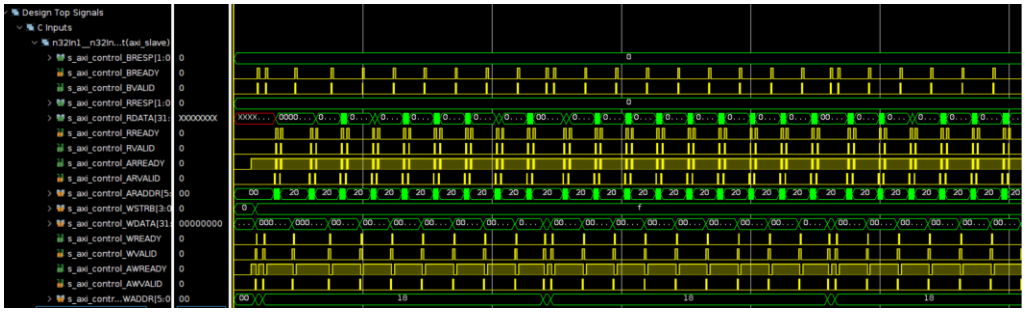
```
* DSP:
N/A

* Memory:
N/A

* FIFO:
N/A

* Expression:
N/A

* Multiplexer:
+-----------+----+-----------+-----+-----------+
|    Name   | LUT| Input Size| Bits| Total Bits|
+-----------+----+-----------+-----+-----------+
|ap_NS_fsm  |  25|          5|    1|          5|
+-----------+----+-----------+-----+-----------+
|Total      |  25|          5|    1|          5|
+-----------+----+-----------+-----+-----------+

* Register:
+--------------------+----+----+-----+-----------+
|        Name        | FF | LUT| Bits| Const Bits|
+--------------------+----+----+-----+-----------+
|ap_CS_fsm           |   4|   0|    4|          0|
|mul_ln11_reg_71     |  32|   0|   32|          0|
|n32In1_read_reg_66  |  32|   0|   32|          0|
|n32In2_read_reg_61  |  32|   0|   32|          0|
+--------------------+----+----+-----+-----------+
|Total               | 100|   0|  100|          0|
+--------------------+----+----+-----+-----------+
```

- Interface

```
================================================================
== Interface
================================================================
* Summary:
+----------------------+-----+-----+-------------+-------------+-------------+
|       RTL Ports      | Dir | Bits|   Protocol  | Source Object|    C Type   |
+----------------------+-----+-----+-------------+-------------+-------------+
|s_axi_control_AWVALID |   in|    1|        s_axi|      control|      pointer|
|s_axi_control_AWREADY |  out|    1|        s_axi|      control|      pointer|
|s_axi_control_AWADDR  |   in|    6|        s_axi|      control|      pointer|
|s_axi_control_WVALID  |   in|    1|        s_axi|      control|      pointer|
|s_axi_control_WREADY  |  out|    1|        s_axi|      control|      pointer|
|s_axi_control_WDATA   |   in|   32|        s_axi|      control|      pointer|
|s_axi_control_WSTRB   |   in|    4|        s_axi|      control|      pointer|
|s_axi_control_ARVALID |   in|    1|        s_axi|      control|      pointer|
|s_axi_control_ARREADY |  out|    1|        s_axi|      control|      pointer|
|s_axi_control_ARADDR  |   in|    6|        s_axi|      control|      pointer|
|s_axi_control_RVALID  |  out|    1|        s_axi|      control|      pointer|
|s_axi_control_RREADY  |   in|    1|        s_axi|      control|      pointer|
|s_axi_control_RDATA   |  out|   32|        s_axi|      control|      pointer|
|s_axi_control_RRESP   |  out|    2|        s_axi|      control|      pointer|
|s_axi_control_BVALID  |  out|    1|        s_axi|      control|      pointer|
|s_axi_control_BREADY  |   in|    1|        s_axi|      control|      pointer|
|s_axi_control_BRESP   |  out|    2|        s_axi|      control|      pointer|
|ap_clk                |   in|    1| ap_ctrl_none|  multip_2num| return value|
|ap_rst_n              |   in|    1| ap_ctrl_none|  multip_2num| return value|
+----------------------+-----+-----+-------------+-------------+-------------+
```

- Co-simulation transcript/waveform





- Jupyter Notebook execution results