Lab1

System Introduction:

將兩個輸入的數字相乘後輸出

Observation & lesson learnt:

1. 不要把 vitis_hls 的檔案放在 virtualbox 共用資料夾

2. 做 co-sim 前要把 ap_control_none 拿掉

Screen dump:

Performance:

```
==============================================================
== Performance Estimates
==============================================================
+ Timing:
    * Summary:
    +--------+---------+---------+-----------+
    | Clock  |  Target | Estimated| Uncertainty|
    +--------+---------+---------+-----------+
    |ap_clk  | 10.00 ns|  5.900 ns|    2.70 ns|
    +--------+---------+---------+-----------+

+ Latency:
    * Summary:
    +---------+---------+---------+---------+-----+-----+---------+
    | Latency (cycles) |  Latency (absolute) |  Interval | Pipeline|
    |  min    |   max   |   min   |    max   | min | max |  Type   |
    +---------+---------+---------+---------+-----+-----+---------+
    |       0 |       0 |    0 ns |    0 ns |   1 |   1 |      no |
    +---------+---------+---------+---------+-----+-----+---------+

    + Detail:
        * Instance:
        N/A

        * Loop:
        N/A
```

Utilization:

```
==============================================================
== Utilization Estimates
==============================================================
* Summary:
+------------------+---------+------+---------+---------+-----+
|       Name       | BRAM_18K| DSP  |   FF    |   LUT   | URAM|
+------------------+---------+------+---------+---------+-----+
|DSP               |       - |    - |       - |       - |    -|
|Expression        |       - |    - |       - |       - |    -|
|FIFO              |       - |    - |       - |       - |    -|
|Instance          |       0 |    3 |     144 |     252 |    0|
|Memory            |       - |    - |       - |       - |    -|
|Multiplexer       |       - |    - |       - |       - |    -|
|Register          |       - |    - |       - |       - |    -|
+------------------+---------+------+---------+---------+-----+
|Total             |       0 |    3 |     144 |     252 |    0|
+------------------+---------+------+---------+---------+-----+
|Available SLR     |    1344 | 3072 |  864000 |  432000 |  320|
+------------------+---------+------+---------+---------+-----+
|Utilization SLR (%)|      0 |   ~0 |      ~0 |      ~0 |    0|
+------------------+---------+------+---------+---------+-----+
|Available         |    4032 | 9216 | 2592000 | 1296000 |  960|
+------------------+---------+------+---------+---------+-----+
|Utilization (%)   |       0 |   ~0 |      ~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_1_1_U1 |mul_32s_32s_32_1_1  |        0|   3|   0|  20|    0|
    +----------------------+--------------------+----------+----+-----+-----+-----+
    |Total                 |                    |        0|   3| 144| 252|    0|
    +----------------------+--------------------+----------+----+-----+-----+-----+

    * DSP:
    N/A

    * Memory:
    N/A

    * FIFO:
    N/A

    * Expression:
    N/A

    * Multiplexer:
    N/A

    * Register:
    N/A
```

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_start               |  in|    1|   ap_ctrl_hs|   multip_2num| return value|
|ap_done                | out|    1|   ap_ctrl_hs|   multip_2num| return value|
|ap_idle                | out|    1|   ap_ctrl_hs|   multip_2num| return value|
|ap_ready               | out|    1|   ap_ctrl_hs|   multip_2num| return value|
|ap_clk                 |  in|    1|   ap_ctrl_hs|   multip_2num| return value|
|ap_rst_n               |  in|    1|   ap_ctrl_hs|   multip_2num| return value|
+-----------------------+-----+-----+------------+--------------+--------------+
```
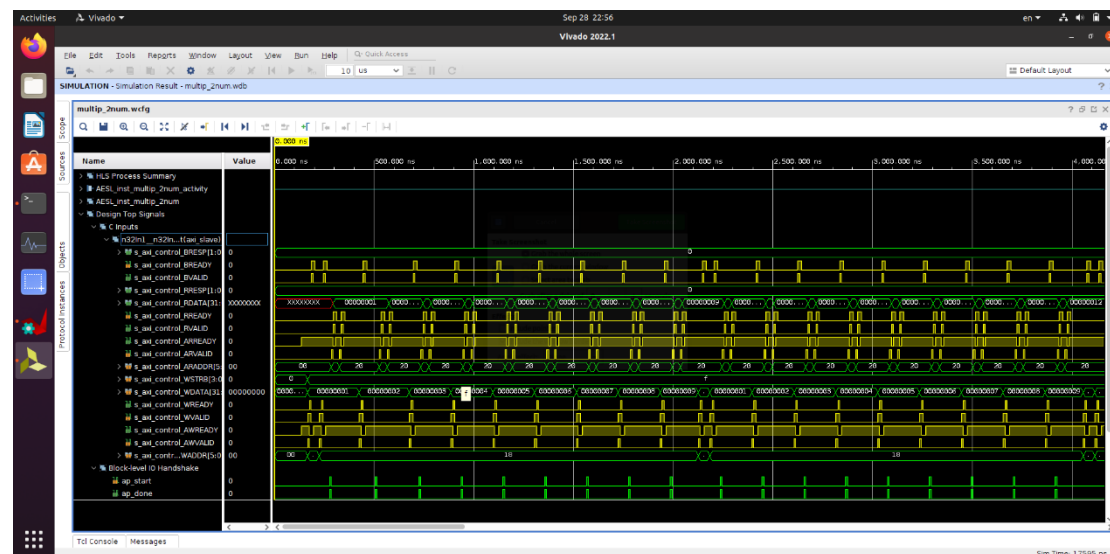
Co-simulation transcript/waveform:

```
INFO: [SIM 2] *************** CSIM start ***************
INFO: [SIM 4] CSIM will launch GCC as the compiler.
   Compiling ../../../MultipTester.cpp in debug mode
   Compiling ../../../Multiplication.cpp in debug mode
   Generating csim.exe
>> Start test!
------------------------
1 * 1 = 1
1 * 2 = 2
1 * 3 = 3
1 * 4 = 4
1 * 5 = 5
1 * 6 = 6
1 * 7 = 7
1 * 8 = 8
1 * 9 = 9
------------------------
2 * 1 = 2
2 * 2 = 4
2 * 3 = 6
2 * 4 = 8
2 * 5 = 10
2 * 6 = 12
2 * 7 = 14
2 * 8 = 16
2 * 9 = 18
------------------------
3 * 1 = 3
3 * 2 = 6
```


Jupyter notebook execution results:

```
Entry: /usr/local/share/pynq-venv/lib/python3.8/site-packages/ipykernel_launcher.py
System argument(s): 3
Start of "/usr/local/share/pynq-venv/lib/python3.8/site-packages/ipykernel_launcher.py"
============================
1 * 1 = 1
1 * 2 = 2
1 * 3 = 3
1 * 4 = 4
1 * 5 = 5
1 * 6 = 6
1 * 7 = 7
1 * 8 = 8
1 * 9 = 9
============================
2 * 1 = 2
2 * 2 = 4
2 * 3 = 6
2 * 4 = 8
2 * 5 = 10
2 * 6 = 12
2 * 7 = 14
2 * 8 = 16
2 * 9 = 18
============================
3 * 1 = 3
3 * 2 = 6
3 * 3 = 9
3 * 4 = 12
3 * 5 = 15
3 * 6 = 18
        3 * 5 = 15
        3 * 6 = 18
        3 * 7 = 21
        3 * 8 = 24
        3 * 9 = 27
        ============================
        4 * 1 = 4
        4 * 2 = 8
        4 * 3 = 12
        4 * 4 = 16
        4 * 5 = 20
        4 * 6 = 24
        4 * 7 = 28
        4 * 8 = 32
        4 * 9 = 36
        ============================
        5 * 1 = 5
        5 * 2 = 10
        5 * 3 = 15
        5 * 4 = 20
        5 * 5 = 25
        5 * 6 = 30
        5 * 7 = 35
        5 * 8 = 40
        5 * 9 = 45
        ============================
        6 * 1 = 6
        6 * 2 = 12
        6 * 3 = 18
        6 * 4 = 24
        6 * 5 = 30
        6 * 6 = 36
        6 * 7 = 42
        6 * 8 = 48
```

```
6 * 8 = 48
6 * 9 = 54
=============================
7 * 1 = 7
7 * 2 = 14
7 * 3 = 21
7 * 4 = 28
7 * 5 = 35
7 * 6 = 42
7 * 7 = 49
7 * 8 = 56
7 * 9 = 63
=============================
8 * 1 = 8
8 * 2 = 16
8 * 3 = 24
8 * 4 = 32
8 * 5 = 40
8 * 6 = 48
8 * 7 = 56
8 * 8 = 64
8 * 9 = 72
=============================
9 * 1 = 9
9 * 2 = 18
9 * 3 = 27
9 * 4 = 36
9 * 5 = 45
9 * 6 = 54
9 * 7 = 63
9 * 8 = 72
9 * 9 = 81
=============================
Exit process
```