SoC Design Lab3

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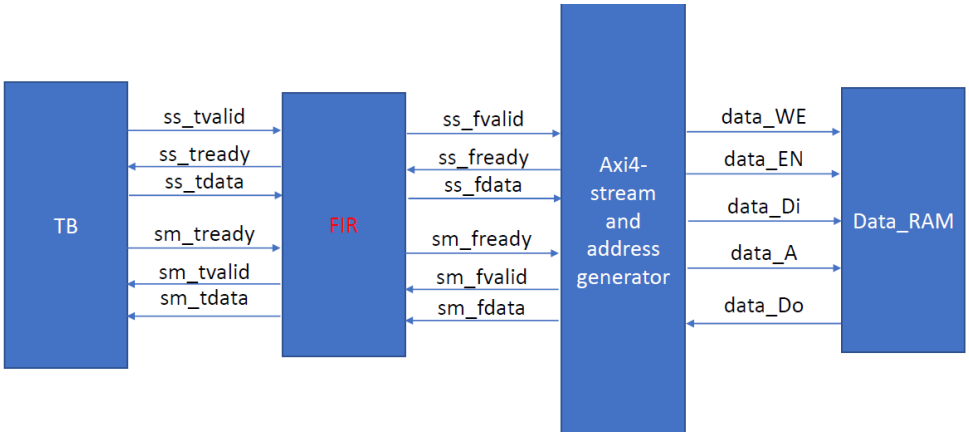
- **Brief introduction about the overall system**

  In this lab, we implement the axi-lite and axi-stream protocol. The whole system contain the fir design, the axi interface and the address generator. The Bram design is provided, we need to use fsm to generator the control signal to read write the ram. It is critical for each control signal set at the right timing.
  For the fir, we need to fetch data in to the mac. The address generator can control the bram address that fulfill the shift register.
  We should initial the tap ram data and ap control signal. When the fir output the result, we should check with golden data. We should fetch the ap_done signal and calculate the total cycle for fir calculation.

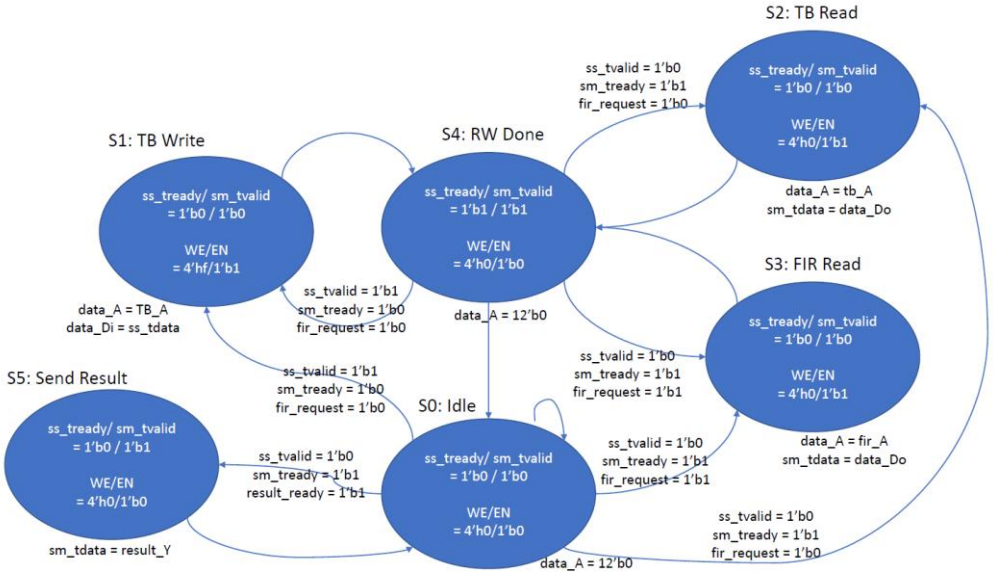
- **What is observed & learned**

  I find that it is necessary to plot waveform to describe the behavior first. And use the fsm to assert each output signal at different state. If I program with verilog in sequential, it usually fail in waveform when I run simulation.
  It is recommend that separate each block in different file. It is efficiency to verify by sub-module. I also export the logic signal and critical data to see the waveform. When I integrate all the block, I also use these exported pin the check the block interactive in the system level.

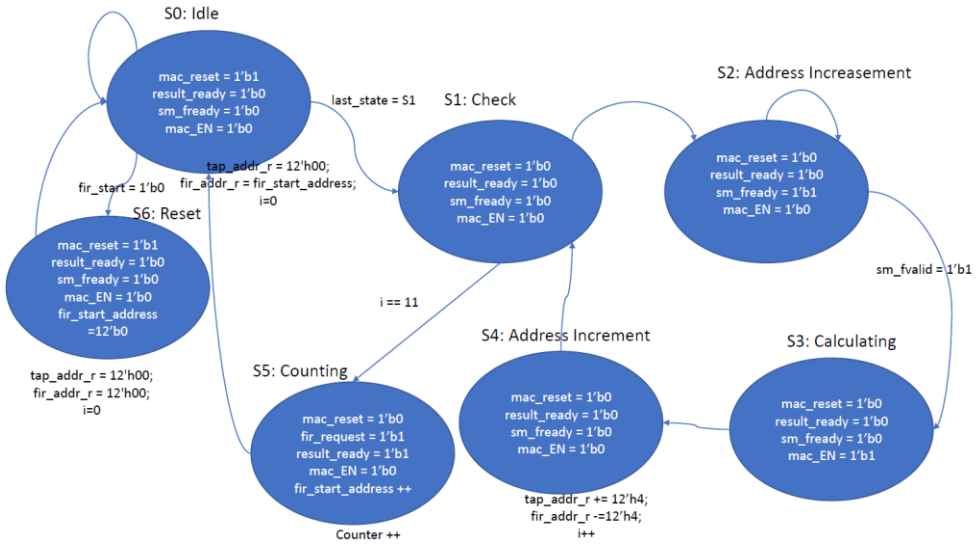
- **AXI4-Lite Write Transacti`Diagram of stream flow with Data_RAM**



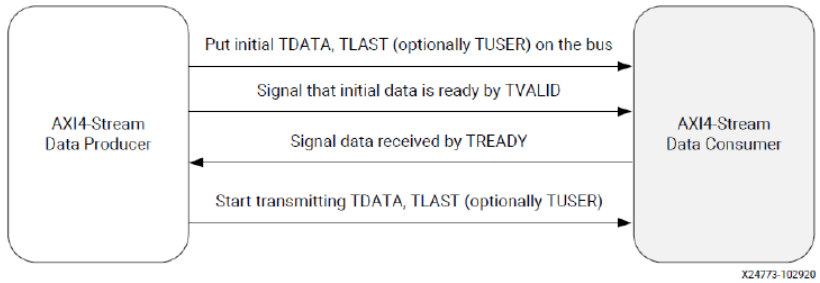
- **FSM of Axi4-stream and Data_RAM**

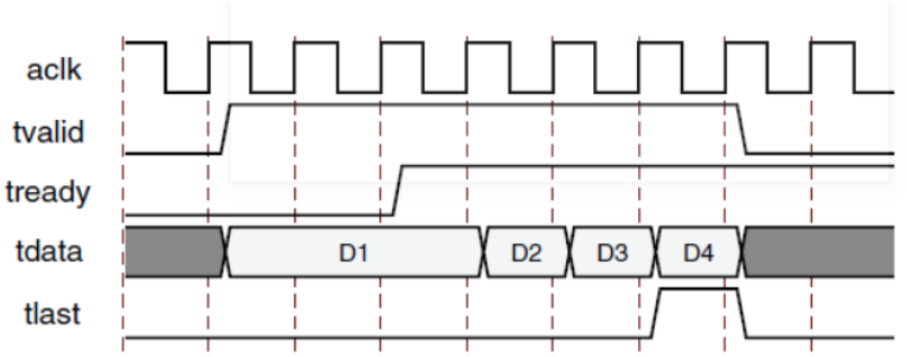


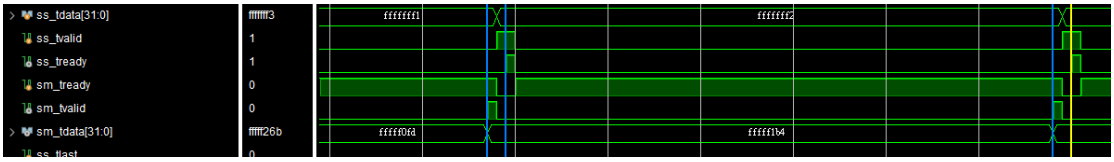
- **FSM of address generator**



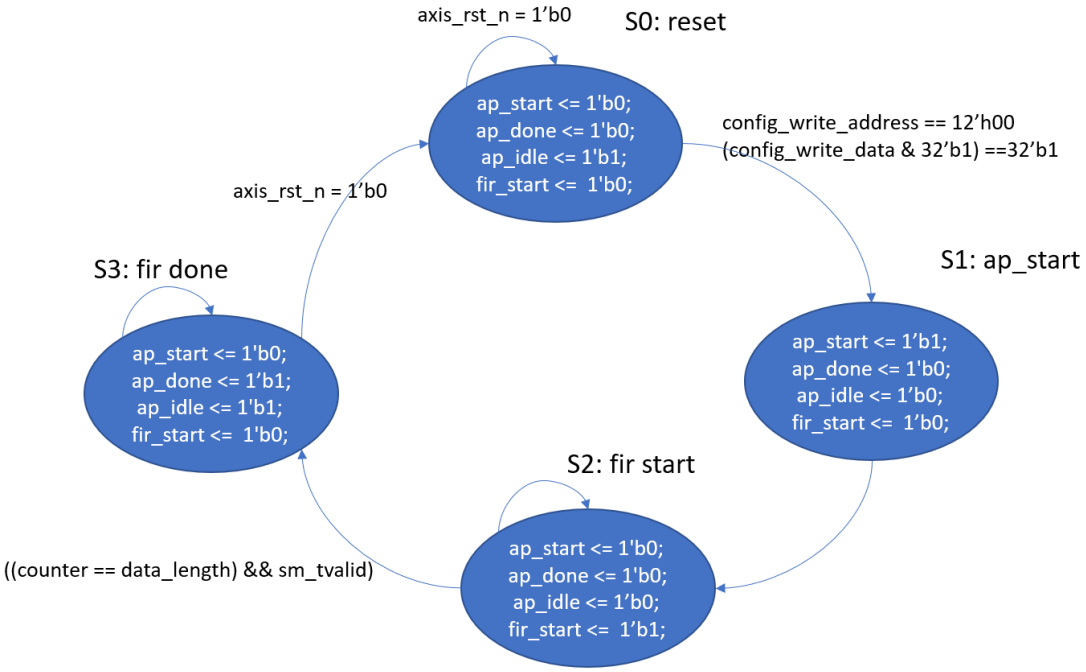
- **AXI4 Stream Transfer Protocol**







- **ap_start/done/idle**



- **Synthesis Result**

LUT	FF	BRAM	URAM	DSP
219	230	0	0	3

Setup		Hold		Pulse Width	
Worst Negative Slack (WNS):	1.276 ns	Worst Hold Slack (WHS):	0.072 ns	Worst Pulse Width Slack (WPWS):	4.500 ns
Total Negative Slack (TNS):	0.000 ns	Total Hold Slack (THS):	0.000 ns	Total Pulse Width Negative Slack (TPWS):	0.000 ns
Number of Failing Endpoints:	0	Number of Failing Endpoints:	0	Number of Failing Endpoints:	0
Total Number of Endpoints:	413	Total Number of Endpoints:	413	Total Number of Endpoints:	223

All user specified timing constraints are met.

- **Check stream read/write**

➢ Piece code of Testbench

```
$display("----Start the data input(AXI-Stream)----");
for(i=0;i< 11;i=i+1) begin //(data_length-1)
    ss(Din_list[i]);
    $display("Din_list[%d]: %d", i, Din_list[i]);
    sm(i+1, i);
end
```

➢ Simulation result

```
----Start the data input(AXI-Stream)----
Din_list[         0]:          1
[PASS] [Pattern         0] Golden answer:          1, Your answer:          1
Din_list[         1]:          2
[PASS] [Pattern         1] Golden answer:          2, Your answer:          2
Din_list[         2]:          3
[PASS] [Pattern         2] Golden answer:          3, Your answer:          3
Din_list[         3]:          4
[PASS] [Pattern         3] Golden answer:          4, Your answer:          4
Din_list[         4]:          5
[PASS] [Pattern         4] Golden answer:          5, Your answer:          5
Din_list[         5]:          6
[PASS] [Pattern         5] Golden answer:          6, Your answer:          6
Din_list[         6]:          7
[PASS] [Pattern         6] Golden answer:          7, Your answer:          7
Din_list[         7]:          8
[PASS] [Pattern         7] Golden answer:          8, Your answer:          8
Din_list[         8]:          9
[PASS] [Pattern         8] Golden answer:          9, Your answer:          9
Din_list[         9]:         10
[PASS] [Pattern         9] Golden answer:         10, Your answer:         10
Din_list[        10]:         11
[PASS] [Pattern        10] Golden answer:         11, Your answer:         11
xsim: Time (s): cpu = 00:00:02 ; elapsed = 00:00:38 . Memory (MB): peak = 2754.391 ; gain = 0.000
```

- **Full Simulation Result**

  The full log of pattern 0~599 are too large, I just cut piece of output log.

  You can check the full log in the report folder.

```
-----------Start simulation-----------
----Start the data_length、coefficient input(AXI-lite)----
 Check Data Length ...
OK: exp =         600, rdata_in =         600
 Check Coefficient ...
OK: exp =           0, rdata_in =           0
OK: exp =         -10, rdata_in =         -10
OK: exp =          -9, rdata_in =          -9
OK: exp =          23, rdata_in =          23
OK: exp =          56, rdata_in =          56
OK: exp =          63, rdata_in =          63
OK: exp =          56, rdata_in =          56
OK: exp =          23, rdata_in =          23
OK: exp =          -9, rdata_in =          -9
OK: exp =         -10, rdata_in =         -10
OK: exp =           0, rdata_in =           0
----End the coefficient input(AXI-lite)----
----Start initial Data BRAM default value(AXI-Stream)----

[PASS] [Pattern        573] Golden answer:       -5673, Your answer:       -5673
[PASS] [Pattern        574] Golden answer:       -5490, Your answer:       -5490
[PASS] [Pattern        575] Golden answer:       -5307, Your answer:       -5307
[PASS] [Pattern        576] Golden answer:       -5124, Your answer:       -5124
[PASS] [Pattern        577] Golden answer:       -4941, Your answer:       -4941
[PASS] [Pattern        578] Golden answer:       -4758, Your answer:       -4758
[PASS] [Pattern        579] Golden answer:       -4575, Your answer:       -4575
[PASS] [Pattern        580] Golden answer:       -4392, Your answer:       -4392
[PASS] [Pattern        581] Golden answer:       -4209, Your answer:       -4209
[PASS] [Pattern        582] Golden answer:       -4026, Your answer:       -4026
[PASS] [Pattern        583] Golden answer:       -3843, Your answer:       -3843
[PASS] [Pattern        584] Golden answer:       -3660, Your answer:       -3660
[PASS] [Pattern        585] Golden answer:       -3477, Your answer:       -3477
[PASS] [Pattern        586] Golden answer:       -3294, Your answer:       -3294
[PASS] [Pattern        587] Golden answer:       -3111, Your answer:       -3111
[PASS] [Pattern        588] Golden answer:       -2928, Your answer:       -2928
[PASS] [Pattern        589] Golden answer:       -2745, Your answer:       -2745
[PASS] [Pattern        590] Golden answer:       -2562, Your answer:       -2562
[PASS] [Pattern        591] Golden answer:       -2379, Your answer:       -2379
[PASS] [Pattern        592] Golden answer:       -2196, Your answer:       -2196
[PASS] [Pattern        593] Golden answer:       -2013, Your answer:       -2013
[PASS] [Pattern        594] Golden answer:       -1830, Your answer:       -1830
[PASS] [Pattern        595] Golden answer:       -1647, Your answer:       -1647
[PASS] [Pattern        596] Golden answer:       -1464, Your answer:       -1464
[PASS] [Pattern        597] Golden answer:       -1281, Your answer:       -1281
[PASS] [Pattern        598] Golden answer:       -1098, Your answer:       -1098
[PASS] [Pattern        599] Golden answer:        -915, Your answer:        -915
FIR spend       36601 cycle
```