CS-472 Design Technologies for Integrated Systems
Homework 2

David Desboeufs

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1 Optimization

We want to optimize the following FIR filter:

$$y[n] = b_0x[n] + b_1x[n-1] + \ldots + b_Nx[n-N]$$

First, to minimize the number of multiplications done, we can group each pair that share the same multiplication factor (i.e. b_0 and b_N, b_1 and b_{N-1}, ...). This is possible due to the fact that constants are known.

$$y = 19(x_0 + x_9) + 390(x_1 + x_8) + 864(x_2 + x_7) + 3072(x_3 + x_6) + 9(x_4 + x_5)$$

Next step is to replace multiplications by additions, for example a multiplication by a factor 2 is a simple shift to the left by 1. Here we take 19 as example:

$$19 = 1 << 4 + 1 << 1 + 1$$

So to replace this multiplication we need to perform 2 shifts and 3 additions.

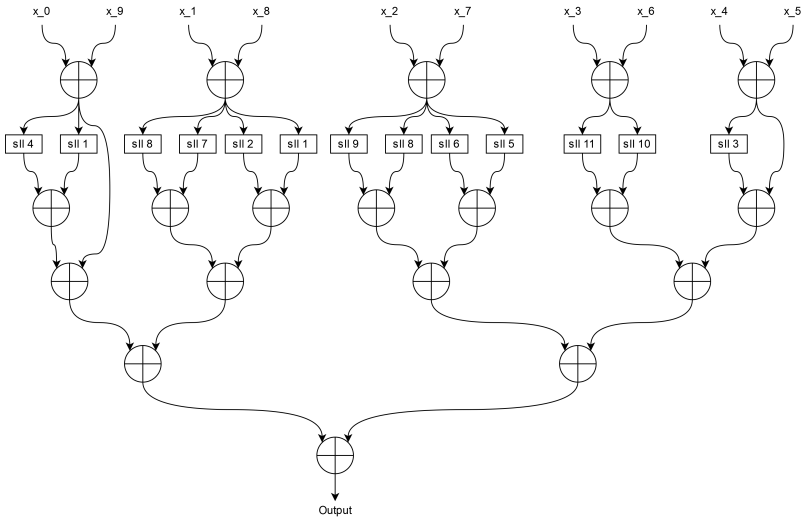

Figure 1: Data Flow

2 Results

```
clock global_clk (rise edge)                          1.75       1.75
clock network delay (ideal)                           0.00       1.75
R_o/Dout_reg[31]/CK (DFFRS_X1)                        0.00       1.75 r
library setup time                                   -0.03       1.72
data required time                                               1.72
-------------------------------------------------------------------------
data required time                                               1.72
data arrival time                                               -1.72
-------------------------------------------------------------------------
slack (MET)                                                      0.00
```

Figure 2: Timing

```
Combinational area:                546.083997
Buf/Inv area:                       87.846000
Noncombinational area:             221.760006
Macro/Black Box area:                0.000000
Net Interconnect area:             540.448359

Total cell area:                   767.844003
Total area:                       1308.292362
```

Figure 3: Total Area

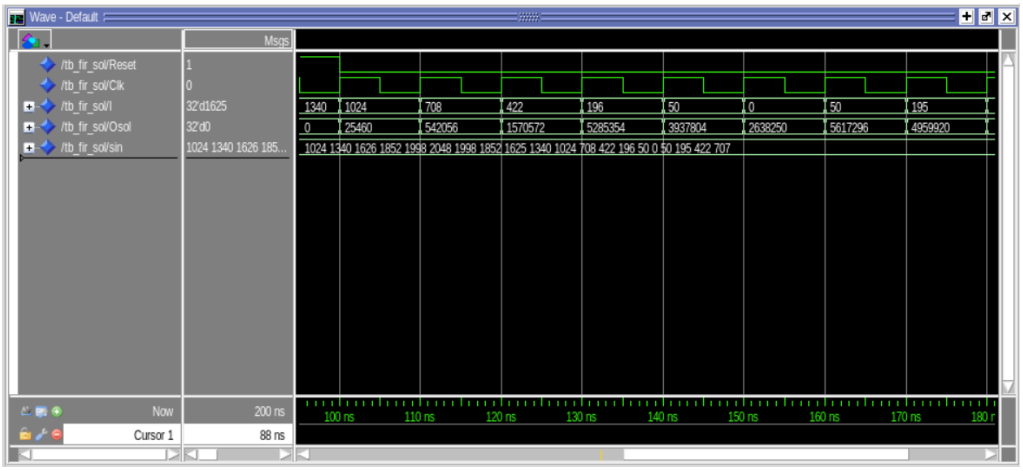

Figure 4: Modelsim Simulation