

Consider the following code segment, with the values  $MAX = 2^{20}$  and  $WSIZE = 5$  and the following data:

- Read from x takes 10 cycles (accounts for lw add)
- Read from w takes 10 cycles (accounts for lw add)
- Write to a register takes 1 cycle.
- Multiply takes 10 cycles (accounts for writing to the register)
- Each addition takes 5 cycles (accounts for writing to the register)
- Write to y takes 10 cycles
- Each comparison takes 5 cycles
- L1 cache hits require 5 cycles
- Cache miss penalty is 10 cycles

```
for( i = 0; i < MAX; ++i ){  
    t = 0;  
    for( j = 0; j < WSIZE; ++j ){  
        t += x[i+j]*w[j];  
        y[i] = t;  
    }  
}
```

a) Without any modifications, how many cycles does the code segment take?

Consider the following code segment, with the values  $MAX = 2^{20}$  and  $WSIZE = 5$  and the following data:

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- Read from w takes 10 cycles (accounts for lw add)
- Write to a register takes 1 cycle.
- Multiply takes 10 cycles (accounts for writing to the register)
- Each addition takes 5 cycles (accounts for writing to the register)
- Write to y takes 10 cycles
- Each comparison takes 5 cycles
- L1 cache hits require 5 cycles
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for( i = 0; i < MAX; ++i ){
    t = 0;
    for( j = 0; j < WSIZE; ++j ){
        t += x[i+j]*w[j];
        y[i] = t;
    }
}
```

b) Discuss the opportunities for reduction of cycle times and determine the improvement in performance when implemented in SIMD with 8 processors.