

Homework 4

Prof. Loh

CS6290 - Spring 2007

Handed Out: 26 Mar 2007 (Mon)

Due: 04 Apr 2007 (Wed)

1. Software Pipelining

Consider the problem of taking two audio streams and combining them into a single audio track. Assume the array x contains the samples for one stream, and array y contains the samples for the second stream. We will compute the combined stream A by taking the average of the two inputs. The code might look like:

```
for(i=0; i < NUM_SAMPLES; i++)
{
    xs = x[i];
    ys = y[i];
    avg = (x[i] + y[i]) / 2.0;
    A[i] = avg;
}
```

The instructions within each iteration contain several dependencies, including some long latency operations (e.g., loads, division). Executing this code on an in-order pipeline may result in numerous stalls due to true data dependencies. Rewrite the code using *software pipelining* to remove all true dependencies within each iteration.

2. Cache Configurations For the following, assume a 32-bit address.

- (a) Consider a cache with 16KB of data, 4-way set associativity, and 32 byte line size. What is the size of each line's tag in bits?
- (b) Consider a cache with 512 sets, 8-way set associativity, and 17-bit tags. How many bytes can the cache store? (What is the data capacity not including overhead for storing tags, valid bits, etc.?)
- (c) Consider a cache with a 64-byte line size and 26-bit tags. What is the set associativity of the cache?

3. Cache Performance

- (a) Assume a cache with four cache lines. Let C1 be such a cache with a direct-mapped organization. Let C2 be a similar cache, but with a fully-associative organization. Normally, greater set associativity decreases cache miss rates by reducing the number of conflict misses. Describe a scenario/cache access pattern, where the direct-mapped C1 achieves a *better* hit rate than the fully-associative C2.
- (b) Given the scenario that you just described, what changes can you make to C2 (assuming it must remain fully associative, have the same number of lines (4), and that the line size stays the same) to improve its cache hit rate?