Lab2 Report

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1.Microbenchmarks

After disassemble mb, we got the assembly for our benchmark.

```
6bf:  c7 45 fc 00 00 00 00 movl   $0x0,-0x4(%rbp)
6c6:  c7 45 f8 00 00 00 00 movl   $0x0,-0x8(%rbp)
6cd:  eb 1b                jmp    6ea <main+0x3a>
6cf:  c7 45 f4 00 00 00 00 movl   $0x0,-0xc(%rbp)
6d6:  eb 08                jmp    6e0 <main+0x30>
6d8:  83 45 fc 01          addl   $0x1,-0x4(%rbp)
6dc:  83 45 f4 01          addl   $0x1,-0xc(%rbp)
6e0:  83 7d f4 04          cmpl   $0x4,-0xc(%rbp)
6e4:  7e f2                jle    6d8 <main+0x28>
6e6:  83 45 f8 01          addl   $0x1,-0x8(%rbp)
6ea:  81 7d f8 3f 42 0f 00 cmpl   $0xf423f,-0x8(%rbp)
6f1:  7e dc                jle    6cf <main+0x1f>
```

There are about 7,000,000 (7027427) branches in our microbenchmark. The iteration is after every 6 branches at 6e4 and one at 6f1. In this case BTH index PHT indexes for these two branches are different. Their prediction counter for every possible history is in different places. Thus, the prediction for this microbenchmark using 2-level predictor should be correct for all the nearly all the branches. Our number of mispredictions result is 3474 for this microbenmark, which is what we expected.

2.Predictor results

	2bit	2level	openend
astar	369580	1785644	447325
bwaves	1182969	1071909	240856
bzip2	1224967	1297677	1203165
gcc	3161868	2223671	221870
gromacs	1363248	1122586	791743
hmmer	2035080	2230774	1995238
mcf	3657986	2024172	1406892
soplex	1065988	1022869	648233

Table-1 Number of mispredicted branches across all three predictors and benchmarks.

	2bit	2level	openend
astar	24.639	11.903	2.982
bwaves	7.886	7.146	1.606
bzip2	8.166	8.651	8.021
gcc	21.079	14.824	1.479
gromacs	9.088	7.484	5.278
hmmer	13.567	14.872	13.302
mcf	24.387	13.494	9.379
soplex	7.107	6.819	4.322
Average MPKI	14.489875	10.649125	5.796125

Table-2 MPKI for all three predictors and benchmarks.

3.Open-ended branch predictor implementation.

Our open-ended branch predictor is based on TAGE branch predictor [1]. The predictor has a base predictor with 4K entries 4 bits counter predictor, 4 tagged components, each has 2K entries, with a 8 bit tag, 4 bits predictor and 2 bit u. The overall bits needed for the open-ended predictor is 128 Kbits (16384bytes) for branch prediction. We observed that by using different bits of branch history for computing indexes and tags of the tagged components, the mispredictions may be less than using same bits of branch history. We used 5, 14, 37, 100 bits global history respectively for computing the tags and 5,17,38,103 bits for computing the indexes.

4.CACTI report

By using CACTI, the area, access latency, leakage power for two-level and open-ended predictor is below:

Two-level predictor level 1:

```
Access time (ns): 0.32999
Total leakage power of a bank (mW): 0.289526
Cache height x width (mm): 0.0391054 x 0.0421587
```

Two-level predictor level 2(we merged 8 tables into 1):

```
Access time (ns): 0.32999
Total leakage power of a bank (mW): 0.289526
Cache height x width (mm): 0.0391054 x 0.0421587
```

Total access time 0.65998 ns

Leakage power 0.579052 mW

Area: height x width (mm) 0.078308 x 0.0421587

Open-ended base preditor:

```
Access time (ns): 0.424035
Total leakage power of a bank (mW): 2.31846
Cache height x width (mm): 0.0712679 x 0.14909
```

Open-ended tagged components (4 components basically are the same):

```
Access time (ns): 0.419944
Total leakage power of a bank (mW): 3.14628
Cache height x width (mm): 0.1346 x 0.100604
```

The access time of the open-ended predictor is 0.424035ns. Since all the tables are accessed in parallel, so the access time is the longest single table access time.

Total leakage power is 14.90358 mW

Area is 0.06479052 mm^2.

References

[1] Andre Seznec and Pierre Michaud. A case for (partially)- tagged geometric history length predictors. *Journal of Instruction Level Parallelism (http://www.jilp.org/vol7)*, April 2006.