Cache Simulation

ECEN 4593

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Summary

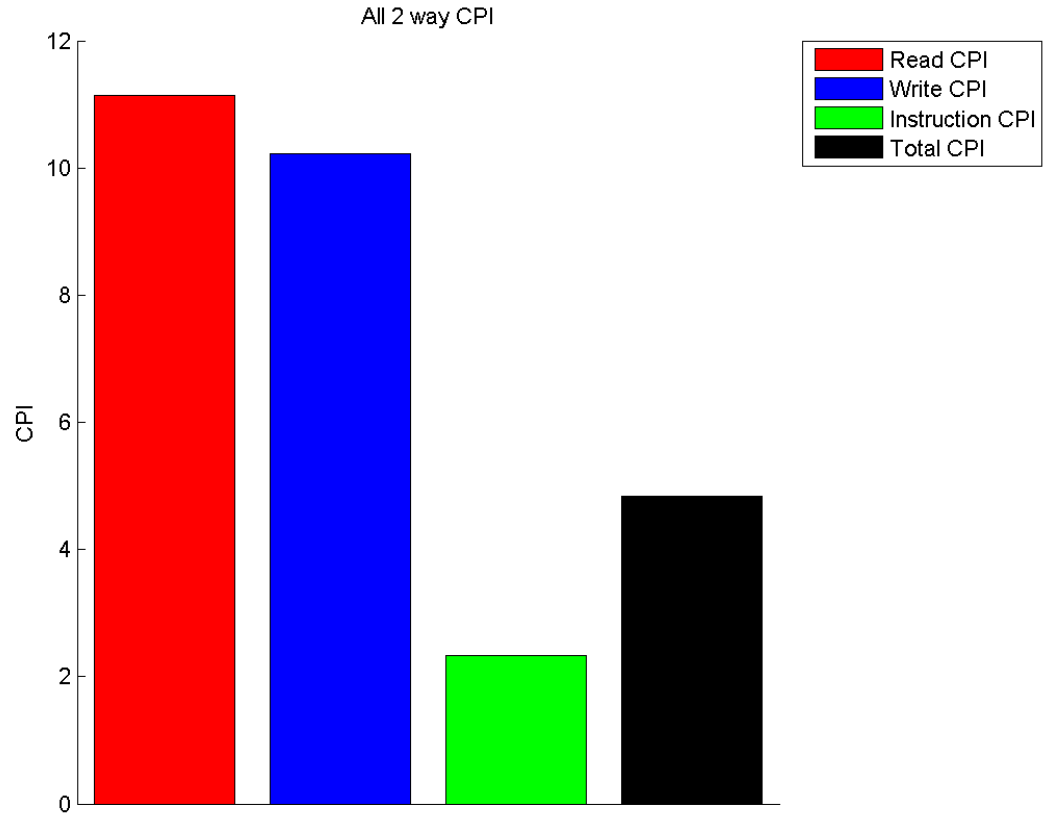
Main Conclusion

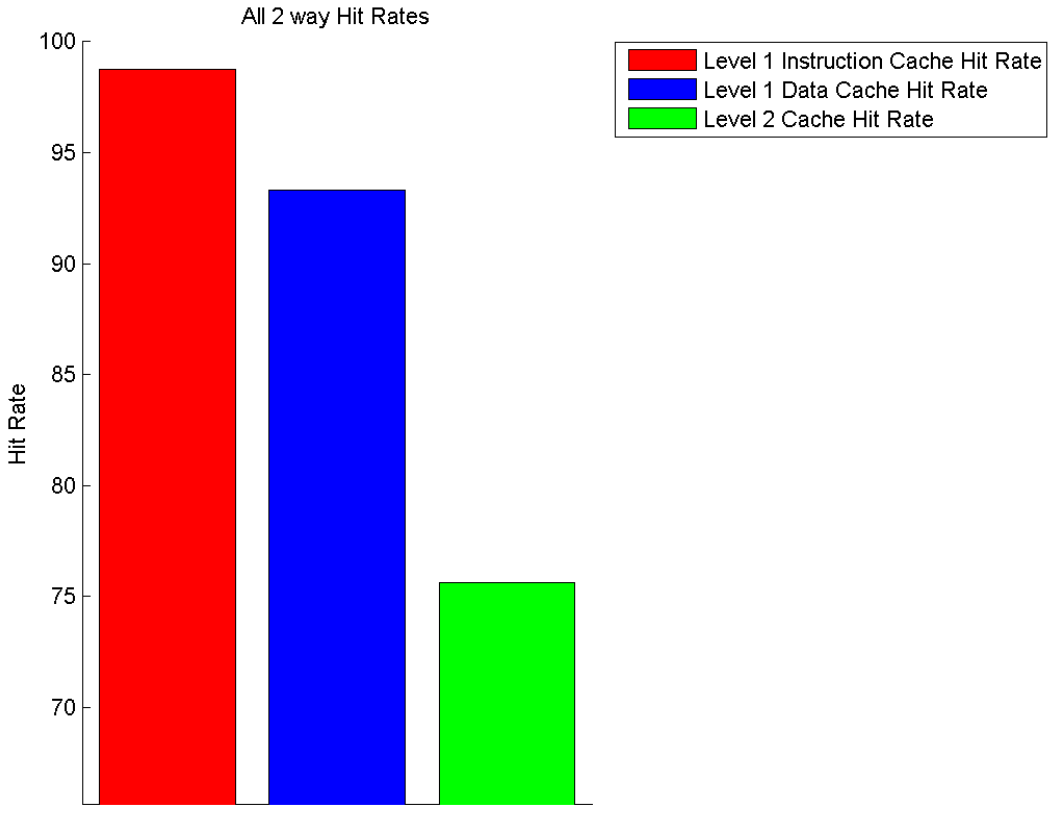
In this project, we simulated various cache configurations using several test, each containing roughly 5 billion memory references. Results were generated to observe the counts of the different reference types and the associated hit/miss rates. The different types of configurations were:

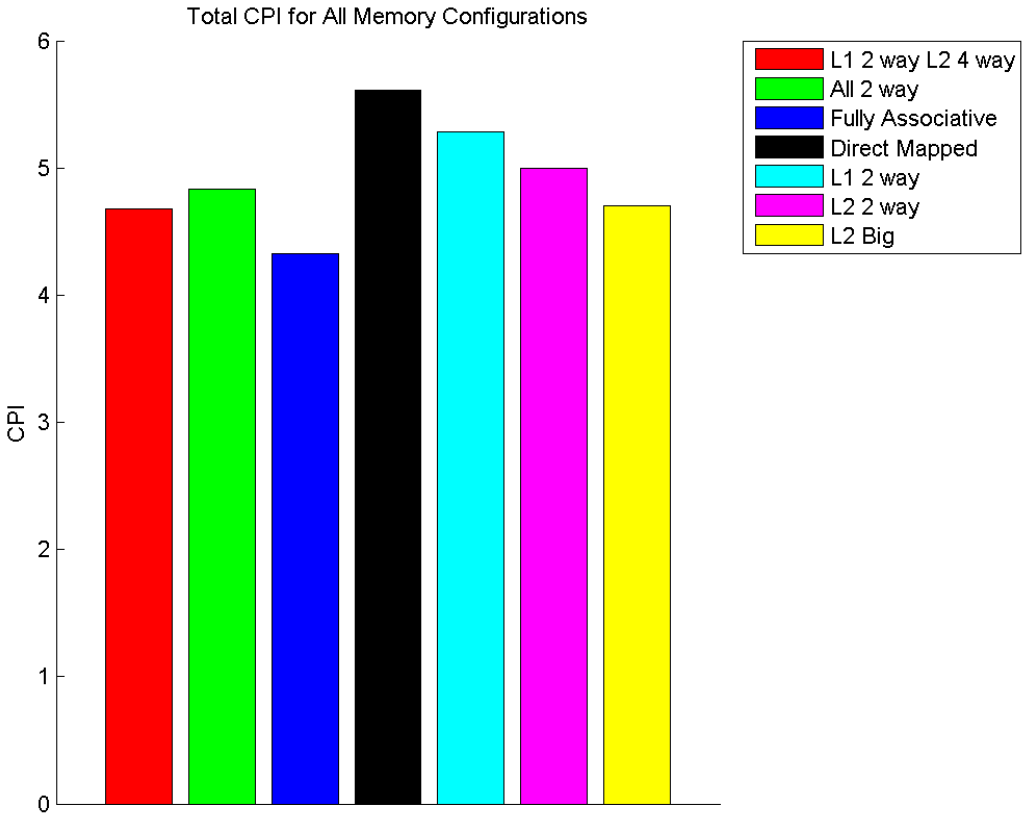
- Base (default) -8KB direct-mapped Icache, 8KB direct-mapped Dcache, with a unified 64KB direct-mapped Level-2 cache.
- L1-2way - 8KB two-way set associative Icache, 8KB two-way set associative Dcache, with a uni- fied 64KB direct-mapped Level-2 cache.
- L2-2way - 8KB direct-mapped Icache, 8KB direct-mapped Dcache, with a unified 64KB two-way set associative Level-2 cache.
- All-2way - 8KB two-way set associative Icache, 8KB two-way set associative Dcache, with a uni- fied 64KB two-way set associative Level-2 cache.
- 2-4way 8KB two-way set associative Icache, 8KB two-way set associative Dcache, with a uni- fied 64KB four-way set associative Level-2 cache.
- L2-Big 8KB two-way set associative Icache, 8KB two-way set associative Dcache, with a unified 128KB direct-mapped Level-2 cache.
- All-FA - Fully Associative 8KB Icache, 8KB Dcache, and 64KB Level-2 cache.

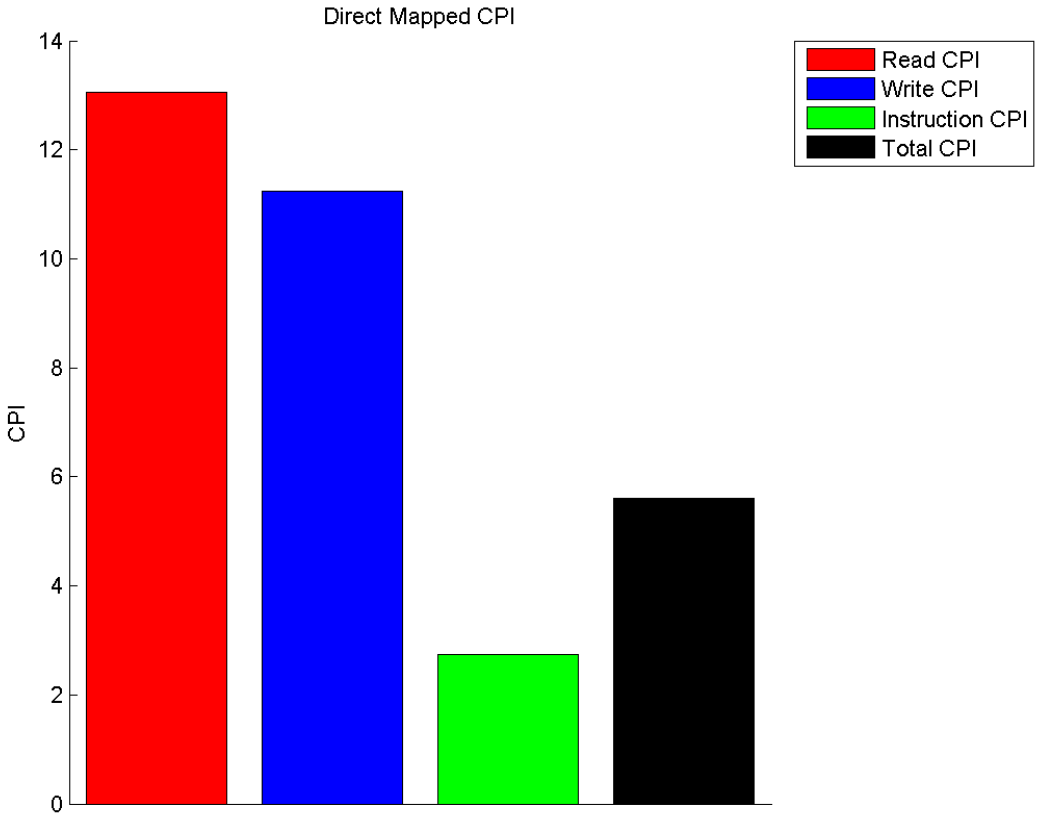
The Folowing are the plots of our results

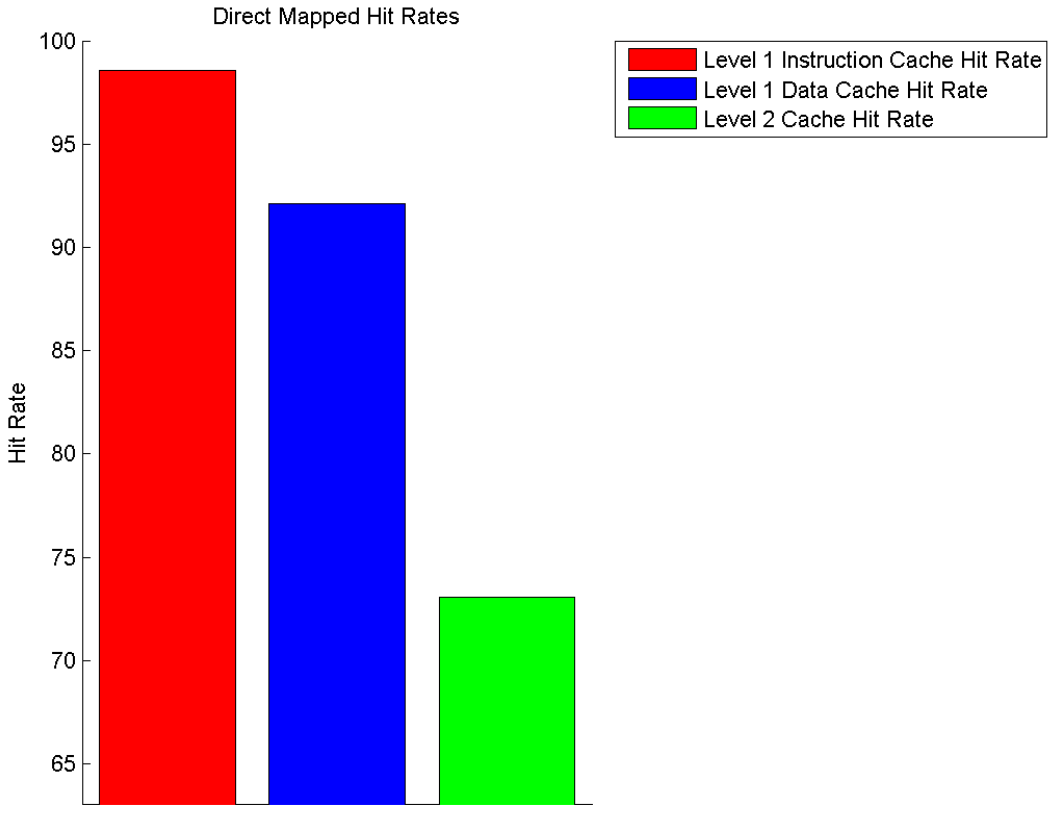
Results Plots

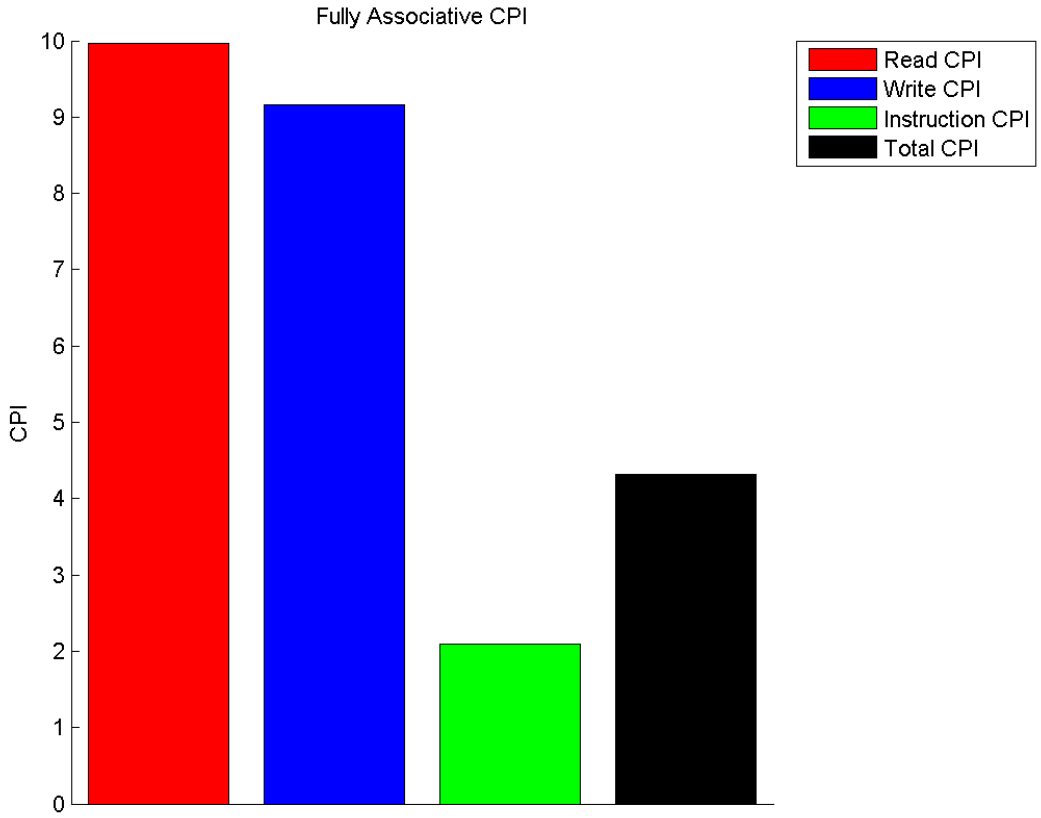

All 2 way CPI
CPI
12
10
8
6
4
2
0
Read CPI
Write CPI
Instruction CPI
Total CPI

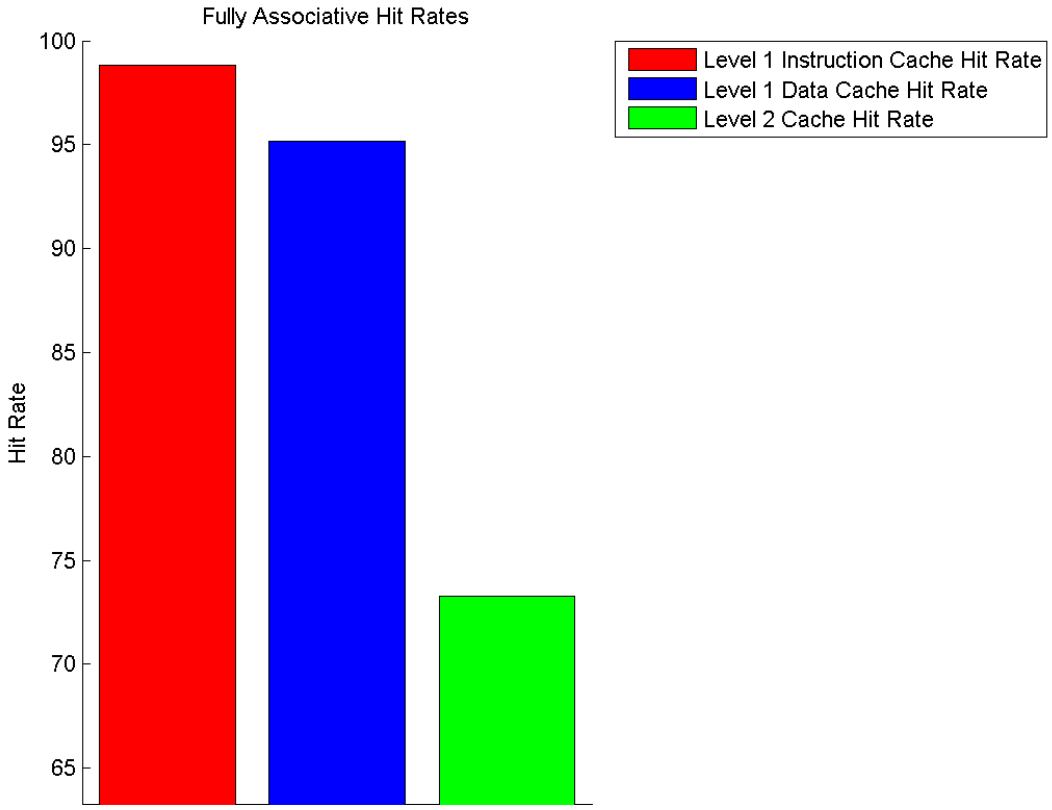

All 2 way Hit Rates
Hit Rate
100
95
90
85
80
75
70
Level 1 Instruction Cache Hit Rate
Level 1 Data Cache Hit Rate
Level 2 Cache Hit Rate

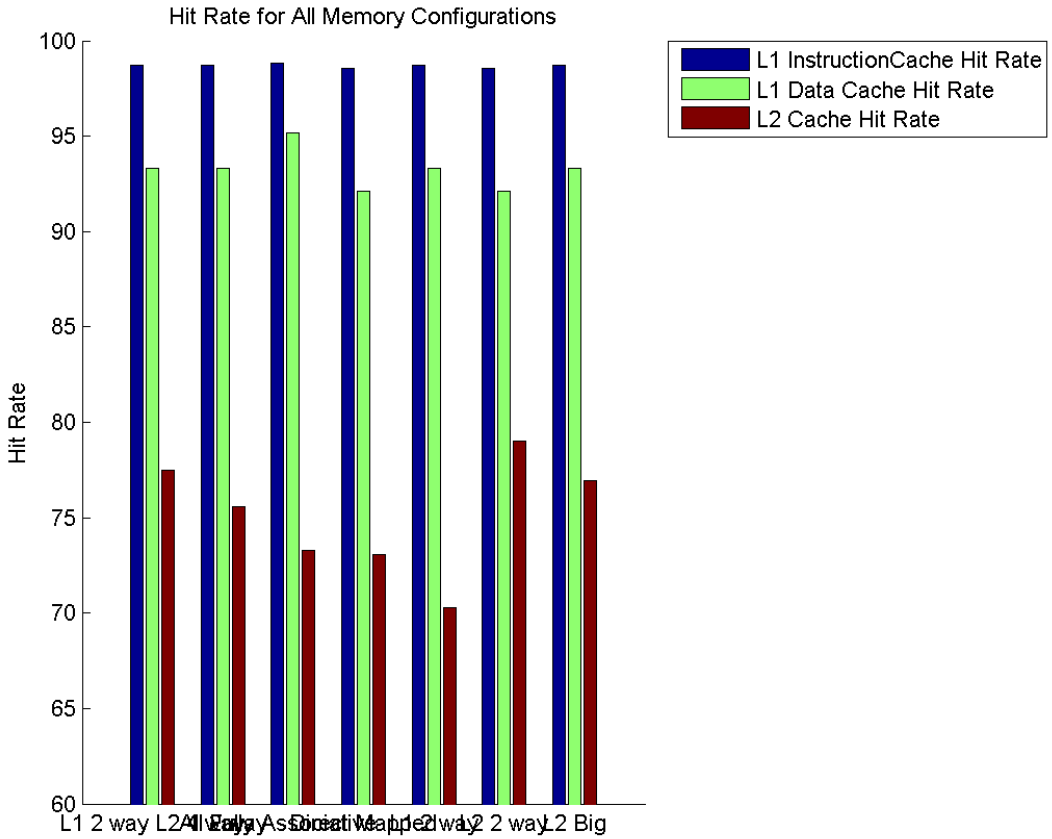

Total CPI for All Memory Configurations
CPI
0
1
2
3
4
5
6
L1 2 way L2 4 way
All 2 way
Fully Associative
Direct Mapped
L1 2 way
L2 2 way
L2 Big

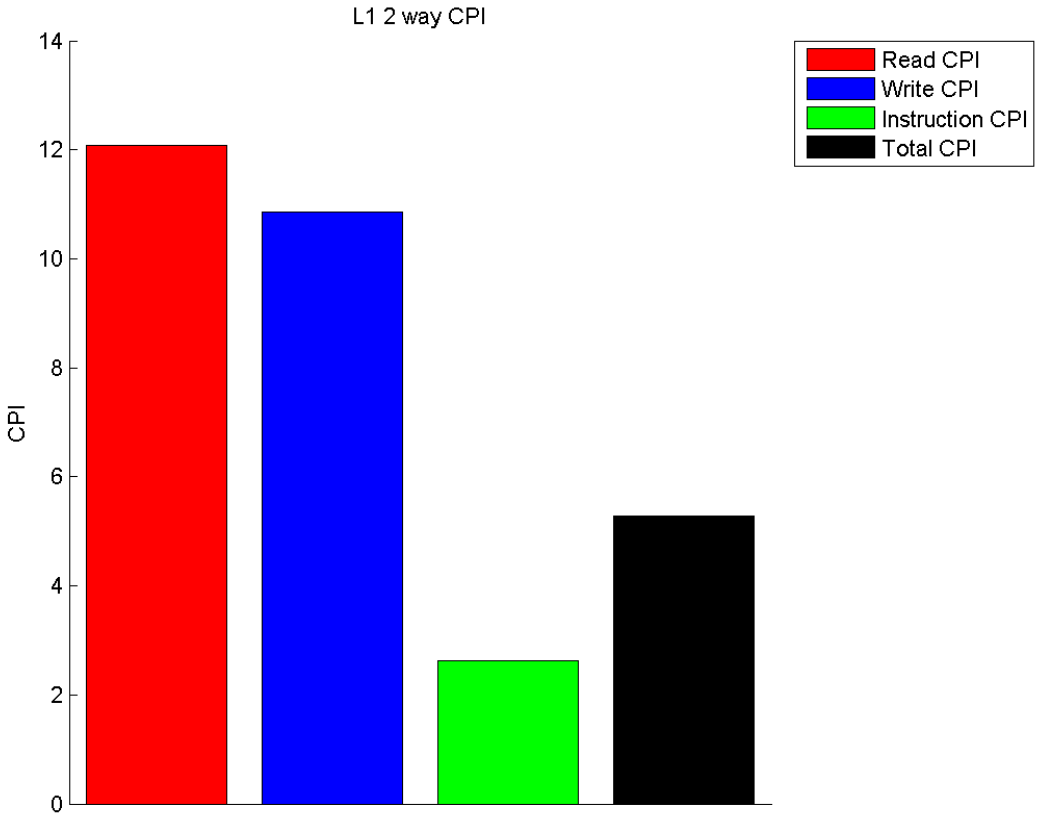

Direct Mapped CPI
Read CPI
Write CPI
Instruction CPI
Total CPI
CPI
0
2
4
6
8
10
12
14

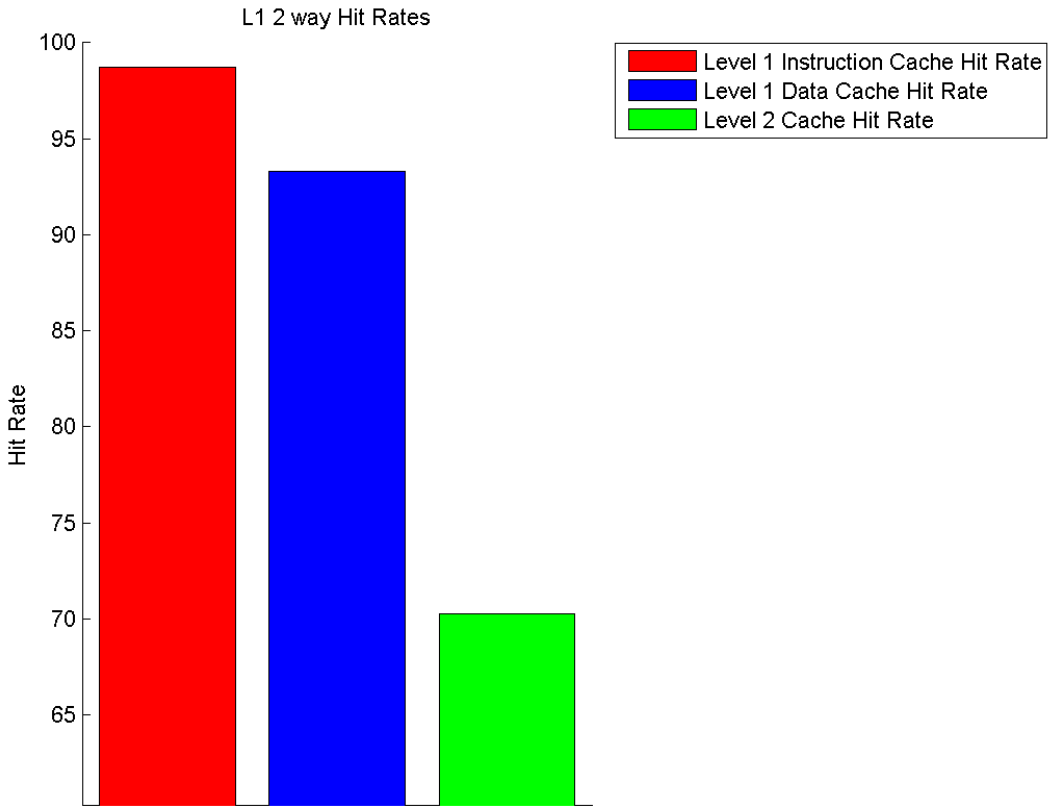

Direct Mapped Hit Rates
Hit Rate
100
95
90
85
80
75
70
65
Level 1 Instruction Cache Hit Rate
Level 1 Data Cache Hit Rate
Level 2 Cache Hit Rate

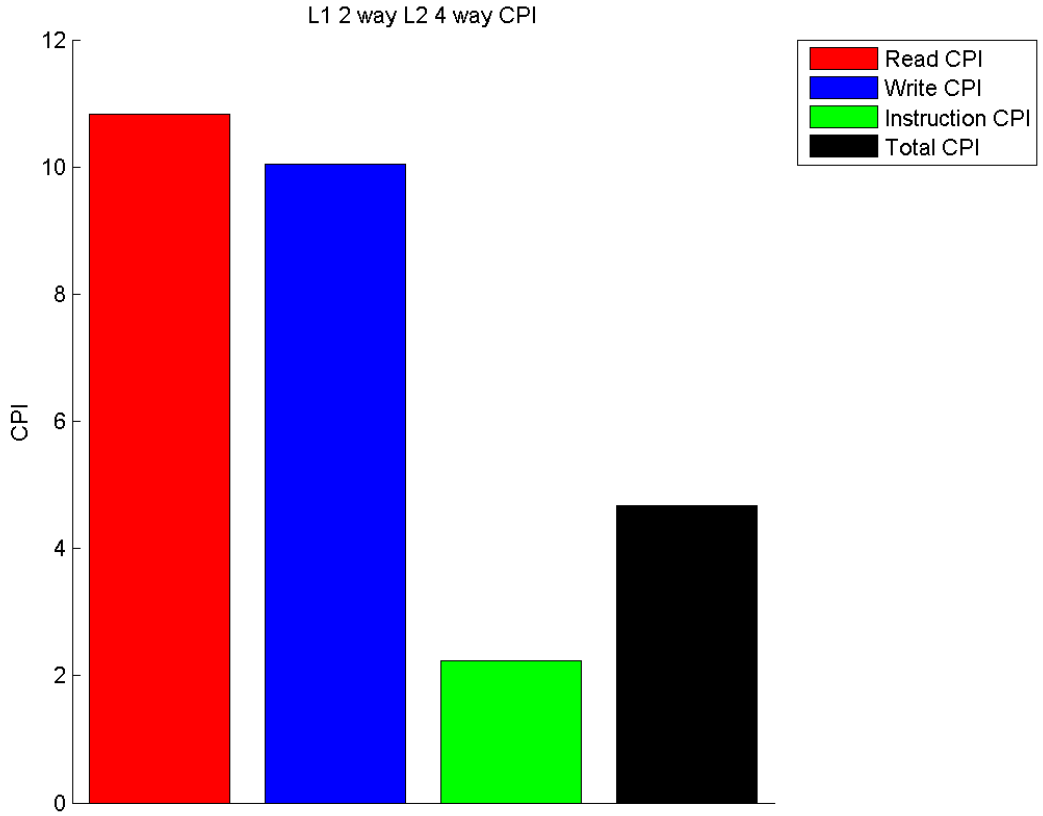

Fully Associative CPI
CPI
10
9
8
7
6
5
4
3
2
1
0
Read CPI
Write CPI
Instruction CPI
Total CPI

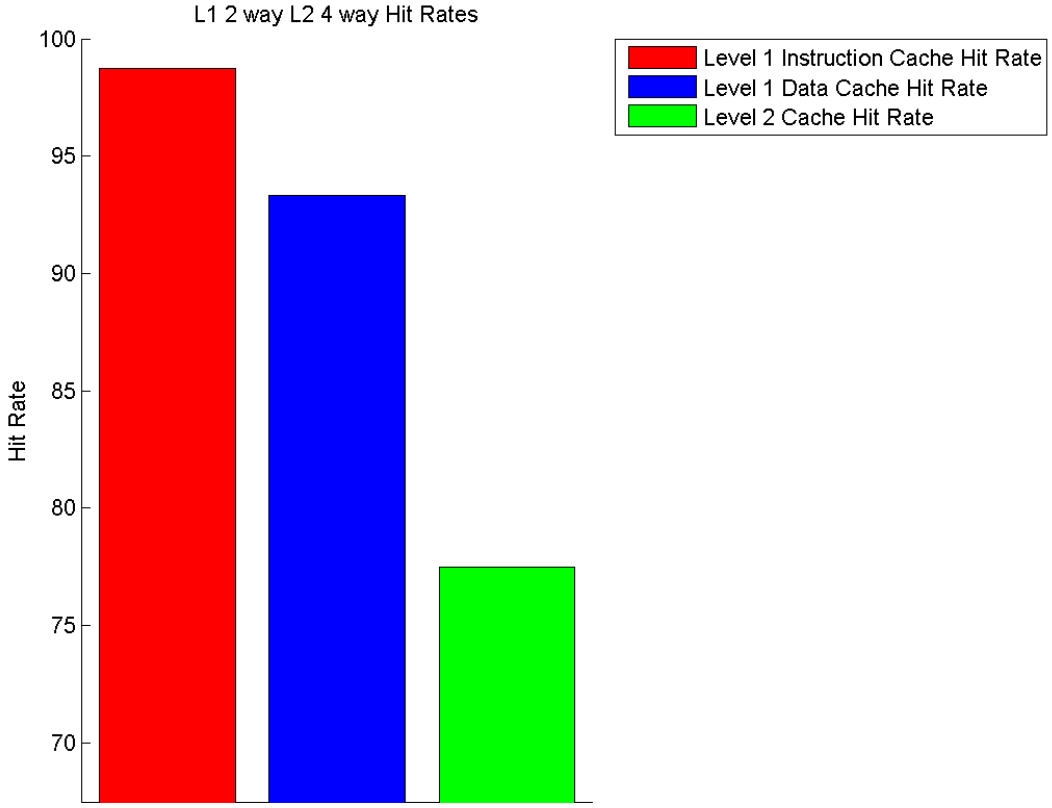

Fully Associative Hit Rates
Hit Rate
100
95
90
85
80
75
70
65
Level 1 Instruction Cache Hit Rate
Level 1 Data Cache Hit Rate
Level 2 Cache Hit Rate

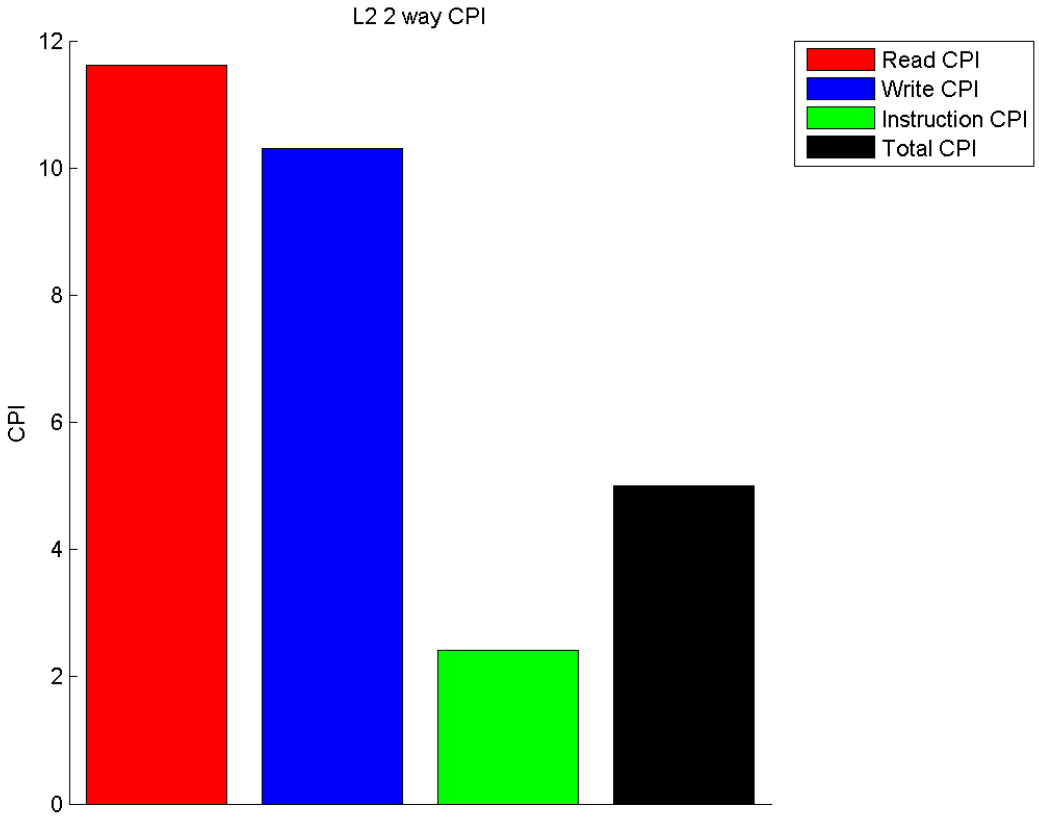

Hit Rate for All Memory Configurations
Hit Rate
100
95
90
85
80
75
70
65
60
L1 InstructionCache Hit Rate
L1 Data Cache Hit Rate
L2 Cache Hit Rate
L1 2 way L2
L2 Big

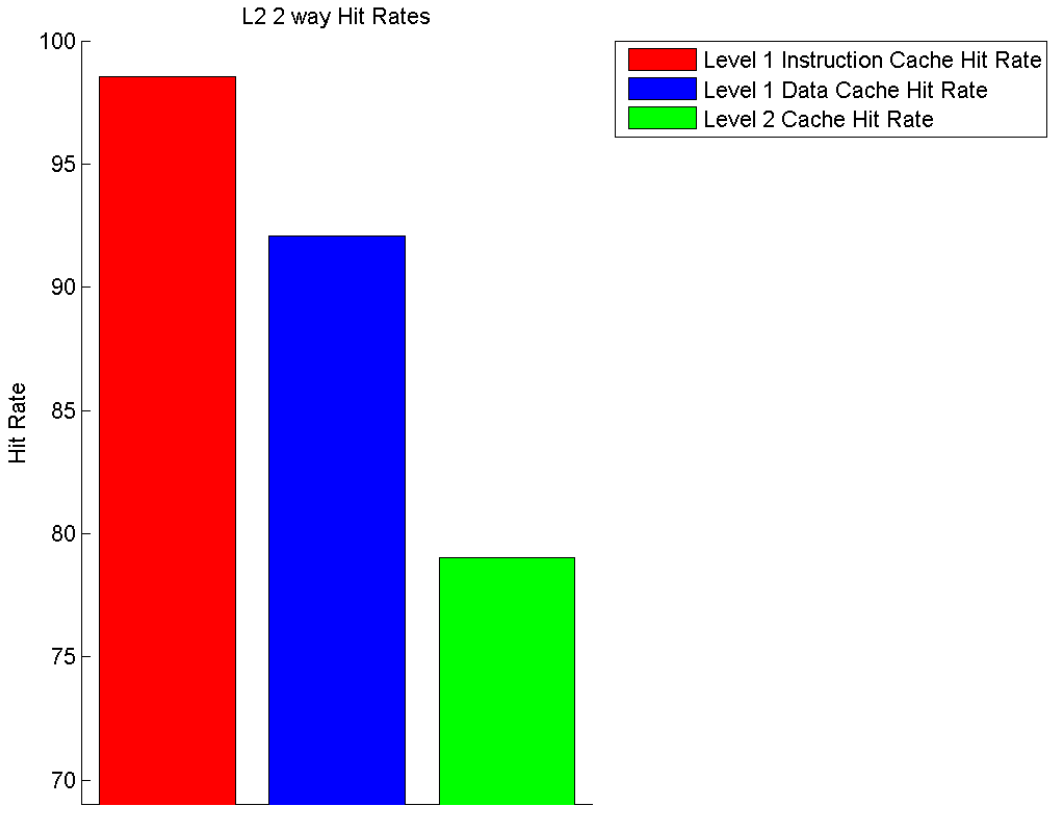

L1 2 way CPI
Read CPI
Write CPI
Instruction CPI
Total CPI
CPI
0
2
4
6
8
10
12
14

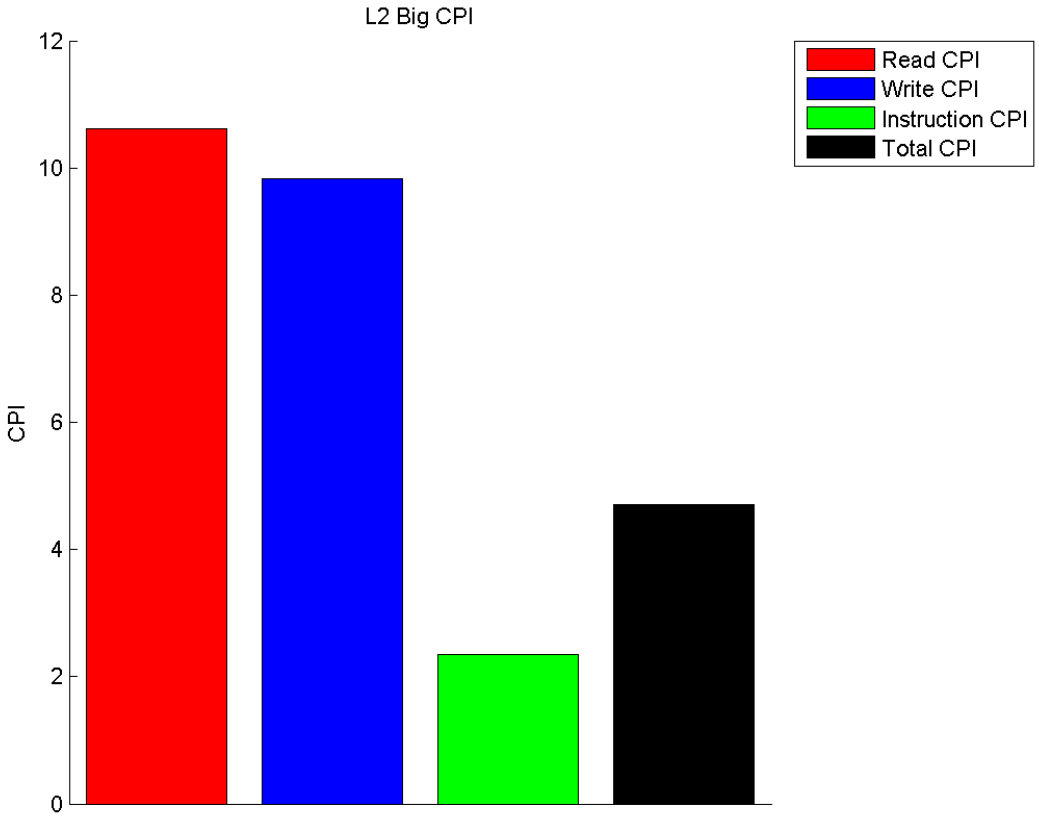

L1 2 way Hit Rates
Hit Rate
100
95
90
85
80
75
70
65
Level 1 Instruction Cache Hit Rate
Level 1 Data Cache Hit Rate
Level 2 Cache Hit Rate

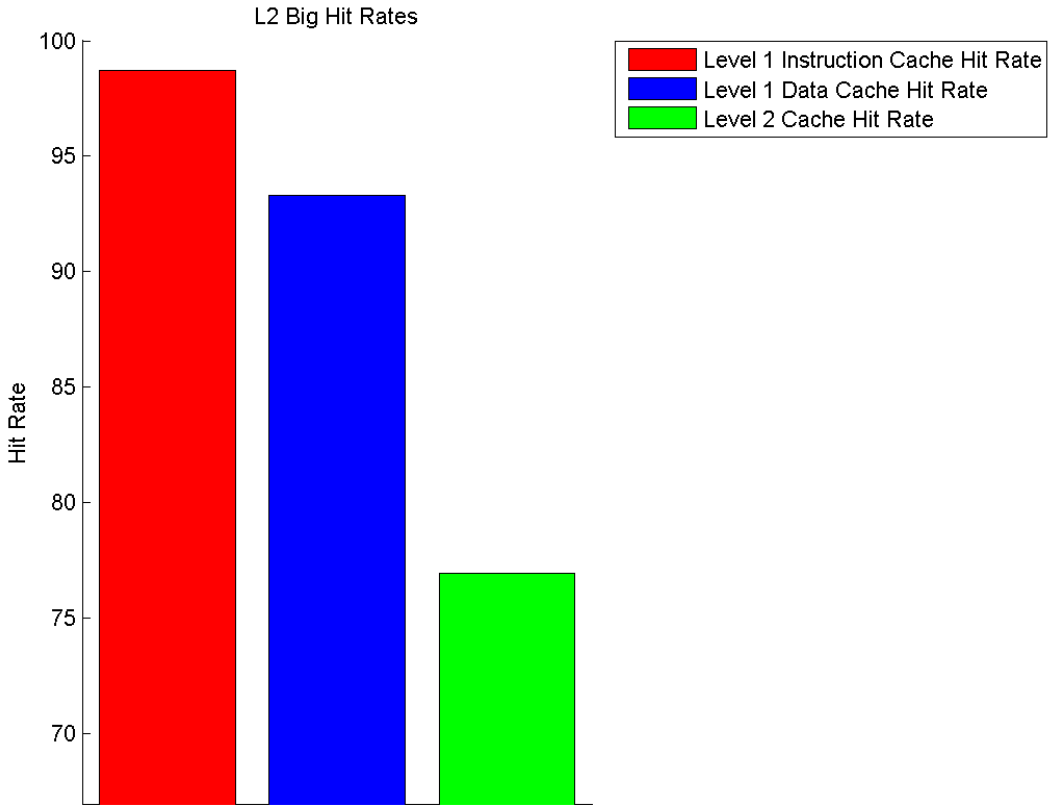

L1 2 way L2 4 way CPI
CPI
12
10
8
6
4
2
0
Read CPI
Write CPI
Instruction CPI
Total CPI


L1 2 way L2 4 way Hit Rates
Hit Rate
100
95
90
85
80
75
70
Level 1 Instruction Cache Hit Rate
Level 1 Data Cache Hit Rate
Level 2 Cache Hit Rate


L2 2 way CPI
CPI
0
2
4
6
8
10
12
Read CPI
Write CPI
Instruction CPI
Total CPI


L2 2 way Hit Rates
Hit Rate
100
95
90
85
80
75
70
Level 1 Instruction Cache Hit Rate
Level 1 Data Cache Hit Rate
Level 2 Cache Hit Rate


L2 Big CPI
Read CPI
Write CPI
Instruction CPI
Total CPI
CPI
0
2
4
6
8
10
12


L2 Big Hit Rates
Hit Rate
100
95
90
85
80
75
70
Level 1 Instruction Cache Hit Rate
Level 1 Data Cache Hit Rate
Level 2 Cache Hit Rate

Affect of chunksize on cost

We also simulated the affect on cost of the variance in chunksize and found that increases the width, while decreasing execution time, also increased cost. The cost/benefit ratio was likely best in the 32 byte width.

Simulation Results

The following pages are the simulation results generated for the specified test and cache-type. The format is test.cache-type.

astar results

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astar.2-4-way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 4 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 18962176494;    Total refs = 5000000000
Inst refs = 3418797090;    Data refs = 308039522


Number of reference types: [Percentage]
     Reads = 1273163388     [25.46%]
     Writes = 308039522     [6.16%]
     Inst = 3418797090     [68.38%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 8744712559     [46.12%]
     Writes = 4479430163     [23.62%]
     Inst = 5738033772     [30.26%]
     Total = 18962176494


Average cycles per activity:
     Read = 6.87;   Write = 14.54;   Inst. = 5.55


Memory Level: L1i
     Hit Count = 5720505286  Miss Count = 227995
     Total Requests =  5720733281
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 227739;  Dirty kickouts = 0;  Transfers = 227995


Memory Level: L1d
     Hit Count = 2111096166  Miss Count = 95725984
     Total Requests =  2206822150
     Hit Rate = [95.66%]   Miss Rate = [4.34%]
     Kickouts = 95725728;  Dirty kickouts = 39157323;  Transfers = 95725984


Memory Level: L2
     Hit Count = 98014320  Miss Count = 37096982
     Total Requests =  135111302
     Hit Rate = [72.54%]   Miss Rate = [27.46%]
     Kickouts = 37095958;  Dirty kickouts = 24005192;  Transfers = 37096982
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $150;  Memory cost = $75
Total cost = $1025
```

---

astar.All-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 19356863450;    Total refs = 5000000000
Inst refs = 3418797090;    Data refs = 308039522


Number of reference types: [Percentage]
     Reads = 1273163388     [25.46%]
     Writes = 308039522     [6.16%]
     Inst = 3418797090     [68.38%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 9082330679     [46.92%]
     Writes = 4536609835     [23.44%]
     Inst = 5737922936     [29.64%]
     Total = 19356863450


Average cycles per activity:
     Read = 7.13;   Write = 14.73;   Inst. = 5.66


Memory Level: L1i
     Hit Count = 5720505286  Miss Count = 227995
     Total Requests =  5720733281
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 227739;  Dirty kickouts = 0;  Transfers = 227995


Memory Level: L1d
     Hit Count = 2111096166  Miss Count = 95725984
     Total Requests =  2206822150
     Hit Rate = [95.66%]   Miss Rate = [4.34%]
     Kickouts = 95725728;  Dirty kickouts = 39157323;  Transfers = 95725984


Memory Level: L2
     Hit Count = 95507164  Miss Count = 39604138
     Total Requests =  135111302
     Hit Rate = [70.69%]   Miss Rate = [29.31%]
     Kickouts = 39603114;  Dirty kickouts = 24209779;  Transfers = 39604138
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

---

astar.All-FA Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 256 : block size = 32
     Icache size = 8192 : ways = 256 : block size = 32
     L2-cache size = 65536 : ways = 1024 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 17981142859;    Total refs = 5000000000
Inst refs = 3418797090;    Data refs = 308039522


Number of reference types: [Percentage]
     Reads = 1273163388     [25.46%]
     Writes = 308039522     [6.16%]
     Inst = 3418797090     [68.38%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 7825503863     [43.52%]
     Writes = 4434255539     [24.66%]
     Inst = 5721383457     [31.82%]
     Total = 17981142859


Average cycles per activity:
     Read = 6.15;   Write = 14.40;   Inst. = 5.26


Memory Level: L1i
     Hit Count = 5720727727  Miss Count = 5554
     Total Requests =  5720733281
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 5298;  Dirty kickouts = 0;  Transfers = 5554


Memory Level: L1d
     Hit Count = 2127174314  Miss Count = 79647836
     Total Requests =  2206822150
     Hit Rate = [96.39%]   Miss Rate = [3.61%]
     Kickouts = 79647580;  Dirty kickouts = 34215058;  Transfers = 79647836


Memory Level: L2
     Hit Count = 80194503  Miss Count = 33673945
     Total Requests =  113868448
     Hit Rate = [70.43%]   Miss Rate = [29.57%]
     Kickouts = 33672921;  Dirty kickouts = 23111735;  Transfers = 33673945
```

```
L1 cache cost (Icache $1800) + (Dcache $1800) = $3600
L2 cache cost = $550;  Memory cost = $75
Total cost = $4225
```

---

astar.default Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32\pagebreak
```

astar results

L2-cache size = 65536 : ways = 1 : block size = 64 Memory ready time = 50 chunksize = 16 : chunktime = 20

```
Execute time = 22047530585;    Total refs = 5000000000
Inst refs = 3418797090;    Data refs = 308039522


Number of reference types: [Percentage]
     Reads = 1273163388     [25.46%]
     Writes = 308039522     [6.16%]
     Inst = 3418797090     [68.38%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 11432189418     [51.85%]
     Writes = 4855722298     [22.02%]
     Inst = 5759618869     [26.12%]
     Total = 22047530585


Average cycles per activity:
     Read = 8.98;   Write = 15.76;   Inst. = 6.45


Memory Level: L1i
     Hit Count = 5720163033  Miss Count = 570248
     Total Requests =  5720733281
     Hit Rate = [99.99%]  Miss Rate = [0.01%]
     Kickouts = 569992;  Dirty kickouts = 0;  Transfers = 570248


Memory Level: L1d
     Hit Count = 2086868848  Miss Count = 119953302
     Total Requests =  2206822150
     Hit Rate = [94.56%]   Miss Rate = [5.44%]
     Kickouts = 119953046;  Dirty kickouts = 46313651;  Transfers = 119953302


Memory Level: L2
     Hit Count = 115040113  Miss Count = 51797088
     Total Requests =  166837201
     Hit Rate = [68.95%]   Miss Rate = [31.05%]
     Kickouts = 51796064;  Dirty kickouts = 26912011;  Transfers = 51797088



L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $50;  Memory cost = $75
Total cost = $525
```

---

astar.L1-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 20643292638;    Total refs = 5000000000
Inst refs = 3418797090;    Data refs = 308039522


Number of reference types: [Percentage]
     Reads = 1273163388     [25.46%]
     Writes = 308039522     [6.16%]
     Inst = 3418797090     [68.38%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 10204093885     [49.43%]
     Writes = 4700636859     [22.77%]
     Inst = 5738561894     [27.80%]
     Total = 20643292638


Average cycles per activity:
     Read = 8.01;   Write = 15.26;   Inst. = 6.04


Memory Level: L1i
     Hit Count = 5720505286  Miss Count = 227995
     Total Requests =  5720733281
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 227739;  Dirty kickouts = 0;  Transfers = 227995


Memory Level: L1d
     Hit Count = 2111096166  Miss Count = 95725984
     Total Requests =  2206822150
     Hit Rate = [95.66%]   Miss Rate = [4.34%]
     Kickouts = 95725728;  Dirty kickouts = 39157323;  Transfers = 95725984


Memory Level: L2
     Hit Count = 87863096  Miss Count = 47248206
     Total Requests =  135111302
     Hit Rate = [65.03%]   Miss Rate = [34.97%]
     Kickouts = 47247182;  Dirty kickouts = 25426888;  Transfers = 47248206
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $50;  Memory cost = $75
Total cost = $925
```

---

astar.L2-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 19862739275;    Total refs = 5000000000
Inst refs = 3418797090;    Data refs = 308039522


Number of reference types: [Percentage]
     Reads = 1273163388     [25.46%]
     Writes = 308039522     [6.16%]
     Inst = 3418797090     [68.38%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 9527603854     [47.97%]
     Writes = 4575457414     [23.04%]
     Inst = 5759678007     [29.00%]
     Total = 19862739275


Average cycles per activity:
     Read = 7.48;   Write = 14.85;   Inst. = 5.81


Memory Level: L1i
     Hit Count = 5720163033  Miss Count = 570248
     Total Requests =  5720733281
     Hit Rate = [99.99%]  Miss Rate = [0.01%]
     Kickouts = 569992;  Dirty kickouts = 0;  Transfers = 570248


Memory Level: L1d
     Hit Count = 2086868848  Miss Count = 119953302
     Total Requests =  2206822150
     Hit Rate = [94.56%]   Miss Rate = [5.44%]
     Kickouts = 119953046;  Dirty kickouts = 46313651;  Transfers = 119953302


Memory Level: L2
     Hit Count = 127502358  Miss Count = 39334843
     Total Requests =  166837201
     Hit Rate = [76.42%]   Miss Rate = [23.58%]
     Kickouts = 39333819;  Dirty kickouts = 24302700;  Transfers = 39334843
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $100;  Memory cost = $75
Total cost = $575
```

---

astar.L2-Big Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 131072 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 18111728604;    Total refs = 5000000000
Inst refs = 3418797090;    Data refs = 308039522


Number of reference types: [Percentage]
     Reads = 1273163388     [25.46%]
     Writes = 308039522     [6.16%]
     Inst = 3418797090     [68.38%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 8383937081     [46.29%]
     Writes = 3990685271     [22.03%]
     Inst = 5737106252     [31.68%]
     Total = 18111728604


Average cycles per activity:
     Read = 6.59;   Write = 12.96;   Inst. = 5.30


Memory Level: L1i
     Hit Count = 5720505286  Miss Count = 227995
     Total Requests =  5720733281
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 227739;  Dirty kickouts = 0;  Transfers = 227995


Memory Level: L1d
     Hit Count = 2111096166  Miss Count = 95725984
     Total Requests =  2206822150
     Hit Rate = [95.66%]   Miss Rate = [4.34%]
     Kickouts = 95725728;  Dirty kickouts = 39157323;  Transfers = 95725984


Memory Level: L2
     Hit Count = 100249135  Miss Count = 34862167
     Total Requests =  135111302
     Hit Rate = [74.20%]   Miss Rate = [25.80%]
     Kickouts = 34860119;  Dirty kickouts = 20261157;  Transfers = 34862167
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

bzip results

bzip.2-4-way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 4 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 24583030591;    Total refs = 5000000000
Inst refs = 3812526036;    Data refs = 261704626


Number of reference types: [Percentage]
     Reads = 925769338     [18.52%]
     Writes = 261704626     [5.23%]
     Inst = 3812526036     [76.25%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 9863754485     [40.12%]
     Writes = 8617088144     [35.05%]
     Inst = 6102187962     [24.82%]
     Total = 24583030591


Average cycles per activity:
     Read = 10.65;   Write = 32.93;   Inst. = 6.45


Memory Level: L1i
     Hit Count = 6101573758  Miss Count = 4671
     Total Requests =  6101578429
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 4415;  Dirty kickouts = 0;  Transfers = 4671


Memory Level: L1d
     Hit Count = 1142316349  Miss Count = 94672302
     Total Requests =  1236988651
     Hit Rate = [92.35%]   Miss Rate = [7.65%]
     Kickouts = 94672046;  Dirty kickouts = 36662551;  Transfers = 94672302


Memory Level: L2
     Hit Count = 58051975  Miss Count = 73287549
     Total Requests =  131339524
     Hit Rate = [44.20%]   Miss Rate = [55.80%]
     Kickouts = 73286525;  Dirty kickouts = 31059800;  Transfers = 73287549
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $150;  Memory cost = $75
Total cost = $1025
```

---

bzip.All-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 25083558983;    Total refs = 5000000000
Inst refs = 3812526036;    Data refs = 261704626


Number of reference types: [Percentage]
     Reads = 925769338     [18.52%]
     Writes = 261704626     [5.23%]
     Inst = 3812526036     [76.25%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 10086351873     [40.21%]
     Writes = 8895044164     [35.46%]
     Inst = 6102162946     [24.33%]
     Total = 25083558983


Average cycles per activity:
     Read = 10.90;   Write = 33.99;   Inst. = 6.58


Memory Level: L1i
     Hit Count = 6101573758  Miss Count = 4671
     Total Requests =  6101578429
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 4415;  Dirty kickouts = 0;  Transfers = 4671


Memory Level: L1d
     Hit Count = 1142316349  Miss Count = 94672302
     Total Requests =  1236988651
     Hit Rate = [92.35%]   Miss Rate = [7.65%]
     Kickouts = 94672046;  Dirty kickouts = 36662551;  Transfers = 94672302


Memory Level: L2
     Hit Count = 54910053  Miss Count = 76429471
     Total Requests =  131339524
     Hit Rate = [41.81%]   Miss Rate = [58.19%]
     Kickouts = 76428447;  Dirty kickouts = 31358427;  Transfers = 76429471
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

---

bzip.All-FA Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 256 : block size = 32
     Icache size = 8192 : ways = 256 : block size = 32
     L2-cache size = 65536 : ways = 1024 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 24281500400;    Total refs = 5000000000
Inst refs = 3812526036;    Data refs = 261704626


Number of reference types: [Percentage]
     Reads = 925769338     [18.52%]
     Writes = 261704626     [5.23%]
     Inst = 3812526036     [76.25%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 9655104585     [39.76%]
     Writes = 8524382059     [35.11%]
     Inst = 6102013756     [25.13%]
     Total = 24281500400


Average cycles per activity:
     Read = 10.43;   Write = 32.57;   Inst. = 6.37


Memory Level: L1i
     Hit Count = 6101574764  Miss Count = 3665
     Total Requests =  6101578429
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 3409;  Dirty kickouts = 0;  Transfers = 3665


Memory Level: L1d
     Hit Count = 1144167534  Miss Count = 92821117
     Total Requests =  1236988651
     Hit Rate = [92.50%]   Miss Rate = [7.50%]
     Kickouts = 92820861;  Dirty kickouts = 35943014;  Transfers = 92821117


Memory Level: L2
     Hit Count = 57133189  Miss Count = 71634607
     Total Requests =  128767796
     Hit Rate = [44.37%]   Miss Rate = [55.63%]
     Kickouts = 71633583;  Dirty kickouts = 30936937;  Transfers = 71634607
```

```
L1 cache cost (Icache $1800) + (Dcache $1800) = $3600
L2 cache cost = $550;  Memory cost = $75
Total cost = $4225
```

---

bzip.default Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 26019113121;    Total refs = 5000000000
Inst refs = 3812526036;    Data refs = 261704626


Number of reference types: [Percentage]
     Reads = 925769338     [18.52%]
     Writes = 261704626     [5.23%]
     Inst = 3812526036     [76.25%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 10888301657     [41.85%]
     Writes = 9024177803     [34.68%]
     Inst = 6106633661     [23.47%]
     Total = 26019113121


Average cycles per activity:
     Read = 11.76;   Write = 34.48;   Inst. = 6.82


Memory Level: L1i
     Hit Count = 6101375143  Miss Count = 203286
     Total Requests =  6101578429
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 203030;  Dirty kickouts = 0;  Transfers = 203286


Memory Level: L1d
     Hit Count = 1132622384  Miss Count = 104366267
     Total Requests =  1236988651
     Hit Rate = [91.56%]   Miss Rate = [8.44%]
     Kickouts = 104366011;  Dirty kickouts = 40274898;  Transfers = 104366267


Memory Level: L2
     Hit Count = 64682859  Miss Count = 80161592
     Total Requests =  144844451
     Hit Rate = [44.66%]   Miss Rate = [55.34%]
     Kickouts = 80160568;  Dirty kickouts = 32534806;  Transfers = 80161592
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $50;  Memory cost = $75
Total cost = $525
```

---

bzip.L1-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 25978858649;    Total refs = 5000000000
Inst refs = 3812526036;    Data refs = 261704626


Number of reference types: [Percentage]
     Reads = 925769338     [18.52%]
     Writes = 261704626     [5.23%]
     Inst = 3812526036     [76.25%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 10515631991     [40.48%]
     Writes = 9361016010     [36.03%]
     Inst = 6102210648     [23.49%]
     Total = 25978858649


Average cycles per activity:
     Read = 11.36;   Write = 35.77;   Inst. = 6.81


Memory Level: L1i
     Hit Count = 6101573758  Miss Count = 4671
     Total Requests =  6101578429
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 4415;  Dirty kickouts = 0;  Transfers = 4671


Memory Level: L1d
     Hit Count = 1142316349  Miss Count = 94672302
     Total Requests =  1236988651
     Hit Rate = [92.35%]   Miss Rate = [7.65%]
     Kickouts = 94672046;  Dirty kickouts = 36662551;  Transfers = 94672302


Memory Level: L2
     Hit Count = 49391612  Miss Count = 81947912
     Total Requests =  131339524
     Hit Rate = [37.61%]   Miss Rate = [62.39%]
     Kickouts = 81946888;  Dirty kickouts = 31998479;  Transfers = 81947912
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $50;  Memory cost = $75
Total cost = $925
```

---

bzip.L2-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 25095920083;    Total refs = 5000000000
Inst refs = 3812526036;    Data refs = 261704626


Number of reference types: [Percentage]
     Reads = 925769338     [18.52%]
     Writes = 261704626     [5.23%]
     Inst = 3812526036     [76.25%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 10248332597     [40.84%]
     Writes = 8741081597     [34.83%]
     Inst = 6106505889     [24.33%]
     Total = 25095920083


Average cycles per activity:
     Read = 11.07;   Write = 33.40;   Inst. = 6.58


Memory Level: L1i
     Hit Count = 6101375143  Miss Count = 203286
     Total Requests =  6101578429
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 203030;  Dirty kickouts = 0;  Transfers = 203286


Memory Level: L1d
     Hit Count = 1132622384  Miss Count = 104366267
     Total Requests =  1236988651
     Hit Rate = [91.56%]   Miss Rate = [8.44%]
     Kickouts = 104366011;  Dirty kickouts = 40274898;  Transfers = 104366267


Memory Level: L2
     Hit Count = 69905792  Miss Count = 74938659
     Total Requests =  144844451
     Hit Rate = [48.26%]   Miss Rate = [51.74%]
     Kickouts = 74937635;  Dirty kickouts = 31387343;  Transfers = 74938659
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $100;  Memory cost = $75
Total cost = $575
```

---

bzip.L2-Big Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 131072 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 24388483093;    Total refs = 5000000000
Inst refs = 3812526036;    Data refs = 261704626


Number of reference types: [Percentage]
     Reads = 925769338     [18.52%]
     Writes = 261704626     [5.23%]
     Inst = 3812526036     [76.25%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 9528316061     [39.07%]
     Writes = 8758061210     [35.91%]
     Inst = 6102105822     [25.02%]
     Total = 24388483093


Average cycles per activity:
     Read = 10.29;   Write = 33.47;   Inst. = 6.40


Memory Level: L1i
     Hit Count = 6101573758  Miss Count = 4671
     Total Requests =  6101578429
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 4415;  Dirty kickouts = 0;  Transfers = 4671


Memory Level: L1d
     Hit Count = 1142316349  Miss Count = 94672302
     Total Requests =  1236988651
     Hit Rate = [92.35%]   Miss Rate = [7.65%]
     Kickouts = 94672046;  Dirty kickouts = 36662551;  Transfers = 94672302


Memory Level: L2
     Hit Count = 58645458  Miss Count = 72694066
     Total Requests =  131339524
     Hit Rate = [44.65%]   Miss Rate = [55.35%]
     Kickouts = 72692018;  Dirty kickouts = 30289093;  Transfers = 72694066
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

gcc results

---

gcc.2-4-way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 4 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 25714009974;    Total refs = 5385175618
Inst refs = 3790327083;    Data refs = 1594848535


Number of reference types: [Percentage]
     Reads = 1036416945     [19.25%]
     Writes = 558431590     [10.37%]
     Inst = 3790327083     [70.38%]
     Total = 5385175618


Total cycles for activities: [Percentage]
     Reads = 9211753170     [35.82%]
     Writes = 4158260189     [16.17%]
     Inst = 12343996615     [48.00%]
     Total = 25714009974


Average cycles per activity:
     Read = 8.89;   Write = 7.45;   Inst. = 6.78


Memory Level: L1i
     Hit Count = 6172996863  Miss Count = 160252200
     Total Requests =  6333249063
     Hit Rate = [97.47%]  Miss Rate = [2.53%]
     Kickouts = 160251944;  Dirty kickouts = 0;  Transfers = 160252200


Memory Level: L1d
     Hit Count = 2643902763  Miss Count = 111630008
     Total Requests =  2755532771
     Hit Rate = [95.95%]   Miss Rate = [4.05%]
     Kickouts = 111629752;  Dirty kickouts = 41398093;  Transfers = 111630008


Memory Level: L2
     Hit Count = 250429265  Miss Count = 62851036
     Total Requests =  313280301
     Hit Rate = [79.94%]   Miss Rate = [20.06%]
     Kickouts = 62850012;  Dirty kickouts = 15461499;  Transfers = 62851036
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $150;  Memory cost = $75
Total cost = $1025
```

---

gcc.All-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 26900527810;    Total refs = 5385175618
Inst refs = 3790327083;    Data refs = 1594848535


Number of reference types: [Percentage]
     Reads = 1036416945     [19.25%]
     Writes = 558431590     [10.37%]
     Inst = 3790327083     [70.38%]
     Total = 5385175618


Total cycles for activities: [Percentage]
     Reads = 9674291276     [35.96%]
     Writes = 3878167215     [14.42%]
     Inst = 13348069319     [49.62%]
     Total = 26900527810


Average cycles per activity:
     Read = 9.33;   Write = 6.94;   Inst. = 7.10


Memory Level: L1i
     Hit Count = 6172996863  Miss Count = 160252200
     Total Requests =  6333249063
     Hit Rate = [97.47%]  Miss Rate = [2.53%]
     Kickouts = 160251944;  Dirty kickouts = 0;  Transfers = 160252200


Memory Level: L1d
     Hit Count = 2643902763  Miss Count = 111630008
     Total Requests =  2755532771
     Hit Rate = [95.95%]   Miss Rate = [4.05%]
     Kickouts = 111629752;  Dirty kickouts = 41398093;  Transfers = 111630008


Memory Level: L2
     Hit Count = 242232419  Miss Count = 71047882
     Total Requests =  313280301
     Hit Rate = [77.32%]   Miss Rate = [22.68%]
     Kickouts = 71046858;  Dirty kickouts = 15388487;  Transfers = 71047882
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

---

gcc.All-FA Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 256 : block size = 32
     Icache size = 8192 : ways = 256 : block size = 32
     L2-cache size = 65536 : ways = 1024 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 23367705028;    Total refs = 5385175618
Inst refs = 3790327083;    Data refs = 1594848535


Number of reference types: [Percentage]
     Reads = 1036416945     [19.25%]
     Writes = 558431590     [10.37%]
     Inst = 3790327083     [70.38%]
     Total = 5385175618


Total cycles for activities: [Percentage]
     Reads = 8378050320     [35.85%]
     Writes = 4443956910     [19.02%]
     Inst = 10545697798     [45.13%]
     Total = 23367705028


Average cycles per activity:
     Read = 8.08;   Write = 7.96;   Inst. = 6.17


Memory Level: L1i
     Hit Count = 6201451332  Miss Count = 131797731
     Total Requests =  6333249063
     Hit Rate = [97.92%]  Miss Rate = [2.08%]
     Kickouts = 131797475;  Dirty kickouts = 0;  Transfers = 131797731


Memory Level: L1d
     Hit Count = 2667134774  Miss Count = 88397997
     Total Requests =  2755532771
     Hit Rate = [96.79%]   Miss Rate = [3.21%]
     Kickouts = 88397741;  Dirty kickouts = 33801767;  Transfers = 88397997


Memory Level: L2
     Hit Count = 200681534  Miss Count = 53315961
     Total Requests =  253997495
     Hit Rate = [79.01%]   Miss Rate = [20.99%]
     Kickouts = 53314937;  Dirty kickouts = 15790266;  Transfers = 53315961
```

```
L1 cache cost (Icache $1800) + (Dcache $1800) = $3600
L2 cache cost = $550;  Memory cost = $75
Total cost = $4225
```

---

gcc.default Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 32625960328;    Total refs = 5385175618
Inst refs = 3790327083;    Data refs = 558431590


Number of reference types: [Percentage]
     Reads = 1036416945     [19.25%]
     Writes = 558431590     [10.37%]
     Inst = 3790327083     [70.38%]
     Total = 5385175618


Total cycles for activities: [Percentage]
     Reads = 12160191981     [37.27%]
     Writes = 4261640360     [13.06%]
     Inst = 16204127987     [49.67%]
     Total = 32625960328


Average cycles per activity:
     Read = 11.73;   Write = 7.63;   Inst. = 8.61


Memory Level: L1i
     Hit Count = 6145071639  Miss Count = 188177424
     Total Requests =  6333249063
     Hit Rate = [97.03%]  Miss Rate = [2.97%]
     Kickouts = 188177168;  Dirty kickouts = 0;  Transfers = 188177424


Memory Level: L1d
     Hit Count = 2608007945  Miss Count = 147524826
     Total Requests =  2755532771
     Hit Rate = [94.65%]   Miss Rate = [5.35%]
     Kickouts = 147524570;  Dirty kickouts = 55576515;  Transfers = 147524826


Memory Level: L2
     Hit Count = 293923461  Miss Count = 97355304
     Total Requests =  391278765
     Hit Rate = [75.12%]   Miss Rate = [24.88%]
     Kickouts = 97354280;  Dirty kickouts = 19479583;  Transfers = 97355304
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $50;  Memory cost = $75
Total cost = $525
```

---

gcc.L1-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 29615075816;    Total refs = 5385175618
Inst refs = 3790327083;    Data refs = 1594848535


Number of reference types: [Percentage]
     Reads = 1036416945     [19.25%]
     Writes = 558431590     [10.37%]
     Inst = 3790327083     [70.38%]
     Total = 5385175618


Total cycles for activities: [Percentage]
     Reads = 10684440756     [36.08%]
     Writes = 3913297495     [13.21%]
     Inst = 15017337565     [50.71%]
     Total = 29615075816


Average cycles per activity:
     Read = 10.31;   Write = 7.01;   Inst. = 7.81


Memory Level: L1i
     Hit Count = 6172996863  Miss Count = 160252200
     Total Requests =  6333249063
     Hit Rate = [97.47%]  Miss Rate = [2.53%]
     Kickouts = 160251944;  Dirty kickouts = 0;  Transfers = 160252200


Memory Level: L1d
     Hit Count = 2643902763  Miss Count = 111630008
     Total Requests =  2755532771
     Hit Rate = [95.95%]   Miss Rate = [4.05%]
     Kickouts = 111629752;  Dirty kickouts = 41398093;  Transfers = 111630008


Memory Level: L2
     Hit Count = 225159148  Miss Count = 88121153
     Total Requests =  313280301
     Hit Rate = [71.87%]   Miss Rate = [28.13%]
     Kickouts = 88120129;  Dirty kickouts = 16973133;  Transfers = 88121153
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $50;  Memory cost = $75
Total cost = $925
```

---

gcc.L2-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 28512788720;    Total refs = 5385175618
Inst refs = 3790327083;    Data refs = 1594848535


Number of reference types: [Percentage]
     Reads = 1036416945     [19.25%]
     Writes = 558431590     [10.37%]
     Inst = 3790327083     [70.38%]
     Total = 5385175618


Total cycles for activities: [Percentage]
     Reads = 10407330171     [36.50%]
     Writes = 4028571224     [14.13%]
     Inst = 14076887325     [49.37%]
     Total = 28512788720


Average cycles per activity:
     Read = 10.04;   Write = 7.21;   Inst. = 7.52


Memory Level: L1i
     Hit Count = 6145071639  Miss Count = 188177424
     Total Requests =  6333249063
     Hit Rate = [97.03%]  Miss Rate = [2.97%]
     Kickouts = 188177168;  Dirty kickouts = 0;  Transfers = 188177424


Memory Level: L1d
     Hit Count = 2608007945  Miss Count = 147524826
     Total Requests =  2755532771
     Hit Rate = [94.65%]   Miss Rate = [5.35%]
     Kickouts = 147524570;  Dirty kickouts = 55576515;  Transfers = 147524826


Memory Level: L2
     Hit Count = 318575879  Miss Count = 72702886
     Total Requests =  391278765
     Hit Rate = [81.42%]   Miss Rate = [18.58%]
     Kickouts = 72701862;  Dirty kickouts = 15808736;  Transfers = 72702886
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $100;  Memory cost = $75
Total cost = $575
```

---

gcc.L2-Big Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 131072 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 25244658340;    Total refs = 5385175618
Inst refs = 3790327083;    Data refs = 1594848535


Number of reference types: [Percentage]
     Reads = 1036416945     [19.25%]
     Writes = 558431590     [10.37%]
     Inst = 3790327083     [70.38%]
     Total = 5385175618


Total cycles for activities: [Percentage]
     Reads = 9475305530     [37.53%]
     Writes = 3159954171     [12.52%]
     Inst = 12609398639     [49.95%]
     Total = 25244658340


Average cycles per activity:
     Read = 9.14;   Write = 5.66;   Inst. = 6.66


Memory Level: L1i
     Hit Count = 6172996863  Miss Count = 160252200
     Total Requests =  6333249063
     Hit Rate = [97.47%]  Miss Rate = [2.53%]
     Kickouts = 160251944;  Dirty kickouts = 0;  Transfers = 160252200


Memory Level: L1d
     Hit Count = 2643902763  Miss Count = 111630008
     Total Requests =  2755532771
     Hit Rate = [95.95%]   Miss Rate = [4.05%]
     Kickouts = 111629752;  Dirty kickouts = 41398093;  Transfers = 111630008


Memory Level: L2
     Hit Count = 250722324  Miss Count = 62557977
     Total Requests =  313280301
     Hit Rate = [80.03%]   Miss Rate = [19.97%]
     Kickouts = 62555929;  Dirty kickouts = 12414606;  Transfers = 62557977
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

gobmk results

gobmk.2-4-way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 4 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 21091534412;    Total refs = 5000000000
Inst refs = 3590215172;    Data refs = 1409784828


Number of reference types: [Percentage]
     Reads = 959845130     [19.20%]
     Writes = 449939698     [9.00%]
     Inst = 3590215172     [71.80%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 4212051167     [19.97%]
     Writes = 4554324621     [21.59%]
     Inst = 12325158624     [58.44%]
     Total = 21091534412


Average cycles per activity:
     Read = 4.39;   Write = 10.12;   Inst. = 5.87


Memory Level: L1i
     Hit Count = 5906549044  Miss Count = 202703417
     Total Requests =  6109252461
     Hit Rate = [96.68%]  Miss Rate = [3.32%]
     Kickouts = 202703161;  Dirty kickouts = 0;  Transfers = 202703417


Memory Level: L1d
     Hit Count = 1926382320  Miss Count = 81940343
     Total Requests =  2008322663
     Hit Rate = [95.92%]   Miss Rate = [4.08%]
     Kickouts = 81940087;  Dirty kickouts = 49176928;  Transfers = 81940343


Memory Level: L2
     Hit Count = 297182448  Miss Count = 36638240
     Total Requests =  333820688
     Hit Rate = [89.02%]   Miss Rate = [10.98%]
     Kickouts = 36637216;  Dirty kickouts = 14278582;  Transfers = 36638240
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $150;  Memory cost = $75
Total cost = $1025
```

---

gobmk.All-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 23153470166;    Total refs = 5000000000
Inst refs = 3590215172;    Data refs = 1409784828


Number of reference types: [Percentage]
     Reads = 959845130     [19.20%]
     Writes = 449939698     [9.00%]
     Inst = 3590215172     [71.80%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 4799534263     [20.73%]
     Writes = 4949693813     [21.38%]
     Inst = 13404242090     [57.89%]
     Total = 23153470166


Average cycles per activity:
     Read = 5.00;   Write = 11.00;   Inst. = 6.45


Memory Level: L1i
     Hit Count = 5906549044  Miss Count = 202703417
     Total Requests =  6109252461
     Hit Rate = [96.68%]  Miss Rate = [3.32%]
     Kickouts = 202703161;  Dirty kickouts = 0;  Transfers = 202703417


Memory Level: L1d
     Hit Count = 1926382320  Miss Count = 81940343
     Total Requests =  2008322663
     Hit Rate = [95.92%]   Miss Rate = [4.08%]
     Kickouts = 81940087;  Dirty kickouts = 49176928;  Transfers = 81940343


Memory Level: L2
     Hit Count = 286228719  Miss Count = 47591969
     Total Requests =  333820688
     Hit Rate = [85.74%]   Miss Rate = [14.26%]
     Kickouts = 47590945;  Dirty kickouts = 17583520;  Transfers = 47591969
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

---

gobmk.All-FA Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 256 : block size = 32
     Icache size = 8192 : ways = 256 : block size = 32
     L2-cache size = 65536 : ways = 1024 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 18162037820;    Total refs = 5000000000
Inst refs = 3590215172;    Data refs = 1409784828


Number of reference types: [Percentage]
     Reads = 959845130     [19.20%]
     Writes = 449939698     [9.00%]
     Inst = 3590215172     [71.80%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 3367538156     [18.54%]
     Writes = 4089557954     [22.52%]
     Inst = 10704941710     [58.94%]
     Total = 18162037820


Average cycles per activity:
     Read = 3.51;   Write = 9.09;   Inst. = 5.06


Memory Level: L1i
     Hit Count = 5910550092  Miss Count = 198702369
     Total Requests =  6109252461
     Hit Rate = [96.75%]  Miss Rate = [3.25%]
     Kickouts = 198702113;  Dirty kickouts = 0;  Transfers = 198702369


Memory Level: L1d
     Hit Count = 1945655004  Miss Count = 62667659
     Total Requests =  2008322663
     Hit Rate = [96.88%]   Miss Rate = [3.12%]
     Kickouts = 62667403;  Dirty kickouts = 39110446;  Transfers = 62667659


Memory Level: L2
     Hit Count = 277074230  Miss Count = 23406244
     Total Requests =  300480474
     Hit Rate = [92.21%]   Miss Rate = [7.79%]
     Kickouts = 23405220;  Dirty kickouts = 11129239;  Transfers = 23406244
```

```
L1 cache cost (Icache $1800) + (Dcache $1800) = $3600
L2 cache cost = $550;  Memory cost = $75
Total cost = $4225
```

---

gobmk.default Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 30885400691;    Total refs = 5000000000
Inst refs = 3590215172;    Data refs = 1409784828


Number of reference types: [Percentage]
     Reads = 959845130     [19.20%]
     Writes = 449939698     [9.00%]
     Inst = 3590215172     [71.80%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 6934342242     [22.45%]
     Writes = 5851441130     [18.95%]
     Inst = 18099617319     [58.60%]
     Total = 30885400691


Average cycles per activity:
     Read = 7.22;   Write = 13.00;   Inst. = 8.60


Memory Level: L1i
     Hit Count = 5894789867  Miss Count = 214462594
     Total Requests =  6109252461
     Hit Rate = [96.49%]  Miss Rate = [3.51%]
     Kickouts = 214462338;  Dirty kickouts = 0;  Transfers = 214462594


Memory Level: L1d
     Hit Count = 1898725978  Miss Count = 109596685
     Total Requests =  2008322663
     Hit Rate = [94.54%]   Miss Rate = [5.46%]
     Kickouts = 109596429;  Dirty kickouts = 60261446;  Transfers = 109596685


Memory Level: L2
     Hit Count = 294761167  Miss Count = 89559558
     Total Requests =  384320725
     Hit Rate = [76.70%]   Miss Rate = [23.30%]
     Kickouts = 89558534;  Dirty kickouts = 22992423;  Transfers = 89559558
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $50;  Memory cost = $75
Total cost = $525
```

---

gobmk.L1-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 28864623302;    Total refs = 5000000000
Inst refs = 3590215172;    Data refs = 1409784828


Number of reference types: [Percentage]
     Reads = 959845130     [19.20%]
     Writes = 449939698     [9.00%]
     Inst = 3590215172     [71.80%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 5742819949     [19.90%]
     Writes = 5558897111     [19.26%]
     Inst = 17562906242     [60.85%]
     Total = 28864623302


Average cycles per activity:
     Read = 5.98;   Write = 12.35;   Inst. = 8.04


Memory Level: L1i
     Hit Count = 5906549044  Miss Count = 202703417
     Total Requests =  6109252461
     Hit Rate = [96.68%]  Miss Rate = [3.32%]
     Kickouts = 202703161;  Dirty kickouts = 0;  Transfers = 202703417


Memory Level: L1d
     Hit Count = 1926382320  Miss Count = 81940343
     Total Requests =  2008322663
     Hit Rate = [95.92%]   Miss Rate = [4.08%]
     Kickouts = 81940087;  Dirty kickouts = 49176928;  Transfers = 81940343


Memory Level: L2
     Hit Count = 249960133  Miss Count = 83860555
     Total Requests =  333820688
     Hit Rate = [74.88%]   Miss Rate = [25.12%]
     Kickouts = 83859531;  Dirty kickouts = 20554517;  Transfers = 83860555
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $50;  Memory cost = $75
Total cost = $925
```

---

gobmk.L2-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 23971308045;    Total refs = 5000000000
Inst refs = 3590215172;    Data refs = 1409784828


Number of reference types: [Percentage]
     Reads = 959845130     [19.20%]
     Writes = 449939698     [9.00%]
     Inst = 3590215172     [71.80%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 5255759416     [21.93%]
     Writes = 4968107204     [20.73%]
     Inst = 13747441425     [57.35%]
     Total = 23971308045


Average cycles per activity:
     Read = 5.48;   Write = 11.04;   Inst. = 6.68


Memory Level: L1i
     Hit Count = 5894789867  Miss Count = 214462594
     Total Requests =  6109252461
     Hit Rate = [96.49%]  Miss Rate = [3.51%]
     Kickouts = 214462338;  Dirty kickouts = 0;  Transfers = 214462594


Memory Level: L1d
     Hit Count = 1898725978  Miss Count = 109596685
     Total Requests =  2008322663
     Hit Rate = [94.54%]   Miss Rate = [5.46%]
     Kickouts = 109596429;  Dirty kickouts = 60261446;  Transfers = 109596685


Memory Level: L2
     Hit Count = 337032978  Miss Count = 47287747
     Total Requests =  384320725
     Hit Rate = [87.70%]   Miss Rate = [12.30%]
     Kickouts = 47286723;  Dirty kickouts = 17689507;  Transfers = 47287747
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $100;  Memory cost = $75
Total cost = $575
```

---

gobmk.L2-Big Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 131072 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 24432123642;    Total refs = 5000000000
Inst refs = 3590215172;    Data refs = 1409784828


Number of reference types: [Percentage]
     Reads = 959845130     [19.20%]
     Writes = 449939698     [9.00%]
     Inst = 3590215172     [71.80%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 4477299701     [18.33%]
     Writes = 4675742197     [19.14%]
     Inst = 15279081744     [62.54%]
     Total = 24432123642


Average cycles per activity:
     Read = 4.66;   Write = 10.39;   Inst. = 6.81


Memory Level: L1i
     Hit Count = 5906549044  Miss Count = 202703417
     Total Requests =  6109252461
     Hit Rate = [96.68%]  Miss Rate = [3.32%]
     Kickouts = 202703161;  Dirty kickouts = 0;  Transfers = 202703417


Memory Level: L1d
     Hit Count = 1926382320  Miss Count = 81940343
     Total Requests =  2008322663
     Hit Rate = [95.92%]   Miss Rate = [4.08%]
     Kickouts = 81940087;  Dirty kickouts = 49176928;  Transfers = 81940343


Memory Level: L2
     Hit Count = 274576843  Miss Count = 59243845
     Total Requests =  333820688
     Hit Rate = [82.25%]   Miss Rate = [17.75%]
     Kickouts = 59241797;  Dirty kickouts = 14565517;  Transfers = 59243845
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

h264ref results

h264ref.2-4-way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 4 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 11054404152;    Total refs = 5000000000
Inst refs = 3369821573;    Data refs = 1630178427


Number of reference types: [Percentage]
     Reads = 1318509106     [26.37%]
     Writes = 311669321     [6.23%]
     Inst = 3369821573     [67.40%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 3382095820     [30.60%]
     Writes = 1141129742     [10.32%]
     Inst = 6531178590     [59.08%]
     Total = 11054404152


Average cycles per activity:
     Read = 2.57;   Write = 3.66;   Inst. = 3.28


Memory Level: L1i
     Hit Count = 5612752700  Miss Count = 32526438
     Total Requests =  5645279138
     Hit Rate = [99.42%]  Miss Rate = [0.58%]
     Kickouts = 32526182;  Dirty kickouts = 0;  Transfers = 32526438


Memory Level: L1d
     Hit Count = 2000115150  Miss Count = 40129184
     Total Requests =  2040244334
     Hit Rate = [98.03%]   Miss Rate = [1.97%]
     Kickouts = 40128928;  Dirty kickouts = 11410984;  Transfers = 40129184


Memory Level: L2
     Hit Count = 73305679  Miss Count = 10760927
     Total Requests =  84066606
     Hit Rate = [87.20%]   Miss Rate = [12.80%]
     Kickouts = 10759903;  Dirty kickouts = 2714743;  Transfers = 10760927
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $150;  Memory cost = $75
Total cost = $1025
```

---

h264ref.All-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 11532376438;    Total refs = 5000000000
Inst refs = 3369821573;    Data refs = 1630178427


Number of reference types: [Percentage]
     Reads = 1318509106     [26.37%]
     Writes = 311669321     [6.23%]
     Inst = 3369821573     [67.40%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 3490722566     [30.27%]
     Writes = 1212871058     [10.52%]
     Inst = 6828782814     [59.21%]
     Total = 11532376438


Average cycles per activity:
     Read = 2.65;   Write = 3.89;   Inst. = 3.42


Memory Level: L1i
     Hit Count = 5612752700  Miss Count = 32526438
     Total Requests =  5645279138
     Hit Rate = [99.42%]  Miss Rate = [0.58%]
     Kickouts = 32526182;  Dirty kickouts = 0;  Transfers = 32526438


Memory Level: L1d
     Hit Count = 2000115150  Miss Count = 40129184
     Total Requests =  2040244334
     Hit Rate = [98.03%]   Miss Rate = [1.97%]
     Kickouts = 40128928;  Dirty kickouts = 11410984;  Transfers = 40129184


Memory Level: L2
     Hit Count = 70547988  Miss Count = 13518618
     Total Requests =  84066606
     Hit Rate = [83.92%]   Miss Rate = [16.08%]
     Kickouts = 13517594;  Dirty kickouts = 3252953;  Transfers = 13518618
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

---

h264ref.All-FA Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 256 : block size = 32
     Icache size = 8192 : ways = 256 : block size = 32
     L2-cache size = 65536 : ways = 1024 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 10572006670;    Total refs = 5000000000
Inst refs = 3369821573;    Data refs = 1630178427


Number of reference types: [Percentage]
     Reads = 1318509106     [26.37%]
     Writes = 311669321     [6.23%]
     Inst = 3369821573     [67.40%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 3019057149     [28.56%]
     Writes = 1055253181     [9.98%]
     Inst = 6497696340     [61.46%]
     Total = 10572006670


Average cycles per activity:
     Read = 2.29;   Write = 3.39;   Inst. = 3.14


Memory Level: L1i
     Hit Count = 5606534084  Miss Count = 38745054
     Total Requests =  5645279138
     Hit Rate = [99.31%]  Miss Rate = [0.69%]
     Kickouts = 38744798;  Dirty kickouts = 0;  Transfers = 38745054


Memory Level: L1d
     Hit Count = 2015018762  Miss Count = 25225572
     Total Requests =  2040244334
     Hit Rate = [98.76%]   Miss Rate = [1.24%]
     Kickouts = 25225316;  Dirty kickouts = 6950799;  Transfers = 25225572


Memory Level: L2
     Hit Count = 61706943  Miss Count = 9214482
     Total Requests =  70921425
     Hit Rate = [87.01%]   Miss Rate = [12.99%]
     Kickouts = 9213458;  Dirty kickouts = 2446110;  Transfers = 9214482
```

```
L1 cache cost (Icache $1800) + (Dcache $1800) = $3600
L2 cache cost = $550;  Memory cost = $75
Total cost = $4225
```

---

h264ref.default Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 15060822013;    Total refs = 5000000000
Inst refs = 3369821573;    Data refs = 1630178427


Number of reference types: [Percentage]
     Reads = 1318509106     [26.37%]
     Writes = 311669321     [6.23%]
     Inst = 3369821573     [67.40%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 5806363198     [38.55%]
     Writes = 1778199415     [11.81%]
     Inst = 7476259400     [49.64%]
     Total = 15060822013


Average cycles per activity:
     Read = 4.40;   Write = 5.71;   Inst. = 4.47


Memory Level: L1i
     Hit Count = 5609082886  Miss Count = 36196252
     Total Requests =  5645279138
     Hit Rate = [99.36%]  Miss Rate = [0.64%]
     Kickouts = 36195996;  Dirty kickouts = 0;  Transfers = 36196252


Memory Level: L1d
     Hit Count = 1961918149  Miss Count = 78326185
     Total Requests =  2040244334
     Hit Rate = [96.16%]   Miss Rate = [3.84%]
     Kickouts = 78325929;  Dirty kickouts = 21603969;  Transfers = 78326185


Memory Level: L2
     Hit Count = 107141928  Miss Count = 28984478
     Total Requests =  136126406
     Hit Rate = [78.71%]   Miss Rate = [21.29%]
     Kickouts = 28983454;  Dirty kickouts = 6078713;  Transfers = 28984478
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $50;  Memory cost = $75
Total cost = $525
```

---

h264ref.L1-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 12635512514;    Total refs = 5000000000
Inst refs = 3369821573;    Data refs = 1630178427


Number of reference types: [Percentage]
     Reads = 1318509106     [26.37%]
     Writes = 311669321     [6.23%]
     Inst = 3369821573     [67.40%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 4034033184     [31.93%]
     Writes = 1446595712     [11.45%]
     Inst = 7154883618     [56.63%]
     Total = 12635512514


Average cycles per activity:
     Read = 3.06;   Write = 4.64;   Inst. = 3.75


Memory Level: L1i
     Hit Count = 5612752700  Miss Count = 32526438
     Total Requests =  5645279138
     Hit Rate = [99.42%]  Miss Rate = [0.58%]
     Kickouts = 32526182;  Dirty kickouts = 0;  Transfers = 32526438


Memory Level: L1d
     Hit Count = 2000115150  Miss Count = 40129184
     Total Requests =  2040244334
     Hit Rate = [98.03%]   Miss Rate = [1.97%]
     Kickouts = 40128928;  Dirty kickouts = 11410984;  Transfers = 40129184


Memory Level: L2
     Hit Count = 64279012  Miss Count = 19787594
     Total Requests =  84066606
     Hit Rate = [76.46%]   Miss Rate = [23.54%]
     Kickouts = 19786570;  Dirty kickouts = 4594850;  Transfers = 19787594
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $50;  Memory cost = $75
Total cost = $925
```

---

h264ref.L2-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 12539530457;    Total refs = 5000000000
Inst refs = 3369821573;    Data refs = 1630178427


Number of reference types: [Percentage]
     Reads = 1318509106     [26.37%]
     Writes = 311669321     [6.23%]
     Inst = 3369821573     [67.40%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 4215796512     [33.62%]
     Writes = 1349872025     [10.76%]
     Inst = 6973861920     [55.62%]
     Total = 12539530457


Average cycles per activity:
     Read = 3.20;   Write = 4.33;   Inst. = 3.72


Memory Level: L1i
     Hit Count = 5609082886  Miss Count = 36196252
     Total Requests =  5645279138
     Hit Rate = [99.36%]  Miss Rate = [0.64%]
     Kickouts = 36195996;  Dirty kickouts = 0;  Transfers = 36196252


Memory Level: L1d
     Hit Count = 1961918149  Miss Count = 78326185
     Total Requests =  2040244334
     Hit Rate = [96.16%]   Miss Rate = [3.84%]
     Kickouts = 78325929;  Dirty kickouts = 21603969;  Transfers = 78326185


Memory Level: L2
     Hit Count = 121805164  Miss Count = 14321242
     Total Requests =  136126406
     Hit Rate = [89.48%]   Miss Rate = [10.52%]
     Kickouts = 14320218;  Dirty kickouts = 3361148;  Transfers = 14321242
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $100;  Memory cost = $75
Total cost = $575
```

---

h264ref.L2-Big Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 131072 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 11545220292;    Total refs = 5000000000
Inst refs = 3369821573;    Data refs = 1630178427


Number of reference types: [Percentage]
     Reads = 1318509106     [26.37%]
     Writes = 311669321     [6.23%]
     Inst = 3369821573     [67.40%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 3361858568     [29.12%]
     Writes = 1317807436     [11.41%]
     Inst = 6865554288     [59.47%]
     Total = 11545220292


Average cycles per activity:
     Read = 2.55;   Write = 4.23;   Inst. = 3.43


Memory Level: L1i
     Hit Count = 5612752700  Miss Count = 32526438
     Total Requests =  5645279138
     Hit Rate = [99.42%]  Miss Rate = [0.58%]
     Kickouts = 32526182;  Dirty kickouts = 0;  Transfers = 32526438


Memory Level: L1d
     Hit Count = 2000115150  Miss Count = 40129184
     Total Requests =  2040244334
     Hit Rate = [98.03%]   Miss Rate = [1.97%]
     Kickouts = 40128928;  Dirty kickouts = 11410984;  Transfers = 40129184


Memory Level: L2
     Hit Count = 70832729  Miss Count = 13233877
     Total Requests =  84066606
     Hit Rate = [84.26%]   Miss Rate = [15.74%]
     Kickouts = 13231829;  Dirty kickouts = 3641639;  Transfers = 13233877
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

hmmer results

---

hmmer.2-4-way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 4 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 17527357776;    Total refs = 5000000000
Inst refs = 3099867619;    Data refs = 1900132381


Number of reference types: [Percentage]
     Reads = 1458512164     [29.17%]
     Writes = 441620217     [8.83%]
     Inst = 3099867619     [62.00%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 6683420567     [38.13%]
     Writes = 5493058317     [31.34%]
     Inst = 5350878892     [30.53%]
     Total = 17527357776


Average cycles per activity:
     Read = 4.58;   Write = 12.44;   Inst. = 5.65


Memory Level: L1i
     Hit Count = 5335586142  Miss Count = 75770
     Total Requests =  5335661912
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 75514;  Dirty kickouts = 0;  Transfers = 75770


Memory Level: L1d
     Hit Count = 2114833184  Miss Count = 302236987
     Total Requests =  2417070171
     Hit Rate = [87.50%]   Miss Rate = [12.50%]
     Kickouts = 302236731;  Dirty kickouts = 129744596;  Transfers = 302236987


Memory Level: L2
     Hit Count = 422512085  Miss Count = 9545268
     Total Requests =  432057353
     Hit Rate = [97.79%]   Miss Rate = [2.21%]
     Kickouts = 9544244;  Dirty kickouts = 8327044;  Transfers = 9545268
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $150;  Memory cost = $75
Total cost = $1025
```

---

hmmer.All-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 17560234100;    Total refs = 5000000000
Inst refs = 3099867619;    Data refs = 1900132381


Number of reference types: [Percentage]
     Reads = 1458512164     [29.17%]
     Writes = 441620217     [8.83%]
     Inst = 3099867619     [62.00%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 6738538145     [38.37%]
     Writes = 5470608079     [31.15%]
     Inst = 5351087876     [30.47%]
     Total = 17560234100


Average cycles per activity:
     Read = 4.62;   Write = 12.39;   Inst. = 5.66


Memory Level: L1i
     Hit Count = 5335586142  Miss Count = 75770
     Total Requests =  5335661912
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 75514;  Dirty kickouts = 0;  Transfers = 75770


Memory Level: L1d
     Hit Count = 2114833184  Miss Count = 302236987
     Total Requests =  2417070171
     Hit Rate = [87.50%]   Miss Rate = [12.50%]
     Kickouts = 302236731;  Dirty kickouts = 129744596;  Transfers = 302236987


Memory Level: L2
     Hit Count = 422294201  Miss Count = 9763152
     Total Requests =  432057353
     Hit Rate = [97.74%]   Miss Rate = [2.26%]
     Kickouts = 9762128;  Dirty kickouts = 8334653;  Transfers = 9763152
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

---

hmmer.All-FA Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 256 : block size = 32
     Icache size = 8192 : ways = 256 : block size = 32
     L2-cache size = 65536 : ways = 1024 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 11034082181;    Total refs = 5000000000
Inst refs = 3099867619;    Data refs = 1900132381


Number of reference types: [Percentage]
     Reads = 1458512164     [29.17%]
     Writes = 441620217     [8.83%]
     Inst = 3099867619     [62.00%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 2528849045     [22.92%]
     Writes = 3169003552     [28.72%]
     Inst = 5336229584     [48.36%]
     Total = 11034082181


Average cycles per activity:
     Read = 1.73;   Write = 7.18;   Inst. = 3.56


Memory Level: L1i
     Hit Count = 5335656434  Miss Count = 5478
     Total Requests =  5335661912
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 5222;  Dirty kickouts = 0;  Transfers = 5478


Memory Level: L1d
     Hit Count = 2388582881  Miss Count = 28487290
     Total Requests =  2417070171
     Hit Rate = [98.82%]   Miss Rate = [1.18%]
     Kickouts = 28487034;  Dirty kickouts = 16666918;  Transfers = 28487290


Memory Level: L2
     Hit Count = 35815917  Miss Count = 9343769
     Total Requests =  45159686
     Hit Rate = [79.31%]   Miss Rate = [20.69%]
     Kickouts = 9342745;  Dirty kickouts = 8329372;  Transfers = 9343769
```

```
L1 cache cost (Icache $1800) + (Dcache $1800) = $3600
L2 cache cost = $550;  Memory cost = $75
Total cost = $4225
```

---

hmmer.default Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 19300058648;    Total refs = 5000000000
Inst refs = 3099867619;    Data refs = 1900132381


Number of reference types: [Percentage]
     Reads = 1458512164     [29.17%]
     Writes = 441620217     [8.83%]
     Inst = 3099867619     [62.00%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 8901734438     [46.12%]
     Writes = 5042116624     [26.12%]
     Inst = 5356207586     [27.75%]
     Total = 19300058648


Average cycles per activity:
     Read = 6.10;   Write = 11.42;   Inst. = 6.23


Memory Level: L1i
     Hit Count = 5335468264  Miss Count = 193648
     Total Requests =  5335661912
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 193392;  Dirty kickouts = 0;  Transfers = 193648


Memory Level: L1d
     Hit Count = 2107239056  Miss Count = 309831115
     Total Requests =  2417070171
     Hit Rate = [87.18%]   Miss Rate = [12.82%]
     Kickouts = 309830859;  Dirty kickouts = 127042822;  Transfers = 309831115


Memory Level: L2
     Hit Count = 417948548  Miss Count = 19119037
     Total Requests =  437067585
     Hit Rate = [95.63%]   Miss Rate = [4.37%]
     Kickouts = 19118013;  Dirty kickouts = 10377436;  Transfers = 19119037
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $50;  Memory cost = $75
Total cost = $525
```

---

hmmer.L1-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 18998669942;    Total refs = 5000000000
Inst refs = 3099867619;    Data refs = 1900132381


Number of reference types: [Percentage]
     Reads = 1458512164     [29.17%]
     Writes = 441620217     [8.83%]
     Inst = 3099867619     [62.00%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 8171959657     [43.01%]
     Writes = 5476557345     [28.83%]
     Inst = 5350152940     [28.16%]
     Total = 18998669942


Average cycles per activity:
     Read = 5.60;   Write = 12.40;   Inst. = 6.13


Memory Level: L1i
     Hit Count = 5335586142  Miss Count = 75770
     Total Requests =  5335661912
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 75514;  Dirty kickouts = 0;  Transfers = 75770


Memory Level: L1d
     Hit Count = 2114833184  Miss Count = 302236987
     Total Requests =  2417070171
     Hit Rate = [87.50%]   Miss Rate = [12.50%]
     Kickouts = 302236731;  Dirty kickouts = 129744596;  Transfers = 302236987


Memory Level: L2
     Hit Count = 413936114  Miss Count = 18121239
     Total Requests =  432057353
     Hit Rate = [95.81%]   Miss Rate = [4.19%]
     Kickouts = 18120215;  Dirty kickouts = 9892904;  Transfers = 18121239
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $50;  Memory cost = $75
Total cost = $925
```

---

hmmer.L2-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 17652295590;    Total refs = 5000000000
Inst refs = 3099867619;    Data refs = 1900132381


Number of reference types: [Percentage]
     Reads = 1458512164     [29.17%]
     Writes = 441620217     [8.83%]
     Inst = 3099867619     [62.00%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 7322718042     [41.48%]
     Writes = 4974719618     [28.18%]
     Inst = 5354857930     [30.34%]
     Total = 17652295590


Average cycles per activity:
     Read = 5.02;   Write = 11.26;   Inst. = 5.69


Memory Level: L1i
     Hit Count = 5335468264  Miss Count = 193648
     Total Requests =  5335661912
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 193392;  Dirty kickouts = 0;  Transfers = 193648


Memory Level: L1d
     Hit Count = 2107239056  Miss Count = 309831115
     Total Requests =  2417070171
     Hit Rate = [87.18%]   Miss Rate = [12.82%]
     Kickouts = 309830859;  Dirty kickouts = 127042822;  Transfers = 309831115


Memory Level: L2
     Hit Count = 427281511  Miss Count = 9786074
     Total Requests =  437067585
     Hit Rate = [97.76%]   Miss Rate = [2.24%]
     Kickouts = 9785050;  Dirty kickouts = 8340647;  Transfers = 9786074
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $100;  Memory cost = $75
Total cost = $575
```

---

hmmer.L2-Big Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 131072 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 18141610750;    Total refs = 5000000000
Inst refs = 3099867619;    Data refs = 1900132381


Number of reference types: [Percentage]
     Reads = 1458512164     [29.17%]
     Writes = 441620217     [8.83%]
     Inst = 3099867619     [62.00%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 7296947663     [40.22%]
     Writes = 5493212553     [30.28%]
     Inst = 5351450534     [29.50%]
     Total = 18141610750


Average cycles per activity:
     Read = 5.00;   Write = 12.44;   Inst. = 5.85


Memory Level: L1i
     Hit Count = 5335586142  Miss Count = 75770
     Total Requests =  5335661912
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 75514;  Dirty kickouts = 0;  Transfers = 75770


Memory Level: L1d
     Hit Count = 2114833184  Miss Count = 302236987
     Total Requests =  2417070171
     Hit Rate = [87.50%]   Miss Rate = [12.50%]
     Kickouts = 302236731;  Dirty kickouts = 129744596;  Transfers = 302236987


Memory Level: L2
     Hit Count = 418914196  Miss Count = 13143157
     Total Requests =  432057353
     Hit Rate = [96.96%]   Miss Rate = [3.04%]
     Kickouts = 13141109;  Dirty kickouts = 8962481;  Transfers = 13143157
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

libquantum results

libquantum.2-4-way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 4 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 29970662679;    Total refs = 5000000001
Inst refs = 3767555829;    Data refs = 1232444172


Number of reference types: [Percentage]
     Reads = 1083175795     [21.66%]
     Writes = 149268377     [2.99%]
     Inst = 3767555829     [75.35%]
     Total = 5000000001


Total cycles for activities: [Percentage]
     Reads = 24609862100     [82.11%]
     Writes = 353316090     [1.18%]
     Inst = 5007484489     [16.71%]
     Total = 29970662679


Average cycles per activity:
     Read = 22.72;   Write = 2.37;   Inst. = 7.95


Memory Level: L1i
     Hit Count = 5006736635  Miss Count = 5134
     Total Requests =  5006741769
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 4878;  Dirty kickouts = 0;  Transfers = 5134


Memory Level: L1d
     Hit Count = 1922666906  Miss Count = 177349393
     Total Requests =  2100016299
     Hit Rate = [91.55%]   Miss Rate = [8.45%]
     Kickouts = 177349137;  Dirty kickouts = 72829157;  Transfers = 177349393


Memory Level: L2
     Hit Count = 161436324  Miss Count = 88747360
     Total Requests =  250183684
     Hit Rate = [64.53%]   Miss Rate = [35.47%]
     Kickouts = 88746336;  Dirty kickouts = 40903547;  Transfers = 88747360
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $150;  Memory cost = $75
Total cost = $1025
```

---

libquantum.All-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 29971322557;    Total refs = 5000000001
Inst refs = 3767555829;    Data refs = 1232444172


Number of reference types: [Percentage]
     Reads = 1083175795     [21.66%]
     Writes = 149268377     [2.99%]
     Inst = 3767555829     [75.35%]
     Total = 5000000001


Total cycles for activities: [Percentage]
     Reads = 24610432296     [82.11%]
     Writes = 353399652     [1.18%]
     Inst = 5007490609     [16.71%]
     Total = 29971322557


Average cycles per activity:
     Read = 22.72;   Write = 2.37;   Inst. = 7.96


Memory Level: L1i
     Hit Count = 5006736635  Miss Count = 5134
     Total Requests =  5006741769
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 4878;  Dirty kickouts = 0;  Transfers = 5134


Memory Level: L1d
     Hit Count = 1922666906  Miss Count = 177349393
     Total Requests =  2100016299
     Hit Rate = [91.55%]   Miss Rate = [8.45%]
     Kickouts = 177349137;  Dirty kickouts = 72829157;  Transfers = 177349393


Memory Level: L2
     Hit Count = 161432721  Miss Count = 88750963
     Total Requests =  250183684
     Hit Rate = [64.53%]   Miss Rate = [35.47%]
     Kickouts = 88749939;  Dirty kickouts = 40904503;  Transfers = 88750963
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

---

libquantum.All-FA Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 256 : block size = 32
     Icache size = 8192 : ways = 256 : block size = 32
     L2-cache size = 65536 : ways = 1024 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 29970131165;    Total refs = 5000000001
Inst refs = 3767555829;    Data refs = 1232444172


Number of reference types: [Percentage]
     Reads = 1083175795     [21.66%]
     Writes = 149268377     [2.99%]
     Inst = 3767555829     [75.35%]
     Total = 5000000001


Total cycles for activities: [Percentage]
     Reads = 24610005537     [82.12%]
     Writes = 353105532     [1.18%]
     Inst = 5007020096     [16.71%]
     Total = 29970131165


Average cycles per activity:
     Read = 22.72;   Write = 2.37;   Inst. = 7.95


Memory Level: L1i
     Hit Count = 5006739332  Miss Count = 2437
     Total Requests =  5006741769
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 2181;  Dirty kickouts = 0;  Transfers = 2437


Memory Level: L1d
     Hit Count = 1922673369  Miss Count = 177342930
     Total Requests =  2100016299
     Hit Rate = [91.56%]   Miss Rate = [8.44%]
     Kickouts = 177342674;  Dirty kickouts = 72824637;  Transfers = 177342930


Memory Level: L2
     Hit Count = 161424713  Miss Count = 88745291
     Total Requests =  250170004
     Hit Rate = [64.53%]   Miss Rate = [35.47%]
     Kickouts = 88744267;  Dirty kickouts = 40903537;  Transfers = 88745291
```

```
L1 cache cost (Icache $1800) + (Dcache $1800) = $3600
L2 cache cost = $550;  Memory cost = $75
Total cost = $4225
```

---

libquantum.default Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 30090872191;    Total refs = 5000000001
Inst refs = 3767555829;    Data refs = 1232444172


Number of reference types: [Percentage]
     Reads = 1083175795     [21.66%]
     Writes = 149268377     [2.99%]
     Inst = 3767555829     [75.35%]
     Total = 5000000001


Total cycles for activities: [Percentage]
     Reads = 24718833337     [82.15%]
     Writes = 364386966     [1.21%]
     Inst = 5007651888     [16.64%]
     Total = 30090872191


Average cycles per activity:
     Read = 22.82;   Write = 2.44;   Inst. = 7.99


Memory Level: L1i
     Hit Count = 5006734590  Miss Count = 7179
     Total Requests =  5006741769
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 6923;  Dirty kickouts = 0;  Transfers = 7179


Memory Level: L1d
     Hit Count = 1920423297  Miss Count = 179593002
     Total Requests =  2100016299
     Hit Rate = [91.45%]   Miss Rate = [8.55%]
     Kickouts = 179592746;  Dirty kickouts = 73149858;  Transfers = 179593002


Memory Level: L2
     Hit Count = 163586826  Miss Count = 89163213
     Total Requests =  252750039
     Hit Rate = [64.72%]   Miss Rate = [35.28%]
     Kickouts = 89162189;  Dirty kickouts = 41019173;  Transfers = 89163213
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $50;  Memory cost = $75
Total cost = $525
```

---

libquantum.L1-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 29977542917;    Total refs = 5000000001
Inst refs = 3767555829;    Data refs = 1232444172


Number of reference types: [Percentage]
     Reads = 1083175795     [21.66%]
     Writes = 149268377     [2.99%]
     Inst = 3767555829     [75.35%]
     Total = 5000000001


Total cycles for activities: [Percentage]
     Reads = 24615392446     [82.11%]
     Writes = 354698378     [1.18%]
     Inst = 5007452093     [16.70%]
     Total = 29977542917


Average cycles per activity:
     Read = 22.73;   Write = 2.38;   Inst. = 7.96


Memory Level: L1i
     Hit Count = 5006736635  Miss Count = 5134
     Total Requests =  5006741769
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 4878;  Dirty kickouts = 0;  Transfers = 5134


Memory Level: L1d
     Hit Count = 1922666906  Miss Count = 177349393
     Total Requests =  2100016299
     Hit Rate = [91.55%]   Miss Rate = [8.45%]
     Kickouts = 177349137;  Dirty kickouts = 72829157;  Transfers = 177349393


Memory Level: L2
     Hit Count = 161393961  Miss Count = 88789723
     Total Requests =  250183684
     Hit Rate = [64.51%]   Miss Rate = [35.49%]
     Kickouts = 88788699;  Dirty kickouts = 40908513;  Transfers = 88789723
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $50;  Memory cost = $75
Total cost = $925
```

---

libquantum.L2-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 30014932033;    Total refs = 5000000001
Inst refs = 3767555829;    Data refs = 1232444172


Number of reference types: [Percentage]
     Reads = 1083175795     [21.66%]
     Writes = 149268377     [2.99%]
     Inst = 3767555829     [75.35%]
     Total = 5000000001


Total cycles for activities: [Percentage]
     Reads = 24651531703     [82.13%]
     Writes = 355684006     [1.19%]
     Inst = 5007716324     [16.68%]
     Total = 30014932033


Average cycles per activity:
     Read = 22.76;   Write = 2.38;   Inst. = 7.97


Memory Level: L1i
     Hit Count = 5006734590  Miss Count = 7179
     Total Requests =  5006741769
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 6923;  Dirty kickouts = 0;  Transfers = 7179


Memory Level: L1d
     Hit Count = 1920423297  Miss Count = 179593002
     Total Requests =  2100016299
     Hit Rate = [91.45%]   Miss Rate = [8.55%]
     Kickouts = 179592746;  Dirty kickouts = 73149858;  Transfers = 179593002


Memory Level: L2
     Hit Count = 163998489  Miss Count = 88751550
     Total Requests =  252750039
     Hit Rate = [64.89%]   Miss Rate = [35.11%]
     Kickouts = 88750526;  Dirty kickouts = 40906049;  Transfers = 88751550
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $100;  Memory cost = $75
Total cost = $575
```

---

libquantum.L2-Big Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 131072 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 29974597627;    Total refs = 5000000001
Inst refs = 3767555829;    Data refs = 1232444172


Number of reference types: [Percentage]
     Reads = 1083175795     [21.66%]
     Writes = 149268377     [2.99%]
     Inst = 3767555829     [75.35%]
     Total = 5000000001


Total cycles for activities: [Percentage]
     Reads = 24613708262     [82.12%]
     Writes = 353413154     [1.18%]
     Inst = 5007476211     [16.71%]
     Total = 29974597627


Average cycles per activity:
     Read = 22.72;   Write = 2.37;   Inst. = 7.96


Memory Level: L1i
     Hit Count = 5006736635  Miss Count = 5134
     Total Requests =  5006741769
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 4878;  Dirty kickouts = 0;  Transfers = 5134


Memory Level: L1d
     Hit Count = 1922666906  Miss Count = 177349393
     Total Requests =  2100016299
     Hit Rate = [91.55%]   Miss Rate = [8.45%]
     Kickouts = 177349137;  Dirty kickouts = 72829157;  Transfers = 177349393


Memory Level: L2
     Hit Count = 161410476  Miss Count = 88773208
     Total Requests =  250183684
     Hit Rate = [64.52%]   Miss Rate = [35.48%]
     Kickouts = 88771160;  Dirty kickouts = 40904698;  Transfers = 88773208
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

mcf results

mcf.2-4-way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 4 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 64587708787;    Total refs = 5000000000
Inst refs = 3554558068;    Data refs = 1445441932


Number of reference types: [Percentage]
     Reads = 1184346362     [23.69%]
     Writes = 261095570     [5.22%]
     Inst = 3554558068     [71.09%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 56159742143     [86.95%]
     Writes = 2802629522     [4.34%]
     Inst = 5625337122     [8.71%]
     Total = 64587708787


Average cycles per activity:
     Read = 47.42;   Write = 10.73;   Inst. = 18.17


Memory Level: L1i
     Hit Count = 5556837506  Miss Count = 3727791
     Total Requests =  5560565297
     Hit Rate = [99.93%]  Miss Rate = [0.07%]
     Kickouts = 3727535;  Dirty kickouts = 0;  Transfers = 3727791


Memory Level: L1d
     Hit Count = 2222035229  Miss Count = 477920277
     Total Requests =  2699955506
     Hit Rate = [82.30%]   Miss Rate = [17.70%]
     Kickouts = 477920021;  Dirty kickouts = 56907367;  Transfers = 477920277


Memory Level: L2
     Hit Count = 242256819  Miss Count = 296298616
     Total Requests =  538555435
     Hit Rate = [44.98%]   Miss Rate = [55.02%]
     Kickouts = 296297592;  Dirty kickouts = 28350393;  Transfers = 296298616
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $150;  Memory cost = $75
Total cost = $1025
```

---

mcf.All-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 65762757685;    Total refs = 5000000000
Inst refs = 3554558068;    Data refs = 1445441932


Number of reference types: [Percentage]
     Reads = 1184346362     [23.69%]
     Writes = 261095570     [5.22%]
     Inst = 3554558068     [71.09%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 57188910693     [86.96%]
     Writes = 2937552140     [4.47%]
     Inst = 5636294852     [8.57%]
     Total = 65762757685


Average cycles per activity:
     Read = 48.29;   Write = 11.25;   Inst. = 18.50


Memory Level: L1i
     Hit Count = 5556837506  Miss Count = 3727791
     Total Requests =  5560565297
     Hit Rate = [99.93%]  Miss Rate = [0.07%]
     Kickouts = 3727535;  Dirty kickouts = 0;  Transfers = 3727791


Memory Level: L1d
     Hit Count = 2222035229  Miss Count = 477920277
     Total Requests =  2699955506
     Hit Rate = [82.30%]   Miss Rate = [17.70%]
     Kickouts = 477920021;  Dirty kickouts = 56907367;  Transfers = 477920277


Memory Level: L2
     Hit Count = 236482836  Miss Count = 302072599
     Total Requests =  538555435
     Hit Rate = [43.91%]   Miss Rate = [56.09%]
     Kickouts = 302071575;  Dirty kickouts = 30722160;  Transfers = 302072599
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

---

mcf.All-FA Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 256 : block size = 32
     Icache size = 8192 : ways = 256 : block size = 32
     L2-cache size = 65536 : ways = 1024 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 64006419233;    Total refs = 5000000000
Inst refs = 3554558068;    Data refs = 1445441932


Number of reference types: [Percentage]
     Reads = 1184346362     [23.69%]
     Writes = 261095570     [5.22%]
     Inst = 3554558068     [71.09%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 55731988539     [87.07%]
     Writes = 2713525247     [4.24%]
     Inst = 5560905447     [8.69%]
     Total = 64006419233


Average cycles per activity:
     Read = 47.06;   Write = 10.39;   Inst. = 18.01


Memory Level: L1i
     Hit Count = 5560562431  Miss Count = 2866
     Total Requests =  5560565297
     Hit Rate = [100.00%]  Miss Rate = [0.00%]
     Kickouts = 2610;  Dirty kickouts = 0;  Transfers = 2866


Memory Level: L1d
     Hit Count = 2228332896  Miss Count = 471622610
     Total Requests =  2699955506
     Hit Rate = [82.53%]   Miss Rate = [17.47%]
     Kickouts = 471622354;  Dirty kickouts = 56471083;  Transfers = 471622610


Memory Level: L2
     Hit Count = 232651854  Miss Count = 295444705
     Total Requests =  528096559
     Hit Rate = [44.05%]   Miss Rate = [55.95%]
     Kickouts = 295443681;  Dirty kickouts = 26355722;  Transfers = 295444705
```

```
L1 cache cost (Icache $1800) + (Dcache $1800) = $3600
L2 cache cost = $550;  Memory cost = $75
Total cost = $4225
```

---

mcf.default Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 69001516345;    Total refs = 5000000000
Inst refs = 3554558068;    Data refs = 1445441932


Number of reference types: [Percentage]
     Reads = 1184346362     [23.69%]
     Writes = 261095570     [5.22%]
     Inst = 3554558068     [71.09%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 59662300021     [86.47%]
     Writes = 3584983790     [5.20%]
     Inst = 5754232534     [8.34%]
     Total = 69001516345


Average cycles per activity:
     Read = 50.38;   Write = 13.73;   Inst. = 19.41


Memory Level: L1i
     Hit Count = 5553186526  Miss Count = 7378771
     Total Requests =  5560565297
     Hit Rate = [99.87%]  Miss Rate = [0.13%]
     Kickouts = 7378515;  Dirty kickouts = 0;  Transfers = 7378771


Memory Level: L1d
     Hit Count = 2208579079  Miss Count = 491376427
     Total Requests =  2699955506
     Hit Rate = [81.80%]   Miss Rate = [18.20%]
     Kickouts = 491376171;  Dirty kickouts = 61081061;  Transfers = 491376427


Memory Level: L2
     Hit Count = 244156909  Miss Count = 315679350
     Total Requests =  559836259
     Hit Rate = [43.61%]   Miss Rate = [56.39%]
     Kickouts = 315678326;  Dirty kickouts = 37111965;  Transfers = 315679350
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $50;  Memory cost = $75
Total cost = $525
```

---

mcf.L1-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 68203945143;    Total refs = 5000000000
Inst refs = 3554558068;    Data refs = 1445441932


Number of reference types: [Percentage]
     Reads = 1184346362     [23.69%]
     Writes = 261095570     [5.22%]
     Inst = 3554558068     [71.09%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 59159947855     [86.74%]
     Writes = 3357610480     [4.92%]
     Inst = 5686386808     [8.34%]
     Total = 68203945143


Average cycles per activity:
     Read = 49.95;   Write = 12.86;   Inst. = 19.19


Memory Level: L1i
     Hit Count = 5556837506  Miss Count = 3727791
     Total Requests =  5560565297
     Hit Rate = [99.93%]  Miss Rate = [0.07%]
     Kickouts = 3727535;  Dirty kickouts = 0;  Transfers = 3727791


Memory Level: L1d
     Hit Count = 2222035229  Miss Count = 477920277
     Total Requests =  2699955506
     Hit Rate = [82.30%]   Miss Rate = [17.70%]
     Kickouts = 477920021;  Dirty kickouts = 56907367;  Transfers = 477920277


Memory Level: L2
     Hit Count = 224412753  Miss Count = 314142682
     Total Requests =  538555435
     Hit Rate = [41.67%]   Miss Rate = [58.33%]
     Kickouts = 314141658;  Dirty kickouts = 35571841;  Transfers = 314142682
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $50;  Memory cost = $75
Total cost = $925
```

---

mcf.L2-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 66148639025;    Total refs = 5000000000
Inst refs = 3554558068;    Data refs = 1445441932


Number of reference types: [Percentage]
     Reads = 1184346362     [23.69%]
     Writes = 261095570     [5.22%]
     Inst = 3554558068     [71.09%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 57447468513     [86.85%]
     Writes = 2998201112     [4.53%]
     Inst = 5702969400     [8.62%]
     Total = 66148639025


Average cycles per activity:
     Read = 48.51;   Write = 11.48;   Inst. = 18.61


Memory Level: L1i
     Hit Count = 5553186526  Miss Count = 7378771
     Total Requests =  5560565297
     Hit Rate = [99.87%]  Miss Rate = [0.13%]
     Kickouts = 7378515;  Dirty kickouts = 0;  Transfers = 7378771


Memory Level: L1d
     Hit Count = 2208579079  Miss Count = 491376427
     Total Requests =  2699955506
     Hit Rate = [81.80%]   Miss Rate = [18.20%]
     Kickouts = 491376171;  Dirty kickouts = 61081061;  Transfers = 491376427


Memory Level: L2
     Hit Count = 257890049  Miss Count = 301946210
     Total Requests =  559836259
     Hit Rate = [46.07%]   Miss Rate = [53.93%]
     Kickouts = 301945186;  Dirty kickouts = 31055973;  Transfers = 301946210
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $100;  Memory cost = $75
Total cost = $575
```

---

mcf.L2-Big Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 131072 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 61642585531;    Total refs = 5000000000
Inst refs = 3554558068;    Data refs = 1445441932


Number of reference types: [Percentage]
     Reads = 1184346362     [23.69%]
     Writes = 261095570     [5.22%]
     Inst = 3554558068     [71.09%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 52912454089     [85.84%]
     Writes = 3102818564     [5.03%]
     Inst = 5627312878     [9.13%]
     Total = 61642585531


Average cycles per activity:
     Read = 44.68;   Write = 11.88;   Inst. = 17.34


Memory Level: L1i b
     Hit Count = 5556837506  Miss Count = 3727791
     Total Requests =  5560565297
     Hit Rate = [99.93%]  Miss Rate = [0.07%]
     Kickouts = 3727535;  Dirty kickouts = 0;  Transfers = 3727791


Memory Level: L1d
     Hit Count = 2222035229  Miss Count = 477920277
     Total Requests =  2699955506
     Hit Rate = [82.30%]   Miss Rate = [17.70%]
     Kickouts = 477920021;  Dirty kickouts = 56907367;  Transfers = 477920277


Memory Level: L2
     Hit Count = 264388875  Miss Count = 274166560
     Total Requests =  538555435
     Hit Rate = [49.09%]   Miss Rate = [50.91%]
     Kickouts = 274164512;  Dirty kickouts = 30394371;  Transfers = 274166560
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

omnetpp results

omnetpp.2-4-way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 4 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 24624143952;    Total refs = 5000000000
Inst refs = 3378592184;    Data refs = 1621407816


Number of reference types: [Percentage]
     Reads = 1003285503     [20.07%]
     Writes = 618122313     [12.36%]
     Inst = 3378592184     [67.57%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 10812702131     [43.91%]
     Writes = 2884530741     [11.71%]
     Inst = 10926911080     [44.37%]
     Total = 24624143952


Average cycles per activity:
     Read = 10.78;   Write = 4.67;   Inst. = 7.29


Memory Level: L1i
     Hit Count = 5562290006  Miss Count = 169506523
     Total Requests =  5731796529
     Hit Rate = [97.04%]  Miss Rate = [2.96%]
     Kickouts = 169506267;  Dirty kickouts = 0;  Transfers = 169506523


Memory Level: L1d
     Hit Count = 2831035564  Miss Count = 128933838
     Total Requests =  2959969402
     Hit Rate = [95.64%]   Miss Rate = [4.36%]
     Kickouts = 128933582;  Dirty kickouts = 52662659;  Transfers = 128933838


Memory Level: L2
     Hit Count = 297846930  Miss Count = 53256090
     Total Requests =  351103020
     Hit Rate = [84.83%]   Miss Rate = [15.17%]
     Kickouts = 53255066;  Dirty kickouts = 16006430;  Transfers = 53256090
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $150;  Memory cost = $75
Total cost = $1025
```

---

omnetpp.All-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 26731294078;    Total refs = 5000000000
Inst refs = 3378592184;    Data refs = 1621407816


Number of reference types: [Percentage]
     Reads = 1003285503     [20.07%]
     Writes = 618122313     [12.36%]
     Inst = 3378592184     [67.57%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 11634865463     [43.53%]
     Writes = 3006093279     [11.25%]
     Inst = 12090335336     [45.23%]
     Total = 26731294078


Average cycles per activity:
     Read = 11.60;   Write = 4.86;   Inst. = 7.91


Memory Level: L1i
     Hit Count = 5562290006  Miss Count = 169506523
     Total Requests =  5731796529
     Hit Rate = [97.04%]  Miss Rate = [2.96%]
     Kickouts = 169506267;  Dirty kickouts = 0;  Transfers = 169506523


Memory Level: L1d
     Hit Count = 2831035564  Miss Count = 128933838
     Total Requests =  2959969402
     Hit Rate = [95.64%]   Miss Rate = [4.36%]
     Kickouts = 128933582;  Dirty kickouts = 52662659;  Transfers = 128933838


Memory Level: L2
     Hit Count = 285155479  Miss Count = 65947541
     Total Requests =  351103020
     Hit Rate = [81.22%]   Miss Rate = [18.78%]
     Kickouts = 65946517;  Dirty kickouts = 17822132;  Transfers = 65947541
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

---

omnetpp.All-FA Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 256 : block size = 32
     Icache size = 8192 : ways = 256 : block size = 32
     L2-cache size = 65536 : ways = 1024 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 21350619282;    Total refs = 5000000000
Inst refs = 3378592184;    Data refs = 1621407816


Number of reference types: [Percentage]
     Reads = 1003285503     [20.07%]
     Writes = 618122313     [12.36%]
     Inst = 3378592184     [67.57%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 9609039874     [45.01%]
     Writes = 2781024934     [13.03%]
     Inst = 8960554474     [41.97%]
     Total = 21350619282


Average cycles per activity:
     Read = 9.58;   Write = 4.50;   Inst. = 6.32


Memory Level: L1i
     Hit Count = 5629221660  Miss Count = 102574869
     Total Requests =  5731796529
     Hit Rate = [98.21%]  Miss Rate = [1.79%]
     Kickouts = 102574613;  Dirty kickouts = 0;  Transfers = 102574869


Memory Level: L1d
     Hit Count = 2872587378  Miss Count = 87382024
     Total Requests =  2959969402
     Hit Rate = [97.05%]   Miss Rate = [2.95%]
     Kickouts = 87381768;  Dirty kickouts = 35789727;  Transfers = 87382024


Memory Level: L2
     Hit Count = 179655647  Miss Count = 46090973
     Total Requests =  225746620
     Hit Rate = [79.58%]   Miss Rate = [20.42%]
     Kickouts = 46089949;  Dirty kickouts = 15197632;  Transfers = 46090973
```

```
L1 cache cost (Icache $1800) + (Dcache $1800) = $3600
L2 cache cost = $550;  Memory cost = $75
Total cost = $4225
```

---

omnetpp.default Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 38112996044;    Total refs = 5000000000
Inst refs = 3378592184;    Data refs = 1621407816


Number of reference types: [Percentage]
     Reads = 1003285503     [20.07%]
     Writes = 618122313     [12.36%]
     Inst = 3378592184     [67.57%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 17170126019     [45.05%]
     Writes = 4025729142     [10.56%]
     Inst = 16917140883     [44.39%]
     Total = 38112996044


Average cycles per activity:
     Read = 17.11;   Write = 6.51;   Inst. = 11.28


Memory Level: L1i
     Hit Count = 5504343699  Miss Count = 227452830
     Total Requests =  5731796529
     Hit Rate = [96.03%]  Miss Rate = [3.97%]
     Kickouts = 227452574;  Dirty kickouts = 0;  Transfers = 227452830


Memory Level: L1d
     Hit Count = 2777241685  Miss Count = 182727717
     Total Requests =  2959969402
     Hit Rate = [93.83%]   Miss Rate = [6.17%]
     Kickouts = 182727461;  Dirty kickouts = 81269890;  Transfers = 182727717


Memory Level: L2
     Hit Count = 376230358  Miss Count = 115220079
     Total Requests =  491450437
     Hit Rate = [76.56%]   Miss Rate = [23.44%]
     Kickouts = 115219055;  Dirty kickouts = 30897936;  Transfers = 115220079
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $50;  Memory cost = $75
Total cost = $525
```

---

omnetpp.L1-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 32288001088;    Total refs = 5000000000
Inst refs = 3378592184;    Data refs = 1621407816


Number of reference types: [Percentage]
     Reads = 1003285503     [20.07%]
     Writes = 618122313     [12.36%]
     Inst = 3378592184     [67.57%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 14172071139     [43.89%]
     Writes = 3440137319     [10.65%]
     Inst = 14675792630     [45.45%]
     Total = 32288001088


Average cycles per activity:
     Read = 14.13;   Write = 5.57;   Inst. = 9.56


Memory Level: L1i
     Hit Count = 5562290006  Miss Count = 169506523
     Total Requests =  5731796529
     Hit Rate = [97.04%]  Miss Rate = [2.96%]
     Kickouts = 169506267;  Dirty kickouts = 0;  Transfers = 169506523


Memory Level: L1d
     Hit Count = 2831035564  Miss Count = 128933838
     Total Requests =  2959969402
     Hit Rate = [95.64%]   Miss Rate = [4.36%]
     Kickouts = 128933582;  Dirty kickouts = 52662659;  Transfers = 128933838


Memory Level: L2
     Hit Count = 253772464  Miss Count = 97330556
     Total Requests =  351103020
     Hit Rate = [72.28%]   Miss Rate = [27.72%]
     Kickouts = 97329532;  Dirty kickouts = 24784895;  Transfers = 97330556
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $50;  Memory cost = $75
Total cost = $925
```

---

omnetpp.L2-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 29625290268;    Total refs = 5000000000
Inst refs = 3378592184;    Data refs = 1621407816


Number of reference types: [Percentage]
     Reads = 1003285503     [20.07%]
     Writes = 618122313     [12.36%]
     Inst = 3378592184     [67.57%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 12769534275     [43.10%]
     Writes = 3248658338     [10.97%]
     Inst = 13607097655     [45.93%]
     Total = 29625290268


Average cycles per activity:
     Read = 12.73;   Write = 5.26;   Inst. = 8.77


Memory Level: L1i
     Hit Count = 5504343699  Miss Count = 227452830
     Total Requests =  5731796529
     Hit Rate = [96.03%]  Miss Rate = [3.97%]
     Kickouts = 227452574;  Dirty kickouts = 0;  Transfers = 227452830


Memory Level: L1d
     Hit Count = 2777241685  Miss Count = 182727717
     Total Requests =  2959969402
     Hit Rate = [93.83%]   Miss Rate = [6.17%]
     Kickouts = 182727461;  Dirty kickouts = 81269890;  Transfers = 182727717


Memory Level: L2
     Hit Count = 422138664  Miss Count = 69311773
     Total Requests =  491450437
     Hit Rate = [85.90%]   Miss Rate = [14.10%]
     Kickouts = 69310749;  Dirty kickouts = 18147271;  Transfers = 69311773
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $100;  Memory cost = $75
Total cost = $575
```

---

omnetpp.L2-Big Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 131072 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 25432866562;    Total refs = 5000000000
Inst refs = 3378592184;    Data refs = 1621407816


Number of reference types: [Percentage]
     Reads = 1003285503     [20.07%]
     Writes = 618122313     [12.36%]
     Inst = 3378592184     [67.57%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 10452319647     [41.10%]
     Writes = 2742125121     [10.78%]
     Inst = 12238421794     [48.12%]
     Total = 25432866562


Average cycles per activity:
     Read = 10.42;   Write = 4.44;   Inst. = 7.53


Memory Level: L1i
     Hit Count = 5562290006  Miss Count = 169506523
     Total Requests =  5731796529
     Hit Rate = [97.04%]  Miss Rate = [2.96%]
     Kickouts = 169506267;  Dirty kickouts = 0;  Transfers = 169506523


Memory Level: L1d
     Hit Count = 2831035564  Miss Count = 128933838
     Total Requests =  2959969402
     Hit Rate = [95.64%]   Miss Rate = [4.36%]
     Kickouts = 128933582;  Dirty kickouts = 52662659;  Transfers = 128933838


Memory Level: L2
     Hit Count = 291485025  Miss Count = 59617995
     Total Requests =  351103020
     Hit Rate = [83.02%]   Miss Rate = [16.98%]
     Kickouts = 59615947;  Dirty kickouts = 15148462;  Transfers = 59617995
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

sjeng results - 16 byte chunksize

sjeng.All-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 16484929329;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 3065836395     [18.60%]
     Writes = 4306099762     [26.12%]
     Inst = 9112993172     [55.28%]
     Total = 16484929329


Average cycles per activity:
     Read = 3.25;   Write = 11.16;   Inst. = 4.49


Memory Level: L1i
     Hit Count = 6161247964  Miss Count = 106711686
     Total Requests =  6267959650
     Hit Rate = [98.30%]  Miss Rate = [1.70%]
     Kickouts = 106711430;  Dirty kickouts = 0;  Transfers = 106711686


Memory Level: L1d
     Hit Count = 1652962197  Miss Count = 67003983
     Total Requests =  1719966180
     Hit Rate = [96.10%]   Miss Rate = [3.90%]
     Kickouts = 67003727;  Dirty kickouts = 36772907;  Transfers = 67003983


Memory Level: L2
     Hit Count = 188261297  Miss Count = 22227279
     Total Requests =  210488576
     Hit Rate = [89.44%]   Miss Rate = [10.56%]
     Kickouts = 22226255;  Dirty kickouts = 12216342;  Transfers = 22227279
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

---

sjeng.All-FA Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 256 : block size = 32
     Icache size = 8192 : ways = 256 : block size = 32
     L2-cache size = 65536 : ways = 1024 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 14139701025;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 1961018059     [13.87%]
     Writes = 3843641666     [27.18%]
     Inst = 8335041300     [58.95%]
     Total = 14139701025


Average cycles per activity:
     Read = 2.08;   Write = 9.96;   Inst. = 3.85


Memory Level: L1i
     Hit Count = 6149998030  Miss Count = 117961620
     Total Requests =  6267959650
     Hit Rate = [98.12%]  Miss Rate = [1.88%]
     Kickouts = 117961364;  Dirty kickouts = 0;  Transfers = 117961620


Memory Level: L1d
     Hit Count = 1677223669  Miss Count = 42742511
     Total Requests =  1719966180
     Hit Rate = [97.51%]   Miss Rate = [2.49%]
     Kickouts = 42742255;  Dirty kickouts = 28288596;  Transfers = 42742511


Memory Level: L2
     Hit Count = 178032175  Miss Count = 10960552
     Total Requests =  188992727
     Hit Rate = [94.20%]   Miss Rate = [5.80%]
     Kickouts = 10959528;  Dirty kickouts = 9763906;  Transfers = 10960552
```

```
L1 cache cost (Icache $1800) + (Dcache $1800) = $3600
L2 cache cost = $550;  Memory cost = $75
Total cost = $4225
```

---

sjeng.default Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 20451581796;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 4901784903     [23.97%]
     Writes = 4733673095     [23.15%]
     Inst = 10816123798     [52.89%]
     Total = 20451581796


Average cycles per activity:
     Read = 5.19;   Write = 12.27;   Inst. = 5.57


Memory Level: L1i
     Hit Count = 6153493906  Miss Count = 114465744
     Total Requests =  6267959650
     Hit Rate = [98.17%]  Miss Rate = [1.83%]
     Kickouts = 114465488;  Dirty kickouts = 0;  Transfers = 114465744


Memory Level: L1d
     Hit Count = 1620645788  Miss Count = 99320392
     Total Requests =  1719966180
     Hit Rate = [94.23%]   Miss Rate = [5.77%]
     Kickouts = 99320136;  Dirty kickouts = 47314155;  Transfers = 99320392


Memory Level: L2
     Hit Count = 220160792  Miss Count = 40939499
     Total Requests =  261100291
     Hit Rate = [84.32%]   Miss Rate = [15.68%]
     Kickouts = 40938475;  Dirty kickouts = 14964988;  Transfers = 40939499
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $50;  Memory cost = $75
Total cost = $525
```

---

sjeng.L1-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 18975932191;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 3983730189     [20.99%]
     Writes = 4505228388     [23.74%]
     Inst = 10486973614     [55.26%]
     Total = 18975932191


Average cycles per activity:
     Read = 4.22;   Write = 11.68;   Inst. = 5.17


Memory Level: L1i
     Hit Count = 6161247964  Miss Count = 106711686
     Total Requests =  6267959650
     Hit Rate = [98.30%]  Miss Rate = [1.70%]
     Kickouts = 106711430;  Dirty kickouts = 0;  Transfers = 106711686


Memory Level: L1d
     Hit Count = 1652962197  Miss Count = 67003983
     Total Requests =  1719966180
     Hit Rate = [96.10%]   Miss Rate = [3.90%]
     Kickouts = 67003727;  Dirty kickouts = 36772907;  Transfers = 67003983


Memory Level: L2
     Hit Count = 172976270  Miss Count = 37512306
     Total Requests =  210488576
     Hit Rate = [82.18%]   Miss Rate = [17.82%]
     Kickouts = 37511282;  Dirty kickouts = 14069120;  Transfers = 37512306
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $50;  Memory cost = $75
Total cost = $925
```

---

sjeng.L2-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 17344705544;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 3612182955     [20.83%]
     Writes = 4422931907     [25.50%]
     Inst = 9309590682     [53.67%]
     Total = 17344705544


Average cycles per activity:
     Read = 3.83;   Write = 11.46;   Inst. = 4.73


Memory Level: L1i
     Hit Count = 6153493906  Miss Count = 114465744
     Total Requests =  6267959650
     Hit Rate = [98.17%]  Miss Rate = [1.83%]
     Kickouts = 114465488;  Dirty kickouts = 0;  Transfers = 114465744


Memory Level: L1d
     Hit Count = 1620645788  Miss Count = 99320392
     Total Requests =  1719966180
     Hit Rate = [94.23%]   Miss Rate = [5.77%]
     Kickouts = 99320136;  Dirty kickouts = 47314155;  Transfers = 99320392

Memory Level: L2
     Hit Count = 238682704  Miss Count = 22417587
     Total Requests =  261100291
     Hit Rate = [91.41%]   Miss Rate = [8.59%]
     Kickouts = 22416563;  Dirty kickouts = 12088723;  Transfers = 22417587
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $100;  Memory cost = $75
Total cost = $575
```

---

sjeng.L2-Big Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 131072 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 16062181067;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 3014187529     [18.77%]
     Writes = 4251838506     [26.47%]
     Inst = 8796155032     [54.76%]
     Total = 16062181067


Average cycles per activity:
     Read = 3.19;   Write = 11.02;   Inst. = 4.38


Memory Level: L1i
     Hit Count = 6161247964  Miss Count = 106711686
     Total Requests =  6267959650
     Hit Rate = [98.30%]  Miss Rate = [1.70%]
     Kickouts = 106711430;  Dirty kickouts = 0;  Transfers = 106711686


Memory Level: L1d
     Hit Count = 1652962197  Miss Count = 67003983
     Total Requests =  1719966180
     Hit Rate = [96.10%]   Miss Rate = [3.90%]
     Kickouts = 67003727;  Dirty kickouts = 36772907;  Transfers = 67003983


Memory Level: L2
     Hit Count = 190788074  Miss Count = 19700502
     Total Requests =  210488576
     Hit Rate = [90.64%]   Miss Rate = [9.36%]
     Kickouts = 19698454;  Dirty kickouts = 11831779;  Transfers = 19700502
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $75
Total cost = $975
```

---

sjeng.2-4-way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 4 : block size = 64
     Memory ready time = 50 chunksize = 16 : chunktime = 20


Execute time = 15703613311;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 2790253285     [17.77%]
     Writes = 4288695826     [27.31%]
     Inst = 8624664200     [54.92%]
     Total = 15703613311


Average cycles per activity:
     Read = 2.96;   Write = 11.12;   Inst. = 4.28


Memory Level: L1i
     Hit Count = 6161247964  Miss Count = 106711686
     Total Requests =  6267959650
     Hit Rate = [98.30%]  Miss Rate = [1.70%]
     Kickouts = 106711430;  Dirty kickouts = 0;  Transfers = 106711686


Memory Level: L1d
     Hit Count = 1652962197  Miss Count = 67003983
     Total Requests =  1719966180
     Hit Rate = [96.10%]   Miss Rate = [3.90%]
     Kickouts = 67003727;  Dirty kickouts = 36772907;  Transfers = 67003983


Memory Level: L2
     Hit Count = 193045090  Miss Count = 17443486
     Total Requests =  210488576
     Hit Rate = [91.71%]   Miss Rate = [8.29%]
     Kickouts = 17442462;  Dirty kickouts = 11624326;  Transfers = 17443486
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $150;  Memory cost = $75
Total cost = $1025
```

sjeng results - 32 byte chunksize

---

sjeng_32_memWidth.2-4-way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 4 : block size = 64
     Memory ready time = 50 chunksize = 32 : chunktime = 20


Execute time = 14540900831;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 2561371245     [17.61%]
     Writes = 3505089746     [24.11%]
     Inst = 8474439840     [58.28%]
     Total = 14540900831


Average cycles per activity:
     Read = 2.71;   Write = 9.08;   Inst. = 3.96


Memory Level: L1i
     Hit Count = 6161247964  Miss Count = 106711686
     Total Requests =  6267959650
     Hit Rate = [98.30%]  Miss Rate = [1.70%]
     Kickouts = 106711430;  Dirty kickouts = 0;  Transfers = 106711686


Memory Level: L1d
     Hit Count = 1652962197  Miss Count = 67003983
     Total Requests =  1719966180
     Hit Rate = [96.10%]   Miss Rate = [3.90%]
     Kickouts = 67003727;  Dirty kickouts = 36772907;  Transfers = 67003983


Memory Level: L2
     Hit Count = 193045090  Miss Count = 17443486
     Total Requests =  210488576
     Hit Rate = [91.71%]   Miss Rate = [8.29%]
     Kickouts = 17442462;  Dirty kickouts = 11624326;  Transfers = 17443486
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $150;  Memory cost = $175
Total cost = $1125
```

---

sjeng_32_memWidth.All-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 32 : chunktime = 20


Execute time = 15107184489;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 2761338715     [18.28%]
     Writes = 3518035082     [23.29%]
     Inst = 8827810692     [58.43%]
     Total = 15107184489


Average cycles per activity:
     Read = 2.93;   Write = 9.12;   Inst. = 4.12


Memory Level: L1i
     Hit Count = 6161247964  Miss Count = 106711686
     Total Requests =  6267959650
     Hit Rate = [98.30%]  Miss Rate = [1.70%]
     Kickouts = 106711430;  Dirty kickouts = 0;  Transfers = 106711686


Memory Level: L1d
     Hit Count = 1652962197  Miss Count = 67003983
     Total Requests =  1719966180
     Hit Rate = [96.10%]   Miss Rate = [3.90%]
     Kickouts = 67003727;  Dirty kickouts = 36772907;  Transfers = 67003983


Memory Level: L2
     Hit Count = 188261297  Miss Count = 22227279
     Total Requests =  210488576
     Hit Rate = [89.44%]   Miss Rate = [10.56%]
     Kickouts = 22226255;  Dirty kickouts = 12216342;  Transfers = 22227279
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $175
Total cost = $1075
```

---

sjeng_32_memWidth.All-FA Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 256 : block size = 32
     Icache size = 8192 : ways = 256 : block size = 32
     L2-cache size = 65536 : ways = 1024 : block size = 64
     Memory ready time = 50 chunksize = 32 : chunktime = 20


Execute time = 13310722705;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 1842293859     [13.84%]
     Writes = 3150547706     [23.67%]
     Inst = 8317881140     [62.49%]
     Total = 13310722705


Average cycles per activity:
     Read = 1.95;   Write = 8.17;   Inst. = 3.63


Memory Level: L1i
     Hit Count = 6149998030  Miss Count = 117961620
     Total Requests =  6267959650
     Hit Rate = [98.12%]  Miss Rate = [1.88%]
     Kickouts = 117961364;  Dirty kickouts = 0;  Transfers = 117961620


Memory Level: L1d
     Hit Count = 1677223669  Miss Count = 42742511
     Total Requests =  1719966180
     Hit Rate = [97.51%]   Miss Rate = [2.49%]
     Kickouts = 42742255;  Dirty kickouts = 28288596;  Transfers = 42742511


Memory Level: L2
     Hit Count = 178032175  Miss Count = 10960552
     Total Requests =  188992727
     Hit Rate = [94.20%]   Miss Rate = [5.80%]
     Kickouts = 10959528;  Dirty kickouts = 9763906;  Transfers = 10960552
```

```
L1 cache cost (Icache $1800) + (Dcache $1800) = $3600
L2 cache cost = $550;  Memory cost = $175
Total cost = $4325
```

---

sjeng_32_memWidth.default Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 32 : chunktime = 20


Execute time = 18215402316;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 4254281623     [23.36%]
     Writes = 3862741495     [21.21%]
     Inst = 10098379198     [55.44%]
     Total = 18215402316


Average cycles per activity:
     Read = 4.51;   Write = 10.01;   Inst. = 4.96


Memory Level: L1i
     Hit Count = 6153493906  Miss Count = 114465744
     Total Requests =  6267959650
     Hit Rate = [98.17%]  Miss Rate = [1.83%]
     Kickouts = 114465488;  Dirty kickouts = 0;  Transfers = 114465744


Memory Level: L1d
     Hit Count = 1620645788  Miss Count = 99320392
     Total Requests =  1719966180
     Hit Rate = [94.23%]   Miss Rate = [5.77%]
     Kickouts = 99320136;  Dirty kickouts = 47314155;  Transfers = 99320392


Memory Level: L2
     Hit Count = 220160792  Miss Count = 40939499
     Total Requests =  261100291
     Hit Rate = [84.32%]   Miss Rate = [15.68%]
     Kickouts = 40938475;  Dirty kickouts = 14964988;  Transfers = 40939499
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $50;  Memory cost = $175
Total cost = $625
```

---

sjeng_32_memWidth.L1-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 32 : chunktime = 20


Execute time = 16912675151;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 3426637309     [20.26%]
     Writes = 3662511588     [21.66%]
     Inst = 9823526254     [58.08%]
     Total = 16912675151


Average cycles per activity:
     Read = 3.63;   Write = 9.49;   Inst. = 4.61


Memory Level: L1i
     Hit Count = 6161247964  Miss Count = 106711686
     Total Requests =  6267959650
     Hit Rate = [98.30%]  Miss Rate = [1.70%]
     Kickouts = 106711430;  Dirty kickouts = 0;  Transfers = 106711686


Memory Level: L1d
     Hit Count = 1652962197  Miss Count = 67003983
     Total Requests =  1719966180
     Hit Rate = [96.10%]   Miss Rate = [3.90%]
     Kickouts = 67003727;  Dirty kickouts = 36772907;  Transfers = 67003983


Memory Level: L2
     Hit Count = 172976270  Miss Count = 37512306
     Total Requests =  210488576
     Hit Rate = [82.18%]   Miss Rate = [17.82%]
     Kickouts = 37511282;  Dirty kickouts = 14069120;  Transfers = 37512306
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $50;  Memory cost = $175
Total cost = $1025
```

---

sjeng_32_memWidth.L2-2way Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 32 : chunktime = 20


Execute time = 15964453144;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 3320227315     [20.80%]
     Writes = 3637679347     [22.79%]
     Inst = 9006546482     [56.42%]
     Total = 15964453144


Average cycles per activity:
     Read = 3.52;   Write = 9.43;   Inst. = 4.35


Memory Level: L1i
     Hit Count = 6153493906  Miss Count = 114465744
     Total Requests =  6267959650
     Hit Rate = [98.17%]  Miss Rate = [1.83%]
     Kickouts = 114465488;  Dirty kickouts = 0;  Transfers = 114465744


Memory Level: L1d
     Hit Count = 1620645788  Miss Count = 99320392
     Total Requests =  1719966180
     Hit Rate = [94.23%]   Miss Rate = [5.77%]
     Kickouts = 99320136;  Dirty kickouts = 47314155;  Transfers = 99320392


Memory Level: L2
     Hit Count = 238682704  Miss Count = 22417587
     Total Requests =  261100291
     Hit Rate = [91.41%]   Miss Rate = [8.59%]
     Kickouts = 22416563;  Dirty kickouts = 12088723;  Transfers = 22417587
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $100;  Memory cost = $175
Total cost = $675
```

---

sjeng_32_memWidth.L2-Big Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 131072 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 32 : chunktime = 20


Execute time = 14800889827;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 2723557449     [18.40%]
     Writes = 3478965786     [23.51%]
     Inst = 8598366592     [58.09%]
     Total = 14800889827


Average cycles per activity:
     Read = 2.89;   Write = 9.02;   Inst. = 4.03


Memory Level: L1i
     Hit Count = 6161247964  Miss Count = 106711686
     Total Requests =  6267959650
     Hit Rate = [98.30%]  Miss Rate = [1.70%]
     Kickouts = 106711430;  Dirty kickouts = 0;  Transfers = 106711686


Memory Level: L1d
     Hit Count = 1652962197  Miss Count = 67003983
     Total Requests =  1719966180
     Hit Rate = [96.10%]   Miss Rate = [3.90%]
     Kickouts = 67003727;  Dirty kickouts = 36772907;  Transfers = 67003983


Memory Level: L2
     Hit Count = 190788074  Miss Count = 19700502
     Total Requests =  210488576
     Hit Rate = [90.64%]   Miss Rate = [9.36%]
     Kickouts = 19698454;  Dirty kickouts = 11831779;  Transfers = 19700502
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $175
Total cost = $1075
```

##sjeng results - 64 byte chunksize

sjeng_64_memWidth.2-4-way_64 Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 4 : block size = 64
     Memory ready time = 50 chunksize = 64 : chunktime = 20


Execute time = 13959544591;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 2446930225     [17.53%]
     Writes = 3113286706     [22.30%]
     Inst = 8399327660     [60.17%]
     Total = 13959544591


Average cycles per activity:
     Read = 2.59;   Write = 8.07;   Inst. = 3.80


Memory Level: L1i
     Hit Count = 6161247964  Miss Count = 106711686
     Total Requests =  6267959650
     Hit Rate = [98.30%]  Miss Rate = [1.70%]
     Kickouts = 106711430;  Dirty kickouts = 0;  Transfers = 106711686


Memory Level: L1d
     Hit Count = 1652962197  Miss Count = 67003983
     Total Requests =  1719966180
     Hit Rate = [96.10%]   Miss Rate = [3.90%]
     Kickouts = 67003727;  Dirty kickouts = 36772907;  Transfers = 67003983


Memory Level: L2
     Hit Count = 193045090  Miss Count = 17443486
     Total Requests =  210488576
     Hit Rate = [91.71%]   Miss Rate = [8.29%]
     Kickouts = 17442462;  Dirty kickouts = 11624326;  Transfers = 17443486
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $150;  Memory cost = $275
Total cost = $1225
```

---

sjeng_64_memWidth.All-2way_64 Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 64 : chunktime = 20


Execute time = 14418312069;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 2609089875     [18.10%]
     Writes = 3124002742     [21.67%]
     Inst = 8685219452     [60.24%]
     Total = 14418312069


Average cycles per activity:
     Read = 2.76;   Write = 8.10;   Inst. = 3.93


Memory Level: L1i
     Hit Count = 6161247964  Miss Count = 106711686
     Total Requests =  6267959650
     Hit Rate = [98.30%]  Miss Rate = [1.70%]
     Kickouts = 106711430;  Dirty kickouts = 0;  Transfers = 106711686


Memory Level: L1d
     Hit Count = 1652962197  Miss Count = 67003983
     Total Requests =  1719966180
     Hit Rate = [96.10%]   Miss Rate = [3.90%]
     Kickouts = 67003727;  Dirty kickouts = 36772907;  Transfers = 67003983


Memory Level: L2
     Hit Count = 188261297  Miss Count = 22227279
     Total Requests =  210488576
     Hit Rate = [89.44%]   Miss Rate = [10.56%]
     Kickouts = 22226255;  Dirty kickouts = 12216342;  Transfers = 22227279
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $275
Total cost = $1175
```

---

sjeng_64_memWidth.All-FA_64 Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 256 : block size = 32
     Icache size = 8192 : ways = 256 : block size = 32
     L2-cache size = 65536 : ways = 1024 : block size = 64
     Memory ready time = 50 chunksize = 64 : chunktime = 20


Execute time = 12896233545;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 1782931759     [13.83%]
     Writes = 2804000726     [21.74%]
     Inst = 8309301060     [64.43%]
     Total = 12896233545


Average cycles per activity:
     Read = 1.89;   Write = 7.27;   Inst. = 3.51


Memory Level: L1i
     Hit Count = 6149998030  Miss Count = 117961620
     Total Requests =  6267959650
     Hit Rate = [98.12%]  Miss Rate = [1.88%]
     Kickouts = 117961364;  Dirty kickouts = 0;  Transfers = 117961620


Memory Level: L1d
     Hit Count = 1677223669  Miss Count = 42742511
     Total Requests =  1719966180
     Hit Rate = [97.51%]   Miss Rate = [2.49%]
     Kickouts = 42742255;  Dirty kickouts = 28288596;  Transfers = 42742511


Memory Level: L2
     Hit Count = 178032175  Miss Count = 10960552
     Total Requests =  188992727
     Hit Rate = [94.20%]   Miss Rate = [5.80%]
     Kickouts = 10959528;  Dirty kickouts = 9763906;  Transfers = 10960552
```

```
L1 cache cost (Icache $1800) + (Dcache $1800) = $3600
L2 cache cost = $550;  Memory cost = $275
Total cost = $4425
```

---

sjeng_64_memWidth.default_64 Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 64 : chunktime = 20


Execute time = 17097312576;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 3930529983     [22.99%]
     Writes = 3427275695     [20.05%]
     Inst = 9739506898     [56.97%]
     Total = 17097312576


Average cycles per activity:
     Read = 4.17;   Write = 8.88;   Inst. = 4.66


Memory Level: L1i
     Hit Count = 6153493906  Miss Count = 114465744
     Total Requests =  6267959650
     Hit Rate = [98.17%]  Miss Rate = [1.83%]
     Kickouts = 114465488;  Dirty kickouts = 0;  Transfers = 114465744


Memory Level: L1d
     Hit Count = 1620645788  Miss Count = 99320392
     Total Requests =  1719966180
     Hit Rate = [94.23%]   Miss Rate = [5.77%]
     Kickouts = 99320136;  Dirty kickouts = 47314155;  Transfers = 99320392


Memory Level: L2
     Hit Count = 220160792  Miss Count = 40939499
     Total Requests =  261100291
     Hit Rate = [84.32%]   Miss Rate = [15.68%]
     Kickouts = 40938475;  Dirty kickouts = 14964988;  Transfers = 40939499
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $50;  Memory cost = $275
Total cost = $725
```

---

sjeng_64_memWidth.L1-2way_64 Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 65536 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 64 : chunktime = 20


Execute time = 15881046631;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 3148090869     [19.82%]
     Writes = 3241153188     [20.41%]
     Inst = 9491802574     [59.77%]
     Total = 15881046631


Average cycles per activity:
     Read = 3.34;   Write = 8.40;   Inst. = 4.33


Memory Level: L1i
     Hit Count = 6161247964  Miss Count = 106711686
     Total Requests =  6267959650
     Hit Rate = [98.30%]  Miss Rate = [1.70%]
     Kickouts = 106711430;  Dirty kickouts = 0;  Transfers = 106711686


Memory Level: L1d
     Hit Count = 1652962197  Miss Count = 67003983
     Total Requests =  1719966180
     Hit Rate = [96.10%]   Miss Rate = [3.90%]
     Kickouts = 67003727;  Dirty kickouts = 36772907;  Transfers = 67003983


Memory Level: L2
     Hit Count = 172976270  Miss Count = 37512306
     Total Requests =  210488576
     Hit Rate = [82.18%]   Miss Rate = [17.82%]
     Kickouts = 37511282;  Dirty kickouts = 14069120;  Transfers = 37512306
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $50;  Memory cost = $275
Total cost = $1125
```

---

sjeng_64_memWidth.L2-2way_64 Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 1 : block size = 32
     Icache size = 8192 : ways = 1 : block size = 32
     L2-cache size = 65536 : ways = 2 : block size = 64
     Memory ready time = 50 chunksize = 64 : chunktime = 20


Execute time = 15274326944;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 3174249495     [20.78%]
     Writes = 3245053067     [21.25%]
     Inst = 8855024382     [57.97%]
     Total = 15274326944


Average cycles per activity:
     Read = 3.36;   Write = 8.41;   Inst. = 4.16


Memory Level: L1i
     Hit Count = 6153493906  Miss Count = 114465744
     Total Requests =  6267959650
     Hit Rate = [98.17%]  Miss Rate = [1.83%]
     Kickouts = 114465488;  Dirty kickouts = 0;  Transfers = 114465744


Memory Level: L1d
     Hit Count = 1620645788  Miss Count = 99320392
     Total Requests =  1719966180
     Hit Rate = [94.23%]   Miss Rate = [5.77%]
     Kickouts = 99320136;  Dirty kickouts = 47314155;  Transfers = 99320392


Memory Level: L2
     Hit Count = 238682704  Miss Count = 22417587
     Total Requests =  261100291
     Hit Rate = [91.41%]   Miss Rate = [8.59%]
     Kickouts = 22416563;  Dirty kickouts = 12088723;  Transfers = 22417587
```

```
L1 cache cost (Icache $200) + (Dcache $200) = $400
L2 cache cost = $100;  Memory cost = $275
Total cost = $775
```

---

sjeng_64_memWidth.L2-Big_64 Simulation Results

```
Memory system:
     Dcache size = 8192 : ways = 2 : block size = 32
     Icache size = 8192 : ways = 2 : block size = 32
     L2-cache size = 131072 : ways = 1 : block size = 64
     Memory ready time = 50 chunksize = 64 : chunktime = 20


Execute time = 14170244207;    Total refs = 5000000000
Inst refs = 3670499634;    Data refs = 1329500366


Number of reference types: [Percentage]
     Reads = 943680682     [18.87%]
     Writes = 385819684     [7.72%]
     Inst = 3670499634     [73.41%]
     Total = 5000000000


Total cycles for activities: [Percentage]
     Reads = 2578242409     [18.19%]
     Writes = 3092529426     [21.82%]
     Inst = 8499472372     [59.98%]
     Total = 14170244207


Average cycles per activity:
     Read = 2.73;   Write = 8.02;   Inst. = 3.86


Memory Level: L1i
     Hit Count = 6161247964  Miss Count = 106711686
     Total Requests =  6267959650
     Hit Rate = [98.30%]  Miss Rate = [1.70%]
     Kickouts = 106711430;  Dirty kickouts = 0;  Transfers = 106711686


Memory Level: L1d
     Hit Count = 1652962197  Miss Count = 67003983
     Total Requests =  1719966180
     Hit Rate = [96.10%]   Miss Rate = [3.90%]
     Kickouts = 67003727;  Dirty kickouts = 36772907;  Transfers = 67003983


Memory Level: L2
     Hit Count = 190788074  Miss Count = 19700502
     Total Requests =  210488576
     Hit Rate = [90.64%]   Miss Rate = [9.36%]
     Kickouts = 19698454;  Dirty kickouts = 11831779;  Transfers = 19700502
```

```
L1 cache cost (Icache $400) + (Dcache $400) = $800
L2 cache cost = $100;  Memory cost = $275
Total cost = $1175
```

Source Code

The following is the source code for the simulation. The file main.cpp acts as the processor while MemoryModule.cpp generates instances of various cache-levels.

main.cpp

```
/**
 * Brian Campuzano, Ryan Riley
 * ECEN 4593, Memory Simulation Project
 * Fall 2013, Professor Pleszkun
 * University of Colorado @ Boulder
 *
 * This file is the main runfile
 */
#include <iostream>
#include <stdio.h>
#include <stdlib.h>
#include <fstream>
#include <string>
#include <vector>
#include <sstream>
#include <map>
#include <iomanip>
#include <cmath>
#include "StdTypes.h"
#include "MemoryModule.h"


#define procBusWidth 4

using namespace std;
using namespace Valhalla;

int main(int argc, char ** argv)
{

  //creating a map to store the addresses of the params
  std::map <string, int*> params;
  //setting default values

  /** \brief These are the default values for the L1 Cache */
  int L1_BLOCK_SIZE = 32;
  int L1_MEMORY_SIZE = 8192;
  int L1_ASSOCIATIVITY = 1;
  int L1_HIT_PENALTY = 1;
  int L1_MISS_PENALTY = 1;

  /** \brief These are the default values for the L2 Cache */
  int L2_BLOCK_SIZE = 64;
  int L2_MEMORY_SIZE = 65536;
  int L2_ASSOCIATIVITY = 1;
  int L2_HIT_PENALTY = 4;
  int L2_MISS_PENALTY = 6;
  int L2_TRANSFER_TIME = 6;
  int L2_TRANSFER_WIDTH = 16;

  /** \brief These are the default values for Main Memory */
  int MAIN_MEMORY_SEND_ADDRESS_TIME = 10;
```

```
int MAIN_MEMORY_READY_TIME = 50;
int MAIN_MEMORY_CHUNK_SEND_TIME = 20;
int MAIN_MEMORY_ADDRESS_WIDTH = 16;

//initializing params map
params["L1_BLOCK_SIZE"] = &L1_BLOCK_SIZE;
params["L1_MEMORY_SIZE"] = &L1_MEMORY_SIZE;
params["L1_ASSOCIATIVITY"] = &L1_ASSOCIATIVITY;
params["L1_HIT_PENALTY"] = &L1_HIT_PENALTY;
params["L1_MISS_PENALTY"] = &L1_MISS_PENALTY;
params["L2_BLOCK_SIZE"] = &L2_BLOCK_SIZE;
params["L2_MEMORY_SIZE"] = &L2_MEMORY_SIZE;
params["L2_ASSOCIATIVITY"] = &L2_ASSOCIATIVITY;
params["L2_HIT_PENALTY"] = &L2_HIT_PENALTY;
params["L2_MISS_PENALTY"] = &L2_MISS_PENALTY;
params["L2_TRANSFER_TIME"] = &L2_TRANSFER_TIME;
params["L2_TRANSFER_WIDTH"] = &L2_TRANSFER_WIDTH;
params["MAIN_MEMORY_SEND_ADDRESS_TIME"] = &MAIN_MEMORY_SEND_ADDRESS_TIME;
params["MAIN_MEMORY_READY_TIME"] = &MAIN_MEMORY_READY_TIME;
params["MAIN_MEMORY_CHUNK_SEND_TIME"] = &MAIN_MEMORY_CHUNK_SEND_TIME;
params["MAIN_MEMORY_ADDRESS_WIDTH"] = &MAIN_MEMORY_ADDRESS_WIDTH;

if(argc > 1){

  //open and read config file and create a report file
  ifstream config(argv[1]);
  string line;
  if (config.is_open())
    {
  cout << "Config filename: " << argv[1] << endl;
  int param_count = 0;
  while (getline(config,line) )
    {
      string buffer;
      stringstream ss(line);
      vector<string> tokens;
      while (ss >> buffer) tokens.push_back(buffer);
      *params[tokens[0]] = atoi(tokens[1].c_str());
      cout << "Set parameter " << tokens[0] << " to " << tokens[1] << endl;
      param_count++;
    }
  config.close();
  cout << "Set " << param_count << " parameter(s) from config file " << endl;
    }
  if ( L1_ASSOCIATIVITY == -1) L1_ASSOCIATIVITY = L1_MEMORY_SIZE / L1_BLOCK_SIZE;
  if ( L2_ASSOCIATIVITY == -1) L2_ASSOCIATIVITY = L2_MEMORY_SIZE / L2_BLOCK_SIZE;
}

//Variables for mem operations
char op;
uint64 address;
uint32 byteSize;
uint64 time = 0;
uint64 refNum = 0;
```

```
uint64 iCount = 0;
uint64 wCount = 0;
uint64 rCount = 0;
uint32 blockSize = 4;
uint64 rTime = 0;
uint64 iTime = 0;
uint64 wTime = 0;
cout << "Creating Main Memory." << endl;
MemoryModule * mainMemory = new MemoryModule();

mainMemory->printMemoryModuleSetup();
cout << "Creating L2 Cache." << endl;

MemoryModule * l2Cache = new MemoryModule("L2",
                                          L2_BLOCK_SIZE,
                                          L2_MEMORY_SIZE,
                                          L2_ASSOCIATIVITY,
                                          L2_HIT_PENALTY,
                                          L2_MISS_PENALTY,
                                          MAIN_MEMORY_SEND_ADDRESS_TIME + MAIN_MEMORY_READY_TIME,
                                          MAIN_MEMORY_CHUNK_SEND_TIME,
                                          MAIN_MEMORY_ADDRESS_WIDTH,
                                          mainMemory,
                                          "Memory");
l2Cache->printMemoryModuleSetup();
cout << "Creating L1 Data Cache." << endl;

MemoryModule * l1DataCache = new MemoryModule("L1Data",
                                              L1_BLOCK_SIZE,
                                              L1_MEMORY_SIZE,
                                              L1_ASSOCIATIVITY,
                                              L1_HIT_PENALTY,
                                              L1_MISS_PENALTY,
                                              0,
                                              L2_TRANSFER_TIME,
                                              L2_TRANSFER_WIDTH,
                                              l2Cache,
                                              "L2");

l1DataCache->printMemoryModuleSetup();
cout << "Creating L1 Instruction Cache." << endl;

MemoryModule * l1InstCache = new MemoryModule("L1Inst",
                                              L1_BLOCK_SIZE,
                                              L1_MEMORY_SIZE,
                                              L1_ASSOCIATIVITY,
                                              L1_HIT_PENALTY,
                                              L1_MISS_PENALTY,
                                              0,
                                              L2_TRANSFER_TIME,
                                              L2_TRANSFER_WIDTH,
                                              l2Cache,
                                              "L2");
```

```
l1InstCache->printMemorySetup();
cout << "After initialization" << endl;

while (scanf("%c %llx %ld\n",&op,&address,&byteSize) == 3)
  {
    switch(op)
  {
  case 'I':
    iCount++;
    break;
  case 'R':
    rCount++;
    break;
  case 'W':
    wCount++;
    break;
  default:
    continue;
  }
    uint64 remainder = address % blockSize;
    if(remainder != 0)
  {
    address -= remainder;
    byteSize += remainder;
  }
    int bytesToFetch = byteSize;

    cout << "-----------------------------------------------------------" << endl;
    cout << "Ref " << refNum;
    cout << ": Addr = " << hex << address;
    cout << ", Type = " << op;
    cout << ", BSize = " << byteSize << endl;
    while (bytesToFetch > 0)
  {
    bytesToFetch -= procBusWidth;

    uint64 tempTime;
    switch(op)
      {
      case 'I':
        //Intruction fetch
        tempTime = l1InstCache->checkMemoryEntry(CACHE_READ, address, procBusWidth);
        time += tempTime;
            iTime += tempTime;

        break;
      case 'R':
        tempTime = l1DataCache->checkMemoryEntry(CACHE_READ, address, procBusWidth);
        time += tempTime;
            rTime += tempTime;
        break;
      case 'W':
        tempTime = l1DataCache->checkMemoryEntry(CACHE_WRITE, address, procBusWidth);
        time += tempTime;
```

```
            wTime += tempTime;
          break;
        default:
          continue;
        }

    address += procBusWidth;

  }
    cout << "Simulated time = " << dec << time << endl;
    refNum++;
  }
/*
  uint64 time = l1DataCache->checkMemoryEntry(CACHE_WRITE, 65536, 32);
  cout << "Time for memory lookup 1: " << time << endl;
  time = l1DataCache->checkMemoryEntry(CACHE_WRITE, 4096, 32);
  cout << "Time for memory lookup 2: " << time << endl;

  time = l1DataCache->checkMemoryEntry(CACHE_READ, 8192, 32);
  cout << "Time for memory lookup 3: " << time << endl;
  time = l1DataCache->checkMemoryEntry(CACHE_READ, 256, 32);
  cout << "Time for memory lookup 4: " << time << endl;

  time = l1DataCache->checkMemoryEntry(CACHE_READ, 512, 32);
  cout << "Time for memory lookup 5: " << time << endl;

*/
/*
  cout << "L1 instruction cache" << endl;
  l1InstCache->printMemoryEntries();
  cout << "L1 data cache" << endl;
  l1DataCache->printMemoryEntries();
  cout << "L2 cache" << endl;
  l2Cache->printMemoryEntries();
*/

cout << "Test Complete." << endl;



if(argc == 3){
  int L1SizeCost = ((L1_MEMORY_SIZE)/4096)*100;
  int L2SizeCost = ((L2_MEMORY_SIZE)/65536)*50;
  int L1AssociativityCost = (log2(L1_ASSOCIATIVITY) * (L1_MEMORY_SIZE/4096)) * 100;
  int L2AssociativityCost = (log2(L2_ASSOCIATIVITY) * (L2_MEMORY_SIZE/65536)) * 50;
  int MemReadyCost = ((50 / MAIN_MEMORY_READY_TIME) - 1) * 200;
  int MemChunkSizeCost = (log2(MAIN_MEMORY_ADDRESS_WIDTH) - log2(16)) * 100;
  int baseMemCost = 75;
  int l1iCost = L1SizeCost + L1AssociativityCost;
  int l1dCost = L1SizeCost + L1AssociativityCost;
  int l2Cost = L2SizeCost + L2AssociativityCost;
  int memCost = baseMemCost + MemReadyCost + MemChunkSizeCost;
  int totalCost = memCost + l2Cost + l1iCost + l1dCost;
```

```
std::stringstream str;

ofstream outfile;
std::string s = argv[1];
cout << s << endl;
std::string delimiter = "/";


std::string token;
token = s.substr(s.find(delimiter)+1, std::string::npos);

str << argv[2] <<"."<< token.c_str();

outfile.open(str.str().c_str());


 outfile << "-------------------------------------------------------------------------\n";
 outfile << "\t" << str.str().c_str() << "\t Simulation Results\n";
 outfile << "-------------------------------------------------------------------------\n\n\n";

 outfile << "\t Memory system: \n";
 outfile <<"\t      Dcache size = " <<  L1_MEMORY_SIZE << " : ways = " << L1_ASSOCIATIVITY <<
 " : block size = " << L1_BLOCK_SIZE << endl;
 outfile <<"\t      Icache size = " <<  L1_MEMORY_SIZE << " : ways = " << L1_ASSOCIATIVITY <<
 " : block size = " << L1_BLOCK_SIZE << endl;
 outfile <<"\t      L2-cache size = " <<  L2_MEMORY_SIZE << " : ways = " << L2_ASSOCIATIVITY <<
 " : block size = " << L2_BLOCK_SIZE << endl;
 outfile <<"\t      Memory ready time = " <<  MAIN_MEMORY_READY_TIME << " chunksize = " <<
 MAIN_MEMORY_ADDRESS_WIDTH << " : chunktime = " << MAIN_MEMORY_CHUNK_SEND_TIME <<
 "\n\n" << endl;

 outfile << "\t Execute time = " << dec << time << ";    Total refs = " << refNum <<
 "\n\t Inst refs = " << iCount << ";    Data refs = " <<  wCount + rCount << "\n\n" << endl;
 outfile << "\t Number of reference types: [Percentage]\n\t      Reads = " << rCount <<
 "     " << "[" << fixed << setprecision(2) <<
 (float) (((float) rCount/(float) (wCount + rCount + iCount)) * 100) << "%]" << endl;
 outfile << "\t      Writes = " << wCount << "     " <<
 "[" << fixed << setprecision(2) <<
 (float) (((float) wCount/(float) (wCount + rCount + iCount)) * 100) << "%]" <<
 endl;
 outfile << "\t      Inst = " << iCount << "     " <<
 "[" << fixed << setprecision(2) <<
 (float) (((float) iCount/(float) (wCount + rCount + iCount)) * 100) << "%]" <<
 endl;
 outfile << "\t      Total = " << wCount + iCount + rCount << "\n\n" << endl;

 outfile << "\t Total cycles for activities: [Percentage]\n\t      Reads = " <<
 rTime << "     " << "[" << fixed << setprecision(2) <<
 (float) (((float) rTime/(float) (wTime + rTime + iTime)) * 100) << "%]" << endl;
 outfile << "\t      Writes = " << wTime << "     " <<
 "[" << fixed << setprecision(2) <<
 (float) (((float) wTime/(float) (wTime + rTime + iTime)) * 100) << "%]" <<
 endl;
 outfile << "\t      Inst = " << iTime << "     " <<
```

```
"[" << fixed << setprecision(2) <<
(float) (((float) iTime/(float) (wTime + rTime + iTime)) * 100) << "%]" <<
endl;
outfile << "\t      Total = " << wTime + iTime + rTime << "\n\n" << endl;

outfile << "\t Average cycles per activity: \n\t      Read = " << fixed << setprecision(2) <<
(float) ((float) rTime/(float) (rCount)) << ";   Write = " << fixed << setprecision(2) <<
(float) ((float) wTime/(float) (wCount))<< ";   Inst. = " << fixed << setprecision(2) <<
float) ((float) time/(float) (iCount))<< endl;

outfile << "\n\n\t Memory Level: L1i \n";
outfile <<"\t      Hit Count = " <<  l1InstCache->hits() << "  " << "Miss Count = " <<
l1InstCache->misses() <<endl;
outfile <<"\t      Total Requests =  " <<  l1InstCache->hits() + l1InstCache->misses() <<endl;
outfile <<"\t      Hit Rate = " <<
"[" << fixed << setprecision(2) <<
(float) (((float) l1InstCache->hits()/ (float) ( l1InstCache->hits() +
l1InstCache->misses())) * 100) <<
"%]" << "  Miss Rate = " <<
"[" << fixed << setprecision(2) <<
(float) (((float) l1InstCache->misses()/ (float) ( l1InstCache->hits() +
l1InstCache->misses())) * 100) <<
"%]" << endl;
outfile <<"\t      Kickouts = " << l1InstCache->kicks()  <<
";  Dirty kickouts = " << l1InstCache->dirtyKicks() <<";  Transfers = " <<
l1InstCache->transfers() << endl;



outfile << "\n\n\t Memory Level: L1d \n";
outfile <<"\t      Hit Count = " <<  l1DataCache->hits() << "  " << "Miss Count = " <<
l1DataCache->misses() <<endl;
outfile <<"\t      Total Requests =  " <<  l1DataCache->hits() +
l1DataCache->misses() <<endl;
outfile <<"\t      Hit Rate = " <<
"[" << fixed << setprecision(2) <<
(float) (((float) l1DataCache->hits()/ (float) ( l1DataCache->hits() +
l1DataCache->misses())) * 100) <<
"%]" << "   Miss Rate = " <<  "[" << fixed << setprecision(2) <<
(float) (((float) l1DataCache->misses()/ (float) ( l1DataCache->hits() +
l1DataCache->misses())) * 100) <<
"%]" << endl;
outfile <<"\t      Kickouts = " << l1DataCache->kicks()  << ";  Dirty kickouts = " <<
l1DataCache->dirtyKicks() <<";  Transfers = " << l1DataCache->transfers() << endl;

outfile << "\n\n\t Memory Level: L2 \n";
outfile <<"\t      Hit Count = " <<  l2Cache->hits() << "  " << "Miss Count = " <<
l2Cache->misses() <<endl;
outfile <<"\t      Total Requests =  " <<  l2Cache->hits() + l2Cache->misses() <<endl;
outfile <<"\t      Hit Rate = " <<  "[" << fixed << setprecision(2) <<
(float) (((float) l2Cache->hits()/ (float) ( l2Cache->hits() + l2Cache->misses())) * 100) <<
"%]" << "   Miss Rate = " <<
"[" << fixed << setprecision(2) <<
(float) (((float) l2Cache->misses()/ (float) ( l2Cache->hits() + l2Cache->misses())) * 100) << "%]"
```

```
    endl;
    outfile <<"\t      Kickouts = " << l2Cache->kicks()  << ";  Dirty kickouts = " <<
    l2Cache->dirtyKicks() <<";  Transfers = " << l2Cache->transfers() << endl;

    outfile << "\n\n\n\t L1 cache cost (Icache $" << l1iCost << ") + (Dcache $" <<
    l1dCost << ") = $" << l1iCost + l1dCost<< "\n";
    outfile << "\t L2 cache cost = $" << l2Cost << ";  Memory cost = $" << memCost << "\n";
    outfile << "\t Total cost = $" << totalCost << endl;


    outfile.close();
  }

  return 0;

}
```

MemoryModule.cpp

```
/**
 * Brian Campuzano, Ryan Riley
 * ECEN 4593, Memory Simulation Project
 * Fall 2013, Professor Pleszkun
 * University of Colorado @ Boulder
 *
 * This file implements the interface described in MemoryModule.h
 */

#include <stddef.h>
#include <iostream>
#include <list>
#include <string>

#include "StdTypes.h"

#include "MemoryModule.h"

using namespace std;

#define MEMORY_MODULE_DEBUG 0
#ifdef MEMORY_MODULE_DEBUG
#define DEBUG_MODULE_COUT(m) cout << m
#else
#define DEBUG_MODULE_COUT(m)
#endif //MEMORY_MODULE_DEBUG

namespace Valhalla
{
  MemoryModule::MemoryModule(void)
  {
    blockSize = 0;
    memorySize = 0;
    associativity = 0;
    hitPenalty = 0;
    transferPenalty = 0;
    nextMemoryModule = NULL;
    hitCount = 0;
    missCount = 0;
    indexBitMask = 0;
    tagBitMask = 0;
    tagShiftAmount = 0;
    indexShiftAmount = 0;
    memoryEntries = NULL;
    dirtyKick = 0;
    kickCount = 0;
    transferCount = 0;
  }

  MemoryModule::MemoryModule(std::string newModuleName,
                uint32 newBlockSize,
```

```
              uint64 newMemorySize,
              uint64 newAssociativity,
              uint32 newHitPenalty,
               uint32 newMissPenalty,
               uint32 mainMemoryStartupPenalty,
               uint32 newTransferPenalty,
               uint32 newBusWidthToNextMemoryModule,
               MemoryModule * newNextMemoryModule,
               std::string newNameNextMemoryModule)
{
  moduleName = newModuleName;
  blockSize = newBlockSize;
  memorySize = newMemorySize;
  associativity = newAssociativity;
  hitPenalty = newHitPenalty;
  missPenalty = newMissPenalty;

  transferPenalty = mainMemoryStartupPenalty +
  newTransferPenalty*(newBlockSize/newBusWidthToNextMemoryModule);

  nextMemoryModule = newNextMemoryModule;
  nameNextMemoryModule = newNameNextMemoryModule;
  hitCount = 0;
  missCount = 0;
  dirtyKick = 0;
  kickCount = 0;
  transferCount = 0;

  if(!initalizeMemoryEntries())
    {
      cerr << "MemoryModule: Failed to initialize memory entries." << endl;
    }
  tagShiftAmount = 0;
  uint64 logHold = rows;
  while(logHold != 1)
    {
      tagShiftAmount++;
      logHold >>= 1;
    }
  indexShiftAmount = 0;
  logHold = blockSize;
  while(logHold != 1)
    {
      indexShiftAmount++;
      logHold >>= 1;
    }
  indexBitMask = rows - 1;
  tagBitMask = ~indexBitMask;
  indexBitMask <<= indexShiftAmount;
  tagBitMask <<= indexShiftAmount;
  tagShiftAmount += indexShiftAmount;
}

uint64 MemoryModule::hits()
```

```
{
  return hitCount;
}

uint64 MemoryModule::misses()
{
  return missCount;
}

uint64 MemoryModule::dirtyKicks()
{
  return dirtyKick;
}

uint64 MemoryModule::kicks()
{
  return kickCount;
}

uint64 MemoryModule::transfers()
{
  return transferCount;
}

uint64 MemoryModule::checkMemoryEntry(CacheOperation operation, uint64 address, uint32 byteSize)
{
  if(nextMemoryModule == NULL)
    {
      //Main memory, increment hit counter return 0
      hitCount++;
      return 0;
    }

  uint64 rv = 0;
  uint64 index = 0;
  uint64 tag = 0;
  uint64 writeBackAddress = 0;
  uint64 endAddressValue = address + byteSize;
  bool hitFlag = false;

  for(; address < endAddressValue; address += blockSize)
    {
      DEBUG_MODULE_COUT("Level " << moduleName << " access addr = 0x" << hex <<
      address << ", reftype = " << dec << operation << endl);
      index = (address & indexBitMask) >> indexShiftAmount;
      tag = (address & tagBitMask) >> tagShiftAmount;
      DEBUG_MODULE_COUT("    index = 0x" << hex << index << ", tag = 0x" << tag);
      for(MemoryList::iterator it = memoryEntries[index].begin(); it != memoryEntries[index].end(); i
        {
          if((it->validBit == true) && (it->tag == tag))
            {
              DEBUG_MODULE_COUT("  HIT" << endl);
              //cache hit, LRU bump
              //copy MemoryEntry and push it to the front, then delete old entry
```

```
                //unsure if this will create a copy...
                MemoryEntry hit = MemoryEntry((*it));
                if(operation == CACHE_WRITE)
                  {
                    hit.dirtyBit = true;
                  }
                memoryEntries[index].push_front(hit);
                memoryEntries[index].erase(it);
                hitCount++;
#ifdef MEMORY_MODULE_DEBUG
                cout << "Add " <<  moduleName << " hit time (+ " << dec << hitPenalty << ")" << endl;
#endif
                rv += hitPenalty;
                hitFlag = true;
                break;
              }
          }
        if(hitFlag)
          {
            hitFlag = false;
            continue;
          }
        DEBUG_MODULE_COUT("  MISS" << endl);
        rv += missPenalty;
#ifdef MEMORY_MODULE_DEBUG
        cout << "Add " << moduleName << "miss time (+ " << dec << missPenalty << ")" << endl;
#endif

        //cache miss write it to cache via LRU
        MemoryEntry missed = MemoryEntry();
        missed.validBit = true;
        if(operation == CACHE_WRITE)
          {
            missed.dirtyBit = true;
          }
        else
          {
            missed.dirtyBit = false;
          }
        missed.tag = tag;
        //delete last memory entry
        MemoryEntry toDelete = memoryEntries[index].back();
        transferCount++;
    if(toDelete.validBit){
      kickCount++;
      if(toDelete.dirtyBit)
        {
          //need to write entry, reconstruct address.
          DEBUG_MODULE_COUT("    checkMemoryEntry: write back needed");
          writeBackAddress = (toDelete.tag << tagShiftAmount) | (index << indexShiftAmount);
          rv += transferPenalty +
          nextMemoryModule->checkMemoryEntry(CACHE_WRITE, writeBackAddress, blockSize);
          dirtyKick++;
        }
```

```
    }
        memoryEntries[index].pop_back();
        //put cache miss at front.
        memoryEntries[index].push_front(missed);

        missCount++;
        if(operation == CACHE_READ)
          {
            rv += nextMemoryModule->checkMemoryEntry(operation, address, blockSize);
            DEBUG_MODULE_COUT("Bringing line into " << moduleName << "." << endl);
            rv += transferPenalty;
            DEBUG_MODULE_COUT("Add " << nameNextMemoryModule << " to " <<
            moduleName << " transfer time (+ "  << dec << transferPenalty << ")" << endl);
            rv += hitPenalty;
#ifdef MEMORY_MODULE_DEBUG
            cout << "Add " << moduleName << "hit replay time (+ " << hitPenalty << ")" << endl;
#endif
          }
        else
          {
        //operation is a cache write, and missed the cache, this code isn't right
            rv += transferPenalty + nextMemoryModule->checkMemoryEntry(CACHE_READ, address, blockSize);
            rv += hitPenalty;
          }
      }
    return rv;
  }

  bool MemoryModule::initalizeMemoryEntries(void)
  {
    if(blockSize == 0 || associativity == 0)
      {
        cerr << "initalizeMemoryEntries: blockSize or associativity equals 0." << endl;
        return false;
      }
    rows = (memorySize/blockSize)/associativity;
    if(rows == 0)
      {
        cerr << "initalizeMemoryEntries: memory rows equals 0." << endl;
        return false;
      }
    MemoryEntry temp;
    memoryEntries = new MemoryList[rows];
    for(uint64 i = 0; i < rows; i++)
      {
        for(uint64 j = 0; j < associativity; j++)
          {
            temp = MemoryEntry();
            temp.validBit = false;
            temp.dirtyBit = false;
            temp.tag = 0;
            memoryEntries[i].push_back(temp);
          }
      }
```

```
    return true;
  }

  void MemoryModule::printMemoryModuleSetup(void)
  {
#ifdef MEMORY_MODULE_DEBUG
    DEBUG_MODULE_COUT("Block Size: " << blockSize << endl);
    DEBUG_MODULE_COUT("Memory Size: " << memorySize << endl);
    DEBUG_MODULE_COUT("Associativity: " << associativity << endl);
    DEBUG_MODULE_COUT("Hit Penalty: " << hitPenalty << endl);
    DEBUG_MODULE_COUT("Transfer Penalty: " << transferPenalty << endl);
    DEBUG_MODULE_COUT("Hit Count: " << hitCount << endl);
    DEBUG_MODULE_COUT("Miss Count: " << missCount << endl);
    DEBUG_MODULE_COUT("Hit Penalty: " << hitPenalty << endl);
    DEBUG_MODULE_COUT("Rows: " << rows << endl);
    DEBUG_MODULE_COUT("Index Bit Mask: 0x" << hex << indexBitMask << endl);
    DEBUG_MODULE_COUT("Tag Bit Mask: 0x" << hex << tagBitMask << dec << endl);
    DEBUG_MODULE_COUT("Tag Shift Amount: " << tagShiftAmount << endl);
    DEBUG_MODULE_COUT("Index Shift Amount: " << indexShiftAmount << endl);
    if(nextMemoryModule == NULL)
      {
        DEBUG_MODULE_COUT("Next Memory Module Doesn't Exist" << endl);
      }
    else
      {
        DEBUG_MODULE_COUT("Next Memory Module Exists" << endl);
      }
    if(memoryEntries == NULL)
      {
        DEBUG_MODULE_COUT("Memory Entries are NULL" << endl);
      }
    else
      {
        DEBUG_MODULE_COUT("Memory Entries not NULL" << endl);
        //printMemoryEntries();
      }
#endif //MEMORY_MODULE_DEBUG
  }

  void MemoryModule::printMemoryEntries(void)
  {
#ifdef MEMORY_MODULE_DEBUG
    uint64 j;
    for(uint64 i = 0; i < rows; i++)
      {
        j = 0;
        for(MemoryList::const_iterator it = memoryEntries[i].begin(); it != memoryEntries[i].end(); it+
          {
            DEBUG_MODULE_COUT("(" << i << "," << j<< ") Valid: " << it->validBit <<
            ", Dirty: " << it->dirtyBit << ", Tag: " << it->tag << endl);
            j++;
          }
      }
```

```
#endif //MEMORY_MODULE_DEBUG
  }
}
```