Appendix: Architecturally-independent and time-based characterization of SPEC CPU 2017

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Abstract—This is an appendix to our ISPASS 2020 extended abstract [1].

REFERENCES

I. APPENDIX
This appendix contains plots of all the SPEC 2006 and SPEC 2017 benchmarks. Each benchmark has 7 figures. Figure (a) is the time-based plot as a function of cache size for different cache sizes. Figure (b), (c), and (d) show the execution being aggregated into MPKI bins. Figure (e) shows the aggregate MPKI. Figure (f) and (g) show the percentage of misses that occur in different MPKI bins when the program execution was in a particular MPKI bin.
(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2017 - cactuBSSN - 5003B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2017 - exchange2 - 4339B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2017 - fotonik3d - 5003B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2017 - gcc i.p. 1 - 1254B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2017 - gcc i.p. 2 - 573B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2017 - gcc i.p. 3 - 543B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2017 - ibm - 4312B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2017 - leela - 2238B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2017 - mcf - 1654B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2017 - nab - 5003B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching

% change in execution
Memory Behavior Analysis: SPEC 2017 - perlbench i.p. 1 - 135B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2017 - perlbench i.p. 2 - 720B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching

Cache Size vs. MPKI over time and cache size

% of misses vs. cache size

% of execution vs. cache size

MPKI Bins vs. % change in execution

MPKI Bins vs. % of execution
Memory Behavior Analysis: SPEC 2017 - perlbench i.p. 3 - 683B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2017 - x264 i.p 3 - 1897B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2017 - xalancbmk - 1296B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2017 - xz i.p. 2 - 3341B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - astart i.p. 1 - 380B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - astar i.p. 2 - 797B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - bzip2 i.p. 1 - 404B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - bzip2 i.p. 2 - 175B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

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(c) Execution without Prefetching

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(d) Effects of Prefetching

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(e) Aggregate MPKI

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(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - bzip2 i.p. 3 - 296B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - bzip2 i.p. 5 - 615B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - bzip2 i.p. 6 - 324B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - dealII - 1915B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - gamess i.p. 1 - 365B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - gamess i.p. 2 - 90B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - gamess i.p. 3 - 1042B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - gcc i.p. 1 - 72B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - gcc i.p. 3 - 131B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - gcc i.p. 5 - 107B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - gcc i.p. 6 - 145B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - gcc i.p. 7 - 174B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - gcc i.p. 8 - 159B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - gcc i.p. 9 - 54B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - gemsfdtd - 1475B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI
Memory Behavior Analysis: SPEC 2006 - gobmk i.p. 1 - 224B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - gobmk i.p. 2 - 594B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - gobmk i.p. 4 - 224B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - gobmk i.p. 5 - 321B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - h264 i.p. 1 - 495B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - h264 i.p. 2 - 323B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - h264 i.p. 3 - 2882B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - lbm - 1273B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

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(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - libquantum - 1640B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - mcf - 304B instructions

(a) MPKI over time and cache size (prefetching enabled)

<table>
<thead>
<tr>
<th>Cache Size</th>
<th>Billion of Instructions</th>
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<tbody>
<tr>
<td>32KB</td>
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<tr>
<td>64KB</td>
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<tr>
<td>128KB</td>
<td>2.24</td>
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<tr>
<td>256KB</td>
<td>0.22</td>
</tr>
<tr>
<td>512KB</td>
<td>0.1</td>
</tr>
<tr>
<td>1GB</td>
<td>0.1</td>
</tr>
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</table>

(b) Execution with Prefetching

<table>
<thead>
<tr>
<th>Cache Size</th>
<th>% of misses</th>
</tr>
</thead>
<tbody>
<tr>
<td>32KB</td>
<td>5.69</td>
</tr>
<tr>
<td>64KB</td>
<td>17.62</td>
</tr>
<tr>
<td>128KB</td>
<td>17.42</td>
</tr>
<tr>
<td>256KB</td>
<td>17.99</td>
</tr>
<tr>
<td>512KB</td>
<td>17.62</td>
</tr>
<tr>
<td>1GB</td>
<td>18.44</td>
</tr>
</tbody>
</table>

(c) Execution without Prefetching

<table>
<thead>
<tr>
<th>Cache Size</th>
<th>% of misses</th>
</tr>
</thead>
<tbody>
<tr>
<td>32KB</td>
<td>5.69</td>
</tr>
<tr>
<td>64KB</td>
<td>17.62</td>
</tr>
<tr>
<td>128KB</td>
<td>17.42</td>
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<tr>
<td>256KB</td>
<td>17.99</td>
</tr>
<tr>
<td>512KB</td>
<td>17.62</td>
</tr>
<tr>
<td>1GB</td>
<td>18.44</td>
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</table>

(d) Effects of Prefetching

<table>
<thead>
<tr>
<th>Cache Size</th>
<th>MPKI Bins</th>
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<tbody>
<tr>
<td>32KB</td>
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<td>512KB</td>
<td>17.62</td>
</tr>
<tr>
<td>1GB</td>
<td>18.44</td>
</tr>
</tbody>
</table>

(e) Aggregate MPKI

<table>
<thead>
<tr>
<th>Cache Size</th>
<th>% of execution</th>
</tr>
</thead>
<tbody>
<tr>
<td>32KB</td>
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</tr>
<tr>
<td>64KB</td>
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<tr>
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<td>17.99</td>
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<td>512KB</td>
<td>17.62</td>
</tr>
<tr>
<td>1GB</td>
<td>18.44</td>
</tr>
</tbody>
</table>

(f) Execution with Prefetching

<table>
<thead>
<tr>
<th>Cache Size</th>
<th>MPKI Bins</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
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<tr>
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<td>512KB</td>
<td>17.62</td>
</tr>
<tr>
<td>1GB</td>
<td>18.44</td>
</tr>
</tbody>
</table>

(g) Execution without Prefetching

<table>
<thead>
<tr>
<th>Cache Size</th>
<th>MPKI Bins</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>64KB</td>
<td>17.62</td>
</tr>
<tr>
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<td>256KB</td>
<td>17.99</td>
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<td>512KB</td>
<td>17.62</td>
</tr>
<tr>
<td>1GB</td>
<td>18.44</td>
</tr>
</tbody>
</table>
Memory Behavior Analysis: SPEC 2006 - namd - 2211B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - omnetpp - 564B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - perl i.p. 1 - 135B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - perl i.p. 2 - 53B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - perl i.p. 3 - 652B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - porvay - 956B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - sjeng - 2209B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - soplex i.p. 1 - 336B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - soplex i.p. 2 - 350B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - sphinx3 - 3118B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - wrf - 3013B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - xalancbmk - 921B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching
Memory Behavior Analysis: SPEC 2006 - zeusmp - 1814B instructions

(a) MPKI over time and cache size (prefetching enabled)

(b) Execution with Prefetching

(c) Execution without Prefetching

(d) Effects of Prefetching

(e) Aggregate MPKI

(f) Execution with Prefetching

(g) Execution without Prefetching

Cache Size

<table>
<thead>
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<th>128MB</th>
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</tr>
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<th>10-20</th>
<th>20-inf</th>
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<td>0.00</td>
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</table>

<table>
<thead>
<tr>
<th>% of execution</th>
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<table>
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<th>% change in execution</th>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>% of misses</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>0.00</td>
</tr>
<tr>
<td>0.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Memory Behavior Analysis: SPEC 2006 - zeusmp - 1814B instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) MPKI over time and cache size (prefetching enabled)</td>
</tr>
<tr>
<td>(b) Execution with Prefetching</td>
</tr>
<tr>
<td>(c) Execution without Prefetching</td>
</tr>
<tr>
<td>(d) Effects of Prefetching</td>
</tr>
<tr>
<td>(e) Aggregate MPKI</td>
</tr>
<tr>
<td>(f) Execution with Prefetching</td>
</tr>
<tr>
<td>(g) Execution without Prefetching</td>
</tr>
</tbody>
</table>