## Effect of following parameters on overall performance of cache

### L1 Cache size vs. Miss rate (For different associativity) [Without L2]

gcc\_trace:

perl\_trace:

Block Size = 64

go\_trace:

vortex\_trace:

### Associativity vs. Miss rate

gcc\_trace:

perl\_trace:

L1 Size = 8192 bytes, Block Size = 64

go\_trace:

vortex\_trace:

### L2 Cache size vs. miss rate (keep L1 size constant)

gcc\_trace:

perl\_trace:

L1 Size = 256 bytes, L1 associativity = 4, Block size = 32

go\_trace:

vortex\_trace:

### Vary size of N address tags in decoupled sector cache vs miss rate (Keep L1 constant, P constant)

gcc\_trace:

perl\_trace:

L2 size = 32768 bytes, L2 Associativity = 1, P = 8, L1 Size =256 bytes, L1 Associativity = 4, Block size = 32

go\_trace:

vortex\_trace:

### Vary size of P data blocks in decoupled sector cache vs miss rate (Keep L1 constant, N constant)

gcc\_trace:

perl\_trace:

L2 size = 32768 bytes, L2 Associativity = 1, N = 1, L1 Size =256 bytes, L1 Associativity = 4, Block size = 32

go\_trace:

vortex\_trace:

## Thoroughly explore the design space and discuss noteworthy trends

### L1 without L2

gcc\_trace:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L1\_MISS\_RATE** | **AAT\_L1** |
| 64 | 2048 | 1 | 0.16122 | 3.93161 |
| 64 | 4096 | 1 | 0.10214 | 2.64161 |
| 64 | 8192 | 1 | 0.06582 | 1.8621 |
| 64 | 16384 | 1 | 0.03931 | 1.31795 |
| 64 | 32768 | 1 | 0.02977 | 1.18619 |
| 64 | 65536 | 1 | 0.0223 | 1.1781 |
| 64 | 2048 | 2 | 0.11584 | 2.95825 |
| 64 | 4096 | 2 | 0.07839 | 2.14411 |
| 64 | 8192 | 2 | 0.04551 | 1.44028 |
| 64 | 16384 | 2 | 0.026 | 1.05013 |
| 64 | 32768 | 2 | 0.01831 | 0.95907 |
| 64 | 65536 | 2 | 0.01613 | 1.06736 |
| 64 | 2048 | 4 | 0.10326 | 2.73149 |
| 64 | 4096 | 4 | 0.06189 | 1.83111 |
| 64 | 8192 | 4 | 0.03859 | 1.33804 |
| 64 | 16384 | 4 | 0.02045 | 0.978025 |
| 64 | 32768 | 4 | 0.01558 | 0.94901 |
| 64 | 65536 | 4 | 0.01466 | 1.08502 |
| 64 | 2048 | 8 | 0.09957 | 2.75031 |
| 64 | 4096 | 8 | 0.05991 | 1.88755 |
| 64 | 8192 | 8 | 0.03161 | 1.28448 |
| 64 | 16384 | 8 | 0.01958 | 1.05888 |
| 64 | 32768 | 8 | 0.015 | 1.03625 |
| 64 | 65536 | 8 | 0.01461 | 1.18392 |
| 64 | 2048 | 16 | 0.09626 | 2.87749 |
| 64 | 4096 | 16 | 0.05829 | 2.05191 |
| 64 | 8192 | 16 | 0.02856 | 1.41738 |
| 64 | 16384 | 16 | 0.01839 | 1.2327 |
| 64 | 32768 | 16 | 0.01498 | 1.23581 |
| 64 | 65536 | 16 | 0.01459 | 1.38348 |
| 64 | 2048 | 32 | 0.09471 | 3.24339 |
| 64 | 4096 | 32 | 0.05571 | 2.39515 |
| 64 | 8192 | 32 | 0.02857 | 1.8176 |
| 64 | 16384 | 32 | 0.01824 | 1.62941 |
| 64 | 32768 | 32 | 0.015 | 1.63625 |
| 64 | 65536 | 32 | 0.01459 | 1.78348 |
| 64 | 4096 | 64 | 0.05411 | 3.15995 |
| 64 | 8192 | 64 | 0.02779 | 2.60044 |
| 64 | 16384 | 64 | 0.01829 | 2.43051 |
| 64 | 32768 | 64 | 0.01499 | 2.43603 |
| 64 | 65536 | 64 | 0.01457 | 2.58304 |

perl\_trace:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L1\_MISS\_RATE** | **AAT\_L1** |
| 64 | 2048 | 1 | 0.21855 | 5.19287 |
| 64 | 4096 | 1 | 0.13725 | 3.41403 |
| 64 | 8192 | 1 | 0.09257 | 2.4506 |
| 64 | 16384 | 1 | 0.05789 | 1.72671 |
| 64 | 32768 | 1 | 0.04292 | 1.47549 |
| 64 | 65536 | 1 | 0.01448 | 1.00606 |
| 64 | 2048 | 2 | 0.16704 | 4.08465 |
| 64 | 4096 | 2 | 0.10552 | 2.74097 |
| 64 | 8192 | 2 | 0.03878 | 1.29222 |
| 64 | 16384 | 2 | 0.01783 | 0.870385 |
| 64 | 32768 | 2 | 0.01264 | 0.83433 |
| 64 | 65536 | 2 | 0.00879 | 0.90588 |
| 64 | 2048 | 4 | 0.15237 | 3.81191 |
| 64 | 4096 | 4 | 0.06866 | 1.98005 |
| 64 | 8192 | 4 | 0.02929 | 1.13344 |
| 64 | 16384 | 4 | 0.01337 | 0.822265 |
| 64 | 32768 | 4 | 0.0091 | 0.80645 |
| 64 | 65536 | 4 | 0.0086 | 0.9517 |
| 64 | 2048 | 8 | 0.14645 | 3.78167 |
| 64 | 4096 | 8 | 0.0594 | 1.87633 |
| 64 | 8192 | 8 | 0.02629 | 1.16744 |
| 64 | 16384 | 8 | 0.01197 | 0.891465 |
| 64 | 32768 | 8 | 0.00879 | 0.89963 |
| 64 | 65536 | 8 | 0.00854 | 1.05038 |
| 64 | 2048 | 16 | 0.13946 | 3.82789 |
| 64 | 4096 | 16 | 0.05433 | 1.96479 |
| 64 | 8192 | 16 | 0.0254 | 1.34786 |
| 64 | 16384 | 16 | 0.01122 | 1.07497 |
| 64 | 32768 | 16 | 0.00862 | 1.09589 |
| 64 | 65536 | 16 | 0.00854 | 1.25038 |
| 64 | 2048 | 32 | 0.13612 | 4.15441 |
| 64 | 4096 | 32 | 0.04598 | 2.18109 |
| 64 | 8192 | 32 | 0.02587 | 1.7582 |
| 64 | 16384 | 32 | 0.01075 | 1.46463 |
| 64 | 32768 | 32 | 0.00855 | 1.49435 |
| 64 | 65536 | 32 | 0.00854 | 1.65038 |
| 64 | 4096 | 64 | 0.04602 | 2.98197 |
| 64 | 8192 | 64 | 0.02574 | 2.55534 |
| 64 | 16384 | 64 | 0.0107 | 2.26353 |
| 64 | 32768 | 64 | 0.00856 | 2.29457 |
| 64 | 65536 | 64 | 0.00854 | 2.45038 |

go\_trace:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L1\_MISS\_RATE** | **AAT\_L1** |
| 64 | 2048 | 1 | 0.08516 | 2.25829 |
| 64 | 4096 | 1 | 0.06099 | 1.73631 |
| 64 | 8192 | 1 | 0.04356 | 1.37238 |
| 64 | 16384 | 1 | 0.0401 | 1.33533 |
| 64 | 32768 | 1 | 0.0319 | 1.23305 |
| 64 | 65536 | 1 | 0.02735 | 1.2892 |
| 64 | 2048 | 2 | 0.07231 | 2.00059 |
| 64 | 4096 | 2 | 0.03348 | 1.15609 |
| 64 | 8192 | 2 | 0.02989 | 1.09664 |
| 64 | 16384 | 2 | 0.02882 | 1.11216 |
| 64 | 32768 | 2 | 0.02872 | 1.18809 |
| 64 | 65536 | 2 | 0.02447 | 1.25084 |
| 64 | 2048 | 4 | 0.03231 | 1.17059 |
| 64 | 4096 | 4 | 0.02994 | 1.12821 |
| 64 | 8192 | 4 | 0.02874 | 1.12134 |
| 64 | 16384 | 4 | 0.02871 | 1.15974 |
| 64 | 32768 | 4 | 0.02869 | 1.23743 |
| 64 | 65536 | 4 | 0.02645 | 1.3444 |
| 64 | 2048 | 8 | 0.0299 | 1.21757 |
| 64 | 4096 | 8 | 0.02877 | 1.20247 |
| 64 | 8192 | 8 | 0.02874 | 1.22134 |
| 64 | 16384 | 8 | 0.0287 | 1.25952 |
| 64 | 32768 | 8 | 0.02869 | 1.33743 |
| 64 | 65536 | 8 | 0.02826 | 1.48422 |
| 64 | 2048 | 16 | 0.02921 | 1.40239 |
| 64 | 4096 | 16 | 0.02877 | 1.40247 |
| 64 | 8192 | 16 | 0.02873 | 1.42112 |
| 64 | 16384 | 16 | 0.0287 | 1.45952 |
| 64 | 32768 | 16 | 0.02869 | 1.53743 |
| 64 | 65536 | 16 | 0.02869 | 1.69368 |
| 64 | 2048 | 32 | 0.02898 | 1.79733 |
| 64 | 4096 | 32 | 0.02877 | 1.80247 |
| 64 | 8192 | 32 | 0.02873 | 1.82112 |
| 64 | 16384 | 32 | 0.02869 | 1.85931 |
| 64 | 32768 | 32 | 0.02869 | 1.93743 |
| 64 | 65536 | 32 | 0.02869 | 2.09368 |
| 64 | 4096 | 64 | 0.02877 | 2.60247 |
| 64 | 8192 | 64 | 0.02873 | 2.62112 |
| 64 | 16384 | 64 | 0.02869 | 2.65931 |
| 64 | 32768 | 64 | 0.02869 | 2.73743 |
| 64 | 65536 | 64 | 0.02869 | 2.89368 |

vortex\_trace:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L1\_MISS\_RATE** | **AAT\_L1** |
| 64 | 2048 | 1 | 0.14528 | 3.58093 |
| 64 | 4096 | 1 | 0.0939 | 2.46033 |
| 64 | 8192 | 1 | 0.05979 | 1.72944 |
| 64 | 16384 | 1 | 0.0412 | 1.35952 |
| 64 | 32768 | 1 | 0.01391 | 0.83727 |
| 64 | 65536 | 1 | 0.01178 | 0.94666 |
| 64 | 2048 | 2 | 0.09773 | 2.55983 |
| 64 | 4096 | 2 | 0.05417 | 1.61127 |
| 64 | 8192 | 2 | 0.02571 | 1.00468 |
| 64 | 16384 | 2 | 0.01431 | 0.792945 |
| 64 | 32768 | 2 | 0.01064 | 0.79033 |
| 64 | 65536 | 2 | 0.00927 | 0.91644 |
| 64 | 2048 | 4 | 0.08432 | 2.31481 |
| 64 | 4096 | 4 | 0.03467 | 1.23227 |
| 64 | 8192 | 4 | 0.0201 | 0.931262 |
| 64 | 16384 | 4 | 0.01166 | 0.784645 |
| 64 | 32768 | 4 | 0.00951 | 0.81547 |
| 64 | 65536 | 4 | 0.00899 | 0.96028 |
| 64 | 2048 | 8 | 0.0794 | 2.30657 |
| 64 | 4096 | 8 | 0.02945 | 1.21743 |
| 64 | 8192 | 8 | 0.01654 | 0.952942 |
| 64 | 16384 | 8 | 0.01121 | 0.874745 |
| 64 | 32768 | 8 | 0.00928 | 0.91041 |
| 64 | 65536 | 8 | 0.00897 | 1.05984 |
| 64 | 2048 | 16 | 0.07922 | 2.50261 |
| 64 | 4096 | 16 | 0.02915 | 1.41083 |
| 64 | 8192 | 16 | 0.0155 | 1.13006 |
| 64 | 16384 | 16 | 0.01088 | 1.06748 |
| 64 | 32768 | 16 | 0.0092 | 1.10865 |
| 64 | 65536 | 16 | 0.00897 | 1.25984 |
| 64 | 2048 | 32 | 0.07349 | 2.77655 |
| 64 | 4096 | 32 | 0.029 | 1.80753 |
| 64 | 8192 | 32 | 0.01499 | 1.51884 |
| 64 | 16384 | 32 | 0.0108 | 1.46573 |
| 64 | 32768 | 32 | 0.00912 | 1.50689 |
| 64 | 65536 | 32 | 0.00897 | 1.65984 |
| 64 | 4096 | 64 | 0.029 | 2.60753 |
| 64 | 8192 | 64 | 0.01496 | 2.31818 |
| 64 | 16384 | 64 | 0.01073 | 2.26418 |
| 64 | 32768 | 64 | 0.00912 | 2.30689 |
| 64 | 65536 | 64 | 0.00897 | 2.45984 |

### L2

#### AAT v/s Cache Size (for different associativity)

gcc\_trace:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **L2\_MISS\_RATE** | **AAT\_L1** | **AAT\_L2** |
| 32 | 256 | 4 | 2048 | 1 | 0.459806 | 3.89582 | 12.2407 |
| 32 | 256 | 4 | 4096 | 1 | 0.335318 | 3.15226 | 9.63621 |
| 32 | 256 | 4 | 8192 | 1 | 0.230411 | 2.52889 | 7.45269 |
| 32 | 256 | 4 | 16384 | 1 | 0.160111 | 2.11857 | 6.01545 |
| 32 | 256 | 4 | 32768 | 1 | 0.130898 | 1.96574 | 5.4801 |
| 32 | 256 | 4 | 65536 | 1 | 0.11433 | 1.91101 | 5.28842 |
| 32 | 256 | 4 | 131072 | 1 | 0.112193 | 1.98742 | 5.55605 |
| 32 | 256 | 4 | 2048 | 2 | 0.374479 | 3.39139 | 10.4738 |
| 32 | 256 | 4 | 4096 | 2 | 0.263232 | 2.72722 | 8.1474 |
| 32 | 256 | 4 | 8192 | 2 | 0.166276 | 2.15152 | 6.13085 |
| 32 | 256 | 4 | 16384 | 2 | 0.118813 | 1.87812 | 5.1732 |
| 32 | 256 | 4 | 32768 | 2 | 0.100914 | 1.79311 | 4.87545 |
| 32 | 256 | 4 | 65536 | 2 | 0.0950296 | 1.80244 | 4.90812 |
| 32 | 256 | 4 | 131072 | 2 | 0.0907212 | 1.86583 | 5.13015 |
| 32 | 256 | 4 | 2048 | 4 | 0.33749 | 3.18391 | 9.74705 |
| 32 | 256 | 4 | 4096 | 4 | 0.210165 | 2.42335 | 7.083 |
| 32 | 256 | 4 | 8192 | 4 | 0.148972 | 2.06205 | 5.81747 |
| 32 | 256 | 4 | 16384 | 4 | 0.0991979 | 1.77479 | 4.81128 |
| 32 | 256 | 4 | 32768 | 4 | 0.0924726 | 1.75678 | 4.74817 |
| 32 | 256 | 4 | 65536 | 4 | 0.0908964 | 1.79193 | 4.87132 |
| 32 | 256 | 4 | 131072 | 4 | 0.090441 | 1.87842 | 5.17426 |
| 32 | 256 | 4 | 2048 | 8 | 0.318435 | 3.09822 | 9.4469 |
| 32 | 256 | 4 | 4096 | 8 | 0.187993 | 2.31896 | 6.71738 |
| 32 | 256 | 4 | 8192 | 8 | 0.138639 | 2.02865 | 5.70048 |
| 32 | 256 | 4 | 16384 | 8 | 0.0971663 | 1.79116 | 4.86862 |
| 32 | 256 | 4 | 32768 | 8 | 0.0919472 | 1.78218 | 4.83714 |
| 32 | 256 | 4 | 65536 | 8 | 0.0906862 | 1.81922 | 4.96691 |
| 32 | 256 | 4 | 131072 | 8 | 0.090441 | 1.90697 | 5.27426 |
| 32 | 256 | 4 | 2048 | 16 | 0.306596 | 3.08433 | 9.39828 |
| 32 | 256 | 4 | 4096 | 16 | 0.185856 | 2.36325 | 6.87251 |
| 32 | 256 | 4 | 8192 | 16 | 0.137098 | 2.07651 | 5.86811 |
| 32 | 256 | 4 | 16384 | 16 | 0.0926828 | 1.82138 | 4.97446 |
| 32 | 256 | 4 | 32768 | 16 | 0.0918771 | 1.83885 | 5.03567 |
| 32 | 256 | 4 | 65536 | 16 | 0.0905461 | 1.87548 | 5.16397 |
| 32 | 256 | 4 | 131072 | 16 | 0.090441 | 1.96407 | 5.47426 |
| 32 | 256 | 4 | 2048 | 32 | 0.307401 | 3.20336 | 9.81519 |
| 32 | 256 | 4 | 4096 | 32 | 0.179446 | 2.43902 | 7.13789 |
| 32 | 256 | 4 | 8192 | 32 | 0.137763 | 2.19469 | 6.28209 |
| 32 | 256 | 4 | 16384 | 32 | 0.0922624 | 1.93306 | 5.36564 |
| 32 | 256 | 4 | 32768 | 32 | 0.0919472 | 1.95347 | 5.43714 |
| 32 | 256 | 4 | 65536 | 32 | 0.0905811 | 1.98989 | 5.5647 |
| 32 | 256 | 4 | 131072 | 32 | 0.090441 | 2.07826 | 5.87426 |
| 32 | 256 | 4 | 2048 | 64 | 0.309713 | 3.44561 | 10.6637 |
| 32 | 256 | 4 | 4096 | 64 | 0.175768 | 2.64536 | 7.86066 |
| 32 | 256 | 4 | 8192 | 64 | 0.137728 | 2.42288 | 7.08135 |
| 32 | 256 | 4 | 16384 | 64 | 0.0922624 | 2.16145 | 6.16564 |
| 32 | 256 | 4 | 32768 | 64 | 0.0919122 | 2.18165 | 6.23641 |
| 32 | 256 | 4 | 65536 | 64 | 0.0906161 | 2.21849 | 6.36544 |
| 32 | 256 | 4 | 131072 | 64 | 0.090441 | 2.30666 | 6.67426 |

perl\_trace:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **L2\_MISS\_RATE** | **AAT\_L1** | **AAT\_L2** |
| 32 | 256 | 4 | 2048 | 1 | 0.461005 | 5.36791 | 12.2659 |
| 32 | 256 | 4 | 4096 | 1 | 0.273437 | 3.77692 | 8.3367 |
| 32 | 256 | 4 | 8192 | 1 | 0.171762 | 2.92026 | 6.22107 |
| 32 | 256 | 4 | 16384 | 1 | 0.127531 | 2.55996 | 5.33128 |
| 32 | 256 | 4 | 32768 | 1 | 0.0997481 | 2.35535 | 4.82596 |
| 32 | 256 | 4 | 65536 | 1 | 0.0493925 | 1.99043 | 3.92474 |
| 32 | 256 | 4 | 131072 | 1 | 0.045935 | 2.08756 | 4.16464 |
| 32 | 256 | 4 | 2048 | 2 | 0.385311 | 4.73439 | 10.7013 |
| 32 | 256 | 4 | 4096 | 2 | 0.218142 | 3.31685 | 7.20051 |
| 32 | 256 | 4 | 8192 | 2 | 0.09024 | 2.23717 | 4.5341 |
| 32 | 256 | 4 | 16384 | 2 | 0.0511953 | 1.92098 | 3.75323 |
| 32 | 256 | 4 | 32768 | 2 | 0.0442804 | 1.89381 | 3.68614 |
| 32 | 256 | 4 | 65536 | 2 | 0.0375383 | 1.89975 | 3.7008 |
| 32 | 256 | 4 | 131072 | 2 | 0.0374148 | 2.02524 | 4.01071 |
| 32 | 256 | 4 | 2048 | 4 | 0.338511 | 4.35668 | 9.7685 |
| 32 | 256 | 4 | 4096 | 4 | 0.146869 | 2.73104 | 5.75377 |
| 32 | 256 | 4 | 8192 | 4 | 0.0669762 | 2.0596 | 4.09556 |
| 32 | 256 | 4 | 16384 | 4 | 0.0436382 | 1.87696 | 3.64453 |
| 32 | 256 | 4 | 32768 | 4 | 0.0377358 | 1.85841 | 3.5987 |
| 32 | 256 | 4 | 65536 | 4 | 0.0374148 | 1.91895 | 3.74821 |
| 32 | 256 | 4 | 131072 | 4 | 0.0372913 | 2.04443 | 4.05812 |
| 32 | 256 | 4 | 2048 | 8 | 0.332066 | 4.34236 | 9.73314 |
| 32 | 256 | 4 | 4096 | 8 | 0.113751 | 2.48992 | 5.1583 |
| 32 | 256 | 4 | 8192 | 8 | 0.0613208 | 2.052 | 4.0768 |
| 32 | 256 | 4 | 16384 | 8 | 0.0415144 | 1.8994 | 3.69993 |
| 32 | 256 | 4 | 32768 | 8 | 0.0373901 | 1.89596 | 3.69144 |
| 32 | 256 | 4 | 65536 | 8 | 0.0372913 | 1.95839 | 3.84562 |
| 32 | 256 | 4 | 131072 | 8 | 0.0372913 | 2.08493 | 4.15812 |
| 32 | 256 | 4 | 2048 | 16 | 0.313049 | 4.26165 | 9.5338 |
| 32 | 256 | 4 | 4096 | 16 | 0.113183 | 2.56607 | 5.34637 |
| 32 | 256 | 4 | 8192 | 16 | 0.0580855 | 2.10547 | 4.20886 |
| 32 | 256 | 4 | 16384 | 16 | 0.0405265 | 1.97198 | 3.87918 |
| 32 | 256 | 4 | 32768 | 16 | 0.0372913 | 1.9761 | 3.88937 |
| 32 | 256 | 4 | 65536 | 16 | 0.0372913 | 2.03937 | 4.04562 |
| 32 | 256 | 4 | 131072 | 16 | 0.0372913 | 2.16591 | 4.35812 |
| 32 | 256 | 4 | 2048 | 32 | 0.337301 | 4.62984 | 10.4431 |
| 32 | 256 | 4 | 4096 | 32 | 0.111355 | 2.7125 | 5.70799 |
| 32 | 256 | 4 | 8192 | 32 | 0.057073 | 2.25883 | 4.5876 |
| 32 | 256 | 4 | 16384 | 32 | 0.040329 | 2.13227 | 4.27503 |
| 32 | 256 | 4 | 32768 | 32 | 0.037316 | 2.13828 | 4.28989 |
| 32 | 256 | 4 | 65536 | 32 | 0.0372913 | 2.20134 | 4.44562 |
| 32 | 256 | 4 | 131072 | 32 | 0.0372913 | 2.32788 | 4.75812 |
| 32 | 256 | 4 | 2048 | 64 | 0.338659 | 4.96532 | 11.2716 |
| 32 | 256 | 4 | 4096 | 64 | 0.112022 | 3.04211 | 6.522 |
| 32 | 256 | 4 | 8192 | 64 | 0.0565791 | 2.57857 | 5.37722 |
| 32 | 256 | 4 | 16384 | 64 | 0.0401561 | 2.45473 | 5.0714 |
| 32 | 256 | 4 | 32768 | 64 | 0.0372913 | 2.46201 | 5.08937 |
| 32 | 256 | 4 | 65536 | 64 | 0.0372913 | 2.52528 | 5.24562 |
| 32 | 256 | 4 | 131072 | 64 | 0.0372913 | 2.65181 | 5.55812 |

go\_trace:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **L2\_MISS\_RATE** | **AAT\_L1** | **AAT\_L2** |
| 32 | 256 | 4 | 2048 | 1 | 0.355817 | 2.40516 | 10.0569 |
| 32 | 256 | 4 | 4096 | 1 | 0.319582 | 2.25549 | 9.30576 |
| 32 | 256 | 4 | 8192 | 1 | 0.290625 | 2.13821 | 8.71719 |
| 32 | 256 | 4 | 16384 | 1 | 0.282847 | 2.11344 | 8.5929 |
| 32 | 256 | 4 | 32768 | 1 | 0.265181 | 2.05509 | 8.30005 |
| 32 | 256 | 4 | 65536 | 1 | 0.249423 | 2.02028 | 8.12538 |
| 32 | 256 | 4 | 131072 | 1 | 0.203403 | 1.88998 | 7.47145 |
| 32 | 256 | 4 | 2048 | 2 | 0.339857 | 2.34336 | 9.74677 |
| 32 | 256 | 4 | 4096 | 2 | 0.277627 | 2.08491 | 8.4497 |
| 32 | 256 | 4 | 8192 | 2 | 0.27291 | 2.06906 | 8.37017 |
| 32 | 256 | 4 | 16384 | 2 | 0.269999 | 2.06466 | 8.3481 |
| 32 | 256 | 4 | 32768 | 2 | 0.266887 | 2.06721 | 8.36089 |
| 32 | 256 | 4 | 65536 | 2 | 0.224832 | 1.92237 | 7.63397 |
| 32 | 256 | 4 | 131072 | 2 | 0.206564 | 1.90819 | 7.56285 |
| 32 | 256 | 4 | 2048 | 4 | 0.276122 | 2.08663 | 8.45832 |
| 32 | 256 | 4 | 4096 | 4 | 0.271555 | 2.06946 | 8.37218 |
| 32 | 256 | 4 | 8192 | 4 | 0.269949 | 2.06663 | 8.35799 |
| 32 | 256 | 4 | 16384 | 4 | 0.269748 | 2.07358 | 8.39283 |
| 32 | 256 | 4 | 32768 | 4 | 0.269698 | 2.08893 | 8.4699 |
| 32 | 256 | 4 | 65536 | 4 | 0.234317 | 1.97202 | 7.88316 |
| 32 | 256 | 4 | 131072 | 4 | 0.197681 | 1.88099 | 7.42631 |
| 32 | 256 | 4 | 2048 | 8 | 0.271304 | 2.08639 | 8.45715 |
| 32 | 256 | 4 | 4096 | 8 | 0.2702 | 2.08372 | 8.44373 |
| 32 | 256 | 4 | 8192 | 8 | 0.269949 | 2.08656 | 8.45799 |
| 32 | 256 | 4 | 16384 | 8 | 0.269748 | 2.0935 | 8.49283 |
| 32 | 256 | 4 | 32768 | 8 | 0.269698 | 2.10886 | 8.56991 |
| 32 | 256 | 4 | 65536 | 8 | 0.236073 | 1.99929 | 8.02004 |
| 32 | 256 | 4 | 131072 | 8 | 0.197681 | 1.90091 | 7.52631 |
| 32 | 256 | 4 | 2048 | 16 | 0.270752 | 2.12393 | 8.64555 |
| 32 | 256 | 4 | 4096 | 16 | 0.27015 | 2.12336 | 8.64267 |
| 32 | 256 | 4 | 8192 | 16 | 0.269899 | 2.1262 | 8.65693 |
| 32 | 256 | 4 | 16384 | 16 | 0.269748 | 2.13335 | 8.69283 |
| 32 | 256 | 4 | 32768 | 16 | 0.269698 | 2.14871 | 8.76991 |
| 32 | 256 | 4 | 65536 | 16 | 0.24315 | 2.06876 | 8.36864 |
| 32 | 256 | 4 | 131072 | 16 | 0.197681 | 1.94077 | 7.72631 |
| 32 | 256 | 4 | 2048 | 32 | 0.270702 | 2.20343 | 9.0445 |
| 32 | 256 | 4 | 4096 | 32 | 0.2702 | 2.20327 | 9.04373 |
| 32 | 256 | 4 | 8192 | 32 | 0.269899 | 2.20591 | 9.05693 |
| 32 | 256 | 4 | 16384 | 32 | 0.269698 | 2.21285 | 9.09178 |
| 32 | 256 | 4 | 32768 | 32 | 0.269698 | 2.22842 | 9.16991 |
| 32 | 256 | 4 | 65536 | 32 | 0.248218 | 2.16967 | 8.87509 |
| 32 | 256 | 4 | 131072 | 32 | 0.197681 | 2.02047 | 8.12631 |
| 32 | 256 | 4 | 2048 | 64 | 0.270702 | 2.36284 | 9.8445 |
| 32 | 256 | 4 | 4096 | 64 | 0.27015 | 2.36247 | 9.84267 |
| 32 | 256 | 4 | 8192 | 64 | 0.269899 | 2.36531 | 9.85693 |
| 32 | 256 | 4 | 16384 | 64 | 0.269698 | 2.37226 | 9.89178 |
| 32 | 256 | 4 | 32768 | 64 | 0.269698 | 2.38782 | 9.9699 |
| 32 | 256 | 4 | 65536 | 64 | 0.248218 | 2.32908 | 9.67509 |
| 32 | 256 | 4 | 131072 | 64 | 0.197681 | 2.17988 | 8.92631 |

vortex\_trace:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **L2\_MISS\_RATE** | **AAT\_L1** | **AAT\_L2** |
| 32 | 256 | 4 | 2048 | 1 | 0.317707 | 3.2644 | 9.2566 |
| 32 | 256 | 4 | 4096 | 1 | 0.205684 | 2.5398 | 6.9139 |
| 32 | 256 | 4 | 8192 | 1 | 0.141185 | 2.1269 | 5.579 |
| 32 | 256 | 4 | 16384 | 1 | 0.103812 | 1.8962 | 4.8332 |
| 32 | 256 | 4 | 32768 | 1 | 0.0573211 | 1.6184 | 3.935 |
| 32 | 256 | 4 | 65536 | 1 | 0.052019 | 1.6322 | 3.9799 |
| 32 | 256 | 4 | 131072 | 1 | 0.0485597 | 1.7064 | 4.2198 |
| 32 | 256 | 4 | 2048 | 2 | 0.224758 | 2.6684 | 7.3297 |
| 32 | 256 | 4 | 4096 | 2 | 0.14652 | 2.1632 | 5.6964 |
| 32 | 256 | 4 | 8192 | 2 | 0.084349 | 1.7654 | 4.4104 |
| 32 | 256 | 4 | 16384 | 2 | 0.0561249 | 1.5942 | 3.8568 |
| 32 | 256 | 4 | 32768 | 2 | 0.0484627 | 1.5686 | 3.774 |
| 32 | 256 | 4 | 65536 | 2 | 0.0451974 | 1.5957 | 3.8616 |
| 32 | 256 | 4 | 131072 | 2 | 0.0446478 | 1.6888 | 4.1626 |
| 32 | 256 | 4 | 2048 | 4 | 0.186156 | 2.4331 | 6.5691 |
| 32 | 256 | 4 | 4096 | 4 | 0.101225 | 1.8844 | 4.7953 |
| 32 | 256 | 4 | 8192 | 4 | 0.0694126 | 1.6838 | 4.1467 |
| 32 | 256 | 4 | 16384 | 4 | 0.0509521 | 1.576 | 3.7981 |
| 32 | 256 | 4 | 32768 | 4 | 0.0453914 | 1.5641 | 3.7595 |
| 32 | 256 | 4 | 65536 | 4 | 0.0445184 | 1.6067 | 3.8974 |
| 32 | 256 | 4 | 131072 | 4 | 0.0444861 | 1.7032 | 4.2092 |
| 32 | 256 | 4 | 2048 | 8 | 0.156607 | 2.2721 | 6.0485 |
| 32 | 256 | 4 | 4096 | 8 | 0.0935954 | 1.8658 | 4.735 |
| 32 | 256 | 4 | 8192 | 8 | 0.0638841 | 1.6789 | 4.1306 |
| 32 | 256 | 4 | 16384 | 8 | 0.049077 | 1.5948 | 3.8587 |
| 32 | 256 | 4 | 32768 | 8 | 0.0446478 | 1.5902 | 3.8439 |
| 32 | 256 | 4 | 65536 | 8 | 0.0444861 | 1.6374 | 3.9967 |
| 32 | 256 | 4 | 131072 | 8 | 0.0444861 | 1.7341 | 4.3092 |
| 32 | 256 | 4 | 2048 | 16 | 0.149656 | 2.2888 | 6.1025 |
| 32 | 256 | 4 | 4096 | 16 | 0.0903948 | 1.9069 | 4.8678 |
| 32 | 256 | 4 | 8192 | 16 | 0.0617827 | 1.7271 | 4.2865 |
| 32 | 256 | 4 | 16384 | 16 | 0.048495 | 1.6529 | 4.0465 |
| 32 | 256 | 4 | 32768 | 16 | 0.0445508 | 1.6514 | 4.0418 |
| 32 | 256 | 4 | 65536 | 16 | 0.0444861 | 1.6993 | 4.1967 |
| 32 | 256 | 4 | 131072 | 16 | 0.0444861 | 1.796 | 4.5092 |
| 32 | 256 | 4 | 2048 | 32 | 0.148912 | 2.4077 | 6.4869 |
| 32 | 256 | 4 | 4096 | 32 | 0.0884873 | 2.0182 | 5.2278 |
| 32 | 256 | 4 | 8192 | 32 | 0.0618473 | 1.8512 | 4.6879 |
| 32 | 256 | 4 | 16384 | 32 | 0.0483657 | 1.7757 | 4.4438 |
| 32 | 256 | 4 | 32768 | 32 | 0.0444861 | 1.7747 | 4.4405 |
| 32 | 256 | 4 | 65536 | 32 | 0.0444861 | 1.823 | 4.5967 |
| 32 | 256 | 4 | 131072 | 32 | 0.0444861 | 1.9197 | 4.9092 |
| 32 | 256 | 4 | 2048 | 64 | 0.148912 | 2.6551 | 7.2869 |
| 32 | 256 | 4 | 4096 | 64 | 0.0887459 | 2.2674 | 6.0332 |
| 32 | 256 | 4 | 8192 | 64 | 0.0620736 | 2.1001 | 5.4926 |
| 32 | 256 | 4 | 16384 | 64 | 0.0479454 | 2.0205 | 5.235 |
| 32 | 256 | 4 | 32768 | 64 | 0.0444861 | 2.0222 | 5.2405 |
| 32 | 256 | 4 | 65536 | 64 | 0.0444861 | 2.0705 | 5.3967 |
| 32 | 256 | 4 | 131072 | 64 | 0.0444861 | 2.1671 | 5.7092 |

### Decoupled sectored cache

#### AAT v/s N:

gcc\_trace:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **L2\_MISS\_RATE** | **AAT\_L1** | **AAT\_L2** | **N** | **P** |
| 32 | 256 | 4 | 32768 | 1 | 0.130898 | 1.96574 | 5.4801 | 1 | 1 |
| 32 | 256 | 4 | 32768 | 1 | 0.155172 | 2.11127 | 5.98986 | 1 | 2 |
| 32 | 256 | 4 | 32768 | 1 | 0.198921 | 2.37356 | 6.90859 | 1 | 4 |
| 32 | 256 | 4 | 32768 | 1 | 0.252513 | 2.69486 | 8.03403 | 1 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.330519 | 3.16253 | 9.67216 | 1 | 16 |
| 32 | 256 | 4 | 32768 | 1 | 0.442012 | 3.83096 | 12.0135 | 1 | 32 |
| 32 | 256 | 4 | 32768 | 1 | 0.587131 | 4.70099 | 15.061 | 1 | 64 |

perl\_trace:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **L2\_MISS\_RATE** | **AAT\_L1** | **AAT\_L2** | **N** | **P** |
| 32 | 256 | 4 | 32768 | 1 | 0.0997481 | 2.35535 | 4.82596 | 1 | 1 |
| 32 | 256 | 4 | 32768 | 1 | 0.125679 | 2.57585 | 5.37051 | 1 | 2 |
| 32 | 256 | 4 | 32768 | 1 | 0.155759 | 2.83163 | 6.00219 | 1 | 4 |
| 32 | 256 | 4 | 32768 | 1 | 0.27077 | 3.8096 | 8.41741 | 1 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.381606 | 4.75208 | 10.745 | 1 | 16 |
| 32 | 256 | 4 | 32768 | 1 | 0.480786 | 5.59544 | 12.8278 | 1 | 32 |
| 32 | 256 | 4 | 32768 | 1 | 0.596809 | 6.58202 | 15.2642 | 1 | 64 |

go\_trace:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **L2\_MISS\_RATE** | **AAT\_L1** | **AAT\_L2** | **N** | **P** |
| 32 | 256 | 4 | 32768 | 1 | 0.265181 | 2.05509 | 8.30005 | 1 | 1 |
| 32 | 256 | 4 | 32768 | 1 | 0.270953 | 2.07924 | 8.42125 | 1 | 2 |
| 32 | 256 | 4 | 32768 | 1 | 0.276925 | 2.10423 | 8.54667 | 1 | 4 |
| 32 | 256 | 4 | 32768 | 1 | 0.286661 | 2.14497 | 8.75112 | 1 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.305781 | 2.22498 | 9.15266 | 1 | 16 |
| 32 | 256 | 4 | 32768 | 1 | 0.346934 | 2.39718 | 10.0169 | 1 | 32 |
| 32 | 256 | 4 | 32768 | 1 | 0.38096 | 2.53956 | 10.7314 | 1 | 64 |

vortex\_trace:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **L2\_MISS\_RATE** | **AAT\_L1** | **AAT\_L2** | **N** | **P** |
| 32 | 256 | 4 | 32768 | 1 | 0.0573211 | 1.6184 | 3.935 | 1 | 1 |
| 32 | 256 | 4 | 32768 | 1 | 0.0636901 | 1.6597 | 4.0687 | 1 | 2 |
| 32 | 256 | 4 | 32768 | 1 | 0.074844 | 1.7322 | 4.303 | 1 | 4 |
| 32 | 256 | 4 | 32768 | 1 | 0.0882933 | 1.8195 | 4.5854 | 1 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.111636 | 1.9712 | 5.0756 | 1 | 16 |
| 32 | 256 | 4 | 32768 | 1 | 0.160325 | 2.2874 | 6.0981 | 1 | 32 |
| 32 | 256 | 4 | 32768 | 1 | 0.251431 | 2.8792 | 8.0113 | 1 | 64 |

#### AAT v/s P:

gcc\_trace:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **L2\_MISS\_RATE** | **AAT\_L1** | **AAT\_L2** | **N** | **P** |
| 32 | 256 | 4 | 32768 | 1 | 0.252513 | 2.69486 | 8.03403 | 1 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.183754 | 2.28263 | 6.59009 | 2 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.167151 | 2.18309 | 6.24143 | 4 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.135031 | 1.99052 | 5.5669 | 8 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.130898 | 1.96574 | 5.4801 | 16 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.130898 | 1.96574 | 5.4801 | 32 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.130898 | 1.96574 | 5.4801 | 64 | 8 |

perl\_trace:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **L2\_MISS\_RATE** | **AAT\_L1** | **AAT\_L2** | **N** | **P** |
| 32 | 256 | 4 | 32768 | 1 | 0.27077 | 3.8096 | 8.41741 | 1 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.162748 | 2.89106 | 6.14896 | 2 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.145634 | 2.74553 | 5.78956 | 4 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.0997481 | 2.35535 | 4.82596 | 8 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.0997481 | 2.35535 | 4.82596 | 16 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.0997481 | 2.35535 | 4.82596 | 32 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.0997481 | 2.35535 | 4.82596 | 64 | 8 |

go\_trace:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **L2\_MISS\_RATE** | **AAT\_L1** | **AAT\_L2** | **N** | **P** |
| 32 | 256 | 4 | 32768 | 1 | 0.286661 | 2.14497 | 8.75112 | 1 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.270852 | 2.07882 | 8.41915 | 2 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.266687 | 2.06139 | 8.33167 | 4 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.266285 | 2.05971 | 8.32324 | 8 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.265181 | 2.05509 | 8.30005 | 16 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.265181 | 2.05509 | 8.30005 | 32 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.265181 | 2.05509 | 8.30005 | 64 | 8 |

vortex\_trace:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **L2\_MISS\_RATE** | **AAT\_L1** | **AAT\_L2** | **N** | **P** |
| 32 | 256 | 4 | 32768 | 1 | 0.0882933 | 1.8195 | 4.5854 | 1 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.0740681 | 1.7271 | 4.2867 | 2 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.0676991 | 1.6858 | 4.1529 | 4 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.0626879 | 1.6532 | 4.0477 | 8 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.0577738 | 1.6213 | 3.9445 | 16 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.0577738 | 1.6213 | 3.9445 | 32 | 8 |
| 32 | 256 | 4 | 32768 | 1 | 0.0573211 | 1.6184 | 3.935 | 64 | 8 |

#### Noteworthy trends in terms of the influence of different parameters on raw measurements and AAT.

1. Miss rate reduces with increasing Cache Size till a certain point after which there are diminishing returns.
2. Miss rate reduces with increasing associativity till a certain point after which there are diminishing returns.
3. AAT reduces with increasing Cache Size till a certain point after which it starts increasing.
4. AAT reduces with increasing Associativity till a certain point after which it starts increasing.
5. Miss rate increases with increasing Data Blocks.
6. Miss rate decreases with increasing Address Tags.
7. AAT increases with increasing Data Blocks
8. AAT decreases with increasing Address Tags till a certain point after which there are diminishing returns.

## Find best memory hierarchy configuration

1. **Configuration that gives the lowest AAT.**

Step 1: Keep L1 constant and optimize L2

Step 2: For optimized L2 find L1 with least AAT

gcc\_trace:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **MISS\_RATE** | **AAT\_L1** | **AAT\_L2** | **L2\_HIT\_TIME** |
| 32 | 256 | 4 | 16384 | 1 | 0.160111 | 2.11857 | 6.0155 | 2.653125 |
| 32 | 256 | 4 | 16384 | 2 | 0.118813 | 1.87812 | 5.1732 | 2.678125 |
| 32 | 256 | 4 | 16384 | 4 | 0.099198 | 1.77479 | 4.8113 | 2.728125 |
| 32 | 256 | 4 | 16384 | 8 | 0.097166 | 1.79116 | 4.8686 | 2.828125 |
| 32 | 256 | 4 | 16384 | 16 | 0.092683 | 1.82138 | 4.9745 | 3.028125 |
| 32 | 256 | 4 | 32768 | 1 | 0.130898 | 1.96574 | 5.4801 | 2.73125 |
| 32 | 256 | 4 | 32768 | 2 | 0.100914 | 1.79311 | 4.8755 | 2.75625 |
| 32 | 256 | 4 | 32768 | 4 | 0.092473 | 1.75678 | 4.7482 | 2.80625 |
| 32 | 256 | 4 | 32768 | 8 | 0.091947 | 1.78218 | 4.8371 | 2.90625 |
| 32 | 256 | 4 | 32768 | 16 | 0.091877 | 1.83885 | 5.0357 | 3.10625 |
| 32 | 256 | 4 | 65536 | 1 | 0.11433 | 1.91101 | 5.2884 | 2.8875 |
| 32 | 256 | 4 | 65536 | 2 | 0.09503 | 1.80244 | 4.9081 | 2.9125 |
| 32 | 256 | 4 | 65536 | 4 | 0.090896 | 1.79193 | 4.8713 | 2.9625 |
| 32 | 256 | 4 | 65536 | 8 | 0.090686 | 1.81922 | 4.9669 | 3.0625 |
| 32 | 256 | 4 | 65536 | 16 | 0.090546 | 1.87548 | 5.164 | 3.2625 |

For L2 size = 32768 and L2 Associativity = 4 find L1 with least AAT.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **L1\_SIZE** | **L1\_ASSOC** | **L1\_MISS\_RATE** | **L2\_MISS\_RATE** | **AAT\_ L1** | **AAT\_L2** | **L1\_HIT\_TIME** | **L2\_HIT\_TIME** |
| 512 | 1 | 0.26533 | 0.0994987 | 1.6264 | 4.89572 | 0.32744141 | 2.80625 |
| 512 | 2 | 0.22039 | 0.119788 | 1.5253 | 5.32179 | 0.35244141 | 2.80625 |
| 512 | 4 | 0.2011 | 0.131278 | 1.5212 | 5.56309 | 0.40244141 | 2.80625 |
| 1024 | 1 | 0.19346 | 0.136462 | 1.4272 | 5.67196 | 0.32988281 | 2.80625 |
| 1024 | 2 | 0.15603 | 0.169198 | 1.3471 | 6.35941 | 0.35488281 | 2.80625 |
| 1024 | 4 | 0.1427 | 0.185004 | 1.3597 | 6.69132 | 0.40488281 | 2.80625 |
| 2048 | 1 | 0.14774 | 0.178692 | 1.3038 | 6.55879 | 0.33476563 | 2.80625 |
| 2048 | 2 | 0.10714 | 0.246407 | 1.2148 | 7.98079 | 0.35976563 | 2.80625 |
| 2048 | 4 | 0.09622 | 0.274475 | 1.2344 | 8.57023 | 0.40976563 | 2.80625 |
| 4096 | 1 | 0.10017 | 0.263552 | 1.18 | 8.34084 | 0.34453125 | 2.80625 |
| 4096 | 2 | 0.07528 | 0.351222 | 1.136 | 10.1819 | 0.36953125 | 2.80625 |
| 4096 | 4 | 0.05992 | 0.440087 | 1.1415 | 12.0481 | 0.41953125 | 2.80625 |
| 8192 | 1 | 0.067 | 0.39403 | 1.1065 | 11.0809 | 0.3640625 | 2.80625 |
| 8192 | 2 | 0.04734 | 0.55978 | 1.0784 | 14.5616 | 0.3890625 | 2.80625 |
| 8192 | 4 | 0.04247 | 0.620909 | 1.112 | 15.8453 | 0.4390625 | 2.80625 |

For L1 size = 8192, L1 Associativity = 2 and L2 size = 32768, L2 Associativity = 4 we get best memory configuration.

perl\_trace:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **MISS\_RATE** | **AAT\_L1** | **AAT\_L2** | **L2\_HIT\_TIME** |
| 32 | 256 | 4 | 16384 | 1 | 0.127531 | 2.55996 | 5.3313 | 2.653125 |
| 32 | 256 | 4 | 16384 | 2 | 0.051195 | 1.92098 | 3.7532 | 2.678125 |
| 32 | 256 | 4 | 16384 | 4 | 0.043638 | 1.87696 | 3.6445 | 2.728125 |
| 32 | 256 | 4 | 16384 | 8 | 0.041514 | 1.8994 | 3.6999 | 2.828125 |
| 32 | 256 | 4 | 16384 | 16 | 0.040527 | 1.97198 | 3.8792 | 3.028125 |
| 32 | 256 | 4 | 32768 | 1 | 0.099748 | 2.35535 | 4.826 | 2.73125 |
| 32 | 256 | 4 | 32768 | 2 | 0.04428 | 1.89381 | 3.6861 | 2.75625 |
| 32 | 256 | 4 | 32768 | 4 | 0.037736 | 1.85841 | 3.5987 | 2.80625 |
| 32 | 256 | 4 | 32768 | 8 | 0.03739 | 1.89596 | 3.6914 | 2.90625 |
| 32 | 256 | 4 | 32768 | 16 | 0.037291 | 1.9761 | 3.8894 | 3.10625 |
| 32 | 256 | 4 | 65536 | 1 | 0.049393 | 1.99043 | 3.9247 | 2.8875 |
| 32 | 256 | 4 | 65536 | 2 | 0.037538 | 1.89975 | 3.7008 | 2.9125 |
| 32 | 256 | 4 | 65536 | 4 | 0.037415 | 1.91895 | 3.7482 | 2.9625 |
| 32 | 256 | 4 | 65536 | 8 | 0.037291 | 1.95839 | 3.8456 | 3.0625 |
| 32 | 256 | 4 | 65536 | 16 | 0.037291 | 2.03937 | 4.0456 | 3.2625 |

For L2 size = 32768 and L2 Associativity = 4 find L1 with least AAT.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **L1\_SIZE** | **L1\_ASSOC** | **L1\_MISS\_RATE** | **L2\_MISS\_RATE** | **AAT\_L1** | **AAT\_L2** | **L1\_HIT\_TIME** | **L2\_HIT\_TIME** |
| 1024 | 1 | 0.28008 | 0.054556 | 1.4367 | 3.95192 | 0.3298828 | 2.80625 |
| 1024 | 2 | 0.24043 | 0.063553 | 1.3505 | 4.14086 | 0.3548828 | 2.80625 |
| 1024 | 4 | 0.23452 | 0.065154 | 1.3839 | 4.17449 | 0.4048828 | 2.80625 |
| 2048 | 1 | 0.19288 | 0.07922 | 1.1969 | 4.46988 | 0.3347656 | 2.80625 |
| 2048 | 2 | 0.15524 | 0.098428 | 1.1163 | 4.87324 | 0.3597656 | 2.80625 |
| 2048 | 4 | 0.13769 | 0.111047 | 1.1173 | 5.13823 | 0.4097656 | 2.80625 |
| 4096 | 1 | 0.11082 | 0.137881 | 0.9764 | 5.70176 | 0.3445313 | 2.80625 |
| 4096 | 2 | 0.08863 | 0.172402 | 0.9391 | 6.42669 | 0.3695313 | 2.80625 |
| 4096 | 4 | 0.05953 | 0.256509 | 0.9073 | 8.19295 | 0.4195313 | 2.80625 |
| 8192 | 1 | 0.06748 | 0.226437 | 0.8743 | 7.56144 | 0.3640625 | 2.80625 |
| 8192 | 2 | 0.03654 | 0.417625 | 0.8121 | 11.5764 | 0.3890625 | 2.80625 |
| 8192 | 4 | 0.02712 | 0.564897 | 0.8369 | 14.6691 | 0.4390625 | 2.80625 |
| 16384 | 1 | 0.04922 | 0.310646 | 0.8623 | 9.32982 | 0.403125 | 2.80625 |
| 16384 | 2 | 0.02076 | 0.733622 | 0.8062 | 18.2123 | 0.428125 | 2.80625 |
| 16384 | 4 | 0.01766 | 0.861835 | 0.8473 | 20.9048 | 0.478125 | 2.80625 |

For L1 size = 16384, L1 associativity = 2 and L2 size = 32768, L2 Associativity = 4 we get best memory configuration

go\_trace:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **MISS\_RATE** | **AAT\_L1** | **AAT\_L2** | **L2\_HIT\_TIME** |
| 32 | 256 | 4 | 32768 | 1 | 0.265181 | 2.05509 | 8.30005 | 2.73125 |
| 32 | 256 | 4 | 32768 | 2 | 0.266887 | 2.06721 | 8.36089 | 2.75625 |
| 32 | 256 | 4 | 32768 | 4 | 0.269698 | 2.08893 | 8.4699 | 2.80625 |
| 32 | 256 | 4 | 32768 | 8 | 0.269698 | 2.10886 | 8.56991 | 2.90625 |
| 32 | 256 | 4 | 32768 | 16 | 0.269698 | 2.14871 | 8.76991 | 3.10625 |
| 32 | 256 | 4 | 65536 | 1 | 0.249423 | 2.02028 | 8.12538 | 2.8875 |
| 32 | 256 | 4 | 65536 | 2 | 0.224832 | 1.92237 | 7.63397 | 2.9125 |
| 32 | 256 | 4 | 65536 | 4 | 0.234317 | 1.97202 | 7.88316 | 2.9625 |
| 32 | 256 | 4 | 65536 | 8 | 0.236073 | 1.99929 | 8.02004 | 3.0625 |
| 32 | 256 | 4 | 65536 | 16 | 0.24315 | 2.06876 | 8.36864 | 3.2625 |
| 32 | 256 | 4 | 131072 | 1 | 0.203403 | 1.88998 | 7.47145 | 3.2 |
| 32 | 256 | 4 | 131072 | 2 | 0.206564 | 1.90819 | 7.56285 | 3.225 |
| 32 | 256 | 4 | 131072 | 4 | 0.197681 | 1.88099 | 7.42631 | 3.275 |
| 32 | 256 | 4 | 131072 | 8 | 0.197681 | 1.90091 | 7.52631 | 3.375 |
| 32 | 256 | 4 | 131072 | 16 | 0.197681 | 1.94077 | 7.72631 | 3.575 |

For L2 size = 131072 and L2 Associativity = 4 find L1 with least AAT.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **L1\_SIZE** | **L1\_ASSOC** | **L1\_MISS\_RATE** | **L2\_MISS\_RATE** | **AAT\_L1** | **AAT\_L2** | **L1\_HIT\_TIME** | **L2\_HIT\_TIME** |
| 512 | 1 | 0.2792 | 0.141082 | 2.069 | 6.23771 | 0.327441406 | 3.275 |
| 512 | 2 | 0.16134 | 0.244143 | 1.708 | 8.402 | 0.352441406 | 3.275 |
| 512 | 4 | 0.10979 | 0.358776 | 1.5892 | 10.8093 | 0.402441406 | 3.275 |
| 1024 | 1 | 0.24235 | 0.162534 | 1.9508 | 6.6882 | 0.329882813 | 3.275 |
| 1024 | 2 | 0.10595 | 0.371779 | 1.5291 | 11.0824 | 0.354882813 | 3.275 |
| 1024 | 4 | 0.06639 | 0.593312 | 1.4495 | 15.7346 | 0.404882813 | 3.275 |
| 2048 | 1 | 0.09042 | 0.435634 | 1.4581 | 12.4233 | 0.334765625 | 3.275 |
| 2048 | 2 | 0.07997 | 0.49256 | 1.4489 | 13.6188 | 0.359765625 | 3.275 |
| 2048 | 4 | 0.05538 | 0.711268 | 1.4183 | 18.2116 | 0.409765625 | 3.275 |
| 4096 | 1 | 0.07375 | 0.534102 | 1.4133 | 14.4911 | 0.34453125 | 3.275 |
| 4096 | 2 | 0.05593 | 0.704273 | 1.3799 | 18.0647 | 0.36953125 | 3.275 |
| 4096 | 4 | 0.05425 | 0.726083 | 1.4244 | 18.5227 | 0.41953125 | 3.275 |
| 8192 | 1 | 0.06315 | 0.623753 | 1.3981 | 16.3738 | 0.3640625 | 3.275 |
| 8192 | 2 | 0.05437 | 0.72448 | 1.3943 | 18.4891 | 0.3890625 | 3.275 |
| 8192 | 4 | 0.05379 | 0.732292 | 1.4424 | 18.6531 | 0.4390625 | 3.275 |

For L1 size = 4096, L1 Associativity = 2 and L2 size = 131072, L2 Associativity = 4 we get best memory configuration.

vortex\_trace:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BLOCKSIZE** | **L1\_SIZE** | **L1\_ASSOC** | **L2\_SIZE** | **L2\_ASSOC** | **MISS\_RATE** | **AAT\_L1** | **AAT\_L2** | **L2\_HIT\_TIME** |
| 32 | 256 | 4 | 16384 | 1 | 0.103812 | 1.89617 | 4.8332 | 2.653125 |
| 32 | 256 | 4 | 16384 | 2 | 0.056125 | 1.59415 | 3.8568 | 2.678125 |
| 32 | 256 | 4 | 16384 | 4 | 0.050952 | 1.57602 | 3.7981 | 2.728125 |
| 32 | 256 | 4 | 16384 | 8 | 0.049077 | 1.59477 | 3.8587 | 2.828125 |
| 32 | 256 | 4 | 16384 | 16 | 0.048495 | 1.65285 | 4.0465 | 3.028125 |
| 32 | 256 | 4 | 32768 | 1 | 0.057321 | 1.61835 | 3.935 | 2.73125 |
| 32 | 256 | 4 | 32768 | 2 | 0.048463 | 1.56855 | 3.774 | 2.75625 |
| 32 | 256 | 4 | 32768 | 4 | 0.045391 | 1.56406 | 3.7595 | 2.80625 |
| 32 | 256 | 4 | 32768 | 8 | 0.044648 | 1.59016 | 3.8439 | 2.90625 |
| 32 | 256 | 4 | 32768 | 16 | 0.044551 | 1.65139 | 4.0418 | 3.10625 |
| 32 | 256 | 4 | 65536 | 1 | 0.052019 | 1.63224 | 3.9799 | 2.8875 |
| 32 | 256 | 4 | 65536 | 2 | 0.045197 | 1.59567 | 3.8616 | 2.9125 |
| 32 | 256 | 4 | 65536 | 4 | 0.044518 | 1.60672 | 3.8974 | 2.9625 |
| 32 | 256 | 4 | 65536 | 8 | 0.044486 | 1.63744 | 3.9967 | 3.0625 |
| 32 | 256 | 4 | 65536 | 16 | 0.044486 | 1.6993 | 4.1967 | 3.2625 |

For L2 size = 32768 and L2 Associativity = 4 find L1 with least AAT.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **L1\_SIZE** | **L1\_ASSOC** | **L1\_MISS\_RATE** | **L2\_MISS\_RATE** | **AAT\_L1** | **AAT\_L2** | **L1\_HIT\_TIME** | **L2\_HIT\_TIME** |
| 512 | 1 | 0.2858 | 0.0491253 | 1.4243 | 3.83788 | 0.3274 | 2.80625 |
| 512 | 2 | 0.2112 | 0.0664773 | 1.24 | 4.20227 | 0.3524 | 2.80625 |
| 512 | 4 | 0.20412 | 0.0687831 | 1.2701 | 4.25069 | 0.4024 | 2.80625 |
| 1024 | 1 | 0.16012 | 0.0876842 | 1.0741 | 4.64762 | 0.3299 | 2.80625 |
| 1024 | 2 | 0.14228 | 0.0986787 | 1.049 | 4.8785 | 0.3549 | 2.80625 |
| 1024 | 4 | 0.11933 | 0.117657 | 1.0346 | 5.27705 | 0.4049 | 2.80625 |
| 2048 | 1 | 0.11013 | 0.127486 | 0.9387 | 5.48345 | 0.3348 | 2.80625 |
| 2048 | 2 | 0.06961 | 0.201551 | 0.8497 | 7.03883 | 0.3598 | 2.80625 |
| 2048 | 4 | 0.0573 | 0.244852 | 0.8652 | 7.94813 | 0.4098 | 2.80625 |
| 4096 | 1 | 0.07071 | 0.198557 | 0.8378 | 6.97596 | 0.3445 | 2.80625 |
| 4096 | 2 | 0.0453 | 0.309934 | 0.7915 | 9.31486 | 0.3695 | 2.80625 |
| 4096 | 4 | 0.0313 | 0.448882 | 0.8024 | 12.2328 | 0.4195 | 2.80625 |
| 8192 | 1 | 0.04678 | 0.300128 | 0.7902 | 9.10894 | 0.3641 | 2.80625 |
| 8192 | 2 | 0.02608 | 0.541411 | 0.7588 | 14.1759 | 0.3891 | 2.80625 |
| 8192 | 4 | 0.02149 | 0.656584 | 0.7957 | 16.5945 | 0.4391 | 2.80625 |

For L1 size = 8192, L1 Associativity = 2 and L2 size = 32768, L2 Associativity = 4 we get best memory configuration.

1. **Closely examine the configuration, its raw measurements, etc., and from this closer examination explain why it gives the lowest AAT compared to all other configurations.**

AAT = Hit Time + Miss rate \* Miss penalty

Miss Rate L1 = (L1 Read misses + L1 Write misses) / (L1 Reads + L1 Writes)

Miss Rate L2 = (L2 Read misses) / (L2 Reads)

L1 Miss Penalty = AAT­­L2 + (L1 Block Size/B.W.)

L2 Miss Penalty = Memory latency + (L2 Block Size/B.W.)

L1 Cache Hit Time α A\* L1\_Cache Size + B \* L1\_BLOCKSIZE + C \* L1\_SET\_ASSOCIATIVITY + D

L2 Cache Hit Time α A\* L2\_Cache Size + B \* L2\_BLOCKSIZE + C \* L2\_SET\_ASSOCIATIVITY + D

**Effect of L2 Size and L2 Associativity**

1. Increasing the Cache Size / Associativity of L2 increases its Hit time whereas the Miss rate reduces with increasing Cache Size till a point after which its almost stagnant.
2. This AATL2 reduces till a point after which Miss rate reduction becomes negligent and Hit time becomes a higher contributing factor.
3. Miss penalty of L1 is proportional on AATL2 and increases with increasing Size of L2.
4. Therefore, AAT of L1 reduces till a point after which it starts increasing.

**Effect of L1 Size and L1 associativity**

1. Increasing the Cache Size / Associativity of L1 increases its Hit time whereas the Miss rate reduces with increasing Cache Size till a point after which its almost stagnant.
2. This AATL1 reduces till a point after which Miss rate reduction becomes negligent and Hit time becomes a high factor.

From these observations we understand that there is need to select the cache size where Hit time increase is balanced by the miss rate reduction. i.e. the value with least AAT. (unique aspect)

**Reasons for using two level Cache**

AAT of L1 Cache with L2 Cache is reduced in comparison to a L1 Cache without L2. Reason being access time of L2 is better than memory latency.

**Reasons for not using Diminished Sectored Cache**

Decoupled sectored cache doesn’t provide any benefit in terms of AAT.

## Compare and contrast different benchmarks

**Are the Best Memory Hierarchies very similar or very different for different benchmarks? Can you conclude anything about the different benchmarks based on their Best Memory Hierarchies (e.g., is anything revealed regarding the degree of compulsory misses, capacity misses, or conflict misses)?**

All the memory hierarchies have their L1 and L2 associativity as same. gcc trace, perl trace and vortex trace have same L2 Sizes. But the L1 sizes for each benchmark are very different.

To study about the degree of conflict misses we can look at the neighboring values of best memory hierarchies in the graphs and come to some conclusions:

1. Conflict misses:

If varying the associativity changes the miss rate then it suffers from conflict misses.

1. Capacity misses:

If varying the Cache Size changes the miss rate then it suffers from Capacity misses

1. Compulsory misses:

If varying associativity or Cache Size doesn’t change the miss rate then it suffers from Compulsory misses

gcc\_trace:

1. Varying associativity doesn’t reduce miss rate by that much hence it doesn’t suffer from conflict misses.
2. Varying size reduces miss rate hence it suffers from capacity misses

perl\_trace:

1. Varying associativity reduces miss rate considerably hence it suffers from conflict misses.
2. Varying size reduces miss rate hence it suffers from capacity misses to more extent than other benchmarks.

go\_trace:

1. Varying associativity doesn’t reduce miss rate by that much hence it doesn’t suffer from conflict misses.
2. Varying size reduces miss rate hence it suffers from capacity misses but to a lesser extent than other benchmarks.
3. Since it has a larger L2 it might suffer from larger number of compulsory misses.

vortex\_trace:

1. Varying associativity reduce miss rate considerably hence it suffers from conflict misses.
2. Varying size reduces miss rate hence it suffers from capacity misses

## Advantages of Decoupled Sector Cache

#### What are the advantages of Decoupled Sector Cache?

A decoupled sectored cache is used to pacify the cost of tag implementation by keeping the tag size small as well as reduce the miss ratio typically inherent in sectored caches.

**Need for small tag sizes:**

In many processor designs the tag array is dual ported and is accessed 2 times a cycle as compared to data array which is accessed once per cycle. It becomes important to keep the tag size small as its size is limited by integration density of the chip.

**Need for sectored Cache:**

In order to keep small tag sizes large cache line sizes can be used. But in general designers prefer small line sizes due to data coherency and traffic reasons. A sectored cache helps solve this problem by assigning each cache block its own valid and dirty flags. Thus, allowing multiple cache blocks in a sector to share same address tag while allowing them to be accessed individually.

**Need for Decoupled sectored Cache:**

In a sectored cache each data block in a sector is linked to a single tag. In applications having poor spatial locality the miss rate is quite high. By using decoupled sectored cache, we can utilize the unused data blocks among multiple tags and reduce the miss rate and memory traffic.

#### Does implementing decoupled sector cache give you any benefits over same size basic cache module?

Decoupled sector cache gives the benefit of reduced tag overhead over basic cache module for same block size.

#### In this project, why we implemented decoupled sector cache over L2 cache and not L1 cache?

For L1 Cache fast data access is necessary and thus we don’t use decoupled sector cache. For a decoupled sectored cache, the miss rate is high as compared to a basic cache module and thus its AAT is also high.

# References:

Andre Seznec, Decoupled Sectored Caches: conciliating low tag implementation cost and low miss ratio, IEEE, 1994