Memory Optimization Lab

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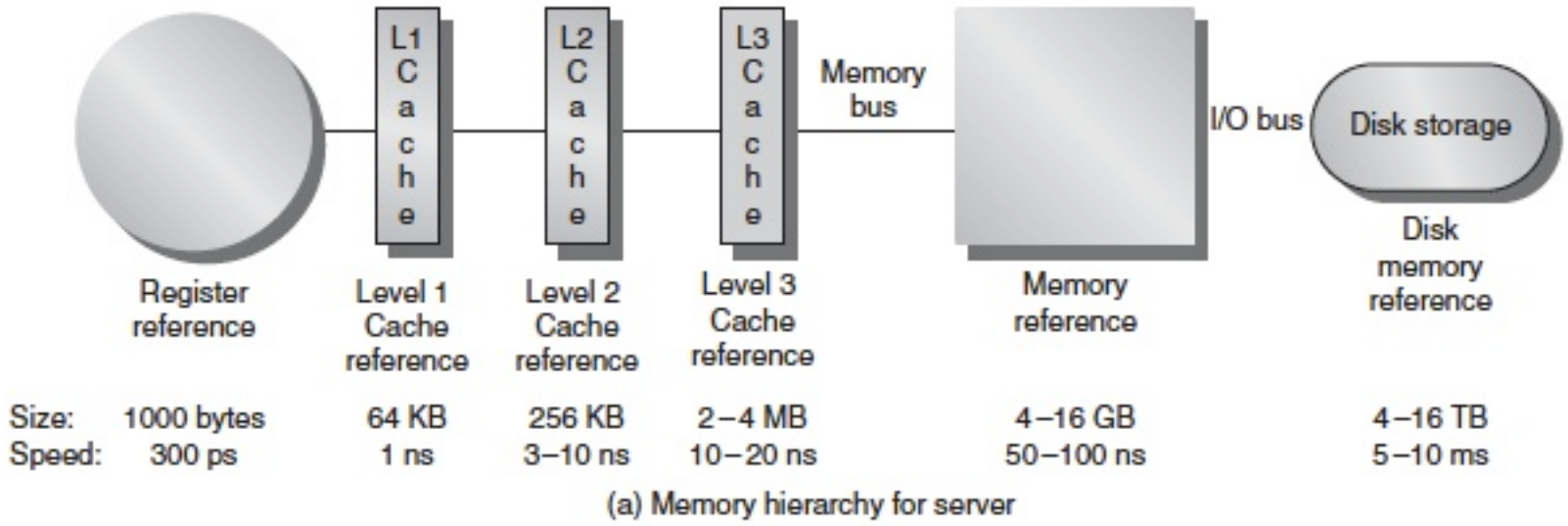
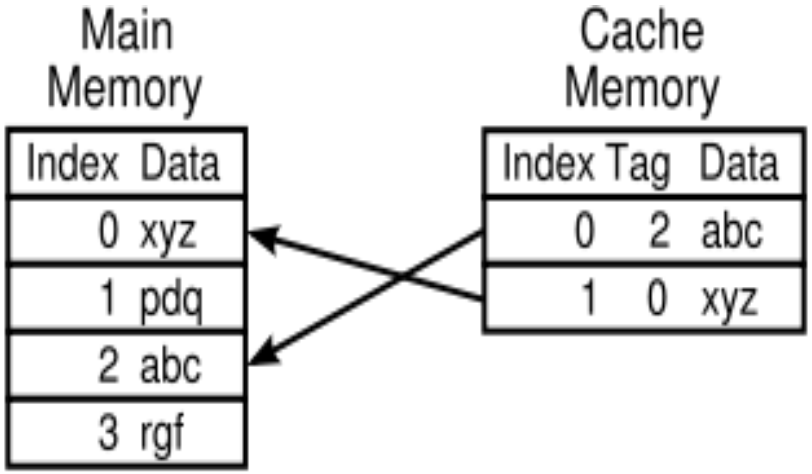
Memory Model



(a) Memory hierarchy for server

- CPU cache is generally set up as a series of lines that can pull in a specified amount of data a given time.
- Accessing Cache infinitely faster than main memory
  - Get as much data in at a time
  - Use that data to its fullest!



Memory Mountain

- It performs memory accesses with different locality patterns.
- Simple approach:
  - Allocate array of size “W” words
  - Loop over the array with stride index “S” and measure speed of memory accesses
  - Vary W and S to estimate cache characteristics
- Changing W varies the total amount of memory accessed by the program.
  - As W gets larger than one level of the cache, performance of the program will drop.
- Changing S varies the spatial locality of each access.
  - If S is less than the size of a cache line, sequential accesses will be fast.
  - If S is greater than the size of a cache line, sequential accesses will be slower.

Transpose

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

1	5	9	13
2	6	10	14
3	7	11	15
4	8	12	16

Fast Transpose - Step 1

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

1	2
5	6

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

- Copy the data on the buffer block

Fast Transpose - Step 2

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

1	5
2	6

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

- Transpose the block

Fast Transpose - Step 3

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

1	5
2	6

1	5	0	0
2	6	0	0
0	0	0	0
0	0	0	0

- Copy the transposed block from the buffer block to the destination matrix

Fast Transpose - Step 4

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

9	10
13	14

1	5	0	0
2	6	0	0
0	0	0	0
0	0	0	0

- Iterates over blocks

Fast Transpose - Step 5

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

9	13
10	14

1	5	0	0
2	6	0	0
0	0	0	0
0	0	0	0

- Iterates over blocks

Fast Transpose - Step 6

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

9	13
10	14

1	5	9	13
2	6	10	14
0	0	0	0
0	0	0	0

- Iterates over blocks

Lab Exercises

- Play and visualize (plot, open-office, etc...) results of the memory-mountain program
- Yesterday's Lab to be completed
- Implement the fast-transpose matrix
- Implement a multi-threaded version of the fast-transpose matrix
- See how the programs behave in cache (perf command)