

SPATIAL MEMORY STREAMING

Somogyi et al., Spatial Memory Streaming, in ISCA 2006

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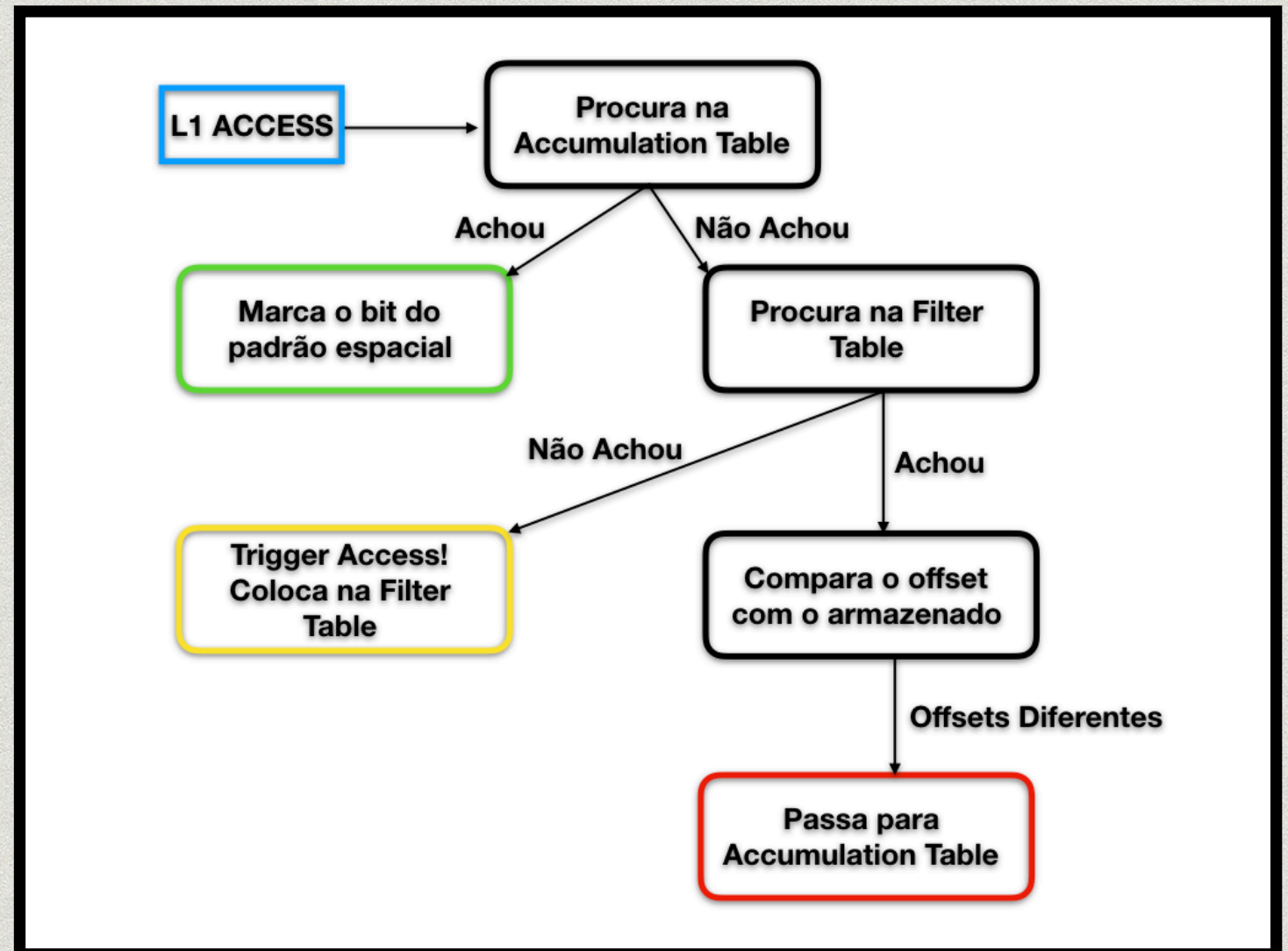
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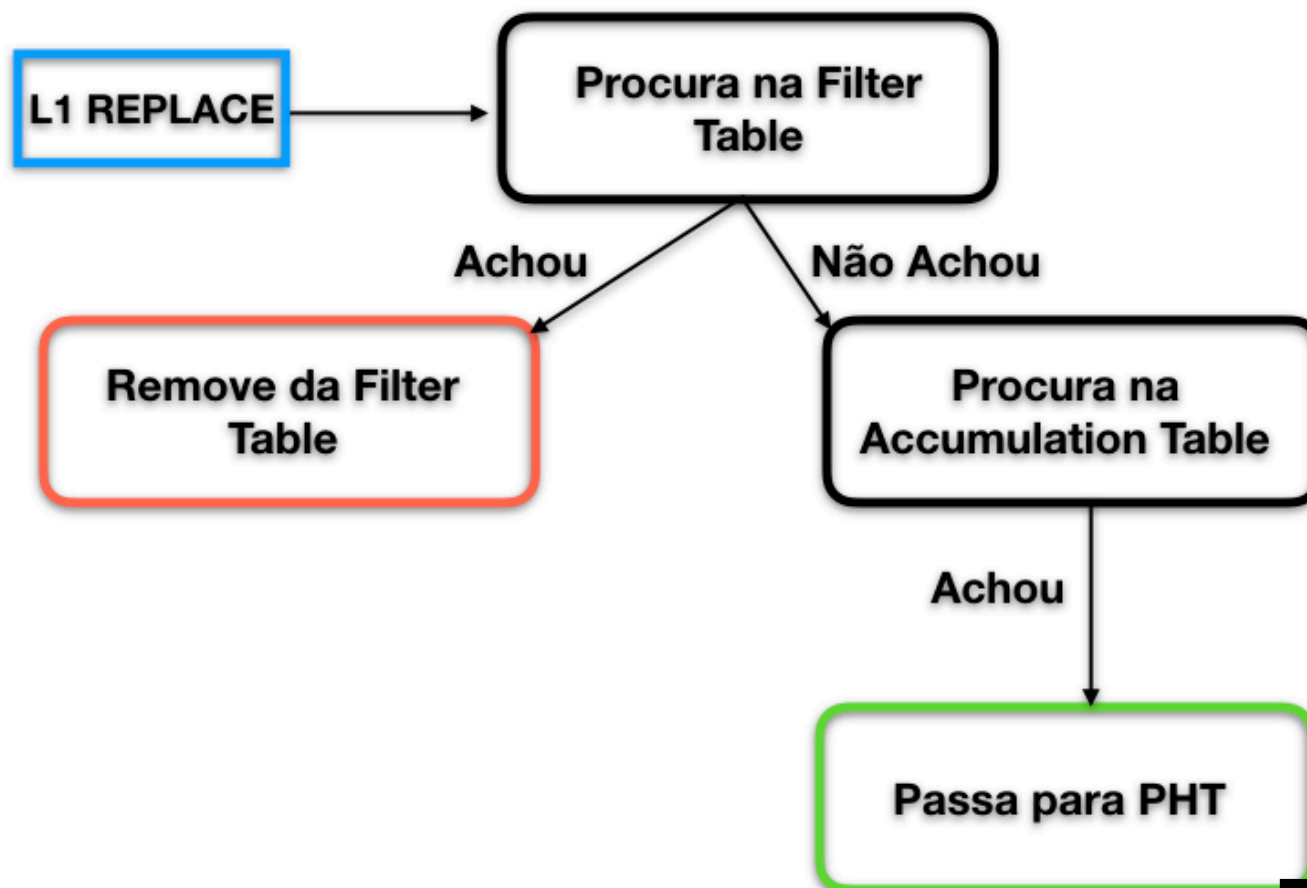
CURITIBA, 27 DE NOVEMBRO DE 2017

Spatial Memory Streaming

- * “Spatial Memory Streaming improves the performance of specific and commercial server applications by exploiting spatial relationships among data beyond a single cache block.”
- * “Unlike prior proposals, we target our design at high-performance commercial server applications in a multi-processor context.”

-Somogyi et al., Spatial Memory Streaming, in ISCA 2006



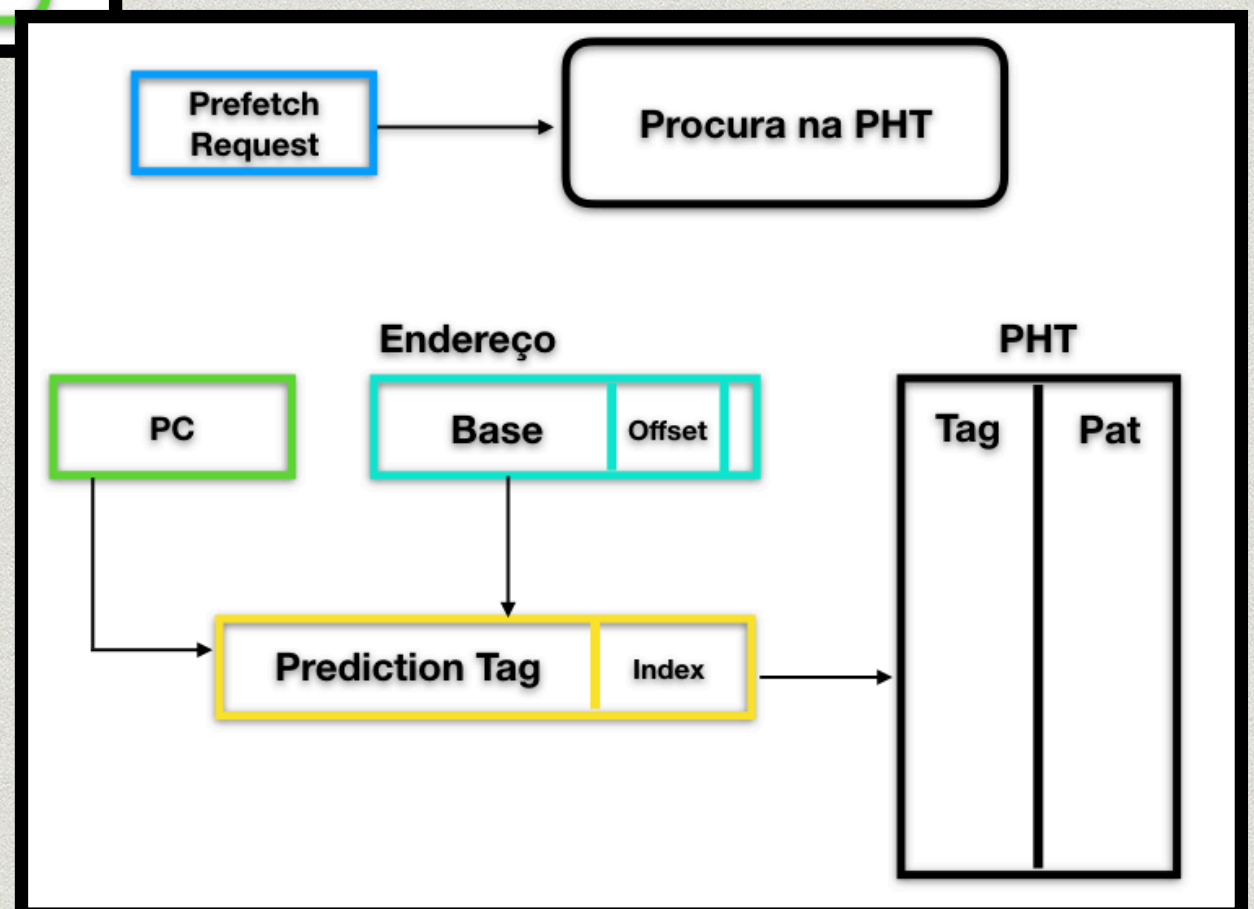


Quando os dados são invalidados da cache L1:

- Move entrada correspondente da *Accumulation Table* para PHT.
- Remove entradas simples da *Filter Table*.

Ao solicitar um prefetch, é feita a busca na PHT (totalmente associativa) - 256 entradas.

- Quando a PHT encontrar uma tag correspondente, ela fará *streaming* dos blocos de cache que foram acessados em sequência.



Geometria dos Componentes

- * A Filter Table contém 32 entradas, armazenando a TAG, PC e LRU (64 bits cada) + offset da primeira chamada e um bit de validade.
- * A Accumulation Table contém 32 entradas, armazenando TAG, PC e LRU (64 bits cada) + 64 bits de padrão (representando 64 blocos consecutivos = uma página de memória) e bit de validade.
- * A PHT contém 256 entradas, armazenando TAG, PC e LRU (64 bits cada) + 64 bits de padrão (da mesma forma que a Accumulation Table), a posição do streaming e o bit de validade.

Parâmetros de Simulação

- * Não há parâmetros de linha de comando, apenas os seguintes defines:
- * `#define tam_t 32 (sms.hpp)` - Tamanho da FT e AT
- * `#define tam_pht 256 (sms.hpp)` - Tamanho da PHT
- * `#define prefetcher 1 (processor.cpp)` - Stride/SMS

Stride	Full SMS	Nerfed SMS
<p>End of dynamic simulation trace End of Simulation</p> <p>#####</p> <p>trace_reader_t fetch_instructions: 200001551</p> <p>#####</p> <p>processor_t Global Cycle Count: 214468989 Cycle: 107.23</p> <p>#####</p> <p>CACHE L1 STATISTICS</p> <p>Num lines: 256 Associativity: 4 Cache Penalty 1</p> <p>Cache Queues: 43605979 Cache HITS: 43483790 Cache MISS: 122189 Cache HIT RATIO: 99.72 Cache MISS RATIO: 0.28</p> <p>#####</p> <p>CACHE L2 STATISTICS</p> <p>Num lines: 65536 Associativity: 8 Cache Penalty 4</p> <p>Cache Queues: 122189 Cache HITS: 110766 Cache MISS: 11423 Cache HIT RATIO: 90.65 Cache MISS RATIO: 9.35</p> <p>#####</p> <p>STRIDE PREFETCHER STATISTICS</p> <p>Requests Made: 10965 Strides Detected: 135 Useful prefetches: 9</p>	<p>End of dynamic simulation trace End of Simulation</p> <p>#####</p> <p>trace_reader_t fetch_instructions: 200001551</p> <p>#####</p> <p>processor_t Global Cycle Count: 652209466 Cycle: 326.10</p> <p>#####</p> <p>CACHE L1 STATISTICS</p> <p>Num lines: 256 Associativity: 4 Cache Penalty 1</p> <p>Cache Queues: 43605979 Cache HITS: 43457875 Cache MISS: 148104 Cache HIT RATIO: 99.66 Cache MISS RATIO: 0.34</p> <p>#####</p> <p>CACHE L2 STATISTICS</p> <p>Num lines: 65536 Associativity: 8 Cache Penalty 4</p> <p>Cache Queues: 148104 Cache HITS: 136673 Cache MISS: 11431 Cache HIT RATIO: 92.28 Cache MISS RATIO: 7.72</p> <p>#####</p> <p>SPATIAL MEMORY STREAMING STATISTICS</p> <p>Requests Made: 43605979 Guesses Taken: 15614940 Useful Guesses: 12518039</p>	<p>End of dynamic simulation trace End of Simulation</p> <p>#####</p> <p>trace_reader_t fetch_instructions: 200001551</p> <p>#####</p> <p>processor_t Global Cycle Count: 214440650 Cycle: 107.22</p> <p>#####</p> <p>CACHE L1 STATISTICS</p> <p>Num lines: 256 Associativity: 4 Cache Penalty 1</p> <p>Cache Queues: 43605979 Cache HITS: 43483734 Cache MISS: 122245 Cache HIT RATIO: 99.72 Cache MISS RATIO: 0.28</p> <p>#####</p> <p>CACHE L2 STATISTICS</p> <p>Num lines: 65536 Associativity: 8 Cache Penalty 4</p> <p>Cache Queues: 122245 Cache HITS: 111025 Cache MISS: 11220 Cache HIT RATIO: 90.82 Cache MISS RATIO: 9.18</p> <p>#####</p> <p>SPATIAL MEMORY STREAMING STATISTICS</p> <p>Requests Made: 122245 Guesses Taken: 117679 Useful Guesses: 19858</p>

STRIDE						
	Astar	Calculix	Dealll	Gromacs	Libquantum	Namd
Cycles / Instructions %	384.86%	107.23%	130.32%	232.04%	494.09%	241.60%
Total # Cycles	769720893	214468989	260637221	464080296	988180568	483208789
L1 Queues	75112242	43605979	87569983	70058364	52245479	70031538
L1 Hits	71238112	43483790	86810333	68134242	47352126	68493396
L1 Misses	3874130	122189	759650	1924122	4893353	1538142
L1 Hit %	94.84	99.72%	99.13%	97.25%	90.63%	97.80%
L1 Miss %	5.16	0.28%	0.87%	2.75%	9.37%	2.20%
L2 Queues	3874130	122189	759650	1924122	4893353	1538142
L2 Hits	2820493	110766	739268	1774120	2	912091
L2 Misses	1053637	11423	20382	150002	4893351	626051
L2 Hit %	72.80	90.65%	97.32%	92.20%	0.00%	59.30%
L2 Miss %	27.20	9.35%	2.68%	7.80%	100.00%	40.70%
Stride Requests	848653	10965	7787	104705	4893317	41298
Stride Guesses Taken	5844	135	956	7432	1223332	4239
Stride Useful Guesses	364	9	15	45	0	0
Stride Useful Guesses %	6,22%	6,66%	1,56%	0.60%	0.00%	0.00%

Resultado:
O SMS é uma solução bastante agressiva, porém mostrou-se mais útil que o Stride prefetcher de forma geral.

SMS						
	Astar	Calculix	Dealll	Gromacs	Libquantum	Namd
Cycles / Instructions %	384.55%	107.22%	130.31%	231.90%	494.08%	240.90%
Total # Cycles	769097495	214440650	260622965	463794825	988169703	481809002
L1 Queues	75112242	43605979	87569983	70058364	52245479	70031538
L1 Hits	71238112	43483734	86810334	68134149	47352175	68493432
L1 Misses	3874130	122245	759649	1924215	4893304	1538106
L1 Hit %	94.84%	99.72%	99.13%	97.25%	90.63%	97.80%
L1 Miss %	5.16%	0.28%	0.87%	2.75%	9.37%	2.20%
L2 Queues	3874130	122245	759649	1924215	4893304	1538106
L2 Hits	2831485	111025	739480	1779823	10	938020
L2 Misses	1042645	11220	20169	144392	4893294	600086
L2 Hit %	73.09	90.82	97.34	92.50%	0,00%	60.99%
L2 Miss %	26.91	9.18	2.66	7.50%	100,00%	39.01%
SMS Requests	3874130	122245	759649	1924215	4893304	1538106
SMS Guesses Taken	3864218	117679	679490	1792659	4893043	1524891
SMS Useful Guesses	289601	19858	306162	312823	8	639308
SMS Useful Guesses %	7,49%	16,87%	45,05%	17,45%	0,00%	41,92%