

ECE 571 – Advanced Microprocessor-Based Design Lecture 14

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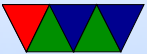
Announcements

- HW4 posted soon
- Reminder about project and topics



Cache Power and Energy

Large area, low-hanging fruit



Decay Caches

- Kaxiras, Ho, Martinosi (ISCA 2001)
- Turn off cache lines not being used to reduce leakage
- DRAM cache with no refresh
- Decayed values can be re-fetched from memory.
Tradeoff.



Drowsy Caches

- Flautner, Kim, Martin, Blaauw, Mudge. ISCA 2002.
- Move cold cache lines into “drowsy” mode.
Lower power enough to hold state, not enough to lose contents. Reduce leakage. Better than decay as not lose data.



Adaptive Caches

- Albonese (Micro 1999). Manually turn off ways in cache with an instruction.
- Size the caches



Cache Compression

- Dynamic zero compression for cache energy reduction (L Villa, M Zhang, K Asanović. Micro 2001).
- Cache Compression (“sign compression” – top bits)
Energy savings 20% (simulated) (Kim, Austin, Mudge WMPI 2002)



Banking and Filtering

- Filter cache, banking (only have half of cache active) (Mudge 2001)
- Slowing Down Cache Hits, Banked Data Cache. (Huang, Renau, Yoo, and Torrellas. Micro 2000.)
- Vertical Banking, Horizontal Banking (Su and Despain, ISLPED 1995).



Code Scheduling

- Can Schedule code for lower power.
- Better cache rates lower power. performance/power can go hand in hand. (Kandemir, Vijaykrishnan, Irwin)



Branch Predictors

- Parikh, Skadron, Zhang, Barcella, Stan
- 4 concerns:
 1. Accuracy. Not affect power, but performance
 2. Configuration (may affect power)
 3. Number of lookups
 4. Number of updates
- Tradeoff power vs time.



- brpred can be size of small cache, 10% of power
- Can use banking to mitigate



Branch Predictors

- can watch icache, not activate predictor if nobranches
- Pipeline gating, keep track of each predicted branch confidence. If confidence hits certain threshold, stop speculating. Show this may or may not be good.
- Integer code, large predictors good
- FP, tight loops, predictors not as important.



Branch Predictor Evaluation

- (Strasser, 1999). Simulation, small branch predictor can help energy.
- (Co, Weikle, Skadron) Formula for break even point. Leakage matters, what brpred hides is stall cycles.
- SEPAS: A Highly Accurate Energy-Efficient Branch Predictor (Baniasadi, Moshovos. ISLPED 2004).
Once a branch prediction reaches steady state (unlikely to change) stop accessing/updating predictor, saving



energy.

- Low Power/Area Branch Prediction Using Complementary Branch Predictors (Sendag, Yi, Chuang, Lija. IPDPS 2008)

Complementary Branch Predictor to handle the tough cases.



Prefetching

- Prefetching does not get looked at as closely. Various studies show it can be a win energy wise, but it is a close thing.
- (Guo, Chheda, Koren, Krishna, Moritz. PACS'04)
HW Prefetch increase power 30%; have compiler help augment with hints, filters.
- (Tang, Liu, Gu, Liu, Gaudiot. Computer Architecture Letters, 2011).



Mixed results.

