Scribing - September 16th

News

- AMD Fx - "Fastest" CPU (in terms of frequency)
- 8.722 GHz overclocked
- FX-8370, 4.3GHz turbo, TDP 125W, Piledriver x86 core architecture
- High voltage (2V)
- Integrated liquid cooling
  - Pre-filled, micro-channels, integrated pump

Performance Analysis and Its Impact on Design

- IEEE 1998
- Importance of performance analysis now and throughout history
  - Analysis vs. design, which is superior?
- "Architecture should not write checks that designers cannot cash"
  - Do architects know what's possible and what constraints are there?

Design Process

- Lead architects consider bounds of potential design
- Performance team creates performance model
- Performance architects create test cases
  - Test model

Terminology

- Path length = instruction count
- Separable components of CPU (Phil emma)
  - CPI = Infinite-cache-CPI + FCE
  - Infinite-cache-CPI (no stall) = e_busy + e_idle
  - FCE (finite cache effect, miss penalty)
  - Miss rate = cycles per miss x misses per instruction
  - Linear relationship between CPI and misses/instruction

Performance Validation

- Generate performance test cases
- Early tests are random
- After failing tests are below threshold, move to focused and handwritten tests
- Latency tests
- Cost estimate for large basic-blocks is based on program dependence graphs
- Best/worst case timings for a basic-blocks can be used as test cases
- Bandwidth tests

Performance Signature Dictionary
- Apart from specifications for cycle count
- Steady state loop performance
- Derive more elaborate performance signature
- Signatures are plots of various quantities that follow characteristic patterns
    - e.g. Periodic pattern of pipeline state

Trace Distortion
- Instruments can cause distortion due to invasiveness (alters behavior)
    - e.g. mtrace (tracing tool)
    - 60 times slower than un-instrumented
    - Collects I/D addresses
    - AIX clock interrupt occurs 100 times per second to wake scheduler (real world time)
    - However, since 60x slower, 60x more interrupts
    - Interrupts have to be slowed by 60x as well

Analysis of Redundancy and Application Balance in the SPEC CPU2006 Benchmark Suite
- Written when 2006 was being created/compiled
- The Laboratory for Computer Architecture at UT Austin advised/analyzed current benchmark choices
- Final paper written on final program selection
- SPEC
    - Open submission, wide-audience for programs (e.g. GCC)
    - Initial tests to eliminate programs
    - Performance data given to UT researchers, who did cluster analysis
    - SPEC made choices based on data

Motivation
- Many benchmarks are similar
- Running more benchmarks that are similar produces no gains
- Good benchmark suite should have good representations of different clusters
    - Reduces experimentation effort
    - Increases coverage

Reduce
- Measure properties (K)
    - microarchitecture independent properties
    - microarchitecture dependent properties
- Display properties (K)
- Workload space consist of clusters of benchmarks

- Choose 1 per cluster
  - Explore space
  - Might be impossible to have uniform distribution throughout the space
- Statistical techniques to combine data and dimensions
  - High dimensionality
    - Principal components (PC)
    - Principal component analysis (PCA)
    - Some variables/components have different variability, reduce to those which give the most variability
    - Capture most of the information
    - Look in the PC space
- Clustering analysis
  - K-means
    - Create K-clusters (or iterate through and find k with best error)
    - Procedure (k=3)
      - Randomly select 3 cluster centers
      - Assign benchmarks to cluster centers
      - Move centers to the center of clusters
      - Repeat until convergence
  - Hierarchical clustering
    - Linkage strategies
      - Farthest distance
      - Center
      - Euclidian distance (sqrt(a^2+b^2))
      - Manhattan distance (90 degree angles, a+b)
    - Procedure
      - Iteratively join clusters (each benchmark is a cluster)
      - Join the two closest by linkage strategy
      - Repeat
  - Dendrogram
    - Indicates how benchmarks are similar
    - Tells what benchmarks to use if only a limited number of benchmarks can be run
- SPEC removed most similar benchmarks

Software
- Statistica
- R
- MATLAB