Advanced Systems Lab

Profiling Tools for Performance Metrics

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Performance Counters

CPUs have special registers (performance counters) that can be used to record various performance critical metrics/events.

Supported metrics include (not available on every processor!):

scalar executed floating point operations

vectorized executed floating point operations

branch misses

cache misses

Also, more fined grained metrics, e.g., number of divisions

Reading Performance Counters

Performance Application Programming Interface (PAPI)

- *Requires modifying the profiled program's code*

Profilers:

- *Intel's VTune: can generate an extensive analysis of the profiled program with many metrics and graphs, in active development*
- *Linux's Perf: command line tool, "less heavy-weight" alternative to VTune*

Perf Example (1/2)

Given a program a.out:

```
perf stat ./a.out
Performance counter stats for './a.out':
              0.79 msec task-clock:u              #    0.751 CPUs utilized
                 0      context-switches:u        #    0.000 /sec
                 0      cpu-migrations:u          #    0.000 /sec
                79      page-faults:u             #   99.912 K/sec
         2,052,295      cycles:u                  #    2.596 GHz
         2,403,057      instructions:u            #    1.17  insn per cycle
           511,384      branches:u                #  646.750 M/sec
             5,022      branch-misses:u           #    0.98% of all branches
        10,261,475      slots:u                   #   12.978 G/sec
         2,736,393      topdown-retiring:u        #     26.7% retiring
           482,892      topdown-bad-spec:u        #      4.7% bad speculation
           965,785      topdown-fe-bound:u        #      9.4% frontend bound
         6,076,402      topdown-be-bound:u        #     59.2% backend bound
```

Perf Example (2/2)

To measure a specific metric:

```
perf stat -e LLC-load-misses ./a.out
 Performance counter stats for './a.out':

               291      LLC-load-misses:u
```

The exact name event (metric) name depends on the CPU. `perf list` shows the supported events.

Multiple events can be measured:

```
perf stat -e fp_arith_inst_retired.256b_packed_single,LLC-load-misses ./a.out
 Performance counter stats for './a.out':
           240,000      fp_arith_inst_retired.256b_packed_single:u
               285      LLC-load-misses:u
```

Reading multiple events requires multiplexing → reduced accuracy