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:

```bash
perf stat ./a.out
```

Performance counter stats for './a.out':

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

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
```

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

Reading multiple events requires multiplexing \(\rightarrow\) reduced accuracy