Power-Sleuth: A Tool for Investigating your Program’s Power Behavior
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1. Power Profiling in different frequencies

Power characterization:
- What is the execution time of each phase?
- What is the power of each phase?
- How is execution time/power affected by frequency scaling?

![Power-Sleuth characterizes application phases using performance and power models](image)

**Analytical DVFS performance model**

- Decrease in execution time and energy consumed under max/min frequency for the phases of gcc/166.

2. Profile applications at \( f_{\text{max}} \) and predict execution time and power at \( f_{\text{max}} \) and \( f_{\text{min}} \)

How does Power-Sleuth work?
- **Runs** an application once
- **Detects** phases using ScarPhase library
- **Measures** power consumption under max/min frequency without re-running the application

**No power measurements required!**

Power-Sleuth delivers
- **Accurate prediction:** less than 4% average error for both execution time and power prediction (running SPEC2006)
- **Per phase analysis:** instead of total energy and execution time, Power-Sleuth predicts for each program phase separately

![Power-Sleuth DVFS](image)

**Power-performance counters correlation model**

\[
P = f \times C_{\text{pred}} \times V^2 + P_{\text{static}}
\]

\[
C_{\text{pred}} = \sum_{k=0}^{5} \frac{\text{param}_k \times \text{event}_k}{\text{cycles}} + \text{param}_0
\]

3. Power-Sleuth accuracy

**Execution time does not scale linearly with frequency:** need the analytical DVFS model

**No power measurement infrastructure required**

- We estimate power for both max and min frequency

![Execution time prediction error for different profiling and target frequencies](image)

**Power prediction error. Profiling is performed under maximum frequency.**

![Optimal DVFS scheduling](image)

**Optimal DVFS scheduling**

- Performance constraints for specific phases
- Optimizing power-efficiency (e.g. minimum EDP)

Minimizing EDP under the constraint that performance is not penalized more than 10%. The appropriate DVFS schedule is provided by Power-Sleuth.