Phase Recognition from Power Traces of HPC Workloads

Achievement: The development of a software method that is able to correctly detect and associate the phases of a power trace to known kernels with a high percentage.

Significance and Impact: This work addresses some of the limitations in the current state-of-the-art in understanding workloads’ power consumption behavior. As power constraints and energy costs loom large in high performance computing, it can help schedulers to optimize performance under a power constraint.

Research Details:
- This work addresses the limitations of the previous approaches in the following two aspects:
  - The workload identification operates at the granularity of an entire power trace or application, with no ability to drill down into parts of the trace.
  - To match a power trace to the workload that generated it, there must be prior power traces collected from that exact workload. Novel combinations of known kernels are unrecognizable.
- The goal is to decompose a given power trace into its constituent kernels and accurately identify each kernel. The output of our algorithm will be a list of non-overlapping time intervals, each one labeled with the kernel inferred to be running in each interval.
- Our approach has four steps: 1) Identify change points corresponding to possible phase boundaries in the test trace. 2) Identify candidate phases (possibly overlapping), where each phase is an interval starting at either the beginning of the trace or a change point, and ending at either a change point or the end of the trace. 3) Attempt to identify the task type of each candidate phase. 4) Choose a final partition of the trace from among the candidate phases.

Sponsor/Facility: DoD

PI and affiliation: Chung-Hsing Hsu (ORNL).

Team: Prof. Suzanne Rivoire and her students (Sonoma State University), Chung-Hsing Hsu (ORNL).


Overview:
Prior work has shown that power consumption traces of HPC workloads exhibit distinctive statistical characteristics, which allows the workload that generated a given power trace to be inferred with high accuracy. However, these power signatures apply to the entire power trace, with no ability to break it down further into phases or to recognize novel combinations of known workloads. In this work, we propose a software method for partitioning a power trace into phases and matching each phase to a known kernel or workload. We evaluated the method on a set of 388 power traces collected from 21 benchmarks, including CPU stressors, the NAS Parallel Benchmarks; and Mahout data analytics workloads. The results show that the method is able to, on average, attribute 78% of the points in a concatenated trace to the correct kernel.