Building Run-Time CPU Power Models from Real Data

Matthew J. Walker, Stephan Diestelhorst, Andreas Hansson, Bashir M. Al-Hashimi and Geoff V. Merrett

http://www.powmon.ecs.soton.ac.uk/powermodeling

Abstract

Being able to accurately estimate CPU power consumption is a key requirement for both controlling online CPU energy-saving techniques and design-space exploration. Models built and validated using measured data from an actual device are valuable as their accuracy is known and trusted. We present our techniques and freely available software tools for running experiments on mobile development boards and using the recorded data to build accurate and stable run-time power models. Our novel methodology uniquely considers the stability of the model and we demonstrate how it allows the models to achieve a higher accuracy on a wider range of workloads. We show how our tools are able to predict run-time power of an ARM Cortex-A15 CPU with an average error of less than 3% when validated with over 50 workloads.

1 Experiment Platform

We present a pre-built OS and software tools to streamline the process of running experiments that require CPU power, voltage, temperature and performance monitoring counters (PMCs) on an ODROID-XU3 mobile development board. A web-based data analysis tool allows the collected data to be easily filtered and interpreted (see examples and download our collected data at the link above). There will be support for other platforms in the near future.

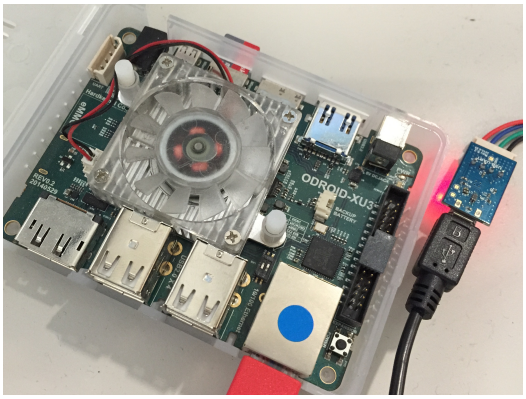

Figure 1: We demonstrate our methodology and software tools on a Hardkernel ODROID-XU3 development board

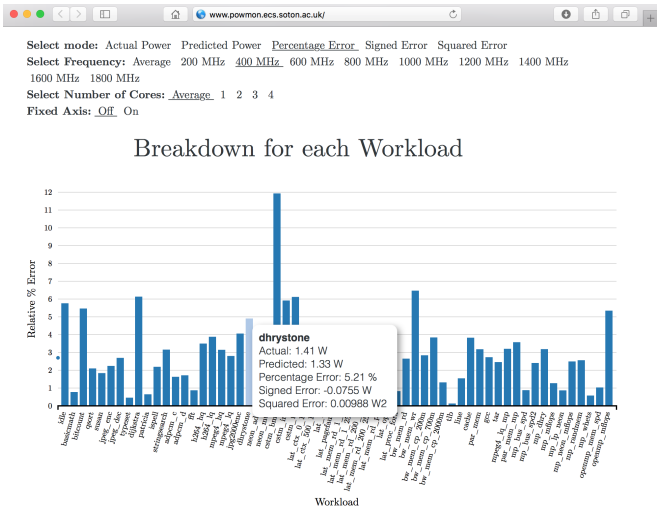

Figure 2: We present a web-based data analyser and model results viewer for visualising recorded data and evaluating the quality of the produced models.

2 Model Generation Software

We present our model-building software that takes the experimental data, chooses the optimum model inputs, and creates power models. In particular, our automated methodology: ensures stability in the model, overcomes heteroscedasticity, and uses a robust model formulation. We explain why these three points are important for power modelling and we demonstrate their effects experimentally. While our software package builds CPU power models, the techniques we demonstrate can be applied to other applications. We also present our web-based model model analyser, where the output files form this software can be drag-and-dropped to generate dynamic graphs and statistics for analysing the model. Examples can be found on our website (address above).

3 Run-Time Power Models

We provide our stable power models, which can be used for research, design-space exploration, or run-time management applications, where an accurate and fast model is required. Hardware performance monitoring counter (PMC) data, either from a real device or a simulator (e.g. gem5), can be used as inputs to the models.

This work is supported by ARM, EPSRC and the PRiME Project