

Run-time Power Estimation for Mobile and Embedded Asymmetric Multi-Core CPUs

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Introduction

- A run-time manager (RTM) can make significant energy savings by making smart decisions when controlling the processor's operation (e.g. DVFS, DPM, task-core mapping)
- To make smart decisions, it needs to know (in real-time) how much power is currently being consumed
- Aim of this research is to build run-time power models



Figure 1 Simplified experiment methodology

Performance Counter (PMC) Power Model

- Performance counter events (e.g. L2 cache miss, branch mis-prediction) correlate well with power consumption;
- A run-time power model was built for a BeagleBoard-xM (Figure 3)
- Extremely accurate: <3.2% error across large range of workloads when running in **real-time** (Figure 2)

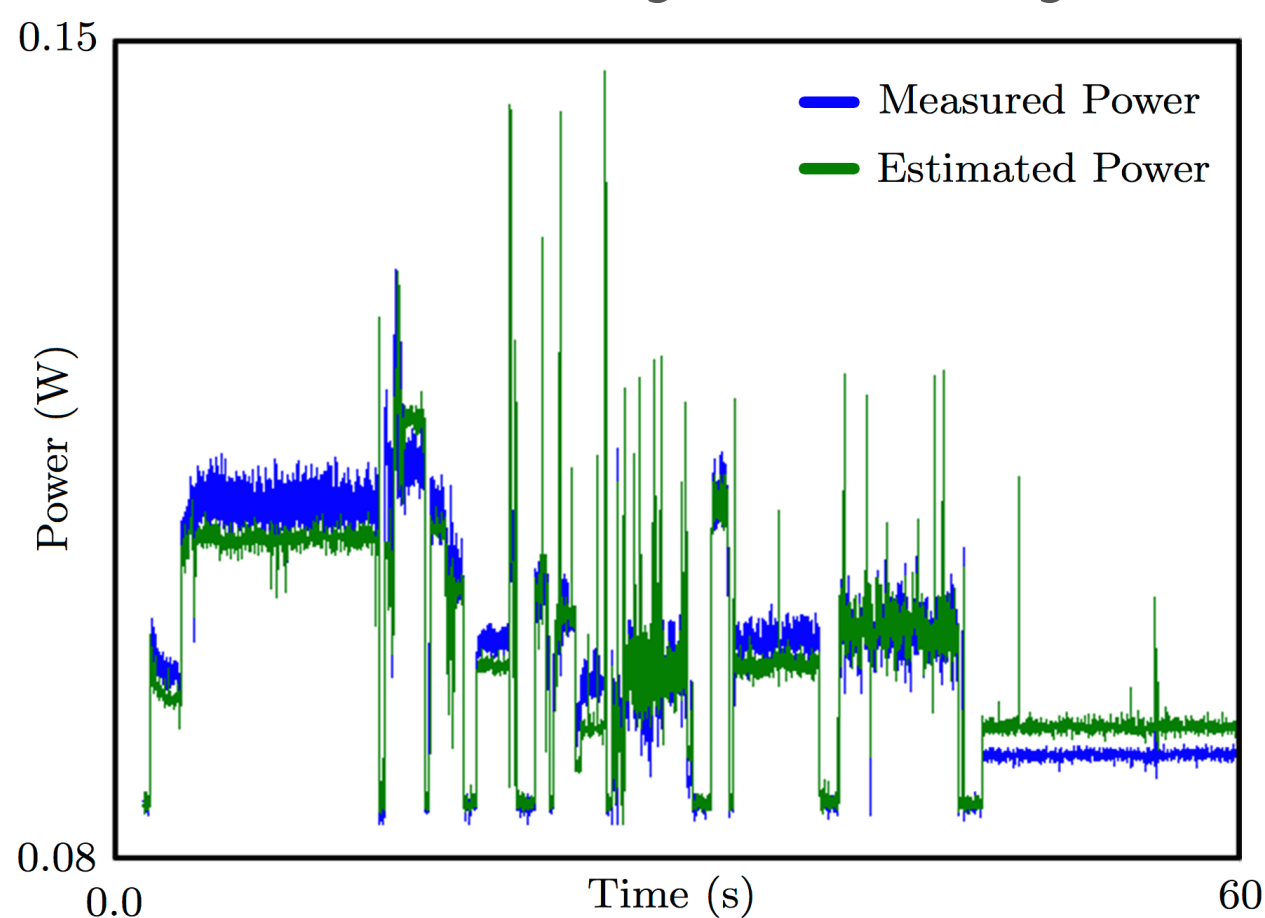


Figure 2 Run-time power and estimated power from PMC model

Development Platforms

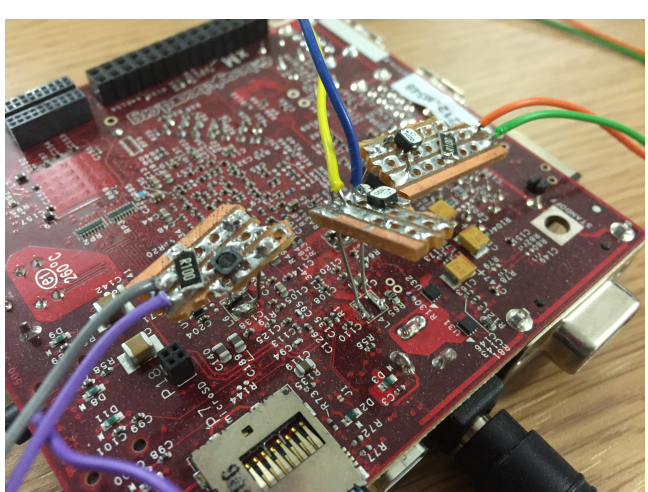


Figure 3 BeagleBoard-xM

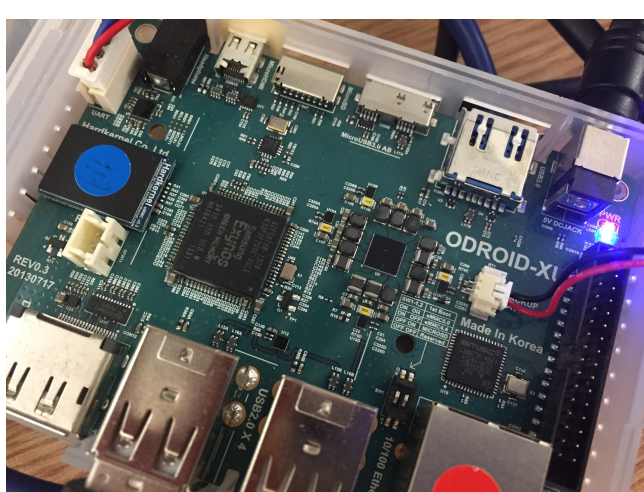


Figure 4 ODROID-XU+E Board

Utilisation Power Model

- Problem with PMCs: they are difficult/impossible to obtain on most mobile/embedded devices
- Will a simpler metric do?
- Power model using simple CPU utilisation was built on a Samsung **big.LITTLE** SoC (used in Samsung Galaxy S5, Chromebook 2, Samsung Galaxy Note 3 - all released in 2014)
- Error of 5.6% on 'little' Cortex-A7 and 7.2% on 'big' Cortex-A15 (per-core power estimation)
- Utilisation models can be applied to any platform
- Power of each task can be estimated
- Can foresee how much power a task would consume if it were running with a different core/frequency (Error: 10%)

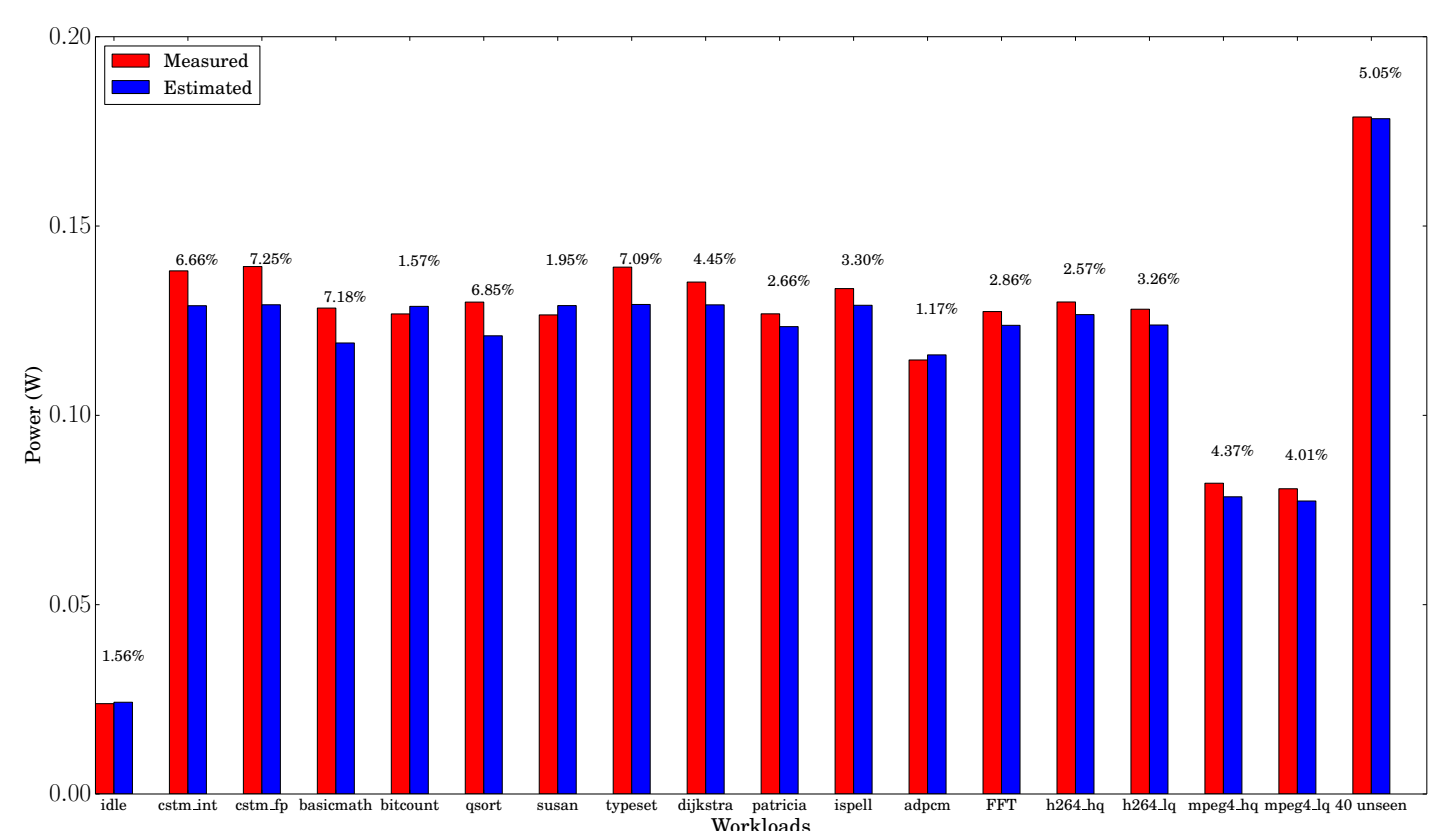


Figure 4 Utilisation model power and predicted power across workloads

Conclusion

- Two run-time power models built; PMC-based model more accurate but less practical than utilisation-based model
- Utilisation model can predict the power profile of one core from statistics from another in a big.LITTLE system

Further Work

- Implement on Android and test on real smartphone
- Analyse big.LITTLE trade-offs - how to make the smartest decisions
- Use to aid run-time management