Design

**Energy Optimization for I/O Intensive Applications:**
- Increase energy efficiency by using power feedback
- Intrusive DVFS exploration for each program phase
- Phase detection with power and performance trace
- Full system Energy, EDP, and Power minimization
- Memory DVFS and per-core DVFS ready

**Energy - Critical Future Applications:**
- Datacenter server machines
- Battery-critical and portable devices

**Design goals:**
- Robust energy efficiency optimization
- Automatic parameter space exploration
- Replace current Linux governors
- Adapt to new power management technology
- Optimal DVFS Selection

**Benefits:**
- Transparent DVFS coordination
- Platform independent operation

Implementation

**Energy Instrumentation:**
- High precision processor energy trace
- High bandwidth energy information
- Zero instrumentation overhead
- CPU / DRAM / Storage breakdown

**Feedback-Driven Energy Optimization**
1. Identify program phases
2. Explore the DVFS parameter space
3. Track the Energy of each DVFS point
4. Apply the best point

**Live Phase Optimization Illustrated**
- I/O - bound phase → min DVFS
- CPU - bound phase → max DVFS
- Better than Linux Governors

**Multicore FDIO Requirements**
- Model-based CPU energy accounting
- Per-core DVFS (Future architectures)
- Energy-aware I/O kernel tracking
- Individual core phase detection

Current Work

**Universal Function Level Energy Optimization**
- Function level DVFS selection
- Feedback - driven scheme
- Transparent binary decomposition
- Function level energy metadata and control

**Energy efficient I/O processing on SoC GPUs**
- Energy Characterization and management of Heterogeneous SoC processors
- Energy efficient thermal resource allocation

The research leading to these results has received funding from the European Union Seventh Framework Programme [FP7/2007-2013], including funding from the IOLANES (FP7-ICT-248615) and CamuloNimbo (FP7-257993) Projects in Computing Systems.

USENIX Federated Conferences Week, June 24-28, 2013, San Jose, CA