学术论文

Energy-Efficient Phase-Aware Load Balancing on asymmetric multicore processors

基于非对称多核处理器的低功耗负载均衡方法

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MOTIVATION

Phase-Irrelevant load balancing:

- Task migration decisions are made based on the load historical contribution. It is the sum of the time spent waiting to run (runnable state) and the time spend running (running state) by this task during the scheduling period.
- Such computation method is based on the task priority and the average CPU utilization without the consideration of the task online characteristics in this equation.

Phase-Aware Load Balancing:

- Tasks include a series of execution phases memory/computation intensive etc.
- The load balancing decision is optimized by extending the load calculation and prediction which takes the task phase change into account.

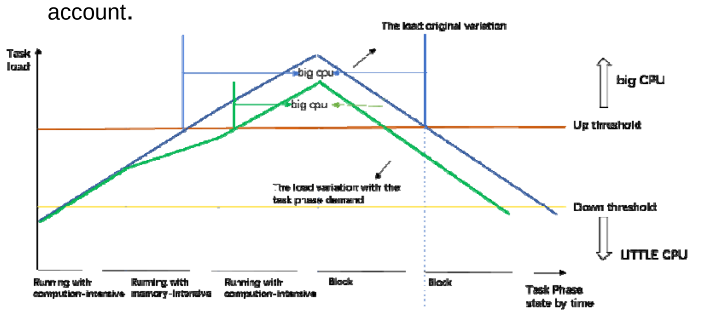

Figure 1. The different load balancing affecting the energy efficiency based on different load tracking method

PHASE-AWARE LOAD BALANCING METHOD

The phase indicator is generated based on CPI_B:

- H(High computation demand):The indicator is the CPU capacity. This task type is more benefited from the big core which preferred to be moved to the big core.
- M(Media demand):The indicator equals CPI_B. This task is moved according to the resource requirement
- L(Low demand):The indicator is a half. This task type is more benefited from the LITTLE core which preferred to be leaved on the LITTLE core for energy efficient consideration.

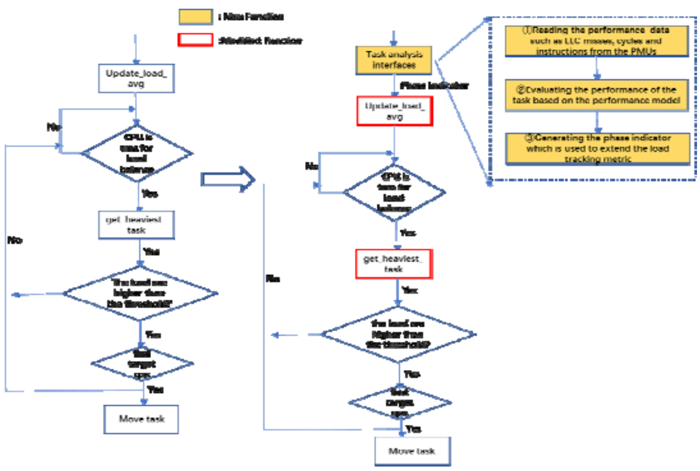

Figure 2. The basic idea of the phase-aware load balancing

IMPLEMENTATION

This method is implemented by an example on the ARM big.LITTLE platform with Linux kernel 3.4.

System interface:

- Some callback functions are provided to accessing per-thread. performance counter data when the scheduling tick arrived.
- Analysis the performance data based on the model.
- Generating the phase indicator.

Monitor module:

- Accessing the underlying performance monitor counters (PMCs).
- When the monitor module is loaded, the pointer of callback function is assigned.

Task selecting rule which is more suitable for the target CPU based on the task phases.

RESULTS

The Energy Cost Evaluation:

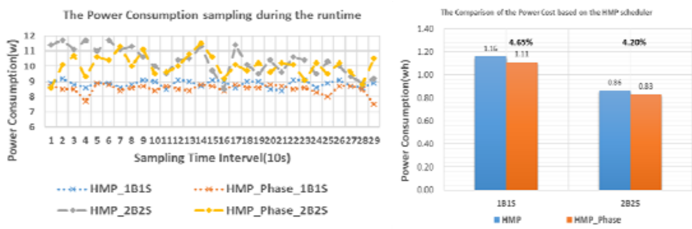

Figure 3. The average 4.65% and 4.20% energy cost can be on 1B1S and 2B2S separately with DVFS enabled

The Performance Evaluation:

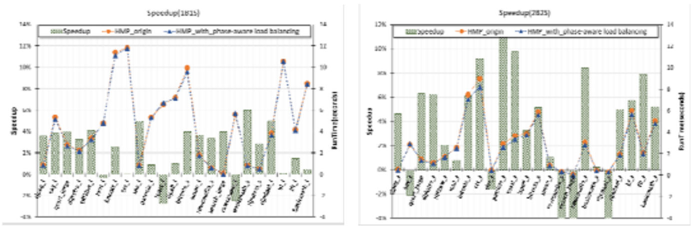

Figure 4. The average 2.3% and 3.6% performance improvement can be achieved on 1B1S and 2B2S.

CONCLUTION

In this work, we take phase-based performance and energy variance into account and introduce a novel load balancing algorithm. We compared proposed method with latest load balancer with load balancing method in mainstream operating system. Results shows that proposed method effectively reduce energy consumption while maintaining overall runtime performance.

FUTURE WORKS

- Collecting performance event data in different scenarios.
- Using machine learning technique to predict the phase of program.
- Using the machine learning predicting results to load-balancing.

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