Energy Consumption Optimization of Rendering in Blender Cycles on ×86 Architectures

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1 INTRODUCTION

We present an energy measurement of rendering in Blender Cycles by employing High Performance Computing (HPC) systems built on different HW architectures. For two specific architectures (Haswell, Knights Landing) where tunning of the CPU frequencies was possible we provide detailed results including comparisons of rendering time.

2 OUR APPROACH

We have extended Cycles [Jaros and Riha 2018; Jaros et al. 2017] engine in form of Blender's plug-in to support remote utilization of HPC resources and to allow optimization of the energy consumption of the rendering task.

In order to reduce energy consumption of a scene rendering we have used MERIC library [Vysocky, Beseda, Riha, Zapletal, Nikl, Lysaght, and Kannan Vysocky et al.] developed at IT4Innovations for HPC application resources consumption evaluation, that can also tune selected hardware parameters during the application runtime. The library allows us to do Dynamic Voltage and Frequency Scaling (CF) and Uncore Frequency Scaling (UnCF) [1], and control the separate parts of the chip more effectively in comparison to automated power capping.

The energy measurement of the whole node is defined by the equation $E = energy_{cpu} + baseline * time$, where energy consumed by CPUs is measured from Intel Running Average Power Limit (RAPL) counters and the power baseline is defined from data provided by Intelligent Platform Management Interface (IPMI). The value from IPMI is compared with the power baseline from High Definition Energy Efficiency Monitoring (HDEEM, [Hackenberg et al. 2014]) in Tab. 1.

HSW-freq [GHz]	1.4	1.6	1.8	2.0	2.2	2.4	turbo
HDEEM baseline [W]	65	66	68	68	69	71	73
HSW-freq [GHz]	2.4						
IPMI baseline [W]	70						
KNL-freq [GHz]	1.3						
IPMI baseline [W]	75						

Table 1: The measured power baseline for Haswell and KNL by IPMI and HDEEM.

3 RESULTS

The analysis of the energy consumption in different hardware settings has been done on IT4Innovations Salomon cluster that is based on nodes with two Intel Xeon E5-2680v3 (HSW) processors with 12 cores each, and on TU-Dresden Taurus cluster island with Intel Xeon Phi Processor 7210 (KNL).

The systems in the default configuration and with optimal settings are compared in the Tab. 2. The KNL AC (air cooling) consumes less energy already in the default configuration and after applying the best hardware settings in comparison to HSW AC we reach up to 18 % energy savings with runtime longer about 3 %.

Platform	Default settings	Optimal settings	Energy and time savings
Classroom scene			
HSW AC	**19318 J; 65 s**	18286 J; 79 s	E+5%; T-22%
KNL AC	16681 J; 66 s	**16681 J; 66 s**	E+14%; T-2%
Dweebs scene			
HSW AC	**19072 J; 64 s**	18249 J; 78 s	E+4%; T-22%
KNL AC	15978 J; 62 s	**15743 J; 66 s**	E+17%; T-3%
Fishy Cat scene			
HSW AC	**18794 J; 63 s**	17755 J; 73 s	E+6%; T-16%
KNL AC	15607 J; 61 s	**15431 J; 65 s**	E+18%; T-3%

Table 2: Runtime and energy consumption of Haswell (HSW AC) and KNL (KNL AC) nodes with Air Cooling system in the default and optimal settings. For the baseline 70W was used.

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[1] Uncore frequency refers to frequency of subsystems in the physical processor package that are shared by multiple processor cores. E.g., L3 cache or on-chip ring interconnect.