Research Proposal: An usability analysis of the user-experience of Core i7-8700K Using SPEC CPU2017 depend on Performance, Event, and Energy Characterization

CSE-0410 Summer 2021

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Acknowledgment

I would like to thank my honourable**Khan Md. Hasib Sir** for his time, generosity and critical insights into this project.

***Abstract*—In This paper describes the results of measurement based studies focusing on performance,event and energy efficiency of SPEC CPU2017 speed and rate benchmark runs on the Intel's Core i7-8700K processor.SPEC CPU2017 is the most recent incarnation of standard benchmarks designed to stress a system's processor, memory subsystem, and compiler.In order to meet growing application demands, modern processors are constantly evolving. Today they integrate multiple processor cores, an on-chip interconnect, large shared caches, specialized hardware accelerators, and memory controllers on a single die. We quantitatively evaluate the compilers with respect to metrics such as benchmark build times, executable code sizes, and execution times. The benchmarks are compiled using comparable optimization levels and they are run on an Intel 8th generation Core i7-8700K. Findings from these studies can be used to guide future performance evaluations and computer architecture research.**

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I. Introduction

Computing has been constantly evolving as technology, applications, and markets continue to change and advance. Mobile, IoT, and cloud computing have been major drivers of innovations recently and are likely to remain so in the next decade. The end of semiconductor scaling and demise of Moore's and Dennard's laws indicate that future performance improvements will have to come from architectural improvements and new computing structures rather than from getting smaller and faster transistors. Emerging new applications in domains such as machine learning, and block chain present a new set of challenges requiring more performance and increased energy-efficiency of modern processors. Market trends continue to shrink time-to market. Modern Intel processors, starting with the Sandy Bridge micro architecture, have the Running Average Power Limit (RAPL) interface [2] that is designed to limit on-chip power usage while ensuring maximum performance.

II. Advantages of our research

Intel finally expanded the core count of its mainstream processors, facilitating solid all-around performance from the Core i7-8700K. Aggressive Turbo Boost bins ensure great performance in lightly-threaded workloads, while six cores cut through demanding tasks much more adeptly than Core i7-7700K. Intel's Core i7 line-up is still expensive, but you'll pay a lot less per core than in prior generations.Core i7-8700K serves as this generation's flagship, sporting six Hyper-Threaded cores. Already, that's a big increase from Kaby Lake's 4C/8T maximum. It features the company's highest clock rates, accelerating up to 4.7 GHz via Turbo Boost. The -8700K does sacrifice some base frequency in exchange for a higher core count, though. Its 3.7 GHz specification is 500 MHz lower than the -7700K, offsetting the increased power consumption and heat generated by a 6C/12T configuration.

III. Literature Review

Ahead of the 5th October reviews NDA, Lab501 posted their review of the Core i7-8700K six-core processor using samples not provided by Intel, paired with an Aorus Z370 Ultra Gaming motherboard. The tests reveal that the i7-8700K trades blows with the Ryzen 7 1800X in multi-threaded tests, despite two fewer cores, and has a clear leadership in single-threaded tests. It also reveals that the i7-8700K may not be as pricier than the i7-7700K as previously thought. Interestingly, the i7-8700K also spells trouble for "Skylake-X" Core i7 SKUs such as the i7-7800X and i7-7820X, as it offers multi-threaded performance in proximity to them, while being cheaper overall.

The Core i7-8700K is able to sustain its Turbo Boost frequencies of 4.20 GHz better than Intel's other Core X HEDT chips, which translates into higher gaming performance. The tests reveal that today's games still don't need six cores, and on the merit of high sustained clock speeds alone, the i7-8700K is shaping up to be among the fastest processors you can choose for gaming PC builds. Lab501 also got the i7-8700K to overclock to 5.1 GHz with relative ease. The chip runs feisty hot at overclocked speeds, but rewards with HEDT-like performance. Find other interesting findings of Lab501 in the source link below.

IV. Problem statement (research question)

A. *Question:How is 8th generation i7 processor different from 7th generation i7?*

solution:The desktop i7–8700 and above have 6 cores, where as the i7–7700 and 7700k (7th gen) has 4 cores. The mobile i7 (8th gen) have 4 cores, where as the i7–7500 and above only have 2 cores, resulting in higher multi-core performance for the 8th gen processors. (60 percent faster for mobile, 20–40 percent faster for desktop). The mobile and desktop CPUs have UHD620 and UHD630 respectively, instead of the 7th gen's HD620 and HD630, resulting in a 20–30 percent increase in integrated graphics performance.

V. Proposed Methodology

The test computer is built around an Intel 8th generation Core i7-8700K. The processor is based on Coffee Lake architecture and is manufactured using Intel's 14nm++ technology node [10]. It consists of six 2-way hyperthreaded physical cores. Each processor core includes separate 8-way setassociative 32 KiB first level caches for instructions (L1I) and data (L1D) and a 4-way 256 KiB unified level 2 cache (L2). The last level cache (LLC or L3) of 12 MiB is shared among all processor cores and is built as a 16-way set-associative structure. The processor's nominal clock frequency is 3.70 GHz. However, turbo boost frequency can reach 4.70 GHz for a single core or 4.3 GHz for all six cores. The test computer has 32 GiB DDR4 2400MHz RAM memory. The integrated memory controller is configured as dual-channel with a maximum bandwidth of 39 GiB/s. It runs Ubuntu 18.04 LTS with Linux kernel 4.15.0. Hyperthreading is disabled during experiments in this study.

VI. Motivation of our research

This paper aims to provide a clear understanding of how frequency scaling impacts performance, energy efficiency, and a new PE metric that combines both performance and energy efficiency. The measurements are conducted on an Intel Core i7-8700K processor running recently introduced SPEC CPU2017 benchmark suites [9], while varying the number of threads/copies and processor clock frequency. Section II describes the experimental setup and the metrics for evaluation. Section III explains the results obtained and Section IV gives concluding remarks.

VII. Tools and Evaluation Methods

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VIII. Goals and Metrics

This paper aims to provide a comprehensive evaluation of the SPEC CPU2017 benchmarks when executed on the most recent Intel Core i7-8700K processor. Specifically, we focus on answering the following questions. 1. What is the impact of compilers on performance metrics? The SPEC CPU2017 benchmarks are compiled using the Intel Parallel Studio XE 18.0.1 and GNU compilers 5.5.0 with standard optimization parameters similar to those in the configuration files provided by SPEC (using –O3 optimization level). 2. What are the main characteristics of the SPEC benchmarks? To answer this question, we use the Linux perf and likwid tools to determine the number of instructions retired, the opcode mix (branch, load, stores) as well as main parameters capturing the behavior of branch predictor structures and cache hierarchy. 3. What are performance bottlenecks? Each benchmark is analyzed using the Intel's Top-down Microarchitectural Analysis (TMAM) [12]. Pipeline and clock-cycle views of each benchmark are used to determine their bottlenecks.

IX. Conclusion

These results reveal effectiveness of the i7-8700K pipeline and bottlenecks exposed by the CPU2017 benchmarks, including a breakdown to memory bound, core-bound, and front-end bound pipelines slots. The paper shows the results of measurement-based studies focusing on the impact of frequency scaling on performance, energy, and the PE metric that captures both performance and energy. The main findings of this work are as follows. (a) Increasing the number of threads/copies to match the number of cores generally improves performance of SPEC CPU2017 benchmarks. (b) For single threaded/copy runs, the best performance is achieved when the clock frequency is at maximum, the best energy efficiency is achieved for an intermediate 2.70 GHz processor clock, and the best PE is achieved for the nominal frequency of 3.7 GHz. (c) For multithreaded/copy runs, the best performance is achieved when the clock frequency is at its maximum, whereas the best energyefficiency is achieved when the clock frequency is at an intermediate 1.70 GHz, and the best PE is obtained when the clock frequency is at 2.70 GHz.

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