DOES POWER PERFORM?

An analysis of the relationship between power and performance of consumer CPUs

GLOSSARY

TDP (Thermal Design Power): A measure of power consumption, in watts, under a heavy stress load

Core, or CPU Core : The "brain" of a CPU. It receives instructions, and performs calculations, or operations, to satisfy those instructions. A CPU has multiple cores

CB (cinebench r20) Score: Cinebench is a popular test suite that evaluates your CPU's single and multi-core capabilities, by giving it a simulated workload.

DATA SUMMARY

		Single core CB score	Multi-core CB score	TDP	CoreCount
N	Valid	48	48	48	48
	Missing	0	0	0	0
Mean		439.08	5109.77	117.33	10.38
Median		449.50	3844.00	95.00	8.00
Std. Deviation		52.759	3196.419	50.346	6.648
Variance		2783.525	10217097.12	2534.738	44.197
Range		187	15637	215	28
Minimum		331	1811	65	4
Maximum		518	17448	280	32

INTRODUCTION

The Idea that power-hungry CPUs have higher performance seems intuitive, but empirical data on the exact link was difficult to find. We believe manufacturers are still primarily concerned with total performance output as opposed to power efficiency

We believe, in an ever increasingly data and processing reliant world, it is important to understand the relationship of doing a digital task and the amount of energy it uses.

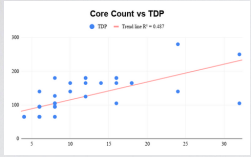
In this study we analyse the correlation between CPU (central processing unit) performance and power consumption popular on consumer CPUs.

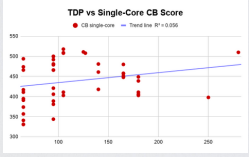
DATA COLLECTION

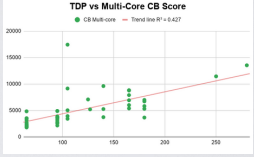
The data collection was a relatively mundane process. We collected Cinebench r20 score data directly from Cinebench's publicly available online score catalog. Other data such as TDP, core count and clock speed was collected directly from the manufacturer's listings.

Some significant outliers were also identified and eliminated from then data set. Two CPUs failed to cope with the CB test and so failed to return a reliable score for us to examine.

We also chose to eliminate CPUs from Intel's Xenon range and AMD's Epyc range. While these chips are occasionally found in consumer personal computers, they are specialized for very high load work, usually as part of a large server and so provided a misleading skew towards high-efficiency .







STATISTICAL ANALYSIS AND RESULTS

The first significant correlation we identified was between Core Count and TDP, as seen in the graph to the left. A Pearson's R correlation coefficient of 0.487 with a significance at the sigma 0.01 (two-tailed) level was observed. This implies a moderately strong positive correlation which we can be quite confident in. We expected this as more cores implies a larger overall CPU which it follows would need more energy, controlling for other variables.

Graphs of power consumption vs CB scores are below. Interestingly, the correlation between TDP and Multi-Core scores was about 8 times stronger than between TDP and single-core CB scores (Pearson's R of 0.427 and 0.056 respectively). Both results were again significant at the 0.01 level. This higher correlation can be accounted for by the power required for the overhead running cost of the chip. This is the power used that is not directly attributed to the task of performing operations within a core.

These graphs show the the correlation between power (TDP) and performance in either a single core or over the entire chip

This graph displays how power (TDP) correlates with the total core count of the chip

CONCLUSION

These results confirm our hypothesis that CPU power consumption and CPU performance are still closely linked. We believe this is due to the fact that power use and the "clock speed", or rate at which data can be processed by a core, have been observed to be linearly proportional to each other. However the strength of the correlations observed, especially between TDP and CB multi-core score ($R^2 = 0.487$) make it clear that there is much improvement to be made in the sector. As referenced above, this difference is due to energy used in the overhead running of the chip. We identify this as the area with the highest potential for efficiency improvements

It is clear that data and computation is at the very center of the immediate human future. According to Forbes, more information has been created in the past 3 years that in the entirety of previous human history, and the volumes of electrical power being used by computers and data centers is increasing exponentially. The importance of the project is to show how this can vary across CPU brands and architectures.

A higher emphasis on power to performance ratio if is crucial to CPU design if future energy use by with the technology industry is to be in any way sustainable