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The Rise of Ryzen

By Douglas A. Lyon

Abstract

AMD has moved from 23 to 32% desktop market share between Q2 and Q3 of 2019, while Intel has fallen from 76 to 68% during the same time period. This is clearly a zero-sum game, where a win for AMD is a loss for Intel.

This article offers an explanation for why AMD has been able to take market share away from Intel on the desktop [CPU]. Bottom line, it is all about the transistor budget and the design rule.

1 INTRODUCTION

According to a report by CpuBenchmark.net, AMD has moved from 23 to 32% desktop market share between Q2 and Q3 of 2019, while Intel has fallen from 76 to 68% during the same time period [CPU].

How can we account for the rise of Ryzen (the AMD name for their CPU)?

In 2018, 259 million desktop computers were shipped around the world. In 2017, the average selling price of a PC was 629 U.S. dollars [STATISTA]. This works out to compute the total addressable market for desktops to be about $162B USD per year.

Clearly, most CPUs are in the sub $500 price range and AMD and Intel both have entries that are in the $500 price range, so let's focus on that. The AMD and Intel $500 CPUs have very different architectures and different approaches. AMD has a CPU called the Ryzen 9 3900x this is designed to compete with Intel Core i9-9900K. Cinebench shows AMD tends to win out in multithreaded performance with 12 cores and a 7 nm design rule with a FinFET implementation. The Intel i9-9900K has only 8 cores and is using a 14 nm design rule. AMDs' CPU has a 64 MB L3 cache while Intel has only 16 MB of L3 cache. For software that doesn't take it advantage of multiple cores and multiple threads (i.e. some games, etc.) 9900x dominates (by 10 to 15%) due to a higher clock speed. Intel has integrated graphics in the CPU. In addition, Intel has 15000 developers helping the software industry optimize for their CPU (this makes a big difference). This is a form of marketing that makes Intel hardware more supported. That is, Intel is in the trenches actively helping people support their hardware, and that makes a big difference. On the other hand, in terms of input/output, we have also seen the use of PCIE 4 for Ryzen vs Intel's PCIE 3 with twice the bandwidth in generation 4 PCIE.

The AMD 3900x consumes about 100 watts [TOM] and so does the Intel i9-9900k both run around 70 C during benchmarking.

A 7nm design rule has a clear advantage over a 14nm design rule. We can see this most clearly in the transistor budget. Sorry to say, Intel and AMD have not disclosed the number of transistors in the 3900x

or 9900k, but based on the number of cores and cache sizes there a distinct advantage in fabricating on the smaller design rule. Logically, one asks the question, when is Intel going to move to a 7 nm design rule? Intel says it is slated to do this move in 2021. In CPU years, this seems like an eternity.

How was AMD able to obtain a reasonable yield while Intel seems to be stalled? The answer is "chiplets". The AMD adoption of smaller dies enable it to keep the yield of the larger CPUs under control. Large packages are routine, but the chiplet allows the industry to move away from the large monolithic die and tie smaller dies together in a MCM fashion. The message is that smaller dies have better yields, better heat distribution, better process distribution and enable a multi-vendor ecosystem. The chiplet is the moral equivalent of the interchangeable parts from the industrial revolution, with smaller, well understood functions segmented with simplified interfaces. Naturally, this comes with a communication overhead, but like many other things in engineering, it is all a trade-off.

2 DISCUSSION

Intel appears to be stalled by its own inability to move to 7nm design in a timely fashion. The ongoing delays to the company's 10nm process are well known. Intel says: “Intel's 7nm process technology will deliver 2 times scaling and is expected to provide approximately 20 percent increase in performance per watt with a 4 times reduction in design rule complexity. It will mark the company's first commercial use of extreme ultraviolet (EUV) lithography, a technology that will help drive scaling for multiple node generations.”

Thus, we can expect Intel to embrace the EUV fabrication systems from ASML in the future. Further, 14nm will still be around in 2021, and the transition will be a slow and painful one. We can expect AMD to continue to gain market share while Intel tries to catch up by introducing EUV products in two years. Of course, by then, we expect TSMC to have a 5nm offer and Intel will be playing catchup again [EXTREME].

CONFLICT OF INTEREST

The author has no conflict of interest.

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