Pirouz Saadat Ruppert
June 9th, 2024

Windows on ARM: The Revolution is Imminent

The vast majority of PCs today are powered by Windows; as they have been for the better part of 40 years. While Windows has taken over many cosmetic modernizations with Windows 11, under the hood, the operating system has to juggle support for modern standards with ancient and outdated ones.

In 2012, Microsoft announced Windows on ARM, an attempt at modernizing the operating system by switching from legacy Intel and AMD processors to new and more efficient ARM chips. These new processors are far more efficient than anything seen before and could have altered the PC landscape forever.

However, changing such a fundamental aspect of Windows left legacy applications designed for Intel and AMD chips behind. Windows on ARM successfully supported Windows but application developers made their stance clear: Windows on ARM was not worth their time and energy. Apps that people use every day simply did not work on ARM at all, and the project was deemed a failure. Then, in 2020, when Apple revealed M1, developers saw that they could not have been more wrong.

But What is ARM Really?

Before one can understand the Windows on ARM revolution, one must first understand what ARM actually is. Advanced RISC Machines is a British design company in the business of making the instructions a CPU (the brain of the computer) needs to function. All CPUs need an instruction set architecture

(ISA) to translate code that people write into individual instructions that a CPU can follow. Because every CPU has a different design, they all need their own ISAs.

Imagine two different people who both want to make a sandwich but have different ingredients. You can think of each of them as a CPU. If they both followed the same instructions to create a sandwich they would quickly find problems. Maybe the instructions call for chicken, one person may have the chicken while the other only has tuna. The person with the tuna can not follow these instructions and therefore needs a slightly modified instruction set to create the same product: a sandwich. Like people making sandwiches, every CPU has slightly different ingredients to work with to make the same result. That's why they all need slightly different instruction set architectures.

Another important distinction to know is the difference between RISC and CISC processors. ARM itself stands for Advanced RISC Machines and is the largest company designing RISC ISAs. RISC stands for Reduced Instruction Set Computer while CISC stands for Complex Instruction Set Computer. The philosophical difference between the two is that RISC processors are created to handle small (or reduced) instructions very quickly while CISC processors are built to handle complex instructions over a longer period of time. You can think of this as the difference between

Step 1: Grab the bread
Step 2: Place the bread
Step 3: Grab the lettuce
Step 4:Place the lettuce
Step 5...

vs.

Step 1: Prepare the bread
Step 2: Prepare the lettuce
Step 3...

While the latter method (CISC) seems more efficient to us humans, in computerland, the former (RISC) has been proven to be far more efficient. When CPUs take these instructions in, they are actually running inputs and

outputs through complex [logic gates](#)[1] (mathematical operations) which [benefit greatly](#)[2] from the simplicity of RISC architectures.

In summary, ARM is a company that licenses its (often more efficient) ISAs to other companies that actually build the processors based on them.

Enter Qualcomm

The pioneer of Windows on ARM today is Qualcomm. With its initial release in 2012, Microsoft partnered with Qualcomm to create the Microsoft SQ3 processor, the first ARM processor for Windows laptops. Qualcomm has decades of experience creating low-power ARM processors for tablets, phones, and almost any device running Android. Their expertise extends from fast-charging systems to cellular connectivity, to image processing modules. Despite their experience in ARM designs, the Microsoft SQ3 saw little success, being restricted by the lack of ARM native applications. App developers were just not willing to port their applications to an unproven instruction set architecture.

That all changed in 2020. If Apple's 2020 Macbooks proved one thing, it's that ARM works. Apple released the M1 chip in 2020, their first desktop ARM processor, and the ARM revolution on Mac created sleeker, lighter, and faster computers while Windows laptops lagged behind. Battery life on Windows became a common joke as ARM-powered Macbooks outlasted them by leagues. While chip companies have been hard at work to close the gap with ARM-powered systems, manufacturers are starting to turn their attention back to Windows on ARM. Under pressure from Apple's Macbooks, Microsoft's failed project now looks like the only chance for Windows laptops to catch up. Windows on ARM is back on!

Earlier this year (2024), Qualcomm announced Snapdragon X1. Directly comparing their ARM processor to Apple's M series chips in their Computex presentation, they claim "X Elite is the new performance leader. So comparing against the Apple M3, 2.6 times superior NPU [Neural Processing Unit] performance per watts; two times the NPU performance [outright]; 35% more memory bandwidth, which is incredibly important for AI; 28% multi-threaded CPU performance; and better battery life" [(Snapdragon Computex 2024 Keynote: The PC Reborn)](#)[3]. These claims are massive. If true, they could

completely change the paradigm of the failure of Windows on ARM and PC ARM systems generally. Qualcomm is taking massive strides to make this platform competitive again, and there is good reason to believe them. [Videocardz.com](#)[4] published leaked internal Dell documents from May of this year outlining Dell's extremely bullish stance on the new Qualcomm chips in their headline: "Snapdragon X Series chips cost only half as much as Intel Raptor Lake's, with up to 98% longer battery life." Internal documents from a company are often seen as much more credible than press information, theoretically being the unfiltered truth for executive eyes only. These huge victories for Qualcomm's Snapdragon X1 translate directly into victories for Windows on ARM, and victories for the consumer.

What does this mean for consumers?

Competition is always a good thing and it has been sorely lacking in the ARM on PC market. With the X Elite's foray into the market, and with NVidia and AMD's plans for their own desktop ARM chips, competition and performance are poised to erupt faster than ever before, cheaper than ever before.

Conclusion

Windows on ARM started out on a rocky road down certain death. Through heated competition from Apple and the proven superiority of ARM designs, Windows on ARM is making a miraculous recovery in a new age of ARM PCs. This means consumers will soon be treated to faster, lighter, and cheaper computers all around.

Citations

[1] "Logic Gates." *Wikipedia*, accessed 9 June, 2024, https://en.wikipedia.org/wiki/Logic_gate

[2] "Circuit Simplification Examples." *allaboutcircuits.com*, accessed 9 June 2024, https://www.allaboutcircuits.com/textbook/digital/chpt-7/circuit-simplification-examples

[3] "Snapdragon Computex 2024 Keynote: The PC Reborn." *Youtube*, accessed 9 June, 2024, https://www.youtube.com/live/5R3QpKMciEw?si=-b69k-WrxwcxMsQJ

[4] "Snapdragon X Series chips cost only half as much as Intel Raptor Lake's, with up to 98% longer battery life." *VideoCardz*, accessed 9 June, 2024, https://videocardz.com/newz/snapdragon-x-series-chips-cost-only-half-as-much-as-intel-raptor-lakes-with-battery-life-up-to-98-higher