

Apple M1 Chip

Should you buy now or wait for the next iteration?

Introduction

This review provides technical specifications and known issues for the Apple M1 chip. The purpose of this review is to inform consumer decisions on investing in an M1 MacBook.



Figure 1. Apple M1 chip. Source: (Apple, 2021)

Background. Apple released its M1 chip, represented in Figure 1 above, in the MacBook Air and MacBook Pro 13” laptops in November 2020. It is rumored to be releasing the next iteration of its M chip sometime between July and October of 2021. The M1 is receiving rave reviews from most of its early adopters. According to early benchmarks, the M1 chip is the fastest mobile chip available (Ehrhardt, 2021). The biggest drawback of the M1 at this time is that it can’t natively run x86 software. Developers are working on software versions that will run natively on Apple’s ARM architecture.

Scope. We will compare the three most similar configurations of the MacBook available. These three configurations include the M1 MacBook Air, M1 MacBook Pro 13”, and the most recent Intel MacBook Pro 13”. Each laptop was configured with 16GB RAM and a 1TB SSD. The data presented in this report includes specifications for CPU, GPU, RAM, storage,

display, ports, battery life, cooling, dimensions, weight, cost, benchmarks, and known issues. We are focusing on laptops only, which means we will not discuss the M1 Mac mini.

Specifications

CPU. The CPU, or central processing unit, in a computer can influence the frame rate of videos and games, the response time of applications, and the life of a laptop battery. The Apple M1 is an ARM-based chip. ARM architecture is desirable for its, “low cost, minimal power consumption, and lower heat generation,” than the chip architecture used by Intel (Wikipedia, 2021). Each core in a CPU can work on one task at a time. So, the more cores your CPU has, the more processes it can run at a time, and therefore the more efficient it is. The M1 CPU has 8 cores and uses a 5nm process. Apple’s image of their 5nm chip is shown in Figure 2 below.

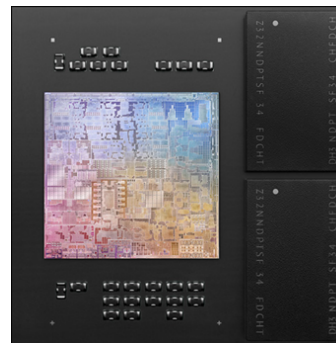


Figure 2. M1. The first personal computer chip built with a 5nm process. Source: (Apple, 2021)

The Intel Core i7 CPU in the MacBook 13” has 4 cores. Intel’s 7nm process isn’t expected until some time in 2022 at the earliest (Ehrhardt, 2021). A smaller process size is faster, consumes less power, and costs less than a larger process

Specifications

size. For more detailed information about processor [process size](#), see the article by MTE in the References section. Although Intel chips are more costly and produce more heat, they are generally faster and more powerful than ARM-based chips.

GPU. The GPU, or graphics processing unit, in a computer can influence the smoothness of frame rates and resolution in videos and games. The M1 is a system on a chip, or SoC, which has, “integrated graphics and onboard memory” (Ehrhardt, 2021). See a representation of the chip architecture in Figure 3 below.



Figure 3. Apple silicon for Mac based on ARM64 architecture. Source: (AppleInsider, 2021)

The M1 and Intel Iris Plus GPUs in our comparison each have 64 execution units. The M1 chip has 8 cores, each with 8 execution units. Intel lists the number of execution units at 64 in the Intel Iris Plus GPU but does not give any information about the number of cores it has. What does this mean?

Well, it’s almost like comparing apples to oranges to use the blanket term “core” with no further explanation. Each manufacturer uses a different architecture for their cores, and each core architecture has an inherent level of efficiency compared to another. In general, more execution units result in more work performed in parallel per clock cycle (Hruska, 2021). However, too many execution units per core can negatively influence efficiency. The term execution unit (EU) is primarily used by Intel. AMD uses the term compute unit (CU), and NVIDIA uses the term streaming multiprocessor (SM), to refer to the equivalent of an execution

unit. Each of these refers to the smaller unit within a core and is a more apples to apples unit of comparison, albeit still not exactly the same due to the differences in architecture. See [Table 4](#) in the Appendix for a detailed comparison of graphics performance benchmarks including the laptops in our review.

RAM. Your computer’s random access memory, or RAM, is its short-term memory. It’s fast and temporary. Currently, the M1 laptops are configurable with only 8GB or 16GB RAM. The more RAM a device has, the faster it will run. Every program you have open at a given time uses RAM, and you can run out of it (Villinger, 2019). If your device is currently using all of its available RAM, it will be forced to use some of your hard drive space. This as-needed use of hard drive space is called swapping, and using the hard drive in this way will cause your computer to run much slower. Worse than that, it has the potential to cause your hard drive to fail in a shorter span of time. We’ll come back to this idea in just a bit.

Storage. The storage in a computer is commonly referred to as its hard drive, for its namesake HDD, or hard disk drive. The newest MacBooks are only configurable with SSDs, or solid state drives, which are faster, more reliable, and smaller than the older technology of the spinning HDDs. However, SSDs are more expensive. Current M1 laptops are configurable up to 2TB SSD, and the Intel 13” is configurable up to 4TB SSD.

Display. Apple uses the term “Retina display” to describe its screens, which includes versions of its LCD and LED screens. The three laptops covered in our comparison all have the same type of LED Retina display screens. LED screens consume less power than LCD screens, therefore LED is better for laptop battery life.

Ports. The number and types of ports your laptop has can determine which peripherals you can use with it. Most laptop owners want the ability to use an external monitor, speakers, keyboard, mouse, headphones, and cell phone

Benchmarks

with their laptop. Any limitations can theoretically be overcome by using an adapter or Bluetooth. However, the M1 laptops have recently been having some issues interacting with these adapters and Bluetooth. We will revisit this topic. Both M1 MacBooks offer two Thunderbolt ports and four USB ports. The Intel MacBook has four Thunderbolt ports, but no USB ports at all.

Battery life. The M1 chip draws very little power, and its battery life is outstanding. The M1 Air and M1 Pro batteries last up to 18 and 20 hours, respectively. This is in stark contrast to the 13" Intel MacBook battery, which only lasts up to 11 hours.



Figure 4. Burning-hot laptop. Source: (Bates, 2014)

Cooling. Because the M1 chips run at lower power, they produce less heat. [Heat](#) degrades computer components over time (Bates, 2014). The MacBook Air has no fan for cooling, and that is why we are recommending it for light duty laptop users. The MacBook Pro has a fan, but owners report that it rarely comes on and is quiet in comparison to Intel MacBooks they have owned. Intel MacBook laptops regularly run hot, and their fans run often and loudly.

Dimensions, weight, and cost. The differences in dimension and weight between the three 13" MacBooks in our comparison are almost negligible. For exact dimensions and weights for each laptop, see [Table 1](#) in the Appendix. The cost goes up by \$250 from the M1 Air to the M1 Pro and by \$300 from the M1 Pro to the Intel Pro.¹

¹ All currencies are in USD.

Benchmarks

Pcmag.com lists benchmark data for the three laptops in our comparison as well as a few laptops made by non-Apple manufacturers. The article, "How Fast Is Apple's M1 Chip? It Depends on the App," by Tom Brant, includes benchmark data for productivity and browsers, emulation versus native apps, and gaming.

Productivity and browsers. In benchmarks for productivity and browser tests, the M1 Pro 13" and M1 Air laptops took first and second place respectively in four out of five trials. See [Table 2](#) in the Appendix for detailed information about productivity and browser data for all three 13" laptops.

Emulation and native apps. All Intel chip computers produced by Apple speak the native language of Windows programs. "In programming, native code is code that is written to run on a specific processor," or chip (Computer Hope, 2017). The M1 ARM-based chips do not speak the same native language as Intel chips and do not run Windows programs natively. The M1 chip requires an emulator, or translator, such as Rosetta 2 (developed by Apple) in order to run Windows programs. Running a Windows program through an emulator is a bit slower than running it natively. In benchmarks for Windows app emulation with Rosetta 2, the M1 MacBooks were 2-3 minutes slower than the Intel MacBook. When running M1 native apps, the M1 MacBooks were 2-5 minutes faster than the Intel MacBook. See [Table 3](#) in the Appendix for detailed information about emulation and native app data for all three 13" laptops, shown in Figure 5 below.



Figure 5. M1 MacBook Air, M1 MacBook Pro, and Intel MacBook Pro 13" models in Silver. Source: (Apple, 2021)

Known Issues

Gaming. In benchmarks for gaming performance, The M1 Pro 13” took first place for GFX Bench 5 Metal (car chase and Aztec High scenarios) and third place for Heaven 4.0. The M1 Air took second place for Rise of the Tomb Raider, and second place (on Low setting) for Total War II: Warhammer. It’s worth noting that Apple laptops are not intended to be gaming machines, much less competitive with high end ones. See [Table 4](#) in the Appendix for detailed information about gaming performance data for all three 13” laptops.

Known Issues

As with all new devices, the M1 MacBooks have experienced their share of technological difficulties. The issues reported by users are discussed below.

Bluetooth. Some M1 MacBook owners report having difficulty when using Bluetooth peripherals. Bluetooth devices exhibited issues with dropping connection or not connecting at all.

External monitors. Other M1 MacBook owners experience a black screen on an external monitor or, less commonly, on their laptop screen when using an external monitor. Sometimes the external monitor works until the laptop is rebooted. In these cases, if the external monitor is still connected when the laptop is rebooted, the monitor goes black when the laptop restarts.

External speakers. Other M1 MacBook owners report having sound drop in and out for about a second when using Bluetooth headphones or speakers.

Boot loop. Some M1 MacBook owners experienced a significant issue with the Big Sur 11.2 update failing. Each OS update installer is supposed to check to make sure that there is enough space available on the computer prior to starting the update. However, the Big Sur 11.2 installer did not check available space prior to starting the update. This led to users with an encrypted laptop “stuck in a boot loop” and

unable to access data (Mr. Macintosh, 2021). Big Sur 11.2.1—released on February 15, 2021—fixed this issue. Prior to update 11.2.1, the only way to stop the boot loop was to erase and reinstall the Mac OS, resulting in potential data loss.

Swap degradation. Perhaps the most concerning issue at present is the swapping mentioned in the RAM section of this report. Some M1 MacBook owners have reported a 1-3% degradation of their SSDs after only two months of use, due to excessive swapping. At that rate, a laptop would have closer to a two-year lifespan than the expected five years. Currently, the only RAM options are either 8GB or 16GB. Hopefully, the next version of the M chip will offer at least a 32GB RAM option to reduce swapping and early SSD degradation.

Conclusions

So, how do the M1 Air, M1 Pro, and Intel Pro 13” laptops stack up against each other? Read on to see our comparisons of each of the machines.



Figure 6. M1 MacBook Air in Gold. Source: (Apple, 2021)

M1 MacBook Air. The Air is thinner, lighter, and less expensive than both of the other 13” options included in our comparison. See the M1 MacBook Air in Gold in Figure 5 above. It has the same display size as, and 100 nits less brightness than, both of its competitors. It has two less Thunderbolt ports and four more USB ports than the Intel Pro, which has no USB ports. It has a battery life that is two hours less than the M1 Pro and seven hours longer than the Intel Pro. The M1 Air costs \$250 less than the M1 Pro and \$550 less than the Intel Pro.

Recommendations

M1 MacBook Pro 13”. The M1 Pro is slightly thicker and weighs 0.2 pound more than the M1 Air. The M1 Pro is the same size as the Intel Pro and weighs 0.1 pound less. The M1 Pro display is 100 nits brighter than the M1 Air and is the same brightness as the Intel Pro. The M1 Pro has two less Thunderbolt ports and four more USB ports than the Intel Pro, which has no USB ports. The M1 Pro battery lasts two hours longer than the M1 Air battery and nine hours longer than the Intel Pro battery. The M1 Pro costs \$250 more than the M1 Air and \$300 less than the Intel Pro.

Intel MacBook Pro 13”. The Intel Pro is slightly thicker and weighs 0.3 pound more than the M1 Air. The Intel Pro is the same size as the M1 Pro and weighs 0.1 pound more. The Intel Pro display is 100 nits brighter than the M1 Air and is the same brightness as the M1 Pro. The Intel Pro has two more Thunderbolt ports than the M1 Air and the M1 Pro, but it has no USB ports where they each have four. The Intel Pro battery lasts seven hours less than the M1 Air battery and nine hours less than the M1 Pro battery. The Intel Pro costs \$300 more than the M1 Pro and \$550 more than the M1 Air.

For a side-by-side comparison of all the data mentioned in the Conclusions section of this report, see [Table 1](#) in the Appendix.

Recommendations

Based on the observations stated up to this point, we feel confident in making the recommendations that follow.

If you need a new laptop as soon as possible, are an Apple fan, and are willing to put up with some growing pains, then the M1 MacBook Air and M1 MacBook Pro 13” (shown in Figure 6) are capable machines. Either of these machines is a fast, responsive, literally cool, and smooth-operating machine at a lower price than a comparable Intel machine.



Figure 7. M1 MacBook Pro 13" in Space Gray. Source: (Apple, 2021)

If you would rather not be the equivalent of a beta-tester for Apple, then try to wait until the next version of the M chip is released. According to informed predictions, the next version M chip may be released sometime between July and October of 2021. Many of the growing pains will be over by then, and the chip may even have hardware upgrades that are better than the current one.

Appendix

Table 1. Comparison of M1 MacBook Air, M1 MacBook Pro, and Intel MacBook Pro Specs. Data Source: (Apple, 2021)

Point of Comparison	M1 MacBook Air	M1 MacBook Pro 13	Intel MacBook Pro 13
CPU	8-Core	8-Core	4-Core 10th-gen i7
GPU	8 Cores, 64 execution units	8 Cores, 64 execution units	Intel Iris Plus, 64 execution units
RAM	16GB	16GB	16GB
Storage	1TB SSD	1TB SSD	1 TB SSD
Display	Retina display with True Tone at 400 nits brightness	Retina display with True Tone at 500 nits brightness	Retina display with True Tone at 500 nits brightness
Ports	Thunderbolt (x2), USB (x4)	Thunderbolt (x2), USB (x4)	Thunderbolt (x4)
Weight	2.8 lbs	3.0 lbs	3.1 lbs
Dimensions	0.16–0.63" High x 11.97" Wide x 8.36" Deep	0.61" High x 11.97" Wide x 8.36" Deep	0.61" High x 11.97" Wide x 8.36" Deep
Battery life	Up to 18 hrs	Up to 20 hrs	Up to 11 hrs
Cost	\$1,649.00	\$1,899.00	\$2,199.00

Note: For the laptops listed in the following Table 2, the higher the score the better. The number scores are based on ratings systems designed by and unique to Geekbench, JetStream, Principled Technologies, and Basemark. There are no corresponding units, and each of the numbers are composite scores used purely for ranking one machine above or below another.

Table 2. Apple M1 Performance Comparisons: Productivity and Browser Tests. Data Source: (Brant, 2020)

Laptop	Geekbench 5 Single-core	Geekbench 5 Multi-core	JetStream2	Principled Technologies WebXPRT 3	Basemark Web 3.0
M1 Pro 13"	1749	7771	185	289	753
M1 Air	1734	7579	183	277	850
Intel Pro 13"	1256	4487	128	182	791
Dell XPS13 (9310)	1504	4505	153	240	951
HP Spectre x360 15	1190	4937	140	226	814
	HIGHER IS BETTER				

Note: The following Table 3 shows the difference between the time it takes when running non-native (or emulated) software versus native software. As previously stated, when a computer uses an emulator to run non-native software, it takes more time to accomplish tasks.

Appendix

Table 3. Apple M1 Performance Comparisons: Emulation and Native App Tests. Data Source: (Brant, 2020)

Laptop	Handbrake 1.1.1 Rosetta 2 Emulation	Handbrake 1.4.0 (beta) Native
M1 Pro 13"	17	8
M1 Air	18	11
Intel Pro 13"	15	13
Dell XPS13 (9310)	15	N/A
HP Spectre x360 15	10	N/A
LOWER IS BETTER (unit of measurement = mins.)		

Note: The following Table 4 shows the frames per second (fps) when running different video games on laptops. You can think of it like flipping cards with still images that are drawn out to show a succession of small movements. When flipped, these still images result in a sort of motion picture. The more frames per second, the smoother the video appears to the eye.

Table 4. Gaming Graphics Performance Benchmarks. Data Source: (Brant, 2020)

Laptop	GFX Bench 5 Metal		Heaven 4.0		Rise of the Tomb Raider			Total War II: Warhammer		
	Car Chase	Aztec High	Ultra	Medium	High	Medium	Low	Ultra	Medium	Low
M1 Pro 13"	178	78	21	64						
M1 Air	163	70	20	63	35	37	58	15	30	46
Intel Pro 13"	53	26	18	40						
Dell XPS13 (9310)	107	45	24	78	29	33	37	18	35	38
HP Spectre x360 15	159	76	45	133	56	71	75	36	71	88
HIGHER IS BETTER (unit of measurement = frames per sec.)										

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