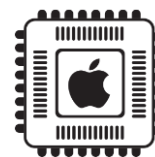




APPLE M1 Ultra



111064559

徐詠祺

Outlines

- ❑ Introduction
- ❑ System SPECS & Performance
- ❑ Technology Analysis
- ❑ Industry Analysis
- ❑ Conclusion
- ❑ Reference

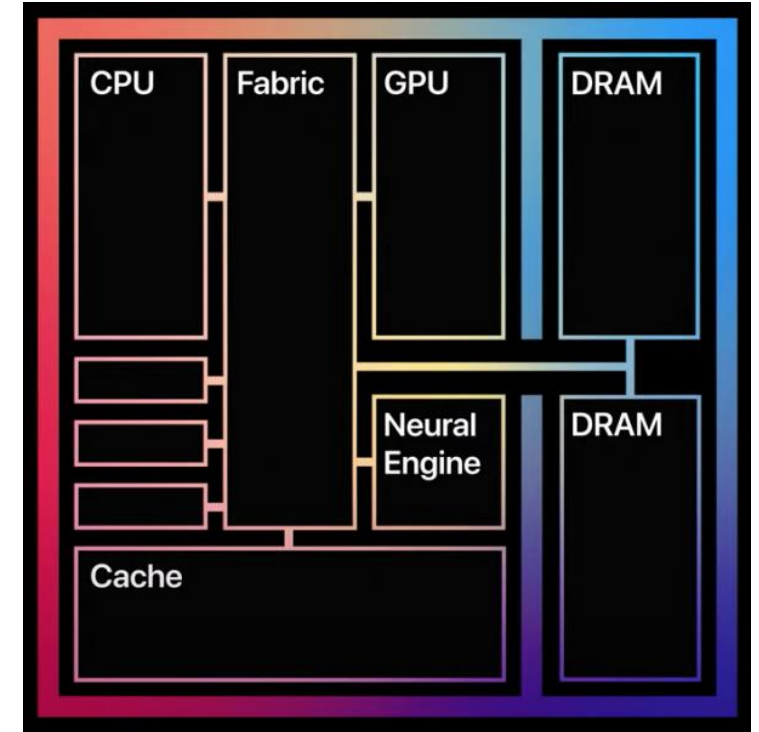
Processor in Mac

- Apple Silicon from 2020~
- M1, the first SoC in Mac



Apple's SoC

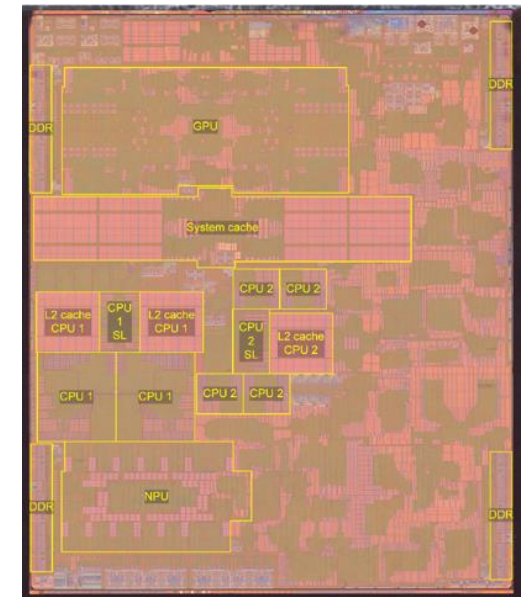
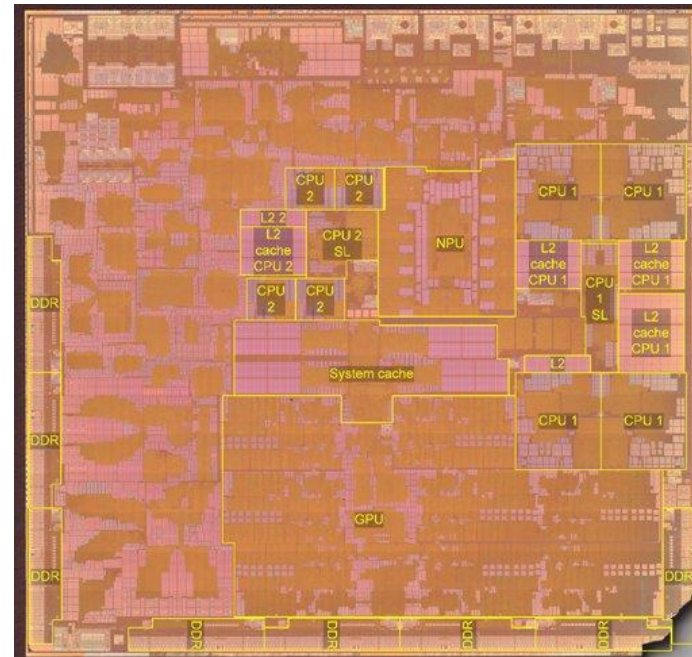
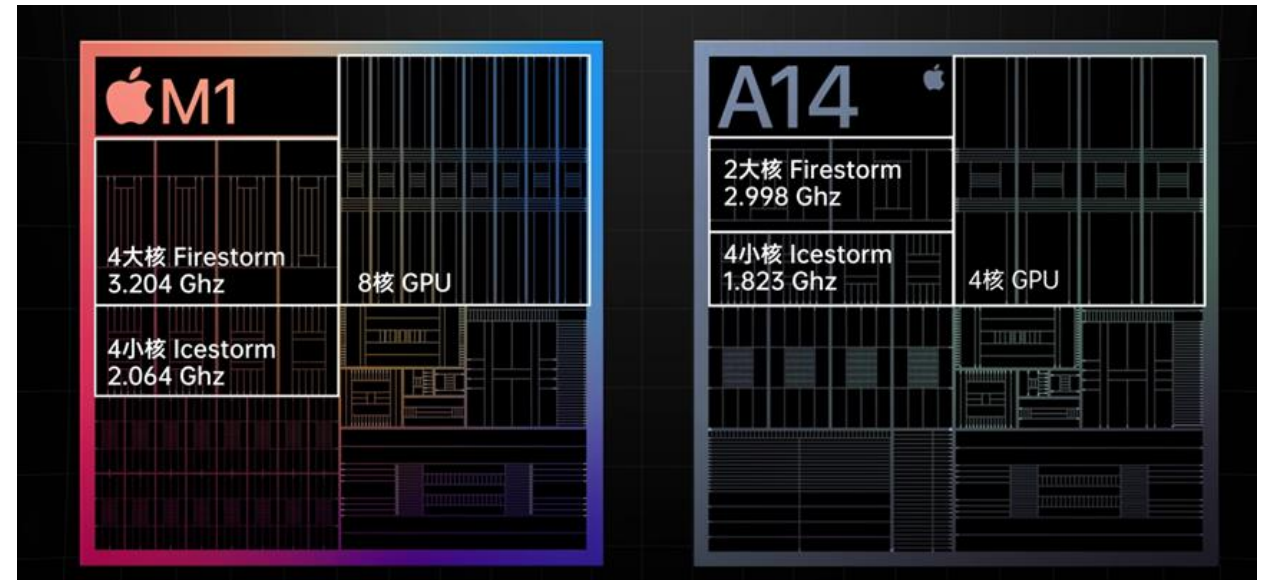
- CPU
- GPU
- IPU: Image Processing Unit
- DSP: Digital Signal Processor
- NPU: Neural processing Unit
- Video encoder/decoder
- Memory: Unified Memory for Apple
- Secure Enclave: encryption, authentication, security



A14 to M1

Mobile chip→ PC chip

- 2 more performance CPU cores (Firestorm)
- Higher single core frequency
- 4 more GPU cores
- Doubles the DDR interface (4 -> 8)
- Area 37% larger
- Largest ARM SoC



M1 series



2020/11



13" MacBook Pro



MacBook Air



24" iMac



Mac mini



12.9" iPad Pro



11" iPad Pro



10.9" iPad Air

2021/10



14" MacBook Pro

2021/10



16" MacBook Pro

2022/03

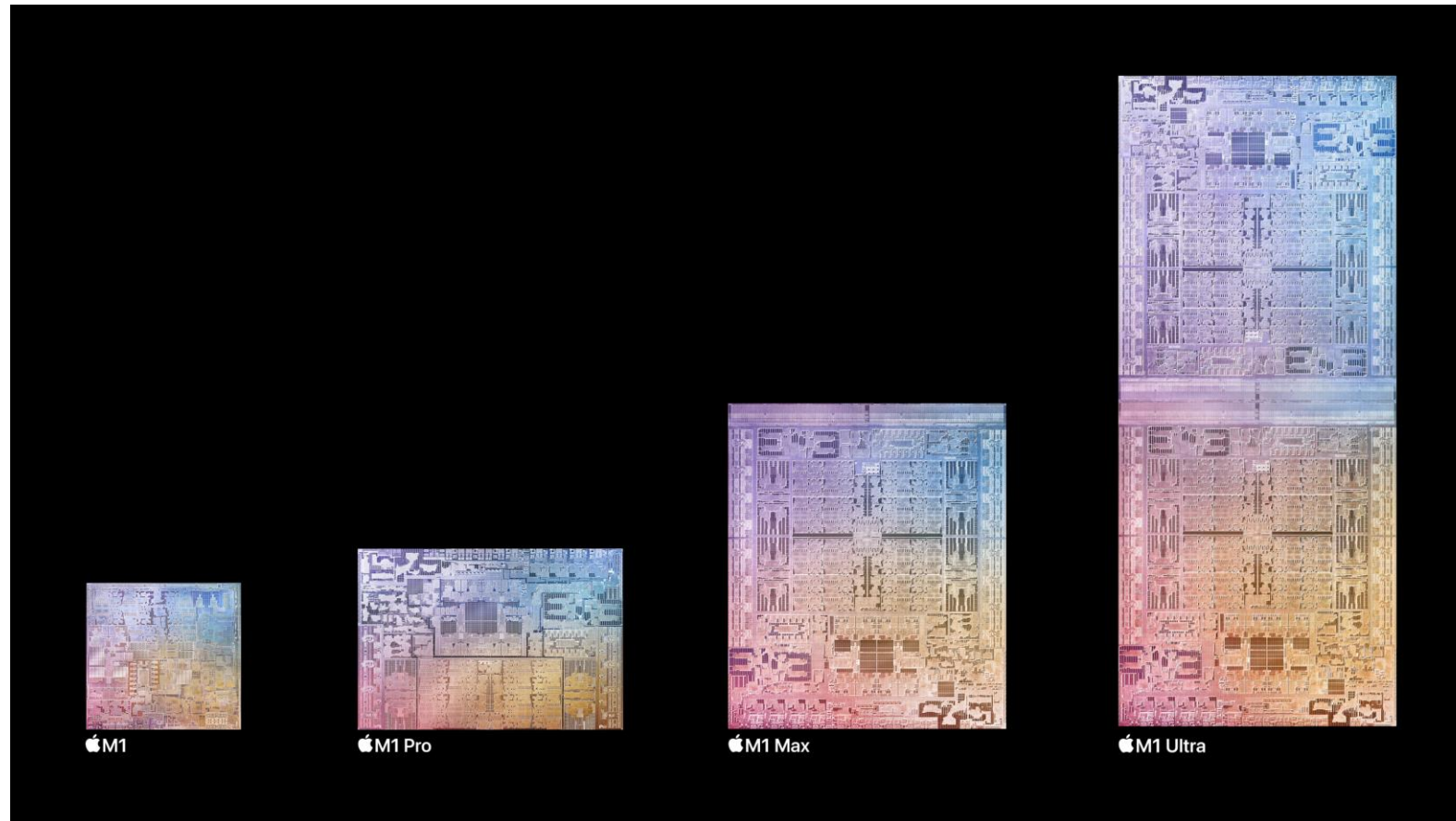


Mac Studio

**Apple M1 Family
March 2022**

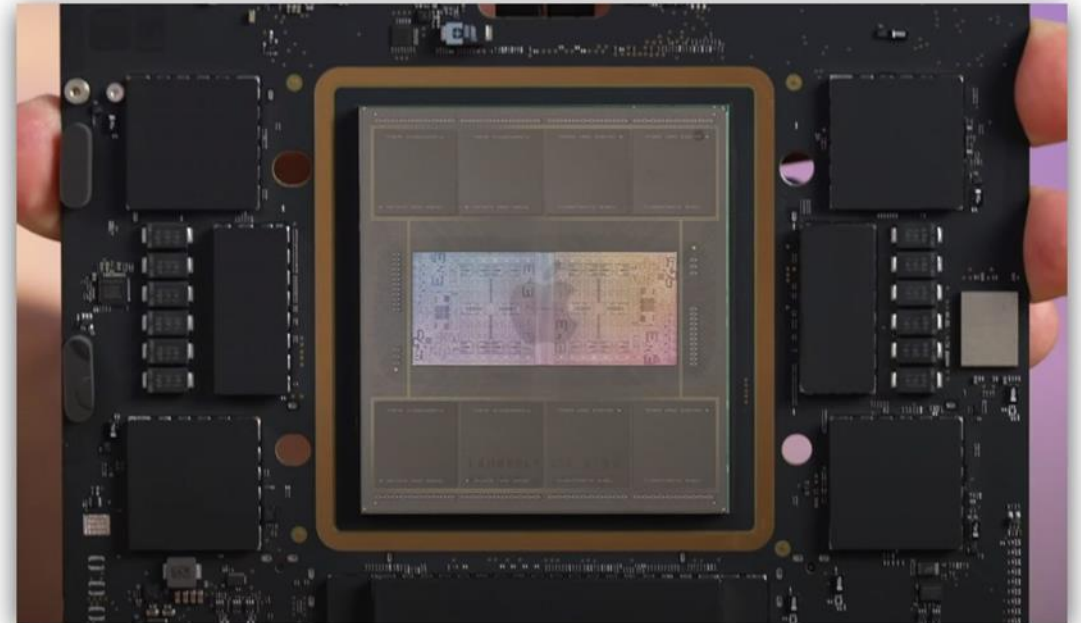
M1 series

- Area & Performance keep increasing



M1 Ultra

- Combine **two M1 Max** (high performance version of M1) by UltraFusion architecture (Chiplet)



Outlines

- ☐ Introduction
- ☒ System SPECs & Performance
- ☐ Technology Analysis
- ☐ Industry Analysis
- ☐ Conclusion
- ☐ Reference

SPECs

- 20 - core/threads CPU
- 16 high performance **'Firestorm'** cores clocked at 3.20 GHz
- 4 high efficiency **'Icestorm'** cores clocked at 2.06 GHz
- Maximum power up to 120 W
- TSMC 5nm
- Chiplet Architecture

20-core CPU

16 high-performance cores

Ultrawide execution architecture
192KB instruction cache
128KB data cache
48MB total L2 cache

4 high-efficiency cores

Wide execution architecture
128KB instruction cache
64KB data cache
8MB total L2 cache

64-core GPU

8192 execution units
Up to 196,608 concurrent threads
21 teraflops
660 gigatexels/second
330 gigapixels/second



Media engine

Hardware-accelerated H.264, HEVC, ProRes, and ProRes RAW
2 video decode engines
4 video encode engines
4 ProRes encode/decode engines

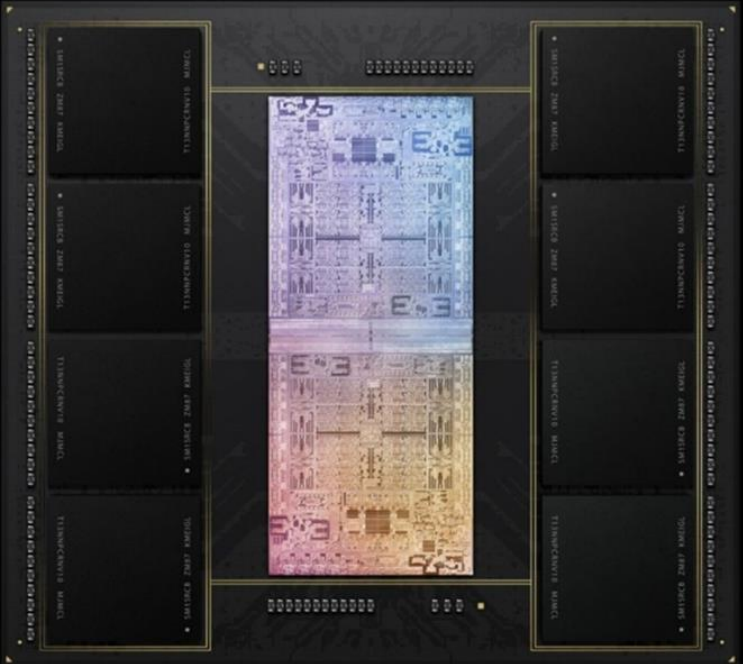
Neural engine

32 cores
22 trillion operations per second

SPECs

- 128GB storage
- 256-bit LPDDR5 interface
- 800 GB/s bandwidth

M1 Ultra

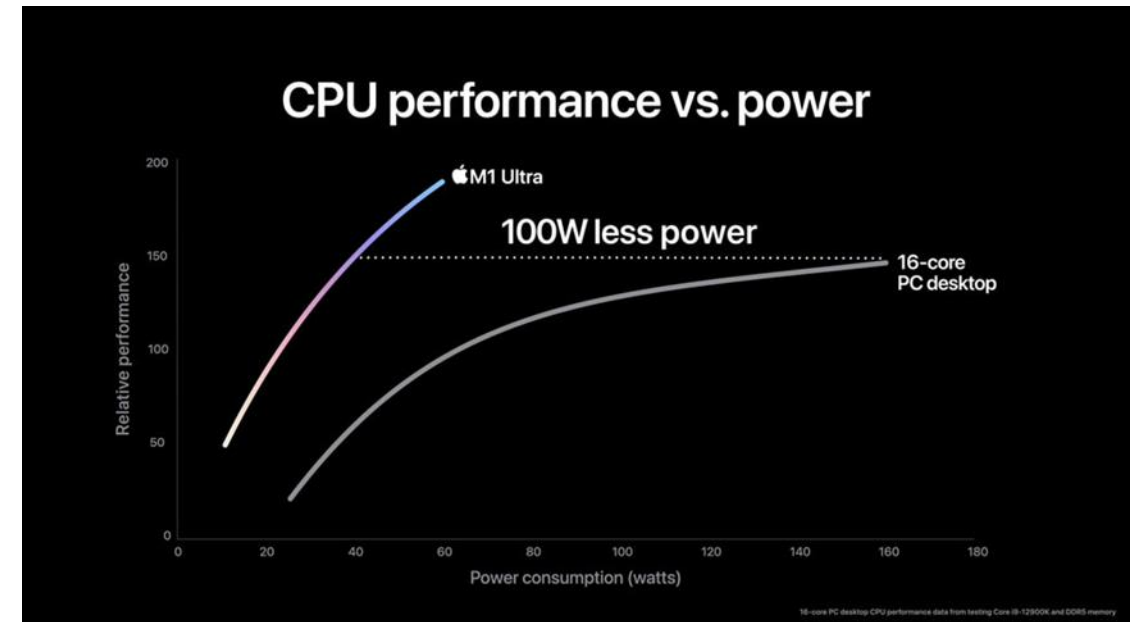
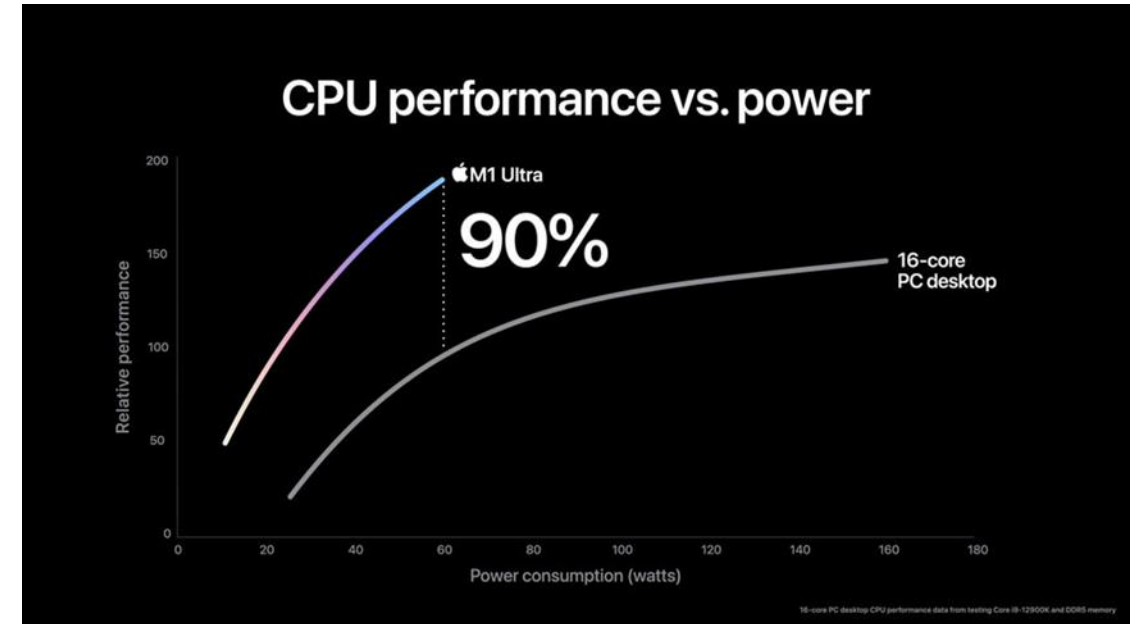


Up to
128GB
unified memory

Up to
800GB/s
memory bandwidth

Performance (CPU)

- vs. **intel i9-12900K** with DDR5 memory
- 90% higher performance in the same power envelope
- Similar multi-thread CPU performance while using 100W less power
- **Best performance per watt (PPW) in industry**



Performance (Memory)

- vs. intel i9-12900K with DDR5 memory

Memory Specifications

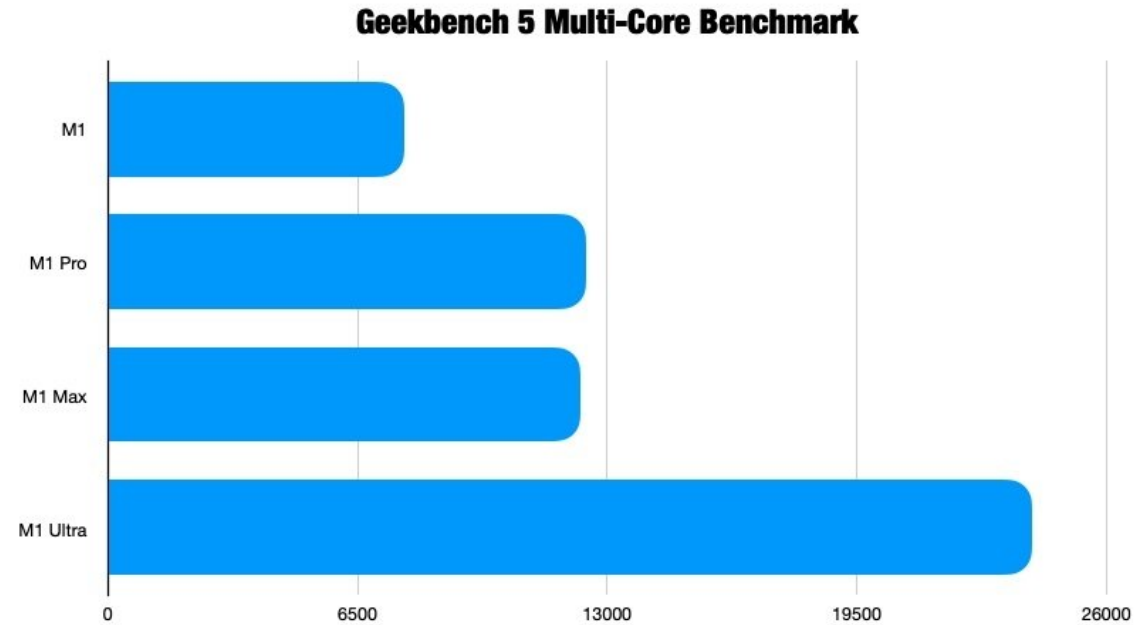
Max Memory Size (dependent on memory type) ?	128 GB
Memory Types ?	Up to DDR5 4800 MT/s Up to DDR4 3200 MT/s
Max # of Memory Channels ?	2
Max Memory Bandwidth ?	76.8 GB/s

Outlines

- ☐ Introduction
- ☐ System SPECS & Performance
- ☒ Technology Analysis
- ☐ Industry Analysis
- ☐ Conclusion
- ☐ Reference

How?

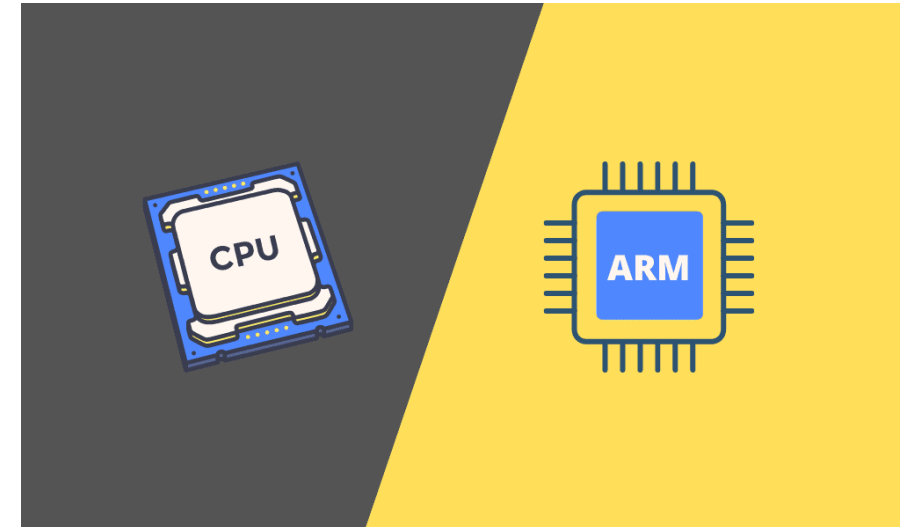
- High performance & Low power
- $1 + 1 = 2?$ (CPU)



ARM

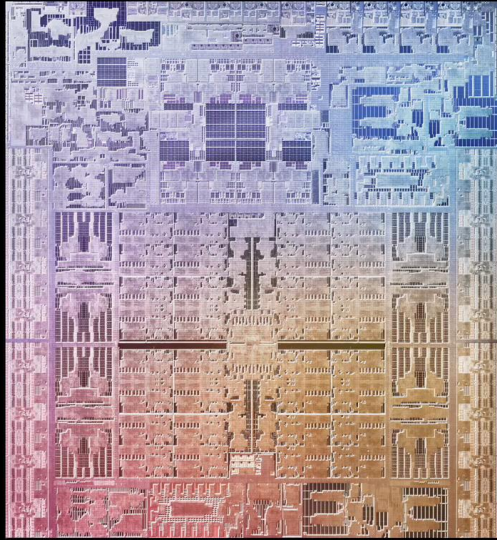
1. RISC instructions are smaller and faster to process
2. less complicated instructions & architecture
3. less effort to translate instruction
4. ability to share workloads across high- and low-performance CPU
5. more advanced technique can be applied to develop (both designing & manufacturing)
6. don't need to support 32-bit operations

As the result: **high power efficient**



UltraFusion – Advanced Packaging

- 2.5D packaging of two SoC
- x2 the **connection density** of any technology available
- x4 the **bandwidth** of the leading multi-chip interconnection technology
- connect over 10000 signals
- behaves like a single chip to software



2.5TB/s

Interprocessor bandwidth

UltraFusion – InFO_LI technique by TSMC

- **Silicon interposer** as silicon bridge between two M1 max
- Area, Power drastically decreasing
- lower the cost

● “Ultra Fusion” Chip-to-Chip Local Interconnect bus (InFO_LI)

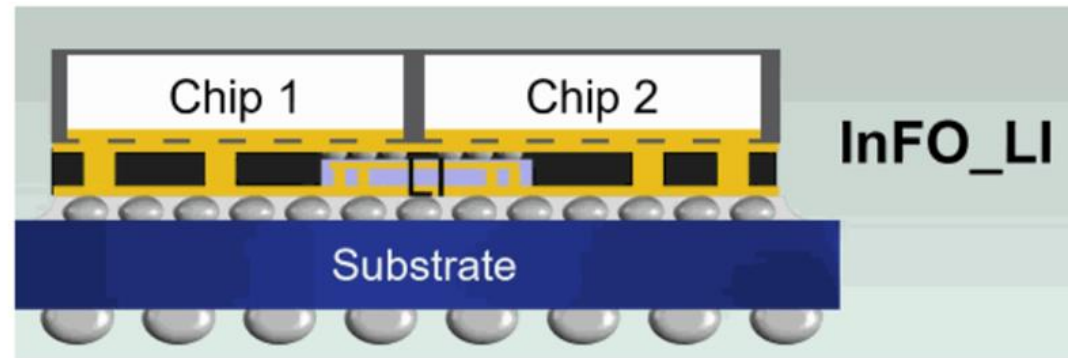
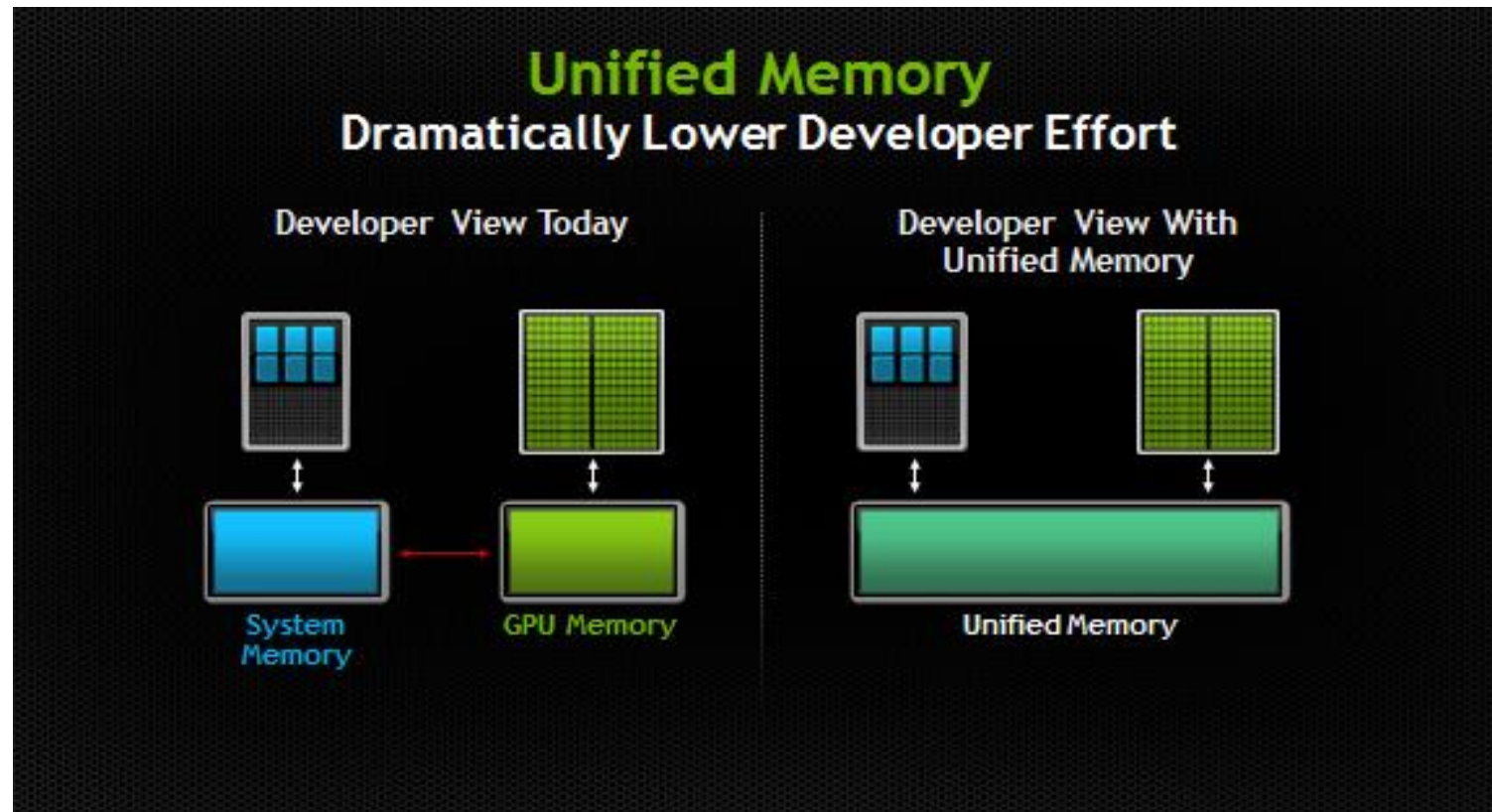


Figure 3. Apple M1 Ultra package (cross-sectional view)

Unified Memory Architecture (UMA)

- Simplify the memory architecture
- Reduce the processing steps of data exchanging
- 800 GB/s bandwidth

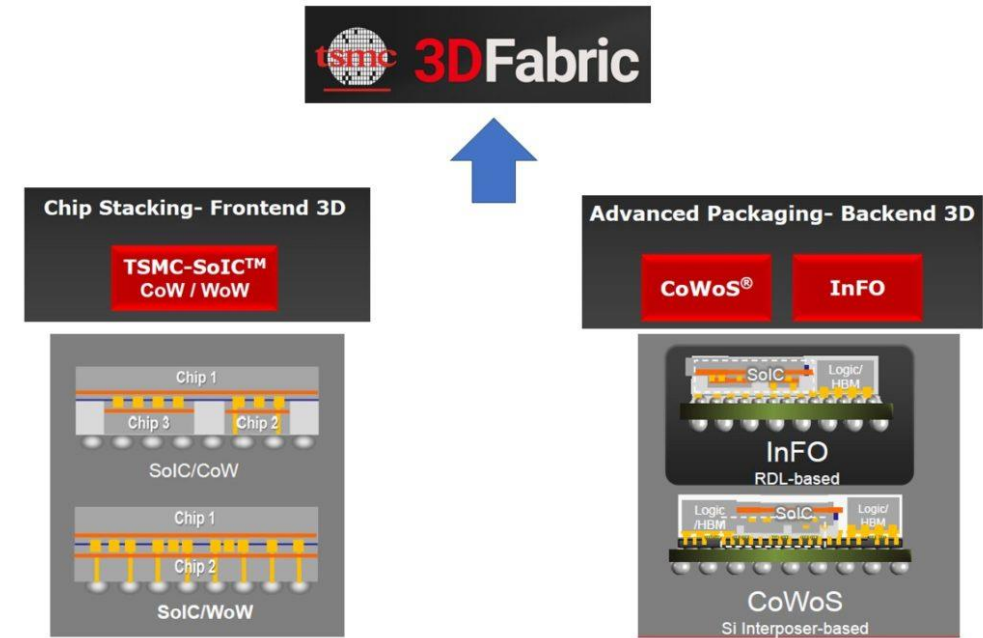
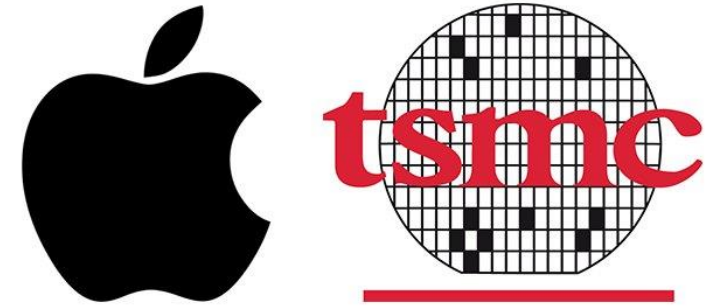
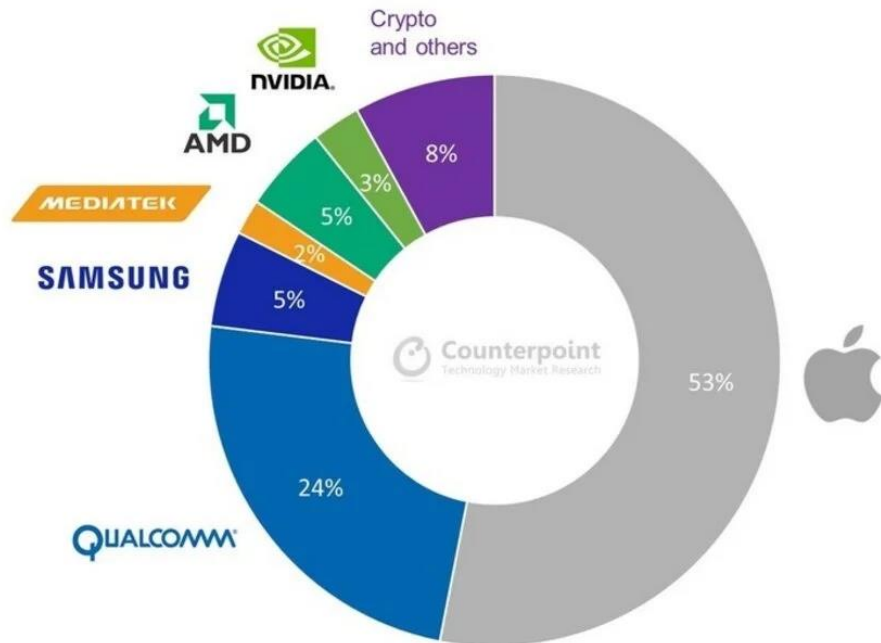


Outlines

- ☐ Introduction
- ☐ System SPECS & Performance
- ☐ Technology Analysis
- ☒ Industry Analysis
- ☐ Conclusion
- ☐ Reference

Industrial Chain - TSMC

- Designer & Manufacturer
- Apple to account for 53% of **TSMC 5nm chips** production in 2021



Market

- Product: mac studio
- For professional designer
(Videographers , Musicians, 3D artists)
- High price



New



10-Core CPU
24-Core GPU
16-Core Neural Engine

32GB unified memory

512GB SSD storage¹

Front: Two USB-C ports, one SDXC card slot

Back: Four Thunderbolt 4 ports, two USB-A ports, one HDMI port, one 10Gb Ethernet port, one 3.5 mm headphone jack

\$1,999.00



New



20-Core CPU
48-Core GPU
32-Core Neural Engine

64GB unified memory

1TB SSD storage¹

Front: Two Thunderbolt 4 ports, one SDXC card slot

Back: Four Thunderbolt 4 ports, two USB-A ports, one HDMI port, one 10Gb Ethernet port, one 3.5 mm headphone jack

\$3,999.00

SWOT Analysis



Strength

1. Best performance per watt
2. High compatibility between SW & HW
3. Apple ecosystem



Weakness

1. Maximum performance (maximum CLK rate lower than x86)
2. High price
3. ARM software supports



Opportunity

1. Attract more user
2. More advanced technique can be applied because of ARM architecture
3. Development of ARM ecosystem



Threat

1. Intel - x86
2. AMD - x86
3. Qualcomm - ARM

Outlines

- ☐ Introduction
- ☐ System SPECS & Performance
- ☐ Technology Analysis
- ☐ Industry Analysis
- ☒ Conclusion
- ☐ Reference

Conclusion

M1 Ultra Feature:

- Best performance per watt in industry
- Last & Strongest member in M1 series
- UltraFusion technique

Future Trending:

- ARM might become more popular in PC architecture
- Advanced packaging will occupy an important position beyond Moore's law

Outlines

- Introduction
- System SPECS
- Technology Analysis
- Industry Analysis
- Conclusion
- **Reference**

Reference

- https://en.wikipedia.org/wiki/Apple_M1
- https://zh.m.wikipedia.org/zh-tw/Apple_Silicon
- <https://hk.xfastest.com/90704/apple-silicon-m1-vs-a14-processor-core-design/>
- <https://www.anandtech.com/show/16226/apple-silicon-m1-a14-deep-dive/2>
- <https://www.edntaiwan.com/20220414nt01-apple-m1-ultra-a-not-so-unique-chiplet-peek/>
- <https://www.techinsights.com/zh-tw/node/49119>
- <https://www.makeuseof.com/x86-vs-arm-which-architecture-should-pc-use/>
- <https://www.apple.com/newsroom/2022/03/apple-unveils-m1-ultra-the-worlds-most-powerful-chip-for-a-personal-computer/>