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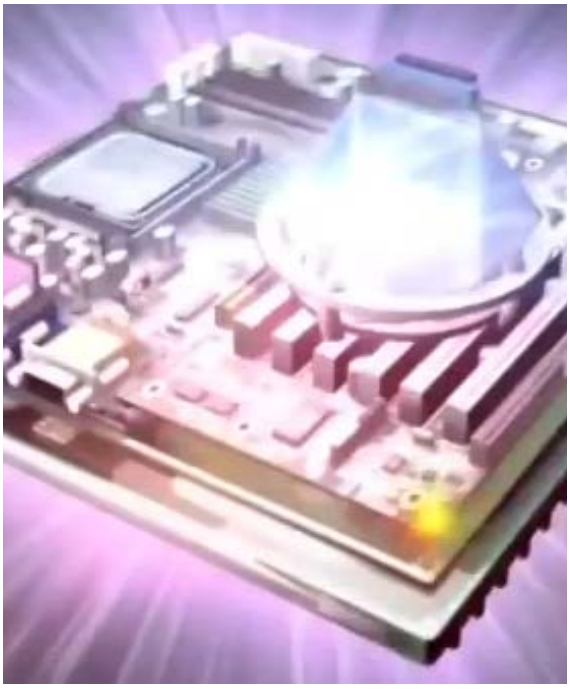
BIONIC CHIPS

~Mansi Vaghasiya

S.E ELEX

6Multicore system-on-chips (SoC) branding for apple's started with the A11 that debuted with iPhone 8. The bionic chip has two high-performance and 4 high-efficiency cores. The efficiency cores are used most of the time to save battery life. however, the high-end performance cores are used when process-intensive tasks such as video playback are activated. The Bionic SoCs also include a processor dedicated to tasks such as speech and face recognition. This is very almost like the built-in GPU in Apple's A-series of SoCs is more efficient for screen rendering, the neural engine is better at Al tasks. Hence the bionic moniker, plus it sounds very high-tech.



These bionic chips have evolved from A11 to A15. Apple A11 Bionic first appeared in the iPhone 8, iPhone 8 plus, and iPhone X is a 64-bit ARM-based SoC that was introduced on September 12, 2017. It has four high-efficiency cores, which are 70% faster than the energy-efficient cores in the A10, two high-performance cores, which are faster than the A10 Fusion by 25%, and for the first time with 30% faster graphics performance than the A10 an Apple-designed three-core GPU. It is also the first A-series chip that enhances AI and machine learning processes to feature Apple's "Neutral Engine".

Apple A12 Bionic first appeared in iPhone XS, XS Max, and XR is a 64-bit ARM-based SoC that was introduced just a year later. It is also used in the eighth-generation iPad, fifth-generation iPad Mini, and third-generation iPad Air. it has two high-performance cores, and four high-efficiency cores, which are faster and efficient than previous versions. The A12 is manufactured by TSMC using a 7 nm FinFET process, the first to ship in a smartphone. It is also used in the Apple TV of the 6th generation.

Apple A12X Bionic first appeared within the third generation of the 12.9" iPad Pro and 11.0" iPad Pro may be a 64-bit ARM-based SoC that was introduced on October 30, 2018. It offers a 90% faster multi-core CPU performance than its predecessor and a 35% faster single-core, the A10X. It has four high-efficiency cores and 4 high-performance cores. It is manufactured in the same way as A12 Bionic.
Apple A12Z Bionic first appeared in the fourth-generation iPad Pro is a 64-bit ARM-based SoC that was introduced on March 18, 2020. The A12Z that helps developers prepare their software for Macs based on Apple silicon is also used in the Developer Transition Kit prototype computer.

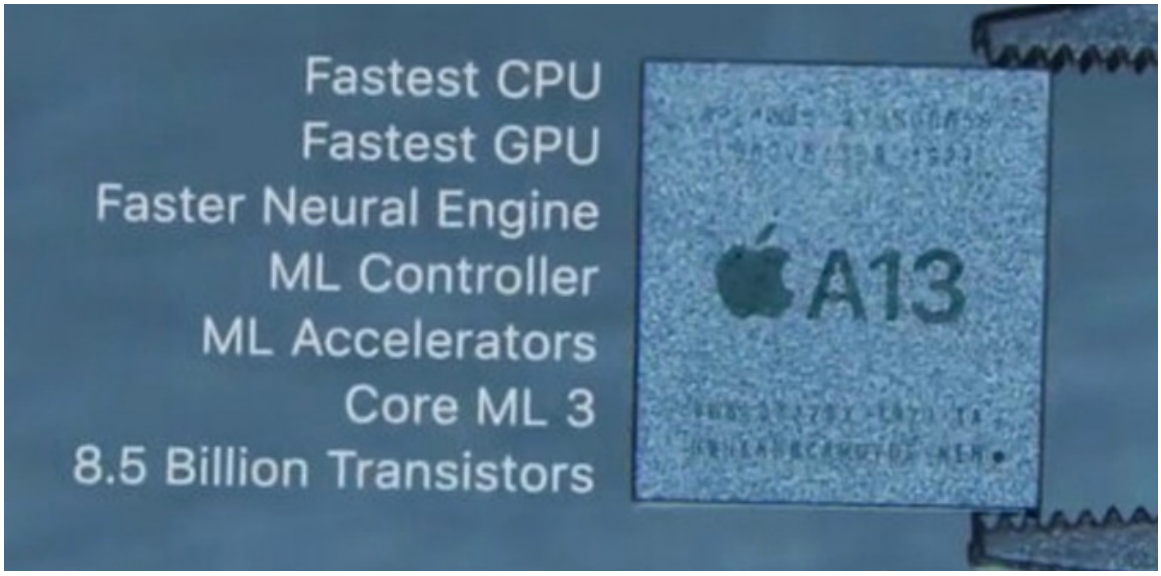
Apple A13 Bionic first appeared within the iPhone 11, 11 Pro, and 11 Pro Max may be a 64-bit ARM-based SoC that was introduced on September 10, 2019. It is also featured in the second-generation iPhone SE which was released on April 15, 2020, and in the 9th generation iPad which was announced on September 14, 2021. The entire A13 Bionic SoC features a total of 18 cores – four-core GPU, a six-core CPU, and an eight-core Neural Engine processor, which is dedicated to handling on-board machine learning processes; four of the six cores on the CPU are low-powered cores that are dedicated to handling less CPU-intensive operations, like browsing the online, voice calls, and sending messages, while two higher-performance cores are used just for more CPU-intensive processes, like recording 4K video or playing a computer game.
After A13 Bionic comes Apple A14 Bionic and the latest is the Apple A15 Bionic that first appeared in the iPhone 13, unveiled on September 14, 2021, is a 64-bit ARM-based SoC. The A15 is made on a 5-nanometer manufacturing process with 15 billion transistors. It has 2 high-performance processing cores, 4 high-efficiency cores, a new 16-core Neural Engine capable of 15.8 trillion operations per second a new 5-core graphics for the iPhone 13 Pro series (4-core for iPhone 13&13 mini) processing unit.

LATEST BIONIC CHIPS

~Neha Vinamra
T.E ELEX

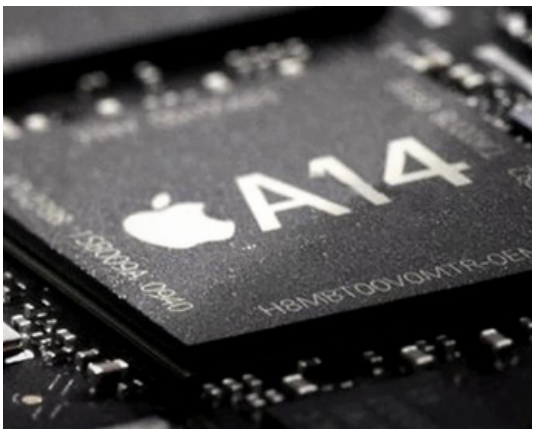
Before jumping on to the latest bionic chips, lets first have a look on the basic definition of bionic chip

So Apple bionic chip is based on its multicore system on chip and the very first version was A11 that was present in iPhone 8. The chip offers 4 high efficiency cores with around 4.3 billion transistors.



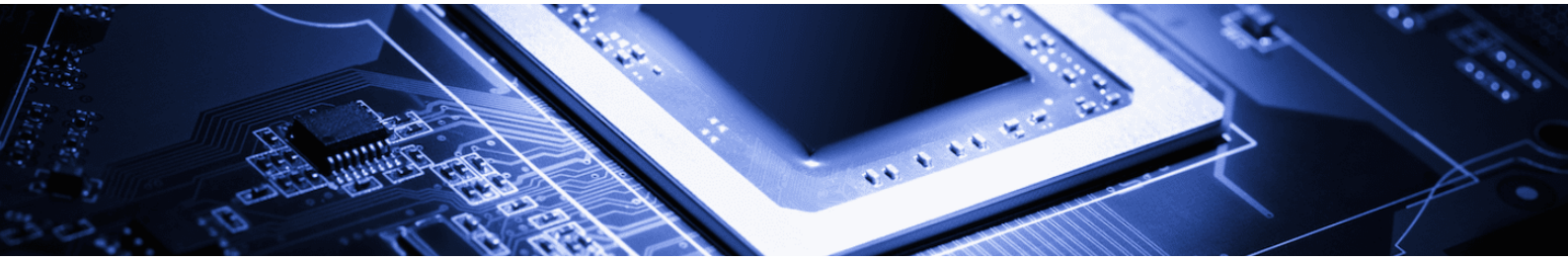
A13

The Apple A13 bionic chip was released on Sep 10 2019 which is mostly found in iPhone 11, 11 Pro/Pro Max, 9th Gen iPad and iPhone SE. The latest chip on comparison with A12 stands out in terms of 40% lower power consumption, and 20% faster.
This chip comes with a 64 bit six core CPU implementing on ARMv8.4-A ISA and along with 2.65 GHz two high cores. The cores are names as “lightning” and “thunder”.
It consists of around 8.5 billion transistors. It is so efficient that it is capable of performing one trillion operations per second.



A14

Now coming on to the latest bionic chip A14, it was released on Sep 15 2020 and is found in 4th Gen iPad Air, iPhone 12 Mini, iPhone 12, iPhone 12 Pro, and iPhone 12 Pro Max. On comparison with A12, it is 40% faster while the GPU is 30% faster. Talking about the design, it has a 64 bit six core CPU implementing on ARMv8. It has two high efficiency cores named as “firestorm” and “icestorm”. It consists of around 11.8 billion transistors which on comparison is around 38.8% more than that present in A13. The A14 chip comprises of Neural engine which is capable of performing 11 trillion operations per second.
The A14 has video codec encoding support for HEVC and H.264. It has decoding support for HEVC, H.264, MPEG-4 Part 2, and Motion JPEG. Codecs VP8 and VP9 are also unofficially supported. Next generation codec AV1 is not supported by hardware acceleration



RECENT BIONIC CHIP - A14 & A15

~Athira Arvind
S.E ELEX

Like its archetypes, the A15 has two elite execution handling centers for the main work and four high-proficiency centers for foundation undertakings that can run ceaselessly as much battery power. In any case, Apple says they're quicker and upheld by another GPU, better execution neural motor for AI and AI assignments, and another picture signal processor for tasks like diminishing photograph commotion. The organization divulged the chip at its iPhone 13 send off occasion.

Apple flaunted the A15 has preferred execution over its rivals, a case that has been valid for a really long time, in view of the Geekbench speed test. In any case, the organization didn't offer insights concerning how much better the A15 is compared and the A14. Qualcomm, the top chipmaker for the Android cell phones, procured startup Nuvia trying to give its processors a major speed help.

The chip's top work is to keep up with the organization's top spot for cell phone speed, guarantee iPhones stay the main gadget designers go after while making new applications, and keep clients content with smart execution and a long helpful life expectancy for the phone.

The Apple A14 Bionic is a 64-bit ARMv8.4-A system on a chip (SoC), designed by Apple Inc. It appears in the fourth generation iPad Air, as well as iPhone 12 Mini, iPhone 12, iPhone 12 Pro, and iPhone 12 Pro Max.

The A14 coordinates an Apple-planned four-center GPU with 30% quicker design execution than the A12. The A14 incorporates committed neural organization equipment that Apple calls another 16-core Neural Engine. The Neural Engine can perform 11 trillion activities each second. Notwithstanding the different Neural Engine, the A14 CPU incorporates second-age AI grid scalar increase gas pedals (which Apple calls AMX blocks). The A14 likewise incorporates another picture processor with further developed computational photography abilities.

BIONIC CHIP IN MACHINE LEARNING

Transistors are key rotation components that process and store data on chips, and the number this year is much higher than the $ 11.8 billion on the A14 chip that empowers the iPhone 12 models introduced in 2020. Miaturization allows chip designers to pack multiple transistors to gain new capabilities. , although progress in miniaturization has slowed in recent years.

Like its predecessors, the A15 has two highly efficient cores for critical performance and four efficient cores for back-end operations that can operate without significantly reducing battery power. But Apple says it is fast and supported by a new graphics processing unit (GPU), a highly efficient neural engine AI and machine learning functions, and a new image signal processor for home tasks such as image reduction. The company unveiled the chip at its iPhone 13 launch event on Tuesday.

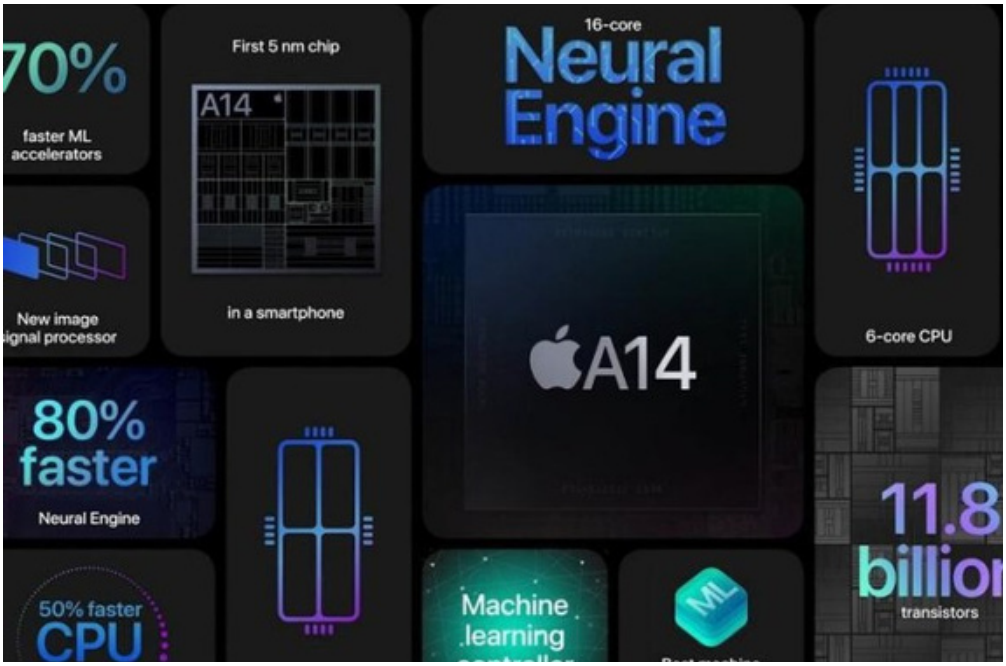
BIONIC CHIP IN MACHINE LEARNING

~Maharshi Thakkar
S.E ELEX

Apple boasts that the A15 has better performance than its rivals, a claim that has been true for years, based on Geekbench's speed tests. However, the company did not provide details on how much better the A15 was compared to the A14. Qualcomm, the top chipmaker for Android smartphones, has acquired the first Nuvia in an effort to give its processors greater speed.

The main function of the chip is to maintain the company's high performance at smartphone speed, to ensure that iPhones remain the first device developers to access new apps, and to keep customers happy with fast performance and long useful phone life.

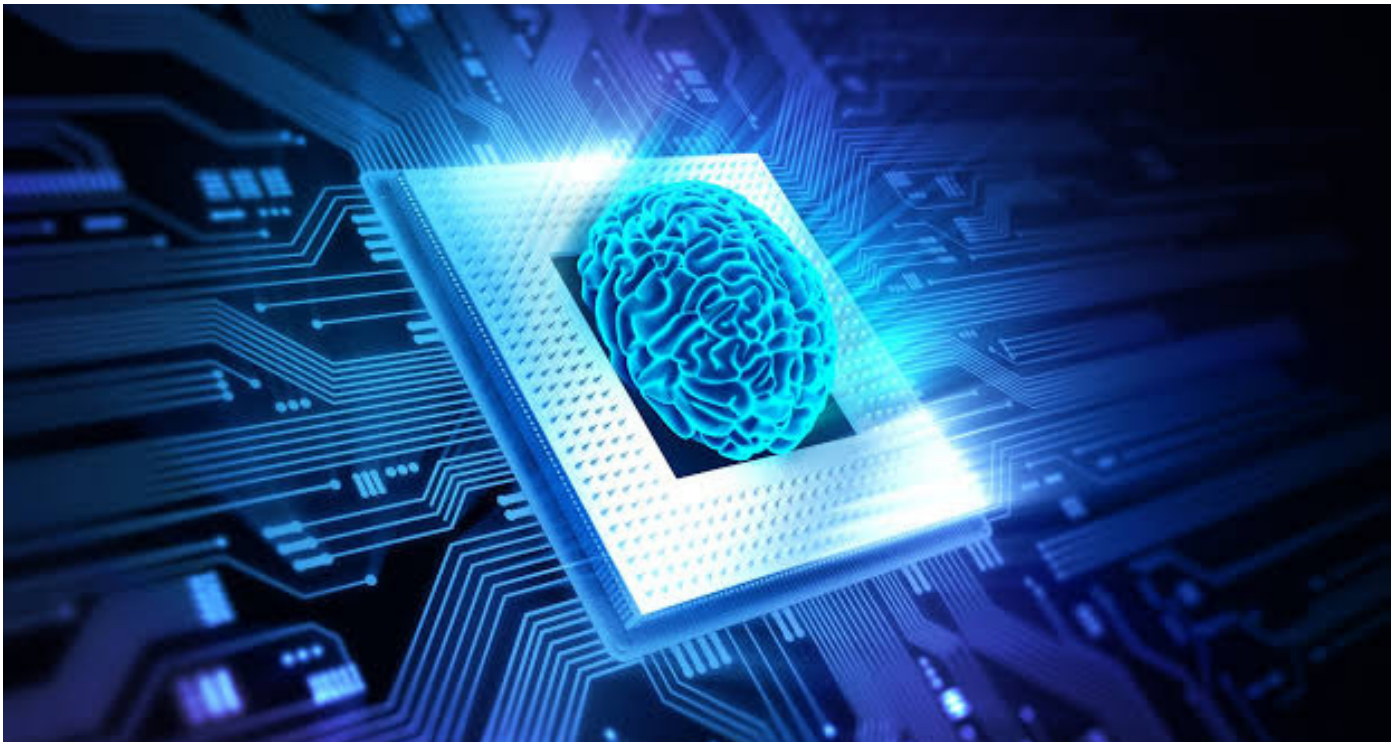
The A15 is an important base for Apple, not just the new iPhone. The A15 will also enable next-generation iPads. And the most powerful variant could be the brains within new Macs, following the Apple M1 processor based on 2020's A14 processor. Apple is in the midst of a two-year process of removing Intel processors from its Macs.



Designing its chips gives Apple a few advantages. It can set its own priorities for the times and the time. It can better integrate its software. And broadly, it can set its own better conclusion, a benefit contained in "Cook's Doctrine," by CEO Tim Cook, "to have" control over "key technologies in its products.
The A15 is built on a 5 nanometer production process - similar to the A14. The iPhone 13 and iPhone 13 Mini come with four basic GPUs, but the iPhone Pro and iPhone 13 Pro Max get five basic GPUs.

The new chip has a 16-core "neural engine", a circuit dedicated to speeding up intellectual property operations using modern machine learning technology. That is useful for increasing the range of functions, which includes producing Siri artificial voice, visualizing photos, focusing on photos and unlocking your phone with Face ID. Although it has 16 cores similar to the A14 chip, 16 increases AI performance from last year's performance of 11 trillion per second to 15.8 trillion per A15, Apple said.

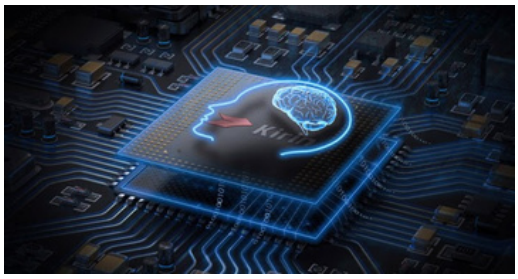
Apple relies on Taiwan Semiconductor Manufacturing Co. (TSMC) to build design chips. Apple often becomes the first recipient of TSMC's latest production technology, taking the opportunity to gradually reduce and improve performance to add new capabilities each year. It usually costs more to get into the best production capacity, but iPhones are premium products.



Intel has suffered in recent years from delays to new production processes. The result of poor performance and improved battery life made the bet of the Apple M1 look very smart. Intel is trying to get back on track with the upcoming new production development with its chips at Alder Lake PC this year as well as a Meteor Lake fan. But even if Intel's plans bear fruit, it will not be until 2024 that the company holds the TSMC and 2025 until it recovers.

BIONIC VS FLAGSHIP SOC: SILICONE COMPETITION

In this article we are going to compare top flagship SoC from different brands that ran previous year(2021) electronics. The ChipSet's being compared include the Snapdragon 888 (Qualcomm), Exynos 2100 (Samsung), Kirin 9000 (Huawei's HiSilicon), Dimensity 1200 (MediaTek) and the A15 Bionic SoC from Apple.



Below table shows detail comparison of Bionic Chip with other flagship SoC:

	A15 BIONIC	SNAPDRAGON 888	EXYNOS 2100	DIMENSITY 1200	KIRIN 9000
CPU Details	Hexa Core 2×3.223GHz Avalanche (Big cores) 4 ×1.82GHz Blizzard (Little cores) custom design	Octa-Core 1 Cortex-X1 @ 2.84GHz 3 Cortex-A78 @ 2.4 GHz 4 Cortex-A55 @1.8GHz	Octa-Core 1 Cortex-X1 @ 2.9GHz 3 Cortex-A78 @ 2.8 GHz 4 Cortex-A55 @2.2GHz	Octa-Core 1 Cortex-A78 @3GHz 3 Cortex-A78 @2.6GHz 4 Cortex-A55 @2GHz	Octa-Core 1 Cortex-A77 @ 3.13 GHz 3 Cortex-A77 @2.54GHz 4 Cortex-A55 @2.05GHz
CPU Cache (L2)	8 MB	1 x 1024KB 3 x 512KB 4 X 128KB	1 x 512KB 3 x 512KB 4 x 64KB	1 x 512KB 3 x 256KB 4 x 64KB	NA
Manufacturing Process	5nm	5nm	5nm	6nm	5nm
GPU (Graphics)	5/4 Core Custom	Adreno 660	Mali-G78 (14 Cores)	Mali-G77 (9 Cores)	Mali-G78 (24 Cores)
AI/ISP	16-core Neural Engine	Hexagon 780	Tri-core NPU	NA	2x big core 1x tiny core
RAM Type	LPDDR4X	LPDDR5/ LPDDR4X	LPDDR5	LPDDR4X	LPDDR5/ LPDDR4X
Modem	External Snapdragon X55	Integrated Snapdragon X60	Integrated Exynos 5123	Integrated Helio M70 5G	Integrated Balong 5000
Benchmark Scores	AnTutu: ~700,950	Antutu: ~700,000	AnTuTu: ~ 680,000	NA	AnTuTu: ~ 650,000

At first glance, we can note the similarities like all are based on 5nm mfg process except dimensity 1200. To be more specific all are based on ARM architecture. Another common thing among all these ChipSet's is the widespread support for 5G networks. With the exception of the Dimensity 1200, all the other ChipSet's here feature support for Sub-6GHz and mmWave 5G networks. Note that the Apple A14 gets a separate modem from Qualcomm while all the other SoCs get an integrated modem. The end-user, however, will hardly notice any difference as far as this specific factor is concerned since all devices that get these SoCs will support most 5G networks currently in operation.

Also, we can notice that 2100 & 888 seems to be more closely related to each other than the others. Only differentiating factor is clock speed in terms of CPU as both parent company are part of arm CXC program (Cortex-X Custom). As, MediaTek and HiSilicon are not part of the CxC program, and therefore, will not have access to the Cortex X1 core - at least for the time being.

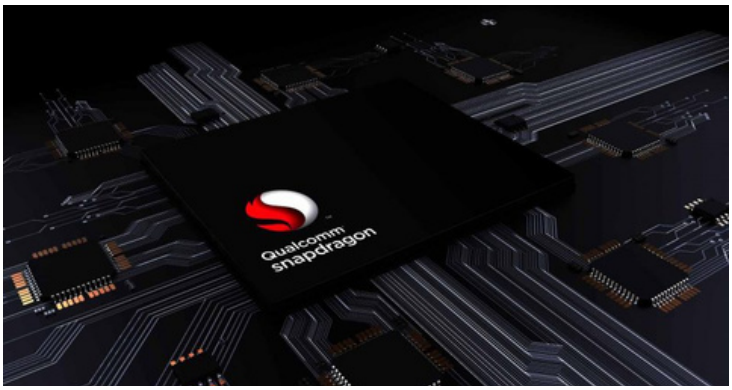
The key takeaway from this is the fact that while Apple has managed to hold on to a comfortable lead over its Android-centric SoCs for a while now, the move towards the X1 core does certainly help the Android camp cover some of that gap. The A15 Bionic is still a generation ahead of the Snapdragon 888 or Exynos 2100, but it's fascinating to see that Apple is no longer getting a healthy 20-25% performance jump YoY. Perhaps, this is the time for Qualcomm and Samsung to reduce the performance gap against the upcoming A-series chips.

A15 Bionic boasts 15.8TOPs while Exynos & Snapdragon capable of processing 26 TOPS. There is a minimum 70% boost to AI performance across all four chips.

At the end Great gadgets can be built from all chips. It comes down to in-house versus third-party handset development.

GPU in Bionic has 4 cores (for non pro variants) & 5 cores (pro variants). It is said to bring 30% to 50% performance gains against the best competition across the lane.

Regarding AI / ISP, Every chip offers a different array of camera features, but all support a growing number of sensors and integrated AI processing. we can't say a whole lot about AI performance based on the trillion operations per second (TOPS) metric that's so often banded about.



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~Mayur Chavan

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