

# ARTIFICIAL INTELLIGENCE COMPUTING FOR CONSUMER 2019

Market & Technology Report - October 2019

*While AI is a feature expected in smartphones, this fantastic technology has spread like wildfire to the smart home ecosystem and is profoundly impacting the semiconductor industry.*

## WHAT'S NEW

- Deepest analysis of the smart home ecosystem
- Deepest analysis of the smartphone application processor analysis
- Quantification of many more devices such as smart watches, headsets, personal robotics, smart TVs, and many more

## KEY FEATURES

- Artificial intelligence (AI) technologies used in consumer applications
- Edge computing for AI
- Types of hardware for smartphones, drones, and smart home devices with a focus on virtual personal assistant
- Ecosystems, market forecast, and trends
- AI software design and players' strategies
- Investments, mergers and acquisitions analysis

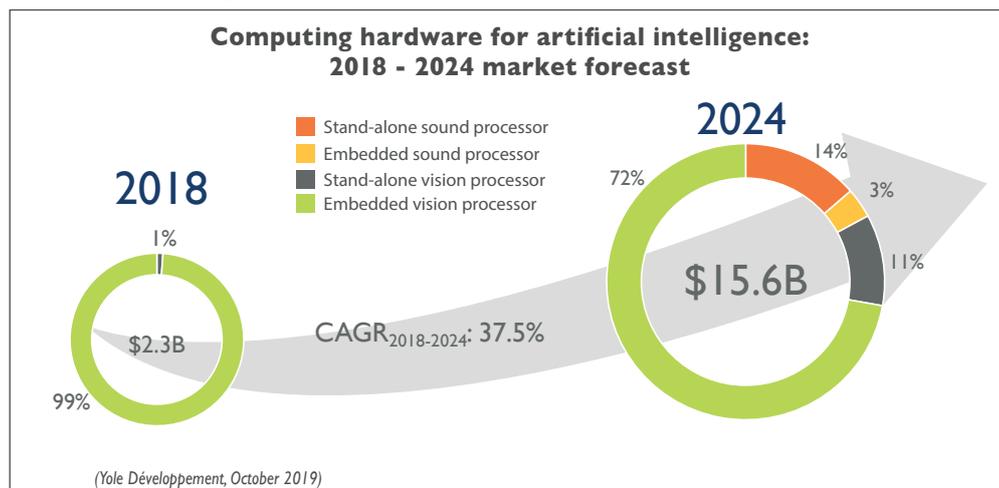
## COMPUTING HARDWARE FOR ARTIFICIAL INTELLIGENCE MARKET IS DYNAMIC, RICH AND DIVERSIFIED

Artificial Intelligence (AI) among consumers is both invisible and yet so present. In our smartphone or our home, this technology enters our daily lives in how we interact with the environment around us. The applications are numerous: biometrics, surveillance, photography, remote control, virtual assistant ... and the impact of artificial intelligence remains immense. The Artificial Intelligence Computing for Consumer 2019 report measures this impact, notably through the market and technology trends in computing hardware dedicated to AI, in other words in mm<sup>2</sup> of silicon.

In recent years, we are seeing the emergence of edge computing. This trend involves placing the calculation at the system level. However, the constraints are strong: always-on, consumption and performance in particular. With the end of Moore's law and the need for power demanded by artificial intelligence algorithms, it was necessary to create a new type of dedicated architecture. This unit has different names: deep learning accelerator, neural engine, neural processing unit,

AI-processing unit ... The goal is the same: to allow, without the need of a power-hungry GPU, to parallelize calculations very numerous in deep learning algorithms, and thus bring intelligence directly to the device level, independent of the cloud. The report distinguishes two types of technologies: either the AI is entirely dedicated to the analysis due to a stand-alone chip, or the unit dedicated to this task is embedded in a system-on-chip (SoC) whose objective is not centered on the analysis. To name a few examples, on the one hand, for the stand-alone chip, Intel Movidius is a perfect example. On the other hand, an «application processor», like Qualcomm' Snapdragon series, which is the central chip of smartphones containing a neural engine are representative of the embedded category.

Yole Développement's analysts estimate that the total market in 2024 for hardware computing for consumer applications will reach \$ 15.6B shared between the stand-alone chip at \$ 3.8B and embedded, supported by the smartphone, up to \$ 11.8 B.



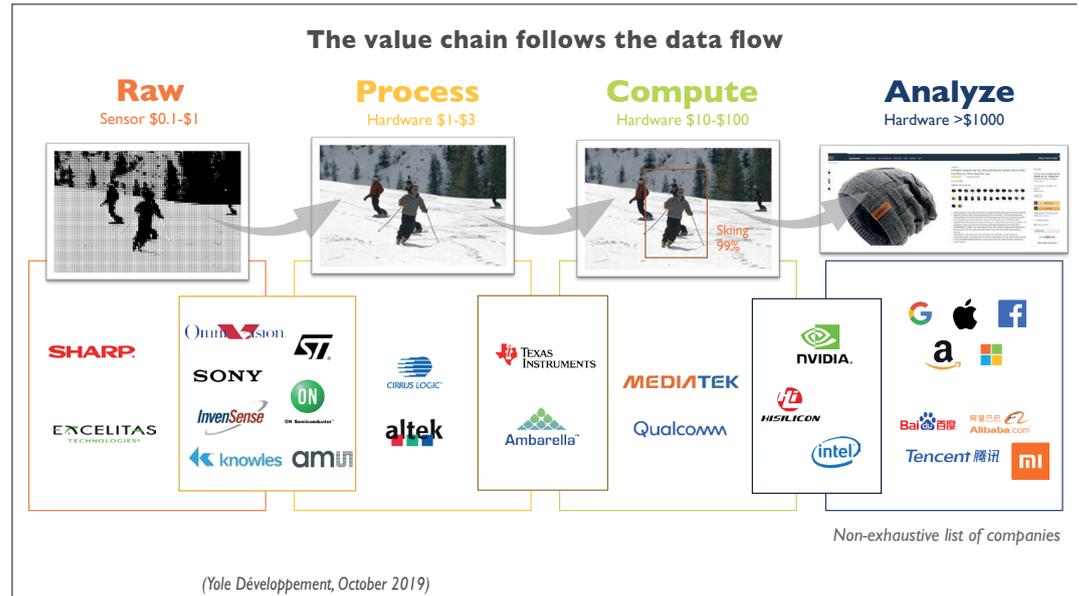
## FOR EACH TYPE OF COMPUTING HARDWARE, THE ACTORS ARE DIFFERENT AND SPECIALIZED

Even if the IP players propose solutions for the whole ecosystem, it is obvious that there is a strong stake to bring the calculation close to the sensor or centralize it in a multifunction chip. In the first case, we find the historical actors as well as the suppliers of sensors who want to add value to their product, so we

think here of ON Semiconductor, Ambarella, TI, Sony, Knowles, ams. On the other we find more and more OEMs who also want to capture this value by designing their own chip: Apple, Samsung, Huawei (with HI Silicon) and more famous players in this ecosystem such as Intel or Qualcomm. The latter stands out by

offering this type of computing for other markets than the smartphone such as virtual personal assistant, drones or smart camera. At the top of the pyramid, the tech giants are also designing

their own hardware, especially at the level of cloud computing where the value is even stronger and the clear objective of the data, today equivalent to a currency, different.

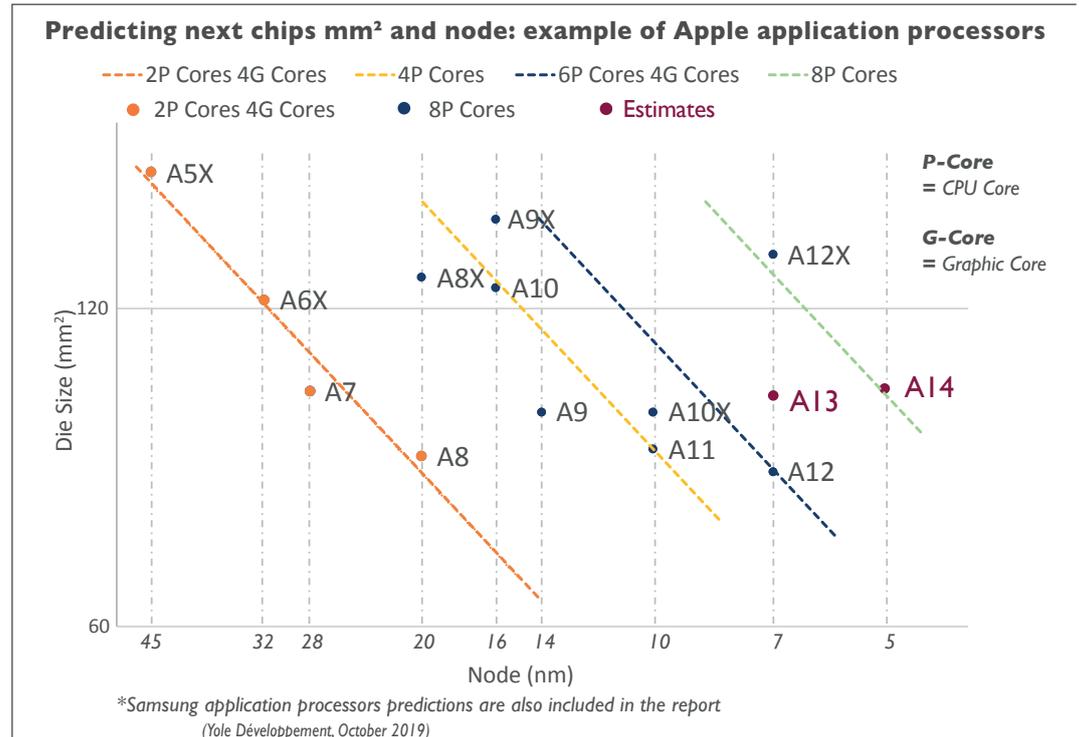


## MM<sup>2</sup> OF SILICON AND DATA, WHEN ARTIFICIAL INTELLIGENCE CREATES NEW STAKES

The objective of this report is to also determine the evolutions in volume and size of chips related to artificial intelligence. It appears, as shown by the trend at Apple, that these dedicated units are devouring more and more silicon, or, in general, more and more chips including AI-related features are overflowing on the market, which opens up big stakes and offers many opportunities. The goal is to understand here the impact of artificial intelligence on the size of the chip by looking at particular dedicated units or neural engine and their propensity to grow. It should be noted for example that the size of this unit has grown five-fold in 2 years and that Yole Développement's team

expects a similar evolution in the coming years for the Apple application processor.

Finally, controlling data provides phenomenal firepower in the field of AI. Data is needed to be more precise, more efficient, and more customizable, through better algorithms. Getting the best algorithms leads to greater penetration and acceptance by the public and, obviously, higher revenues. In this sector, revenues, investment, mergers and acquisitions are mastered by the giants GAFAM and BATX. This report, based on teardowns performed by System Plus Consulting, proposes a detailed analysis of the different strategies of these actors particularly in the smart home ecosystem where AI is at its beginning but where stakes are huge.



## REPORT OBJECTIVES

Provide a scenario for artificial intelligence (AI) within the dynamics of the consumer market, and understand AI's impact on the semiconductor industry:

- Hardware for AI - revenue forecast, volume shipments forecast
- Systems - ASP forecast, revenue forecast, volume shipments forecast
- Focus on consumer applications with embedded technologies: smartphones, drones, cameras, smart/robot homes

Deliver an in-depth understanding of the ecosystem & players:

- Who are the players? What are the relationships inside this ecosystem? Who will win the "data control" battle?
- Who are the key suppliers to watch, and what technologies do they provide?

Offer key technical insight and analysis into future technology trends and challenges:

- Key technology choices
- Technology dynamics
- Emerging technologies and roadmaps



## AUTHORS

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