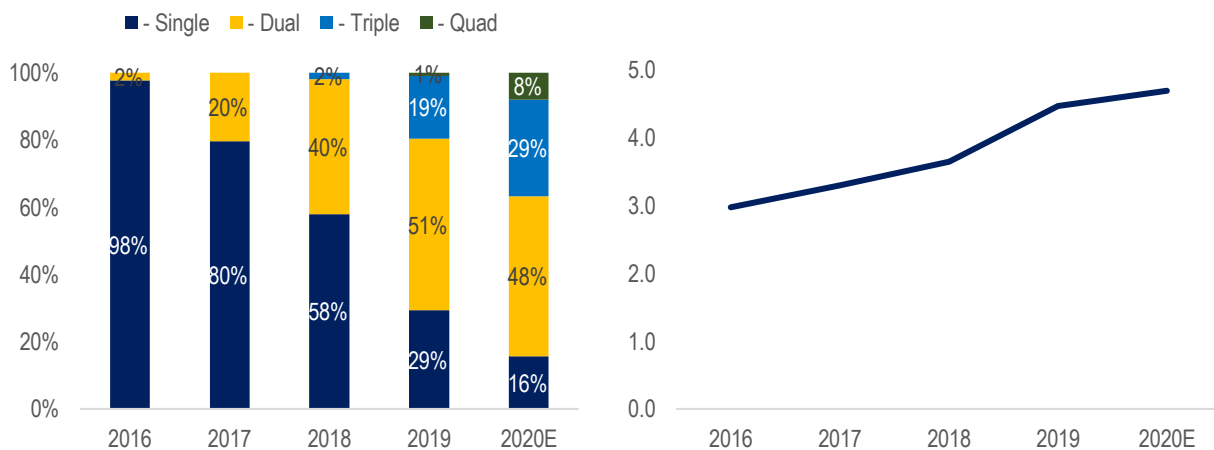




## Smartphone – lens sets growth driven by multi-camera adoption

Figure 1: penetration rate of multi-camera system (LHS) and total lens sets shipment forecast (units bn/RHS)



Source: AMTD Research estimates

**AMTD views:** The global smartphone market hit hard by COVID-19 early this year. While the supply chain has gradually recovered at moment, weaker demand caused by disruption to economics has become a new concern. Global smartphone shipment is expected to drop 5-10% YoY to around 1.26bn units in 2020. However, with the growing importance of camera performance to smartphone, multi-camera adoption has become mainstream among different smartphone brands and lens sets market seems to be less impacted by the downturn in our view. We expect total lens sets from smartphone market will grow by 5% to 4.7bn units, mainly driven by rising penetration rate of multi-camera system. For back camera, the penetration rates of dual/triple/quad models of handset are expected to reach 48%, 29% and 8%, respectively. Today, smartphone camera performance and functionality have improved substantially by combining high-quality lenses with different specific functions, such as large aperture, long focal length, ultra-wide angle, etc., into a tiny complex system. Below we will briefly introduce the development trend of various lens sets.

**AMTD Research**  
**Brian Li**  
 +852 3163-3384  
 brian.li@amtdgroup.com



**AMTD Research**  
**Halsey Wu**  
 +852 3163-3220  
 halsey.wu@amtdgroup.com

**AMTD Research**  
**Yanyan Feng**  
 +852 3163-3231  
 yanyan.feng@amtdgroup.com

## Smartphone

## Lens sets

### 7P – penetration rate rising, 8P – mass production started, and 9P – design completed

As mentioned above, with the increasing importance of camera performance for smartphones, lens suppliers have managed to improve image quality by increasing the number of lenses in a single lens set, mainly: 1) to increase the resolution; 2) to reduce the distortion at the edge of the image; 3) to increase the angle of view (wide angle).

Regarding the current iPhone models, from iPhone 8 to the latest iPhone 11, all the rear cameras are using 6P lens design, while the front cameras are integrating with 4P/5P lens design. New models to be launched this year are expected to use a 7P lens design. Apple always tries to enhance its iPhone camera image quality through high performance chips and algorithms.

On the contrary, Android camp is more aggressive on lens sets. OPPO launched the first smartphone integrated with a 7P lens design in its R17 pro in Nov 2018, and in the following months, Xiaomi and Huawei both equipped the 7P lens design on their flagship models of Mi9 (transparent version) and P30, respectively. Entering 2020, Samsung, Huawei and Xiaomi have even equipped their flagship models (Galaxy S20, P40, CC9 Pro) with 8P lens design. Overall, in 2020, we think 6P is still mainstream design, and penetration rate of 7P design will rise to around 10%, and 8P will become the mainstream design in android flagship models.

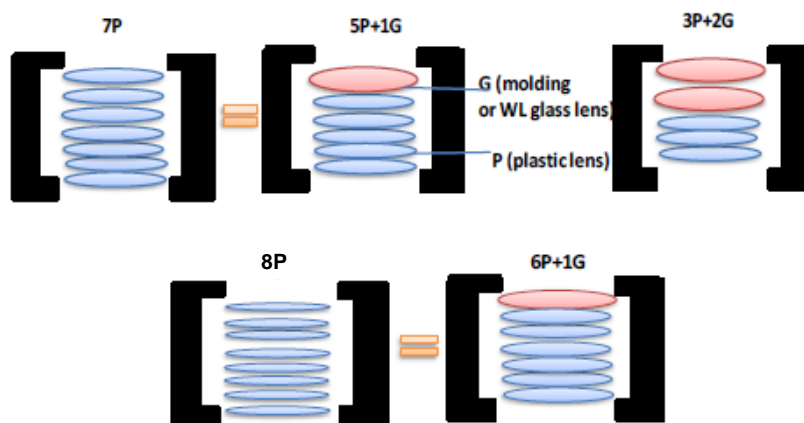
For lens sets suppliers, the plastic lens leader Largan has already started mass production of 8P and even completed the research and development of 9P, while Sunny Optical has already started mass production of 7P and now working on 8P in lens upgrade roadmap. On the other hand, hybrid lens may mark a new breakthrough in lens production technology. Leveraging the advantages of plastic lens' automated mass production and glass lens's superior transmittance, hybrid lens provides higher refractive index, higher yield rate and output. LCE Optics and Sunny Optical has already mass-produced hybrid lens, such as 1G6P while AAC is preparing to commence mass production of WLG lens in 2Q20, according to its 4Q results report, to meet the boost "G+M" lens demand.

Figure 2: 7P lens in Huawei Mate 30 Pro (launched in 3Q19)



Source: Huawei

Figure 3: The structure of hybrid lens



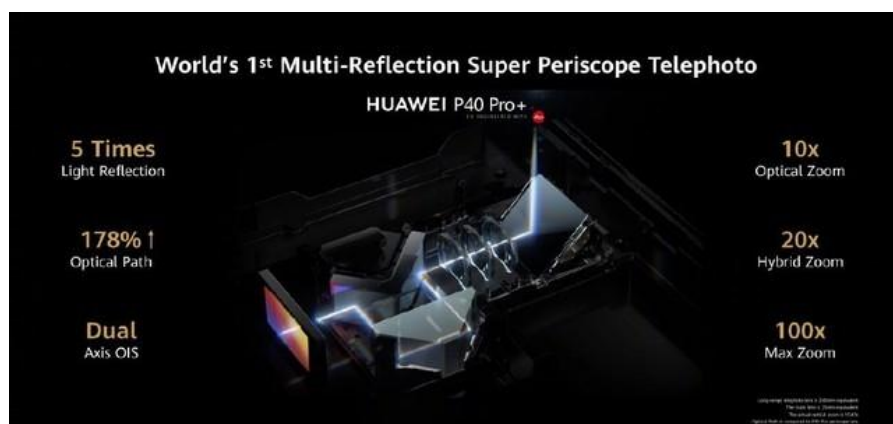
Source: ittbank

### 5x, even 10x periscope lens is becoming mainstream on flagship models

Periscope lens empower smartphone companies' sales growth, as the consumers have more imperative desire for high-quality photos with plenty of details, while it is not possible in the cramped space of a smartphone to allow much gap between the sensor and lens elements to move vertically and create the optical zoom range. The periscope lens is arranged horizontally into phone's internals, however, which provides more space for lens elements to move, thereby extending optical zoom range by L-shaped tunnel. More specially, the lights falling on the prism will be bent at 90-degree, pass through the lens elements and then fall on the sensor where it is processed.

2-3x optical zoom occupies sizeable market share of lens market at present, while an optical zoom of 5x even 10x will further become more popular in near future, in our view. Huawei P40 Pro+, launched in late March, is the world's first model equipped with 10x periscope lens.

Figure 4: The structure of periscope lens



Source: Huawei

### ToF is progressively adopted on front and back cameras

There are three 3D imaging technologies - ToF, structured light and binocular stereo vision, while ToF is becoming the main entrance for 3D data collection and favored by main brands. It actively projects light to measure the distance between camera and the object, outperform in faster processing speed, relatively longer range and better compact design, comparing the

other 3D imaging tech. More importantly, limited by Apple's patent on structured light, Android Camp are more inclined to adopt ToF sensors. According to IHS Markit, global revenue for ToF in the 3D sensing market surpassed US\$500 mn in 2019, and is expected to reach US\$1500 mn by 2022. Huawei, Oppo and Xiaomi has equipped their flagships with ToF on rear cameras, while we expect the ToF penetration rate on front cameras will develop rapidly, considering its low cost and improving accuracy in short range to cover from face recognition to 3D modeling.

Other disruptive technologies, such as extremely small front lens, under-display camera, under-display fingerprint adoptions in smartphones, etc., embrace the product portfolio and help smartphone companies build its differentiated competitive advantages as well, in our view.

## News update

28 Apr 2020

Smartphone

Apple

### Apple pushed iPhone 12 mass production by almost a month

Mass production of the upcoming iPhone 12 models will be delayed for about a month. Apple will also plan to cut the production of new iPhones by as much as 20 percent. The normal production lead time for Apple phones is between June to September. This year, relying heavily on Chinese manufacturing for its iPhones shipped all over the world, iPhone's production will be delayed by a full month because of the pandemic. (Source: [Micky](#))

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24 Apr 2020

Semiconductor

AMD

### AMD launched Ryzen 3 3300X, Ryzen 3 3100

AMD has announced two new desktop CPUs in the Ryzen 3000 series. Based on the 3rd generation Zen 2 architecture, the new Ryzen 3 processors fills in the low-end of the company's successful 3000-series of desktop processors. Both are 4 core, 8 thread processors with SMT, 65W TDP and 18MB cache (L2 + L3). The difference between the two is the clock speed, with the 3100 clocked at 3.6GHz base/3.9GHz boost while the 3300X clocked at 3.8GHz base/4.3GHz boost. Another difference is the price, with the 3100 starting at \$99 while the 3300X will be \$120. Both will go on sale on May 21. (Source: [AMD](#))

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23 Apr 2020

IoT

Apple

### Apple's smart ring could command other devices

A new patent for the Apple Smart Ring might use gesture control to allow users to simply point their finger at a device to send commands and control it. A previous patent stated that it should come with biometric sensors, a tiny touchscreen, and Siri connectivity. The new patent, however, suggested that users could actually have gesture control that connected the Apple Ring with any kind of device they gestured or pointed towards. For example, if you want to link your Apple TV, you can do so just by pointing your finger at it. (Source: [Techtimes](#))

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22 Apr 2020

AI

Alibaba

### Alibaba's DAMO Academy unveiled first hybrid test simulator for self-driving

DAMO Academy, Alibaba's research institute, unveiled the world's first hybrid test platform for autonomous driving simulations that can virtually test eight million kilometers a day, greatly boosting the efficiency of artificial intelligence training for self-driving. Alibaba announced its formal entry into the autonomous driving sector in 2018, with DAMO Academy developing a self-driving platform AutoDrive. The firm had earlier established a self-driving joint venture Banma Network Technology with SAIC Motor in 2015, with its products applied to a variety of production models. (Source: [YicaiGlobal](#))

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22 Apr 2020

Cloud

Tencent

### Tencent Cloud launched CityBase, the bottom platform of smart city

Tencent Cloud launched CityBase, which is the first time for Tencent Cloud to enter the CIM (City Information Modeling) field. CIM uses a unified data platform to integrate the data of different fields and dimensions in a structured and standardized way, and then uses AI technology to summarize or even simulate the prediction. It can be understood that CIM construction is an organic combination of GIS (Geographic Information System) data of large scenes + BIM (Building Information Modeling) data of small scenes + IOT data + AI of artificial intelligence. (Source: [Tencentcloud](#))

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22 Apr 2020

Semiconductor

Micron/Motorola

### Motorola announced new smartphone with integrated Micron tech for 5G

Micron Technology, together with Motorola, announced integration of Micron's low-power DDR5 (LPDDR5) DRAM into Motorola's new Motorola edge+ smartphone, bringing the full potential of the 5G experience to consumers. With 12 gigabytes (GB) of industry-leading Micron LPDDR5 DRAM memory, Motorola edge+ delivers a smooth, lag-free consumer experience. The new phone takes advantage of the faster data speeds and lowers latency of 5G to increase the performance of cloud-based applications such as gaming and streaming entertainment. (Source: [Totaltele](#))

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22 Apr 2020

Semiconductor

SiPearl

### SiPearl announced licensing of Arm Zeus Neoverse CPU IP

SiPearl, a new France-based company that is being backed and receiving grants from the European Commission's European Processor Initiative project, has announced that it has licensed Arm's next-generation Neoverse processor, codename Zeus. SiPearl is still in its infancy as it has only been founded in January of this year, but the new company has lofty goals as it aims to be the design house for Europe's HPC goals. (Source: [Anandtech](#))

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22 Apr 2020

Smartphone

Xiaomi

### Xiaomi reportedly working on a foldable phone similar to the Galaxy Z Flip

Xiaomi is reported to be planning on a new foldable phone that opens and shuts like the Samsung Galaxy Z Flip. The phone is reportedly intended to come in a clamshell-like foldable design, which the company has already started working on. Xiaomi has already made an order for some OLED displays from Samsung Display and others from LG Display. The mass production of Xiaomi's clamshell foldable phone is expected to begin in the second half of 2020. (Source: [Techradar](#))

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20 Apr 2020

Cloud

Alibaba

### Alibaba Cloud will invest more than RMB 200 bn in next 3 years

Alibaba Cloud announced that it will invest another RMB 200 billion into its infrastructure over the next three years, prompted in part by increased demand for services like video conferencing and live streaming as businesses adapt to the COVID-19 pandemic. The investment will focus on expanding Alibaba Cloud's technology, including its operating system, servers and chips, in its data centers. (Source: [Techcrunch](#))

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19 Apr 2020

Semiconductor

TSMC

### TSMC 3nm details announced: 250 million transistors/ mm<sup>2</sup>

Recently, TSMC officially disclosed the details of its latest 3nm process. Its transistor density creates a new record, 250 million/mm<sup>2</sup>. TSMC said the 3nm process transistor density is 3.6 times that of the 7nm process, and the 3nm has a 1.7x density improvement over the 5nm process in terms of density. Besides, the 3nm performance is 5% higher than 5nm and energy consumption increased by 15%. TSMC said that the 3nm process development is in line with its original schedule, it will commence risk trial production in 2021. The mass production will commence in the second half of 2022. (Source: [TSMC](#))

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16 Apr 2020

Semiconductor

Qualcomm

### Qualcomm announced world's most power-efficient NB2 IoT chipset

Qualcomm announced a breakthrough new product to drive the growth of cellular IoT: the Qualcomm® 212 LTE IoT Modem, the world's most power-efficient single-mode NB2 (NB-IoT) chipset. Requiring less than one micro-amp (1uA) of sleep current, the Qualcomm® 212 LTE IoT Modem's cutting-edge power-efficient chipset architecture allows for extremely low average power consumption. To support wide range of batteries and longer life span of the device in the field, the modem couples ultra-low system-level cut-off voltage with provisions for adapting power usage according to varying source power levels. (Source: [Qualcomm](#))

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15 Apr 2020

5G

### 5G basebands captured 2 percent unit share

The global cellular baseband processor market declined 3 percent year-over-year to reach \$20.9 billion in 2019, according to this Strategy Analytics research. Qualcomm, HiSilicon, Intel, MediaTek, and Samsung LSI captured the top-five revenue share rankings in the global cellular baseband processor market in 2019. Qualcomm led the baseband market with 41 percent revenue share in 2019 followed by HiSilicon with 16 percent and Intel with 14 percent.

5G baseband shipments saw a significant traction in the first year and accounted for almost 2 percent of total baseband shipments while capturing 8 percent revenue share, thanks to high average selling prices (ASPs). HiSilicon, Qualcomm and Samsung LSI were the key 5G baseband vendors in 2019 with significant design-wins. (Source: [Strategy Analytics](#))

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14 Apr 2020

Semiconductor

Google

### Google prepared its first self-developed SoC chip for Pixels, Chromebooks

The chip, code-named Whitechapel, was designed in cooperation with Samsung. However, the chips are not expected to be ready to power Pixel phones until next year. Subsequent versions of Google's chip could power Chromebooks. In addition to an 8-core ARM processor and 5 nm technology, Whitechapel will also include hardware optimized for Google's machine-learning technology. A portion of its silicon will also be dedicated to improving the performance and "always-on" capabilities of Google Assistant. (Source: [Axios](#))

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14 Apr 2020

Module

Qualcomm/BOE

### Qualcomm and BOE announced collaboration to develop innovative display products featuring Qualcomm 3D Sonic sensors

Qualcomm and BOE announced their plans to establish a strategic collaboration to develop innovative display products featuring Qualcomm® 3D Sonic ultrasonic fingerprint sensors. This collaboration is expected to extend from mobile and associated 5G technologies to XR and IoT. Both companies have started working on incorporating value-added and distinctive features to BOE's flexible OLED panels, including the Qualcomm 3D Sonic sensor. BOE will offer integrated displays with Qualcomm 3D Sonic fingerprint sensors to its customers. Commercial devices are expected to be available in 2H20. (Source: [Qualcomm](#))

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### AMTD Global Markets Limited

**Address:** 23/F - 25/F, Nexxus Building, 41 Connaught Road Central, Hong Kong

**Tel:** (852) 3163-3288 **Fax:** (852) 3163-3289

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