Driving double-digit growth in the semiconductor industry

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The term 'disruptive' is probably overused these days, but it is normally applied to just one technology. For example, when the PC industry really took off in the late 90s it led to a period of double-digit growth for the semiconductor industry. That wasn't repeated, despite the industry's best efforts, until the mobile phone changed everything, again, in the early 2000s.

Many have been looking for the next disruptive technology that will trigger another period of double-digit market growth for the semiconductor industry. The IoT has, for some time, been seen as that trigger, but perhaps because of its disparate nature it has yet to really make that kind of impact. But now, with the advent of 5G technology, the increased interest and deployment of artificial intelligence, the continued importance of cloud computing and the momentum building behind augmented/virtual reality, there is real anticipation that the industry is in a strong position.

Despite the inevitable and sever impact that COVID-19 will have on all industries, leading to reduced or even negative growth, the long-term forecast is likely to be healthy. In fact, it is hard to underestimate the impact that these disruptive technologies will have, and not only on the semiconductor industry. Part of the reason for that is because, as these technologies converge, they will create a virtuous cycle, each providing the foundation for further growth of the others.

The importance of the Average Selling Price

Part of the reason why the growth figures for the semiconductor industry have remained in single digits, despite the obvious increase in sales, is because manufacturers are constant pressure to reduce the average selling price, or ASP. Independent semiconductor manufacturers (IDMs) compete for almost every design slot, one way to protect that slot is to reduce the price of their products as they mature. While this allows them to charge a premium for new products, the useful lifetime of integrated devices can be extremely long, while the cost of developing a new device continues to increase.

As an example, consider the ASP for sensors. The advent of MEMS technology has really driven the IoT, thanks to their small size and high level of integration. However, this increase in volumes shipped has had a commensurate effect on the price (Figure 1).

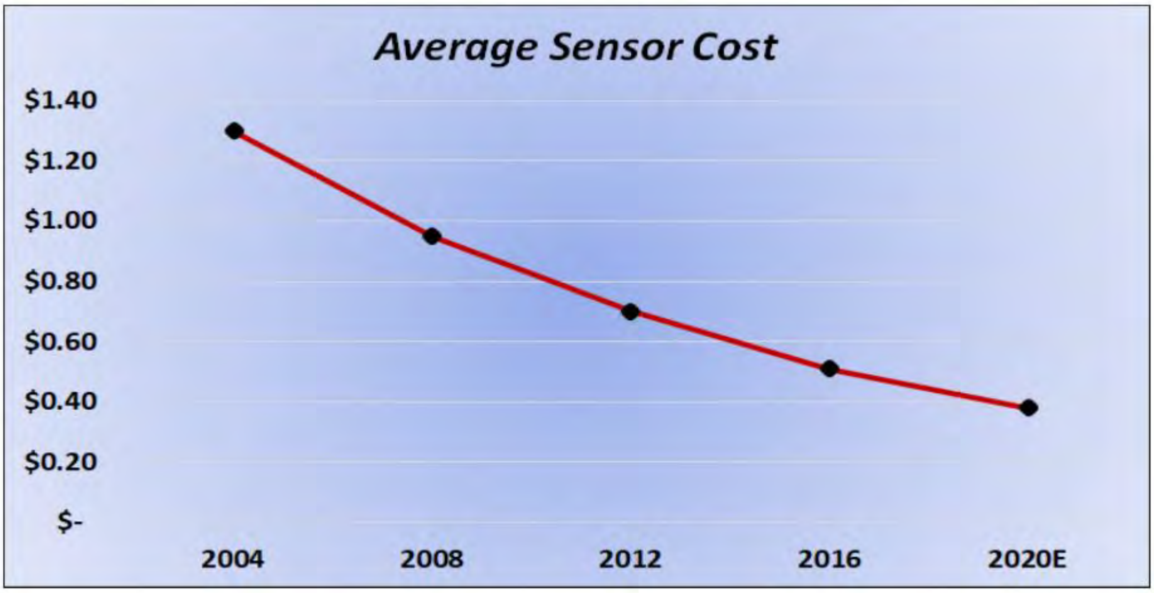

Figure 1: The ASP of sensors continues to fall (Source: Goldman Sachs and [2])

The introduction of 5G in particular represents somewhat of a watershed. While some of the existing infrastructure will remain in service, its roll-out will also necessitate entirely new equipment. This will drive OEMs towards developing new solutions, based on semiconductor devices that may not even exist yet. This is the opportunity for those IDMs ready and able to develop and deploy these new solutions to secure design-wins that may last several generations.

However, there is still some uncertainty involved. As a technology, 5G is essentially two systems with the same name. Initially we can expect 5G services to be deployed using the existing infrastructure, operating in the 6GHz bandwidth. This will deliver on some, but not all, of the promises 5G makes. In order to really see those benefits, we will need to wait until the second phase of infrastructure that will operate in 24GHz and above; the so-called mmWave region.

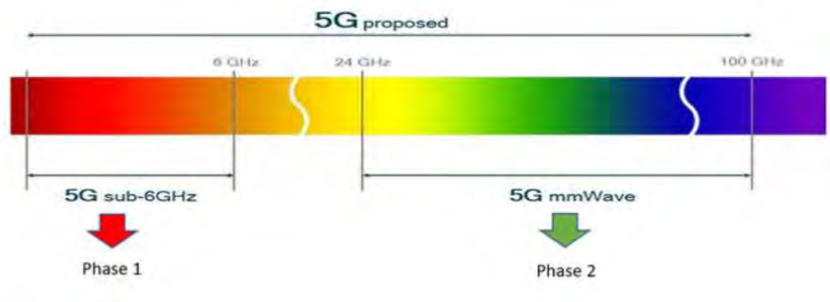

Figure 2: The two phases of 5G roll-out

Although we can only expect 5G mmWave to appear after 2024, it will bring significant performance enhancements, such as a 100X increase in data rate, 10X reduction in latency and 100X expansion in network capacity. This will require a much denser infrastructure in terms of base stations; they will be smaller but far more numerous. The development of the original mobile phone and associated infrastructure triggered a period of double-digit growth for the semiconductor industry; the precedent is set. Little wonder, then, that expectations are high.

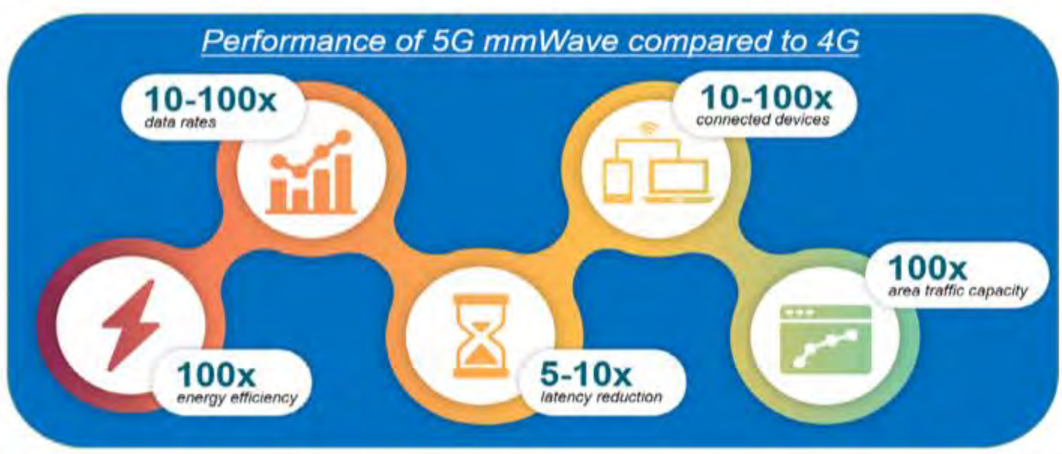

Figure 3: What we can expect from 5G

Unlike those original mobile networks, whose surprise success was the short text message, or SMS, we can expect any number of new applications to arise enabled by the main features of 5G. The high data rate will support live streaming of 8K content, for example, but it will also support much more variability in network traffic. This means we can expect almost anything, from large cargo ships to tiny temperature sensors, to be 5G-enabled.

Technology convergence will drive growth

The convergence between 5G, AI, VR/AR and cloud computing will create a virtuous cycle which will generate growth throughout the industry. Some analysts predict that by 2030 the semiconductor industry could reach $1trillion, and the OSAT (outsourced semiconductor test and assembly) part of the market could be valued at $100 billion. Figure 4 illustrates how this will impact demand and supply of the main packaging types currently used for integrated components. The CAGR forecast figures in the two columns on the far right also take into consideration the impact that 5G will have, shown for Phase 1 (up to 6GHz) and Phase 2 (>24GHz).

Unit: Bn Units	2016	2017	2018	2019E	2020F	2024F	2030F	CAAGR 2016-2019	CAAGR 2019-2024	CAAGR 2019-2030
SO/TSOP/SOT/DIP	76.0	83.0	88.5	83.0	81.0	91.0	140.0	3.0%	1.9%	4.9%
QFP/LCC	13.2	14.5	15.5	14.5	14.0	15.5	18.6	3.2%	1.3%	2.3%
QFN/FC QFN/MIS	41.6	45.8	50.4	48.9	48.4	70.2	158.4	5.5%	7.5%	11.3%
WB BGA/FC BGA/PGA/LGA	1.7	1.7	1.9	1.8	1.9	2.2	3.8	1.9%	4.1%	7.0%
WB CSP/Stacked CSP/FC CSP/FC CSP for DRAM	23.4	28.2	30.7	28.6	29.5	40.5	65.3	6.9%	7.2%	7.8%
WLCSP	26.0	30.5	32.5	30.6	29.2	42.0	84.0	5.6%	6.5%	9.6%
SIP (FC and WB)	4.0	4.2	4.5	4.1	4.0	4.9	8.4	0.8%	3.6%	6.7%

Figure 4: Actual and forecasted shipments by package type (Source: 2016 through; Prismark. 2030F; UTAC)

The expectation is that the lead-frame quad flat no-leads (QFN) package will remain the most cost-effective option, with increased use of moulded interconnect substrate (MIS) from 2019 through to 2030, thanks to its applicability to IoT components such as sensors. For more highly integrated devices, the wafer-level chip-scale package (WLCSP) is still favoured and, as a result, will also see increased use. More established package types, such as surface mount device (SMD) will, of course, remain popular, while demand for the quad-flat pack (QFP) will continue to come from the automotive sector. The application of ball grid array (BGA) and land grid array (LGA) package types implementing flip-chip technology will also be buoyed by the general market growth. We can also expect to see increased demand for system-in-package solutions.

As a result of the opportunities it presents, the move to mmWave technology will disrupt the industry's established supply chain, including OSATs. Developing new test and packaging technologies for 5G will require some innovative approaches as, to date, the majority of IC packaging technologies are designed for frequencies up to 6GHz. Figure 5 charts the evolution of RF front-ends in cellular communications, with a summary of the packaging used and what will be required for 5G phase 1 and phase 2.

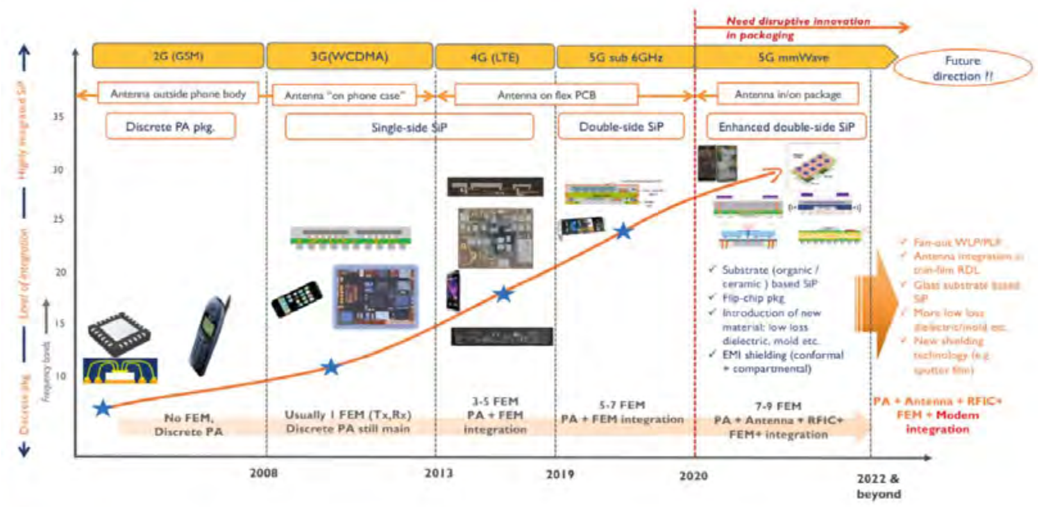

Figure 5: RF front-end packaging in cellular communications

The move to mmWave will require packaging technologies that can accommodate new radio solutions, such as phased array antennas. The high frequencies involved means packages will also exhibit higher insertion losses around the interconnects, which will necessitate the integration of the antenna into the module, to create antenna-in-package (AiP) approaches.

This may mean the industry's standard over-moulded plastic packaging is unsuitable due to the relatively high dielectric constant at frequencies above 20GHz. Ultimately, this may force manufacturers to adopt the more expensive cavity package. To address these challenges the industry needs access to more RF experts, willing to apply their skills to the area of backend test and packaging.

The technology convergence expected to build around 5G will accelerate as we enter phase 2 of deployment, but there are significant challenges to overcome along the way. However, because 5G is going to be so important in the future, we know the industry will meet these challenges and overcome them. The OSAT sector will be instrumental in that success.