GAINING THE EDGE:
Semiconductors and the 5G opportunity
In fact, 5G adoption is widely expected to outpace 4G’s when the fourth-generation technology was introduced. While 5G’s speed advantage over 4G is an obvious selling point, its reliability and low latency are what’s going to create the biggest benefits—opening up vast new applications and use cases. For semiconductor companies, 5G offers plenty of potential. But tapping into that potential will require new monetization models as well as a new organization structure and different routes to market to reach customer bases they’ve never engaged with before.

Like many industries, the high-tech sector has long awaited the introduction of 5G. The fifth-generation wireless technology for digital cellular networks, which carriers began rolling out in 2019, offers unprecedented network speed and reliability, as well as virtually no latency. Not surprisingly, the technology to power this capability is incredibly complex, and promises to reshape the high-tech and mobility landscapes over the next decade.

Regardless of whether they’re participating directly in the development and deployment of 5G, semiconductor companies must understand 5G’s implications and prepare themselves and their strategy accordingly. Companies could either see a sharp increase in demand for their products or could be in a position to make a strategic shift to capitalize on the many new, and as yet largely undefined, opportunities 5G will create. We expect to see a number of interesting inflection points semiconductor companies can take advantage of as this technology is adopted.

As they consider 5G’s implications and how to respond, semiconductor companies should keep the following things in mind.
The speed and behavior of 5G adoption will be different from past network upgrades.

The impact of the evolution of mobile networks was a boost in speed and availability. Yes, connectivity and reliability also improved, but the main benefit of new network technologies was that users could access data much more quickly.

**Speed will jump**

Certainly, 5G will also bring another huge jump in speed, and that’s what will attract the initial wave of adopters and drive the accompanying increase in 5G-enabled mobile handsets. According to Gartner, 5G smartphones are projected to account for nearly 30 percent of smartphone units by 2021—just two full years after their introduction. This number is projected to ramp up to a good 71 percent by 2024 (Figure 1).

5G smartphones are still expected to experience a boost in production, despite challenging market conditions due to COVID-19, what with 187 million units now forecast to be produced in 2020. This ramp-up will affect smartphone architectures, BOM costs and pricing, and will impact 5G modems, RF front-end and memory.

**Figure 1**: Smartphone Forecast by Technology Worldwide, 2019-2024

![Smartphone Forecast by Technology Worldwide, 2019-2024](source: Gartner Market Trends: 5G Impact on Smartphone Semiconductors (15 April 2020))
Reliability and ultra-low latency are the real stars

But greater speed isn’t the most impactful benefit of 5G. 5G’s true value is its extreme reliability and ultra-low latency, which could be as little as 1 millisecond (equivalent to the blink of an eye), compared with a latency of 50 milliseconds that’s typical of 4G networks. This will make possible all sorts of enterprise applications that couldn’t operate via cell networks before, which will mean a massive increase in the number of connected devices operating on the network. Speed is great, and 5G by its nature will already enable many more devices to be connected. But many mission-critical applications simply can’t trust the current network’s reliability. With 5G’s reliability, those concerns largely disappear.

Take smart cities, for instance. Many large metropolises have been on a mission to take better advantage of data and technology to help them manage key city services and critical civic infrastructures. To do that, they need to connect buildings, streets, and a wide range of devices—but progress to date has been limited due to the current 4G networks. By enabling virtually real-time transfer of a massive amount of data across a huge number of Internet of Things devices, 5G can enable cities to automate a whole host of functions, including buildings operations, air and water quality monitoring, autonomous car orchestration, and traffic safety and electric grid control. 2

5G also will be a boon for connected healthcare. By adopting 5G, healthcare providers won’t have to worry about network congestion and slow speeds limiting their ability to make greater use of technology to treat patients. With 5G networks providers can, for instance, expand the use of telemedicine to provide care to patients in remote or rural areas who otherwise wouldn’t have access to a doctor; quickly and reliably transmit huge medical imaging files; gather data via remote monitoring that can be used to deliver personalized and preventive care; and use artificial intelligence to help improve diagnoses and resulting treatment plans. And it all adds up to significantly better outcomes for patients. 3

These are just two examples of how 5G’s extreme reliability will be a true game changer. But at this early stage in the game, no one really knows the extent and types of applications we can expect.

For semiconductor companies, the expected two-stage adoption means two distinct go-to-market strategies and plans will be needed to more fully capitalize on 5G’s potential.

The introduction of 5G will dramatically increase the complexity of RF front-end designs in smartphones and will drive the bill of materials higher. The chip volume and RF frontend modules for 5G mmWave are expected to double in premium smartphones.
The first wave: speed junkies

Most obvious (and straightforward) is for semiconductor companies that compete directly in the mobile handset business to be prepared for the initial bump in 5G handsets driven by users attracted to 5G’s speed. The chip volume and RF frontend modules for 5G and 5G mmWave are expected to double in premium smartphones, and 5G semiconductor revenue—including baseband processors, RF, and power management—will increase from near zero in 2018 to $31.5 billion in 2023,⁴ the vast majority of which will be driven by smartphones.

Meeting this demand will largely be business as usual, although there will be an increase in chips’ baseline memory requirements due to the need to process far more data and handle many more applications. But while the revenue potential here is quite large, it’s a highly competitive segment that’s largely spoken for by established players.
Much more up for grabs are the long-term, and diverse opportunities created by the massive number of new applications beyond smartphones that are expected to begin appearing within a year or two (Figure 2). These include fixed wireless access, automotive infotainment and safety, private enterprise networks, the industrial IoT for security cameras, and always-connected PCs and tablets.

### Figure 2: 5G Semiconductor Revenue by Application ($Millions)

<table>
<thead>
<tr>
<th>Application Segment</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>CAGR 2019-2023</th>
<th>CAGR 2021-2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premium Smartphones</td>
<td>9,992</td>
<td>15,466</td>
<td>18,734</td>
<td>21,383</td>
<td>117.5%</td>
<td>18%</td>
</tr>
<tr>
<td>Basic Smartphones</td>
<td>391</td>
<td>1,788</td>
<td>3,931</td>
<td>7,559</td>
<td>N/A</td>
<td>106%</td>
</tr>
<tr>
<td>Utility Smartphones</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>402</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Infrastructure/Other Wireless</td>
<td>513</td>
<td>774</td>
<td>946</td>
<td>1,081</td>
<td>33%</td>
<td>18%</td>
</tr>
<tr>
<td>Industrial</td>
<td>0</td>
<td>32</td>
<td>136</td>
<td>329</td>
<td>N/A</td>
<td>221%</td>
</tr>
<tr>
<td>Automotive</td>
<td>0</td>
<td>15</td>
<td>83</td>
<td>222</td>
<td>N/A</td>
<td>285%</td>
</tr>
<tr>
<td>Consumer/Compute</td>
<td>70</td>
<td>167</td>
<td>311</td>
<td>496</td>
<td>N/A</td>
<td>72%</td>
</tr>
</tbody>
</table>

Source: Gartner: Forecast Analysis: 5G Semiconductors, Worldwide (Dec 2019)
The importance of knowing your customer

A new IoT company (OEM) identifies a killer application for its product, which is infinitely scaleable with 5G support, and contacts its preferred ODM to help design this particular product. After reviewing the requirements, the ODM decides to use a specific semiconductor company’s chips.

The OEM reviews the ODM’s completed design and decides the chip is too expensive, tweaks the requirements slightly to reduce manufacturing costs. Additionally, the product requires four different types of silicon (Flash, Processor, Connectivity, and Sensor), one or two of which are in short supply, so the OEM switches to another supplier.

This is a fairly common route to market—one that semiconductor companies are intimately familiar with. However, the key difference here is that with 5G, the number of companies taking this route will increase dramatically. That’s why semiconductor companies must partner and attack each of these inflection points in a scaleable way that creates demand for their silicon at every stage.

For a semiconductor company to capitalize on these applications, it will need to work closely with ODMs, OEMs, and other ecosystem partners to have them design the company’s silicon into devices for emerging use cases that didn’t exist before, or at least weren’t as widespread. In other words, getting closer to customers to understand what they’re working on and what their customers are considering will be crucial to semiconductors’ longer-term growth (see box).

Importantly, semiconductor companies shouldn’t forget about the opportunity to use 5G in their own operations—deploying technologies that can capitalize on 5G (such as IoT, blockchain, AI, and analytics) to make their plants smarter, more efficient, and more productive. 5G can play a critical role in a high-speed infrastructure by connecting production with data from different parts of the business (i.e. yield, testing, and customers) to drive greater consistency.
Despite the enthusiasm for 5G, it will take a while to fully identify how to monetize it.

Telecom companies are making tremendous investments in 5G to build out the required infrastructure. But how much will today’s traditional 4G mobile customers be willing to pay for premium 5G service? To drive the use of 5G at scale, telecom companies will probably have to get creative with plans, such as requiring customers to use a certain amount of data each month.

For their part, semiconductor companies are also investing heavily in 5G, whose true potential will be realized only if the chips are available that can process data 100 or 200 times faster than current 4G chips. But they’re investing a disproportionate amount of R&D relative to what they stand to gain from the hardware sector of the value chain, which will account for less than one-third of worldwide IoT spending in 2022 (Figure 3), compared with nearly 60 percent represented by services and software. Additionally, technological advantages in silicon don’t carry much weight beyond immediate implications within the 5G stack—i.e., older technology’s resilience in new use cases and applications.

Figure 3: Worldwide IoT spending 2022

Source: IDC: Worldwide Internet of Things Forecast Update 2022
Companies could identify system-level opportunities in which a combination of specific, differentiated silicon can capture a larger share of the market. For example, instead of simply making silicon for sensors deployed on a logistics cold chain to monitor temperature changes, a semiconductor company could develop a platform using its processors to run predictive analytics on a truck to proactively identify when the temperature inside a truck will likely move outside the acceptable range, or to monitor the equipment that keeps the truck cool. This would deliver significant value to the shipper in terms of avoided spoilage. This capability doesn’t currently exist; the silicon in which companies are investing today is used in monitoring after the temperature excursion. There’s far greater value in adding intelligence to the point of detection, and leveraging the scale at which that solution can be deployed across a 5G-enabled infrastructure.

**Value creation in a platform with embedded silicon**

With customers increasingly expecting less-differentiated hardware and the real value being generated by the end application, silicon eventually will be commoditized. Semiconductor companies need to begin working now to identify new ways to present their products and technology to customers, and new ways to monetize them, to create new value streams across different adoption timeframes. In doing so, they can take advantage of general uncertainty at this early stage about how 5G revenue will flow across enterprises, customers, and infrastructure to pilot different monetization models. This could include offering silicon as a service, which innovative semiconductors are already doing. But several other potentially promising models are possible.

** Semantic companies can take advantage of general uncertainty at this early stage about how 5G revenue will flow across enterprises, customers, and infrastructure to pilot different monetization models.**

**Feature monetization after the point of sale**

Tesla sells its electric-vehicle batteries with much more capacity than some customers actually pay for. But it locks the extra capacity via software and gives customers the option to unlock it by paying an additional fee if they decide they need more at some point. Semiconductor companies could take a similar approach by incorporating additional features in their chips—for example, those that could enable customers to simplify design...
or manufacture at higher volumes—and tailor access to those features to what customers actually need. Doing so could lower the entry-level price point for customers who could later pay more for the embedded features and unlock them immediately if they need it—rather than repurchase or redesign their products. In other words, it shifts the silicon expense from one upfront charge to pay as you go—through such things as compute cycles or data ingested or downloaded.

**Data monetization after the point of sale**

As infrastructure and connectivity increase, so does the sensitivity of the chips needed for 5G. Semiconductor companies could take advantage of the vast amount of internal performance data available to generate valuable insights for end customers through analytics. In other words it’s not only selling customers chips, but also helping customers use the chip better after the sale.

For instance, silicon data could include manufacturing or parametric data, yield data, and quality or reliability data—all of which is used to deliver a high-quality, high-yielding, and reliable chip to customers. There’s also generic performance data on the chip itself that can be captured, such as temperature, number of operations, and electrical data elements.

Would silicon customers find any combination of the above data helpful for advanced parts? Many might. Currently, they only know their silicon specs, but not how the silicon is behaving in real time or where it is within that spec. Those insights could be tremendously helpful as hardware scales to the edge and connectivity increases.

**5G will have a significant impact on semiconductor companies’ customer base**

Semiconductor customers today are very different than they were over the past decade. It used to be semiconductor companies knew which laptops, PCs, or handsets they had to build chips for. Today, their customers aren’t just computing equipment or handset makers, but producers of large and small appliances for the home and the growing universe of other connected industrial and consumer products. 5G’s impressive speed and reliability will only expand and continue to diversify that customer base. As 5G brings higher connectivity and the ability to reliably connect more things, more use cases and companies will look to use semiconductor technology.

**Who’s the real customer?**

In a 5G era, semiconductor companies need to truly understand the potential use cases their products will enable and who’s the end customer of those use cases. Increasingly, it won’t be traditional ODMs or OEMs. In fact, many semiconductor companies may find that in some cases, they’re better off not selling to ODMs and OEMs and letting them figure out how to create value in the marketplace—and, instead have that value conversation directly with the end customer.

Here’s a simple example: A company sells a lot of camera, optoelectronics, or vision intelligence processors. 5G could drive a massive increase in
The increasing proliferation and diversity of the customer base will have significant ramifications for how semiconductor companies structure their organization (especially sales and marketing), develop products, and create their product portfolios.

For instance, traditional semiconductor go-to-market models aren’t built for a highly diverse customer base. Semiconductor companies will find they’ll need different routes to market for different customers or customer types—maybe a combination of direct sales for high-touch, high-volume customers with a high level of custom engineering; and indirect sales for lower-volume customers with niche needs.

The latter will typically require a collaboration ecosystem to build differentiated products because no semiconductor company today is equipped to develop chips for every single use case 5G will enable—and there will be a lot of them. The traditional approach to understanding a customer’s needs, designing the chip, and recouping cost through large-volume sales just won’t work when a semiconductor company is trying to serve hundreds or thousands of customers looking for a chip for a hundred parts they can test in the market. Most semiconductor companies aren’t built for that kind of scale, and it wouldn’t make sense to do it that way anyway. Instead, semiconductor companies will have to think about expanding their scale via an ecosystem from which they can source design ideas for smaller applications and then build the product roadmap that can best serve all those diverse customers. They’ll have to do this while participating in the design journey and proof-of-value effort alongside past customers—essentially, taking on more risk.

A collaboration ecosystem to build differentiated products will be needed because no semiconductor company today is equipped to develop chips for every single use case 5G will enable—and there will be a lot of them.
Conclusion

There’s tremendous excitement around 5G, and for good reason. The technology promises an extraordinary increase in what can be done through cellular networks. The fundamental difference between 5G and 4G is in the significantly greater number of devices that will be connected to the network, as well as the extreme reliability and virtual absence of latency. This isn’t just an improvement in basic speed; it’s a step-function increase in what’s possible.

With these possibilities, the value chain will go through an experimentation phase to uncover how money can be made and the mechanisms through which value is delivered. This is a prime opportunity for semiconductor companies to think boldly beyond simply selling chips; reimagine their revenue streams; and approach old and the vast number of new customers with new business models.

Even semiconductor companies that aren’t directly in the 5G value chain—for example, suppliers to potential 5G participants or enablers of capabilities that will grow as a result of 5G (such as edge, IoT, and automotive)—need to prepare for the shifts in the landscape 5G will drive. This transformative technology’s impact will be felt far and wide.
**References**


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