KPMG

Surviving the silicon storm

Why the automotive industry is the hardest hit and how automakers—and other chip buyers—can prepare for future semiconductor shortages

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Letter to our readers

Nothing has demonstrated more clearly how much the economy and our way of life depend on semiconductors than the current global shortage. A series of events—a perfect storm of natural and man-made events, including the COVID-19 pandemic—has created a serious shortage of semiconductor products that is expected to last well into 2022.

From makers of PCs and smartphones to manufacturers of simple electronic devices, companies that use semiconductors are cutting production and trimming earnings forecasts. Rollout of 5G wireless network nodes is being affected. Gamers can't get their PlayStations. A Texas company that makes sensors to remotely check the temperature of wet cement can't provide its products, interrupting construction schedules.[1]

But no sector has been hit like automotive. While automakers account for about 10 percent of global semiconductor sales, we estimate that they will suffer about 80 percent of the $125 billion in lost sales due to the shortage.[2] Last fall, automakers began feeling the pinch and started announcing production cuts. And in May 2021, many leading automakers were predicting that production will be affected through the end of the year.

Automotive was hit sooner and harder than other industries largely because automakers still tend to lack the close relationships with semiconductor suppliers that other customers have developed over time. Despite the rising importance of semiconductors in their products, automakers have not treated chips as critical components. They mostly rely on third parties, such as Tier 1 suppliers, to deal with chipmakers and generally lack visibility into and understanding of the supply chain.

And, when COVID-19 hit and car sales stalled, they slashed orders for electronic components to preserve capital—just as they did with orders for tires and mufflers. Meanwhile, other semiconductor customers—companies that have seen chip shortages before—didn't cancel orders, even if end demand for their products was in question. When demand for cars rebounded later in the year, automakers found they were at the back of the line in a market with a severe supply/demand imbalance.

In this paper, we analyze the causes of the shortage and the outlook for a return to normal—and the ways in which automakers and other chip users can minimize the impact of future shortages. The supply/demand mismatch will not be resolved quickly. Despite accelerated capacity expansion plans by chipmakers—and even with growing political pressure to build up domestic supplies in Europe and the United States—there are no quick fixes due to the time it takes to bring new production online.

In the meantime, we advise automakers to:

- Collaborate directly with semiconductor suppliers and foundries, sharing longer-term roadmaps and forecasts.
- Consider making investments in chip-making capacity as many consumer electronics firms do.
- Invest in advanced technologies and software to enable data-driven supply-chain decision making.
- Overhaul the ways in which chips are selected and used to add flexibility to the supply chain.
- Address organizational barriers to optimize the semiconductor supply chain.

Scott Jones
Principal and Advisory Telecom, Media & Technology Practice Leader

[1] Source: Don Clark, "The semiconductor shortage is affecting industries far beyond cars and computing," *The New York Times*, April 15, 2021
[2] KPMG estimates

The gathering storm

1

Supply and demand in the semiconductor market periodically fall out of sync, but very rarely to the extent seen today. This time, a convergence of unanticipated events—the pandemic, a freezing winter in Texas, a drought in Taiwan, a factory fire—has severely limited supply in a market where demand was already pulling ahead of available capacity (see "A perfect storm").

The pandemic itself had the greatest and perhaps most unexpected impact. When the economy shut down in the spring of 2020, unemployment spiked, and demand for goods and services fell—just as one would expect in any economic shock (albeit on a greater scale than previously seen). But the stay-home mandates produced a surge in chip demand for use in PCs and servers. As Americans began to telecommute, shop from home and use streaming services for entertainment, sales of laptop computers, smart TVs and cellphones rose and demand for cloud servers and infrastructure to support remote work, streaming, and online shopping spiked, with server shipments up 18.4 percent in the second quarter.[3]

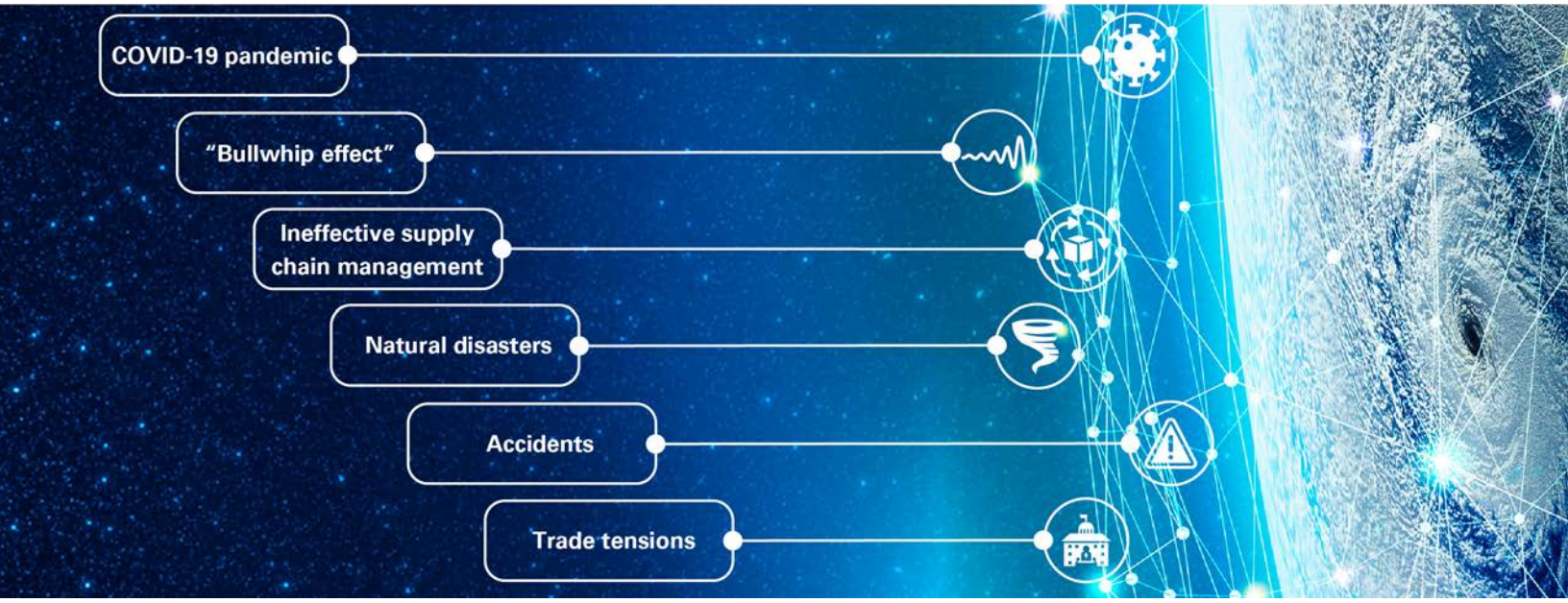
This fresh demand hit a market where demand growth was already strong. With the rollout of 5G infrastructure, the increasing use of artificial intelligence, growth in electric vehicles (EVs) and connected cars, and the rising demand for chips in internet of things (IoT) sensors and consumer products, global semiconductor sales grew to around $450 billion in 2020 and are expected to break $500 billion in the next 12 months.[4]

[3] Source: International Data Corporation, Worldwide Quarterly Server Tracker, September 8, 2020

[4] Source: World Semiconductor Trade Statistics, March 2021; KPMG analysis

A perfect storm

The COVID-19 pandemic has affected the global semiconductor supply chain in an unprecedented way, but multiple concurrent factors contributed to making the current shortage more difficult to handle. Any one of these factors could have been managed by itself, but the confluence of events has created a situation that will be very difficult to recover from in the short term.



COVID-19 pandemic: The 2020 pandemic triggered an initial slowdown, or in some cases, a complete halt in demand followed by a very strong pickup in demand for devices enabling working from home and online shopping and entertainment (e.g., computers, infrastructure, and data centers).

Bullwhip effect: Exaggerated or inaccurate demand resulting from muddled and indirect information across the supply chain. Automakers do not usually collaborate closely with semiconductor manufacturers and foundries, which makes it difficult to react effectively to major demand changes.

Supply-chain management: Automakers still rely largely on low- or no-buffer just-in-time sourcing strategies, using short-term forecasts (despite 26-week lead times for semiconductors). Many components have a single source and contracts have strict quality requirements. All these factors limit supply-chain flexibility in a shortage.

Natural disasters: A severe winter storm in Texas in February 2021 shut down several wafer fabrication plants (fabs), including two facilities of major automotive semiconductor suppliers (Infineon and NXP).[5] Taiwan is in the grip of a drought and the government is considering water rationing, which could limit production at some of the largest fabs operated by Taiwan Semiconductor Manufacturing Co. (TSMC).[6]

Accidents: In March 2021, a fire burned through 600 square meters of a 300mm wafer fab in Japan owned by Renesas, a key supplier of automotive chips. Company president Hidetoshi Shibata has warned of a "very big" impact on global chip supply.[7]

Trade tensions: Citing national security concerns, the U.S. restricted exports of some semiconductor manufacturing equipment to China in 2020.

[5] Source: Willy Shih, "Severe Winter Weather In Texas Will Impact Many Supply Chains Beyond Chips," *Forbes*, February 19, 2021
[6] Source: Raymond Zhong and Amy Chang Chien, "Drought in Taiwan Pits Chip Makers Against Farmers," *New York Times*, April 8, 2021
[7] Source: Tim Kelly, "Renesas says to restore full capacity at fire-damaged chip plant by end-May," *Reuters*, April 19, 2021

Why automotive has been hit so hard

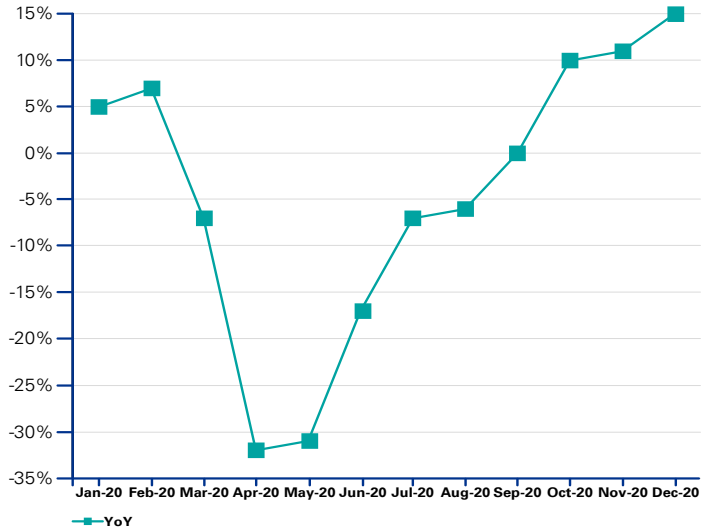
When the pandemic hit, automakers were forced to halt production. Then, as the global economy faltered and demand for cars stalled, most automakers canceled chip orders—plunging automotive semiconductor demand by 30 percent from year-earlier levels (Exhibit 1). Based on their experience with previous supply imbalances, other semiconductor customers, including automakers such as Toyota, kept to their long-term delivery schedules. In other industries, such as PCs and servers, chip customers increased orders to meet rising demand caused by the stay-home mandates, which accelerated semiconductor sales.

When auto sales began to rebound in the second half of 2020, supplies of automotive chips quickly began running low. But by the time automakers were ready to take their canceled shipments, the semiconductor capacity had been allocated to other customers—and automakers found themselves at the end of the line. By year-end, the lack of chips meant carmakers could not meet rising production targets. Ford said in February 2021 that it could lose 10 to 20 percent of its planned first-quarter production because it could not get enough semiconductors, and it predicted it could lose 50 percent of its planned second-quarter production and 10 percent of planned production for the second half.[8]

General Motors, which halted production at six plants due to parts shortages, said in May 2021 that semiconductor-related losses will cost it as much as $2 billion in profit in 2021.[9] In its first-quarter earnings call in May 2021, Stellantis disclosed that it lost 11 percent of planned production in the first quarter and, like Ford, expects things to get worse in the second quarter, before shortages begin to ease in the second half of the year.[10]

The semiconductor crunch, which is now expected to last through year-end 2021 and well into 2022,[11] highlights a larger supply-chain problem for many automakers. Despite the critical role semiconductors play and will continue to play in their products (see "Rising need makes automotive more vulnerable to supply shocks"), automakers do not yet have the kind of understanding

Exhibit 1. Demand for automotive semiconductors plunged by 30 percent in spring 2020



Source: *World Semiconductor Trade Statistics, Bluebook Sales Data, 2020–2019*

and visibility of the global semiconductor supply chain or the relationships with chipmakers that they need in order to ensure sufficient supplies in hard times. Since they usually do not deal directly with semiconductor suppliers or foundries, many automakers have no direct financial investment in capacity and do not make any purchase commitments to semiconductor firms.

Japanese and Korean automakers that have direct connections with semiconductor suppliers have generally fared better during the shortage.[12] And since the crunch began, other automakers have started to build direct relationships with their chip suppliers. Volkswagen, for example, says it is considering sourcing chips directly from manufacturers, rather than through its Tier 1 suppliers.[13] But the auto industry has a long way to go to build the kind of relationships that other major semiconductor customers have with their suppliers—and position themselves for future shortages.

[8] Source: Ford Motor Company, first quarter 2021 earnings call, April 28, 2021

[9] Source: Jeanne Whalen, "General Motors and Ford halt production at more factories as global semiconductor shortage worsens," *Washington Post*, April 8, 2021; GM first-quarter 2021 earnings call, May 5, 2021

[10] Source: Breana Noble, "Stellantis revenues up 14% to $44.4B in first three months of the year, despite semiconductor shortage" *The Detroit News*, May 5, 2021

[11] Source: Jeanne Whalen, "Chip shortage will last beyond 2022 as demand far outstrips supply, Intel chief says," *Washington Post*, April 13, 2021

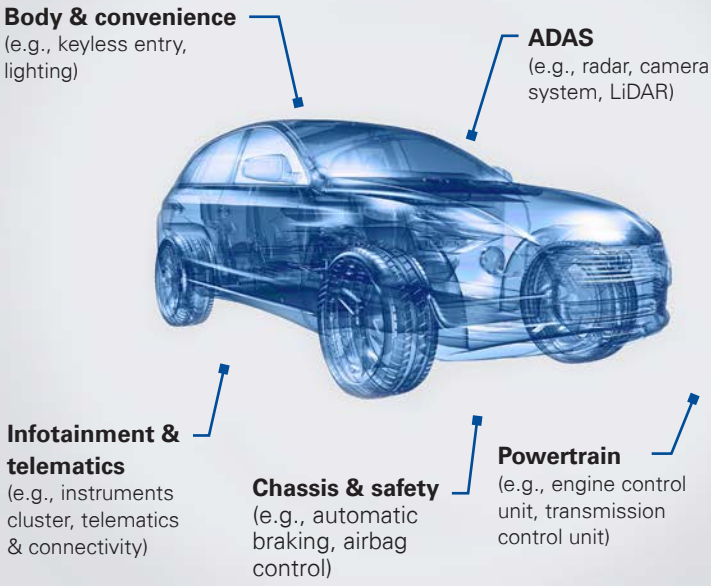
[12] Source: River Davis, "How Toyota supply chain helped it weather the chip shortage", *Bloomberg*, April 7, 2021

[13] Source: Jan Schwartz and Christoph Steitz, "Volkswagen looks at direct buying to secure scarce chips," *Reuters*, February 2, 2021

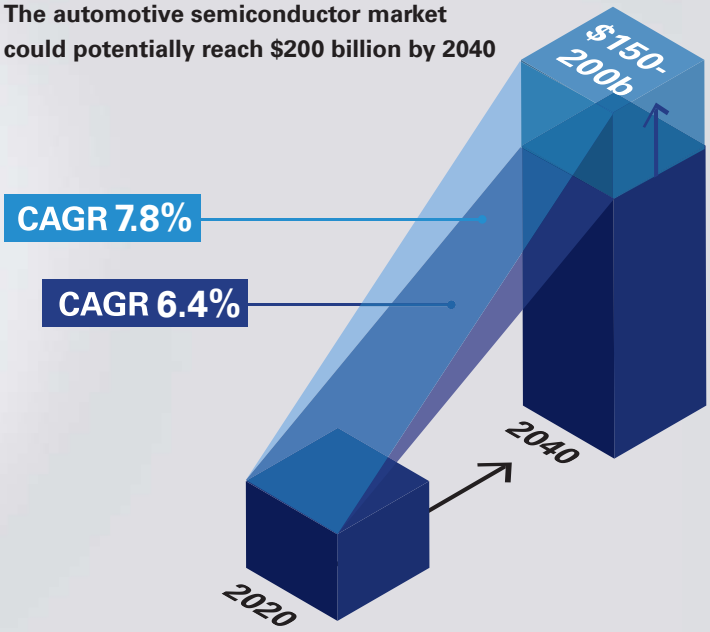
Rising need makes automotive more vulnerable to supply shocks

As we detailed in *Automotive semiconductors: the new ICE age* last year,[14] semiconductors are used in everything from engine controls to entertainment and sound systems. New features like advanced driver-assistance systems (ADAS) depend on an array of sensors and microprocessors—and the chip count will rise even more when electrification and full autonomy arrive. We estimate that a Level 4 or Level 5 autonomous car might require up to 10 times the electronics of a current car with no automation.

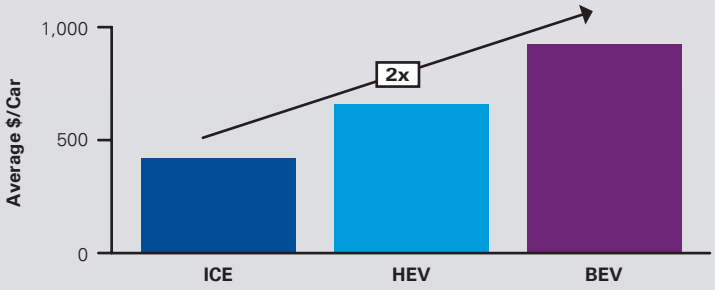
Automotive Semiconductors, the New ICE Age



The automotive semiconductor market could potentially reach $200 billion by 2040

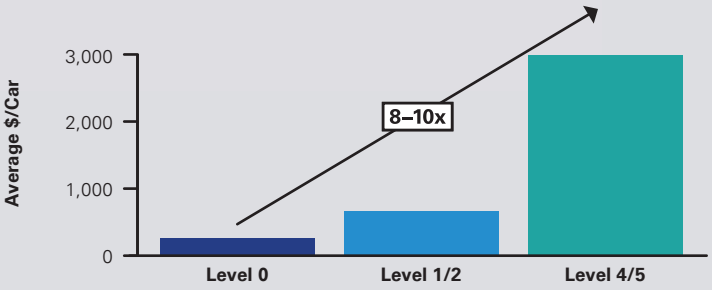


Average fully electric cars will have twice as much semiconductor content as ICE cars



Source: KPMG Automotive Semiconductor Market Model, 2019

Average Level 4/5 (autonomy) cars today have 8–10 times the semiconductor content as Level 0 cars



Source: KPMG Automotive Semiconductor Market Model, 2019

Chip purchases by automakers have been rising rapidly over the past decade, and the market could potentially reach $200 billion by 2040. Despite this growth, however, automotive customers still account for less than 10 percent of overall semiconductor sales today. Still, as they design in more sophisticated chips, they will be competing increasingly for supply with consumer electronics and telecom giants that buy much higher volumes.

Even for the simplest parts that automakers need—sensors to monitor tire pressure, for example—automakers will face rising competition. These devices are usually based on less advanced technologies where capacity is not being added. Yet demand is increasing for these simple parts in IoT applications such as monitoring industrial equipment or home appliances. Unlike automakers, these customers are used to providing chipmakers with long-term forecasts and sometimes contribute financially to secure capacity. And they do not require the strict testing and certification that automakers need.

[14] Source: Automotive Semiconductors: The new ICE age, KPMG (U.S.) 2020.

Other industries are not immune

The current semiconductor shortage is not only affecting automakers, but it has now also spilled into several other industries. Consumer electronics manufacturers are warning the shortage could also affect the availability of smartphones, tablets, and game consoles. Internet companies are reporting delays in getting network switches and other gear.[15]

IT Sector

- Demand for computing equipment used by business and government rose in 2020, after dipping in 2019, thanks in part to the shift to remote work.[16]
- "There's a serious imbalance in supply and demand of chips in the IT sector globally," Koh Dong-jin, co-chief executive who heads Samsung's mobile business unit, said at a shareholder meeting in March 2021.[17]

Consumer

- Both Qualcomm and Samsung are reported to be struggling to meet demand for processor chips used in smartphones.[18]
- Companies like Apple, AMD, Sony, and Qualcomm have raised concerns over device shortages, including parts for iPhones and consoles like the PlayStation 5.
- Broadcom cited supply-chain challenges in its latest quarterly earnings call in March.[19]
- In its April 28 earnings call, Apple warned that supply constraints could reduce June-quarter revenue by $3 billion to $4 billion.[20]

Network/Telecommunication

- There is no sign of semiconductor demand slowing in areas like telecom. "I think that it will take a couple years simply because the demand is continuing to increase," Cisco chairman and CEO Chuck Robbins told Yahoo Finance Live. "I think we see a few quarters of real stress in the supply chain, and we think that it will be more predictable. It may not be where we want it to be, but it will be more predictable."[21]

[15] Source: "The Global Chip Shortage: Worst Hit Industries," CFO, April 15, 2021
[16] Source: Louis Columbus, "COVID-19's Impact On Tech Spending This Year," *Forbes*, March 20, 2020
[17] Source: Edward White and Kathrin Hille, "Samsung warns of deepening semiconductor shortage," *Financial Times*, March 17, 2021
[18] Source: Stephen Nellis, Josh Horwitz, Hyunjoo Jin, "Qualcomm struggles to meet chip demand as shortage spreads to phones: sources," *Reuters*, March 11, 2021
[19] Source: Ian King, "Broadcom CEO Says Demand Is 'Real' as Chip Orders Flood In," *Bloomberg*, March 4, 2021
[20] Source: Dan Gallagher, "Apple Couldn't Dodge the Chip Pain Forever," *The Wall Street Journal*, April 28, 2021.
[21] Source: Brian Sozzi, "Semiconductor shortage could go on for 'a couple of years': Cisco CEO," *Yahoo Finance*, March 30, 2021

No simple solutions

2

This is not the first shortage the semiconductor industry has experienced; nor will it be the last. Due to the amount of money, time and resources it takes to build new capacity, the industry doesn't build extra or redundant capacity. According to semiconductor executives and analysts we have spoken with, the industry is currently running at over 90 percent capacity utilization and at 100 percent for critical parts. If unused capacity exists, it is not in foundries that can handle surge demand or in lines needed for automotive.

In the near term, there are not many options. Customers can draw down buffer inventory (assuming there is any left) and chipmakers can expedite shipments to automakers with low inventories. Semiconductor manufacturers can switch capacity allocated to new product qualification but this can impact longer-term growth strategies. And even if an automaker can solve the supply problem for some chips, without a coordinated effort that ensures every component is delivered on time, cars cannot be completed.

The bottom line: semiconductor shortages will not ease until new capacity is added. Chipmakers have announced plans to accelerate investment in new wafer fab capacity, and political leaders are looking for ways to end the shortages and limit the economic damage. But no matter how much the chipmakers want to help customers—or how hard policy makers push—there are no quick fixes.

The staggering cost of adding capacity

A new wafer manufacturing facility, known as a wafer fab, can take up to two years to build. At the same time, the cost of new equipment is rising as wafer sizes increase and feature sizes decrease. For example, a new extreme ultraviolet lithography (EUV) tool for the most advanced fabs costs more than $100 million.[22]

Because of the high up-front costs to build fabs, the semiconductor industry is careful not to build excess capacity. However, in response to the shortage, TSMC, the world's largest foundry, has committed to accelerating capacity expansion. In March, it announced plans to spend as much as $28 billion on capital investments in 2021 alone, and a total of $100 billion over the next three years.[23] Intel announced plans to invest $20 billion in new capacity that it would use for its own needs and to establish a foundry business to build chips for other semiconductor companies.[24]

The shortage highlights how the rising cost of fab capacity has shaped the chip market. First, as the cost of fabs continues to rise, fewer players can afford to build manufacturing capacity and, as a result, chip companies are outsourcing more production to foundries. In 2020, the top five wafer manufacturers accounted for an estimated 54 percent of global semiconductor capacity, up from 36 percent in 2009.[25] And, as manufacturing has become more concentrated, buyers have less opportunity to diversify supply.

[22] Source: Dan Gallagher, "Chip Makers Push Spending to the Extreme," *Wall Street Journal*, November 13, 2019
[23] Source: Debby Wu, "TSMC to Spend $100 Billion Over Three Years to Grow Capacity," *Bloomberg*, March 31, 2021
[24] Source: Don Clark, "Intel to Spend $20 Billion on 2 New Chip Factories in Arizona," *The New York Times*, March 23, 2021
[25] Source: 2020 Semiconductor Industry Association Factbook

A renewed focus by political leaders

Even before the pandemic disrupted the semiconductor supply chain, there was growing political concern in the U.S. and Europe about relying so heavily on a small group of Asian suppliers, especially for defense applications and communication networks. In our 16th annual semiconductor industry survey, the top threat cited by industry leaders was the impact of trade tensions and nationalism, followed by supply-chain disruption (Exhibit 2).[26] Both concerns have proved valid.

Now, with their automotive industries suffering from the chip shortage, U.S. and European political leaders are again calling for "reshoring" chip production as a matter of national and economic security. President Joe Biden, for example, included $50 billion in his proposed infrastructure legislation to help the chip industry build more domestic plants.[27] In April 2021, he convened a virtual summit at the White House with 19 executives from the semiconductor, tech, auto, and consumer electronics industries to discuss ways to build more chip production capacity in the U.S. and help avoid future shortages.

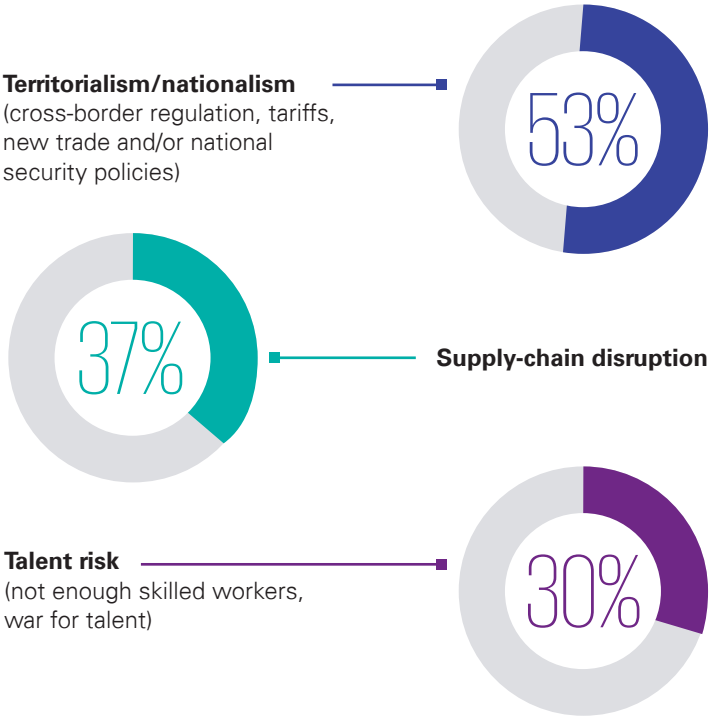
Chip manufacturing had already been caught up in the U.S.-China trade war. In May 2020, for example, the Trump Administration imposed export controls on semiconductor manufacturing equipment to China. Shortly thereafter, TSMC announced that it will build a 20,000-wafer-a-month plant in Arizona rather than in its home base of Taiwan.[28]

After the Biden industry summit, Intel CEO Pat Gelsinger announced that his company was in talks with automotive semiconductor suppliers to use existing Intel capacity to make their chips, with the goal of increasing supply in six to nine months.[29]

In Europe, where the car industry is a mainstay of the economy, the auto industry and other semiconductor users are pushing for new chip capacity within the European Union. In March 2021, the EU announced it will subsidize the building of more chip fabs, doubling capacity to 20 percent of the world's production, with the money coming from the $800 billion fund set aside for helping countries recover from COVID-19.[30]

Even if the Biden initiative succeeds, it may be of limited help to automakers in the near term. Any new fabs that result from the initiative will likely focus on producing the most advanced newer technologies—and not the relatively low-tech chips that automakers can't get today.

Exhibit 2. Supply-chain disruption is a key concern



Source: KPMG Global semiconductor industry outlook 2021.

[26] Source: KPMG Global semiconductor industry outlook 2021
[27] Source: Alex Leary and Paul Ziobro, "Biden Calls for $50 Billion to Boost U.S. Chip Industry," *Wall Street Journal*, March 31, 2021
[28] Source: Alan Patterson, "Politics Haunts TSMC's US Fab Plan," *EETimes*, May 19, 2020
[29] Source: Stephen Nellis, "Intel in talks to produce chisp for automakers within six to nine months–CEO," *Reuters*, April 12, 2021
[30] Source: James Vincent, "EU aims to double chip manufacturing amid growing fears about 'digital sovereignty,' " *TheVerge*, March 10, 2011

U.S.

- **Biden Administration initiative:** "This is about making sure the United States can meet every challenge we face in this new era—pandemics, but also in defense, cybersecurity, climate change, and so much more," President Biden said. "And the best way to do that is by protecting and sharpening America's competitive edge by investing here at home."[31]
- **Intel** announced its new manufacturing strategy, which includes both investing $20 billion to build two new fabs in Arizona and setting up Intel Foundry Services to offer to build chips for other semiconductor suppliers for the first time.[32]

Europe

- **The European Union,** citing the need for "digital sovereignty" has set a goal to double chip manufacturing. The EU also wants all households to have 5G access and gigabit internet connectivity by 2030; for "all key public services" to be available online in every member state; and for the bloc to have its first quantum computer. Funding for these projects will come from the EU's €672.5 billion ($800 billion) coronavirus response fund, 20 percent of which is earmarked for tech investments.[33]

Asia

- **TSMC,** the biggest foundry in the world, will spend up to $100 billion over the next three years to expand capacity.[34]
- **China:** China's Ministry of Industry and Information Technology urged domestic chipmakers to prioritize supply to the Chinese auto industry while also expanding their production.[35] Chinese companies are blaming U.S. trade sanctions, which they say has led to worldwide stockpiling.[36]

Global

- **GlobalFoundries,** a U.S.-based company owned by Abu Dhabi's Mubadala fund and the second-largest foundry behind TSMC, has committed at least $1.4 billion to build fabs in Germany, Singapore, and the U.S., producing chips from 12 to 90 nanometers.[37]
- **Semi.org:** According to Semi, an international industry trade association, manufacturers are adding record capacity: "The global semiconductor industry is on track to register a rare three consecutive years of record highs in fab equipment spending with a 16 percent increase in 2020 followed by forecast gains of 15.5 percent this year and 12 percent in 2022."[38]

[31] Source: Remarks by President Biden at Signing of an Executive Order on Supply Chains, whitehouse.gov, February 24, 2021
[32] Source: Don Clark, "Intel to Spend $20 Billion on 2 New Chip Factories in Arizona," *The New York Times*, March 23, 2021
[33] Source: James Vincent, "EU aims to double chip manufacturing amid growing fears about 'digital sovereignty,' " *TheVerge*, March 10, 2011
[34] Source: Debbie Wu, "TSMC to Spend $100 Billion Over Three Years to Grow Capacity," *Bloomberg*, April 1, 2021
[35] Source: "China urges chipmakers to allocate more capacity to China auto market," *Reuters*, February 9, 2021
[36] Source: Cheng Ting-fang and Lauly Li, "Huawei blames US for global chip supply crunch," *Nikkei Asia*, April 12, 2021
[37] Source: Alexandra Alper, Supantha Mukherjee, "GlobalFoundries pours $1.4 billion into fab expansion amid chip demand boom", *Reuters*, March 3, 2021
[38] Source: Global Fab Equipment Spending Poised to Log Three Straight Years of Record Highs, Semi Reports, Semi.org, March 16, 2021

Not the last time

The semiconductor industry has gone through cycles of supply/demand imbalance before. And they have always been resolved—eventually. Given the unprecedented level of demand, current capacity utilization, and the time it takes to add capacity, the current shortage is expected to last at least through the end of 2021 and could continue well into 2022.

This chip shortage is driven largely by strong demand growth. We believe that this demand growth will continue, driven by new uses in automotive and other sectors (Exhibit 3). In the coming years, billions of communications and memory chips will be needed for 5G handsets and network nodes. There are already more than 5 billion mobile phone subscribers—half of them using smartphones.[39] By 2030 there could be more than 24 billion IoT connected devices.[40] And demand for semiconductors used in cloud computing and media streaming is expected to continue growing by more than 9 percent per year.[41]

Exhibit 3. Where semiconductor demand is growing

	Top Product Categories for Growth		
Products and Applications	**Sensors / MEMS**	**Analog**	**Microprocessors**
Internet of things	●	◔	◔
5G	◑	◔	◔
Automotive	●	●	●
Artificial intelligence	◑	◕	●
Consumer electronics	◔	◑	●
Data centers / Storage	◔	◕	●

Source: *KPMG Global semiconductor industry outlook 2021*

[39] Source: Smartphone Ownership Is Growing Rapidly Around the World, but Not Always Equally, Pew Research, February 2019.
[40] Source: Global IoT market to grow to 24.1 billion devices in 2030, generating $1.5 trillion annual revenue, *Transforma Insights*, May 19, 2020
[41] Source: Global Data Center Chip Market, Allied Market Research, April 2019

How automakers can do better the next time

3

The automotive industry needs to change how it does business with the semiconductor industry if it hopes to avoid future supply problems. First, the industry needs to replace just-in-time thinking with longer-term supply planning for critical semiconductor components. Automakers and parts suppliers also need to collaborate more closely with semiconductor manufacturers at every point in the design and production process. And, like other major chip customers, they may need to reserve forward capacity or even help finance chip manufacturing plants.

The auto industry's reliance on semiconductor suppliers will only grow. So automotive companies need to adapt fast. Among the major changes that could put automakers in a better competitive position are:

Closer collaboration: Instead of relying on Tier 1 suppliers or on indirect supply-chain management, automakers can collaborate directly with semiconductor manufacturers. Collaboration can take many forms: formal partnerships, periodic strategic roadmap and forecasting sessions, and direct sourcing, for example. Automakers need to understand the dynamics of the semiconductor supply chain and how they differ from other parts of the automotive supply chain. For example, standard supply contracts impose steep penalties for missed deliveries. But this has not helped during the chip shortage: "Legal agreements do not build wafers," one semiconductor executive told us.

Consider making direct investments in chip-making capacity: Automakers can take an active role in ensuring that there is capacity for the chips they need, by reserving capacity, guaranteeing demand, or by making direct investments to increase capacity. Some foundries are already selling capacity instead of just wafer products. These arrangements allow customers to "own" reserved capacity for critical components without having to invest in the fab itself.

Use data-driven supply-chain decision making: As supply chains become more complex, planning by spreadsheet is no longer adequate. "Cognitive planning" can be used to configure and integrate supply-chain activities using machine learning and artificial intelligence.

Overhaul the process for selecting, designing in, and sourcing: In the longer term, automakers can avoid supply problems by reducing reliance on custom parts—using standard parts that can be modified or updated via software, for example. Selecting hardware that works with open-source software can help reduce costs and guarantee access to multiple suppliers. This approach is being used by operators of 5G mobile networks to avoid expensive proprietary hardware.

Address organizational barriers to optimize the semiconductor supply chain: Consider organizational changes to streamline and optimize the way the semiconductor supply chain is managed. A possible change is creating dedicated centralized teams to oversee electronics and semiconductors supply chains.

These are a few of the ways in which automakers can help minimize the impact of periodic supply shortages. Some of these steps are not easy and involve risks. Collaborating directly with chipmakers—and going around Tier 1 parts suppliers—will put stress on some traditional relationships, for example.

But this is about more than minimizing the damage from chip shortages. It is about competing in the new automotive business, where electronics are as important as pistons or castings. The new competitors—including Tesla—understand this and are investing in chip design and managing the semiconductor supply chain as a consumer electronics company would.[44] Unless other automakers adapt, they risk losing competitive ground.

[44] Source: Place your billion-dollar bets wisely: Powertrain strategies for the post-ICE automotive industry, KPMG (U.S.) 2021

How we can help

KPMG combines deep semiconductor, automotive, and industry experience with supply chain and operation services.

Semiconductor and technology industry services:

From the newest start-ups to industry giants, technology companies face unique strategic and operating challenges. The technology and semiconductor professionals at KPMG combine industry knowledge with technical experience to provide insights that help technology leaders deal with their complex business models. Our professionals go beyond today's challenges to anticipate the potential long- and short-term consequences of shifting business, financial, and technology strategies.

Supply chain and operations services:

Effective supply-chain management can accelerate corporate growth and profitability, increase operational efficiency, and offer new and differentiated value to customers. It's needed across all industries amid today's ever-changing technological, economic, and regulatory challenges.

KPMG understands the complexities of designing and managing supply chains, and our strategic business approach helps create and sustain bottom-line value across the extended supply chain—from suppliers to customers.

Our advisors have assisted clients to:

1. Expand their geographic footprints, from both a market penetration and a cost-efficiency perspective
2. Harness the flexibility of outsourced manufacturing and logistics operations
3. Become more demand-driven in their supply-chain planning and execution processes
4. Achieve greater visibility and transparency in their decision making
5. Leverage cognitive planning to configure and integrate supply-chain solutions through artificial intelligence and machine-learning techniques
6. Reduce revenue at risk from potential supply-chain disruption
7. Optimize working capital and operating costs with new tools and better processes.

We can help you execute your customer growth strategies with a full range of process, technology, and people change initiatives essential to building durable competitive advantages.

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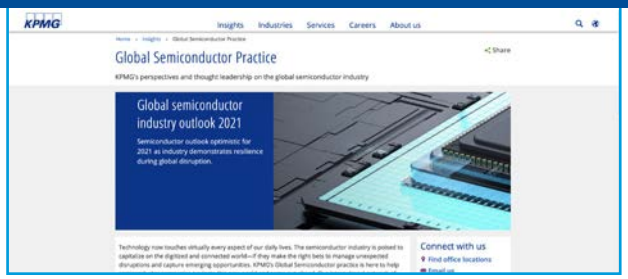

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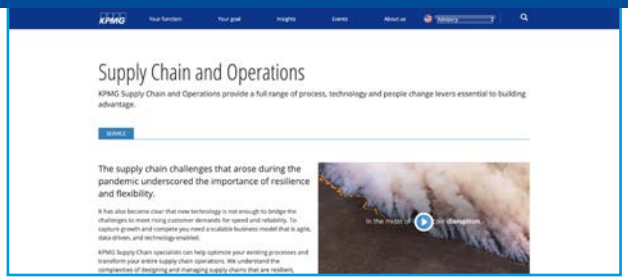

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Scott Jones is a principal in the Technology, Media & Telecommunications group in the KPMG Strategy practice and has 20 years of experience working with semiconductor and other high-tech companies. He began his career with Intel's Enterprise Products Group and has worked as a semiconductor analyst for JP Morgan. Scott has authored a number of publications on R&D effectiveness, autonomous driving systems, automotive semiconductors, advanced manufacturing processes, and zero-based budgeting.

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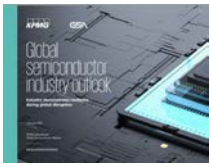

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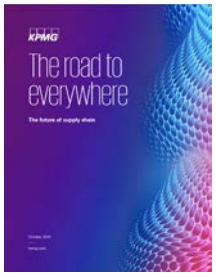

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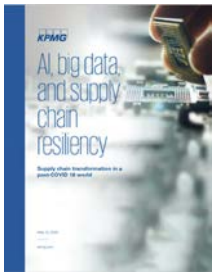

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