Before the Wireless Communications Bureau, Federal Communications Commission

DA 21-550
WT Docket No. 21-195

Impact of the Global Semiconductor Shortage on the U.S. Communications Sector

Submitted June 10, 2021

Written Comments from the Semiconductor Industry Association

The Semiconductor Industry Association (SIA)[1] welcomes the opportunity to provide written comments in the matter of WT Docket No. 21-195 on the impact of the global semiconductor shortage on the U.S. communications sector. The SIA agrees with the FCC that ensuring reliable access to semiconductors is important for communications capabilities that are key to the nation's national and economic security. Semiconductors are critical for U.S. economic growth, jobs, technology leadership, and U.S. national security.

SIA's main points in this submission are the following:

[1]The Semiconductor Industry Association (SIA) is the voice of the semiconductor industry, one of America's top export industries and a key driver of America's economic strength, national security, and global competitiveness. Semiconductors – the tiny chips that enable modern technologies – power incredible products and services that have transformed our lives and our economy. The semiconductor industry directly employs over a quarter of a million workers in the United States, and U.S. semiconductor company sales totaled $208 billion in 2020. SIA represents 98% of the U.S. semiconductor industry by revenue and nearly two-thirds of non-U.S. chip firms. Through this coalition, SIA seeks to strengthen leadership of semiconductor manufacturing, design, and research by working with Congress, the Administration, and key industry stakeholders around the world to encourage policies that fuel innovation, propel business, and drive international competition. Learn more at www.semiconductors.org.

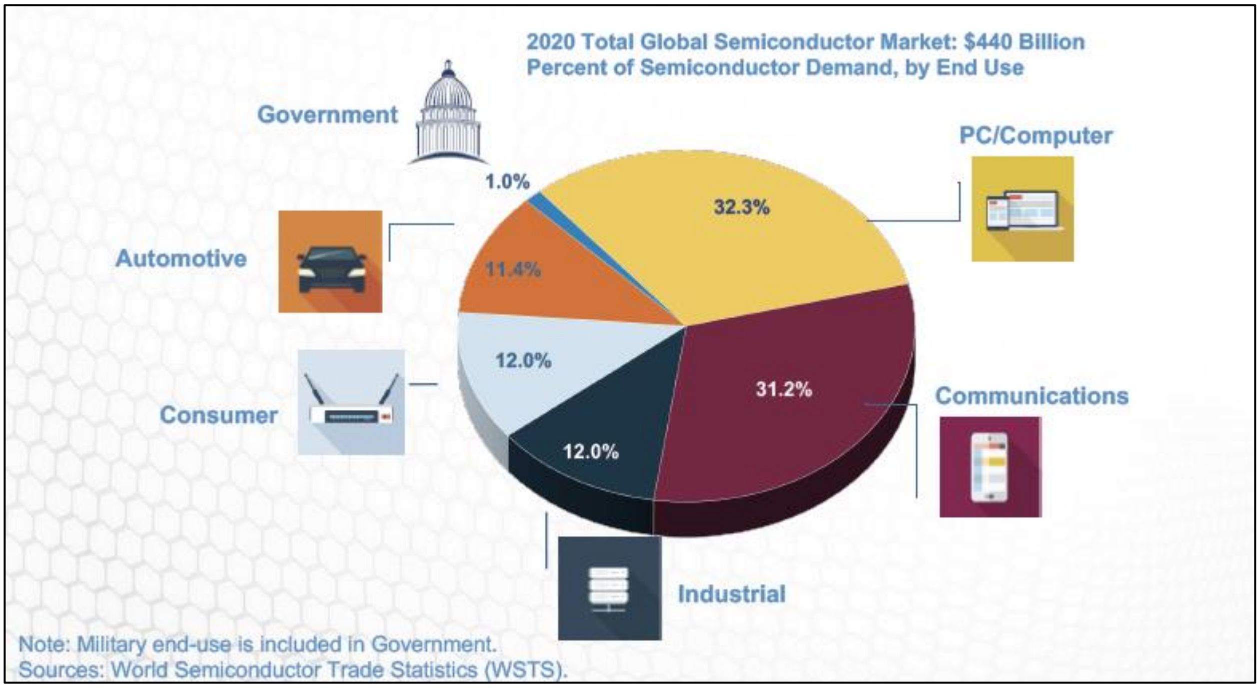
I. The current supply-demand disruption in the semiconductor market was caused by the COVID-19 pandemic that upended the global economy and disrupted worldwide supply chains, including the semiconductor industry supply chain, causing the current short-term market uncertainty.
II. The current supply-demand market disruption is a short-term phenomenon that the global industry is working hard to resolve.
III. The global semiconductor market is susceptible to such supply-demand disruption due to vulnerabilities in the global semiconductor supply chain; and
IV. The U.S. should adopt smart policies to mitigate future market vulnerabilities and enhance the U.S. economy, national security, and supply chain resilience.

(I) The current supply-demand disruption in the semiconductor market was caused by the COVID-19 pandemic that upended the global economy and disrupted worldwide supply chains, including the semiconductor industry supply chain, causing the current short-term market uncertainty.

Semiconductors are the brains of modern electronics, enabling highly advanced technologies in communications, as well as in many other applications such as computing, healthcare, and transportation. Global semiconductor sales increased 6.8 percent in 2020, demonstrating an overall growing demand for chips across a range of end markets despite major market disruptions caused by the COVID-19 pandemic. According to the World Semiconductor Trade Statistics (WSTS) program, global semiconductor sales are forecasted to increase by 19.7 percent year-over-year in 2021.

The global communications end-use market for semiconductors comprises a large and important market for the semiconductor industry both globally and in the United States. The chart below shows the global share of the semiconductor market in 2020 by major end-use market. Communications comprised 31.2 percent of the total end-use market for semiconductors which translated into $137.6 billion of the total $440.4 billion market, second only to the computer end-use market. When it came to the Americas market, of which the U.S. is the vast majority, the communications end-use market share was also 31.2 percent in 2020, which translated to total sales of $29.7 billion. The only other larger single country market for communications end-use semiconductors in 2020 was the China market at $59.6 billion.[2]

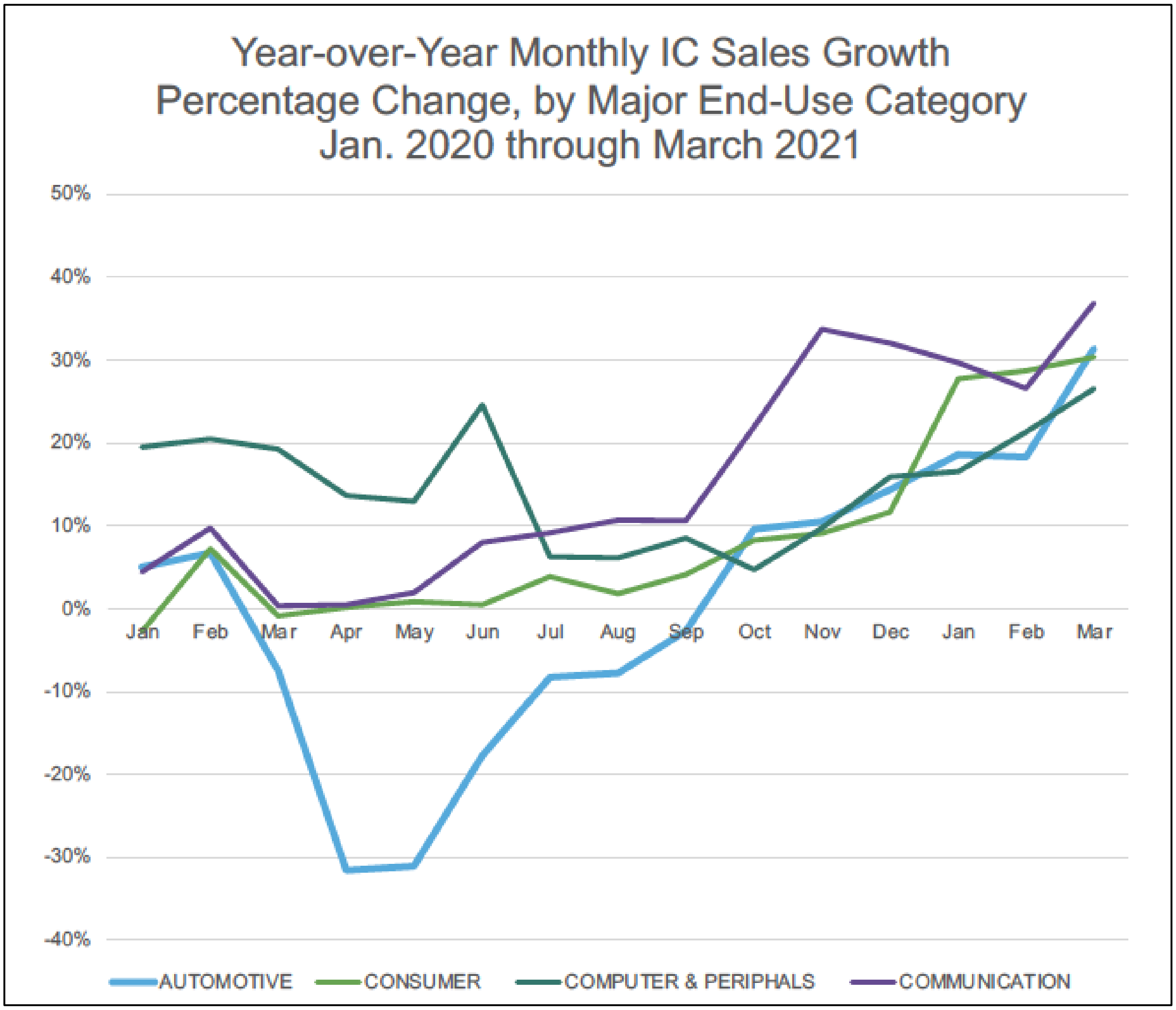
[2] All semiconductor end-use market data from the World Semiconductor Trade Statistics (WSTS) 2020 Annual End-Use Survey. Communications end-use semiconductors are defined as those used in the following applications: wireless handset (e.g., mobile phone, cellular phone, digital cordless phone, smart phone, tablet, etc.); networking & remote access (e.g., transmission, switching (including PBX), relay, hub, router, modem, etc.); and other communications (e.g., mobile base station, broadcasting equipment, corded phone, analog cordless phone, FAX, pager, transceiver, etc.).



Through the second half of 2020 and into 2021, a global shortage of certain semiconductors has impacted parts of the semiconductor market, particularly the automotive market. The shortage has largely been the result of substantial shifts in demand due to the COVID-19 pandemic. The semiconductor industry is working diligently to ramp up production to meet renewed demand.

The events leading to the current chip shortage began during the second quarter of 2020. As the COVID-19 spread globally, various end markets were impacted differently. For example, chipmakers saw surging and unexpected demand for semiconductors used in end markets to enable remote healthcare, work-at-home, and virtual learning, which were needed during the pandemic. This unexpected increase in demand occurred in the communications end-use market. On the other hand, as the pandemic caused an overall decrease in economic activity, automakers reduced production and cancelled or decreased chip purchases.

The table below illustrates this market evolution with auto sales drastically decreasing and then rebounding during the middle of 2020, while monthly sales for all other end-uses including communications held steady and later grew on a year-over-year basis. As Q1 2021 ended, monthly sales for all major end-use categories were running 27 to 37 percent above the levels of a year ago. The semiconductor industry has worked to ramp up production to meet the steep jump in demand across the board, and while market balance will be achieved, restoring it takes time.



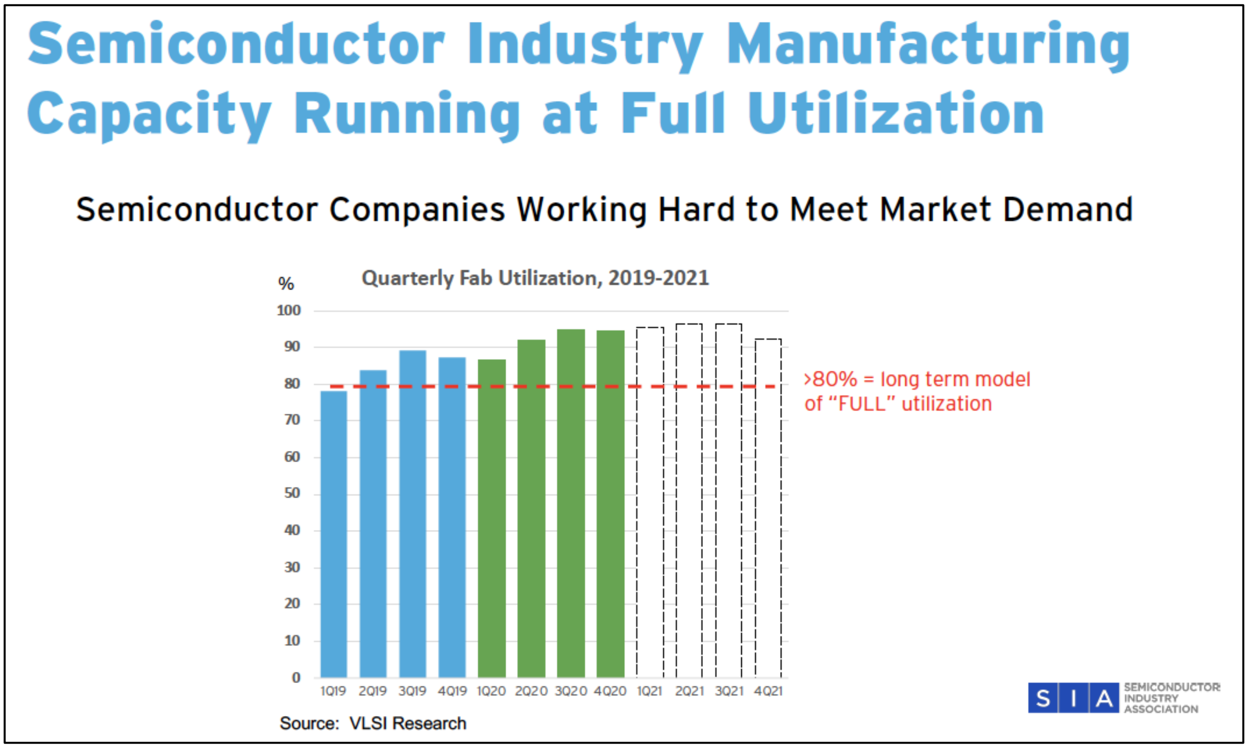
Source: World Semiconductor Trade Statistics (WSTS).

(II) The current supply-demand disruption is a short-term phenomenon that the global industry is working hard to resolve.

Semiconductor manufacturing is not suited to rapid and large shifts in demand, because capacity is finite, and it takes time to ramp up semiconductor production. New semiconductor fabrication facilities ("fabs") require years of planning, design, construction, and preparation for commercial production. Once facilities are operating, the process of making a semiconductor is one of the most complex manufacturing processes. Lead times of up to 26 weeks are the norm in the industry to produce a finished chip. Most industry analysts believe the current short-term supply shortage will ease in the coming months as supply adjusts to meet demand, but it will take time.

To meet increased demand during the current global chip shortage, the semiconductor industry is substantially increasing its fab capacity utilization, a term that refers to the percentage of total available manufacturing capacity that is being used at any given time.

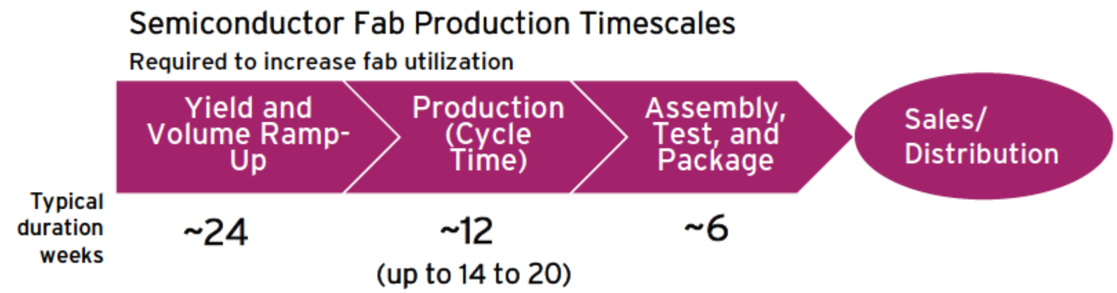
When market demand runs high, such as in a cyclical market upturn like the one the market is in now, fabs will typically run above 80 percent capacity utilization, with some individual fabs running as high as between 90-100 percent. As the table below shows, the industry has been steadily increasing overall fab utilization over the past two years and is estimated to increase utilization even more during most of 2021 to meet demand. Higher fab utilization will increase chip output and allow the industry to fully meet the increased demand in the market.



Unfortunately, increasing semiconductor capacity utilization, and thus chip output, is not as easy as "flipping a switch", but rather it takes time, because semiconductors are incredibly complex to produce. Making a chip is one of the most – if not *the* most – capital and R&D intensive manufacturing process on earth. Chip fabrication is intricate and requires highly specialized inputs and equipment to achieve the needed precision at miniature scale. There can be up to 1,400 process steps (depending on the complexity of the process) in the overall manufacturing of just the semiconductor wafers alone. And each process step typically involves the use of a variety of highly sophisticated tools and machines. In short, making semiconductors is exceedingly hard and time-consuming.

As noted above, **manufacturing a finished chip for a customer can take up to 26 weeks.** While manufacturing a finished semiconductor wafer, known as the cycle time, takes about 12 weeks on average, advanced processes can take up to 14-20 weeks. To perfect the fabrication process of a chip to ramp-up production yields and volumes takes even much more time – around 24 weeks.

Once the fabrication process is complete, the semiconductors on the silicon wafer must then go through yet another stage of production known as back-end assembly, test, and package (ATP), before the chips are final and ready for delivery to the end customer. ATP can take an additional 6 weeks to complete. **Therefore, the typical lead time, which is from when a customer places an order to receiving the final product, can take up to a total of 26 weeks.** The table below provides some average times required in the chip fabrication process.



Ultimately, the semiconductor industry is doing all it possibly can in the short-term to increase utilization and meet increased demand across all customers. Unfortunately, the time described above to fabricate a semiconductor is a constant.

The semiconductor industry has a wealth of experience operating in a complex supply chain, which will help it successfully navigate the challenges of the current demand environment. Besides increasing utilization and ramping up yields and volume, many semiconductor firms are also creating command centers to assist with the most urgent customer requests and working closely with customers to ensure that no double- or even triple-ordering is occurring. These strategies are helping provide the quickest and most efficient delivery of product to customers during this challenging period.

Over the long-run, total global fab capacity will need to increase to meet long-term demand growth for chips that cannot be met through increased utilization alone. The global semiconductor industry is planning accordingly to meet this projected market growth in the years ahead, through record levels of investment in manufacturing and R&D.

The shortage is a reminder of the essential role semiconductors play in so many critical areas of society, including communication. This trend will only continue as demand for electronics and connectivity grows. In the long-term, as chips play an even bigger role in an ever-expanding array of products, global demand for chips will continue to rise.

(III) The global semiconductor market is susceptible to such supply-demand disruptions due to vulnerabilities in the global semiconductor supply chain

While the global structure of the semiconductor supply chain, developed over the course of the past three decades, has served the industry well, it has also created vulnerabilities. The COVID-19 global pandemic and the ensuing supply shortage has brought out into sharper relief these vulnerabilities for global supply chains generally and for the semiconductor industry supply chain specifically.

The COVID-19 pandemic has upended the global economy and disrupted worldwide supply chains, causing significant near-term market uncertainty. The rising cost of innovation for semiconductor manufacturing and design, particularly at the leading edge for memory, logic, and advanced analog, continues to pose challenges. Additionally, while the U.S. remains the global leader in semiconductor design and R&D, the lion's share of chip manufacturing now occurs in Asia. This trend is supported by broad non-market incentives and policies by foreign nations that recognize manufacturing production as the critical key to microelectronics market dominance and military success. Finally, global geopolitical instability is especially impacting trade policy, forcing the U.S. industry to consider how to remain competitive in a world of unforeseen uncertainty and policy constraints.

The U.S. semiconductor industry relies on its deep global supply chains and access to overseas markets, but there are significant risks for the United States. The global structure of the semiconductor supply chain has enabled the industry to deliver continual cost reductions and performance gains that ultimately have made possible the explosion in end user adoption of information technology and digital services**.** Semiconductors are highly complex products to design and manufacture. The need for deep technical know-how and scale has resulted in a highly specialized global value chain in which regions perform different roles according to their comparative advantages. All countries, particularly key U.S. allies, are interdependent in this integrated global value chain, relying on free trade to move materials, equipment, IP, and products around the world to the optimal location for performing each activity. However, some large foreign nations do not currently operate in an entirely free market and have significant restrictions and incentive targets for their own domestic production.

This global structure creates enormous value for consumers, businesses, and governments that use semiconductors and products enabled by semiconductors. The global value chain helps drive innovation in semiconductor technology while reducing costs. In contrast, a hypothetical alternative with parallel, fully "self-sufficient" local semiconductor supply chains in each region to meet its current levels of semiconductor consumption would require at least $1 trillion in incremental upfront investment and would result in a 35 to 65 percent overall increase in semiconductor prices, and ultimately higher cost of electronic devices for end users.[3] Clearly this hypothetical alternative to global value chains is a nonstarter for both the semiconductor industry and the world, and the global semiconductor industry will continue to rely on the global value chain for the foreseeable future. The process of researching, designing, and manufacturing semiconductors is so complex today that no one country or one company can do it alone. The U.S. has the opportunity to target and capture the next increment of semiconductor

[3] These and other findings and background information about the global semiconductor supply chain in this submission can be found in the recently-released SIA and BCG report *"Strengthening the Global Semiconductor Supply Chain in an Uncertain Era"*, April 2020.

investments to help re-balance global production capacity into the U.S. and regions with better political and environmental stability.

In the past few years, however, several factors have emerged that could put the successful continuation of this global model at risk. While geographic specialization has served the industry and its consumers well historically, it has also created potential vulnerabilities in the global value chain. For example,

1) There are more than 50 points across the value chain where one region holds more than 65% of the global market share.

2) About 75% of semiconductor manufacturing capacity, as well as many suppliers of key materials (such as silicon wafers, photoresist and other specialty chemicals and sputtering targets), is concentrated in China and East Asia, a region significantly exposed to high seismic activity, geopolitical tensions, and lack of fresh water and power.

3) 100% of the world's highly advanced (below 10 nanometers) logic semiconductor manufacturing capacity is currently located in South Korea (8%) and Taiwan (92%), due in part to healthy incentives and government support from these nations.[4]

4) More than 60% of the world's back-end semiconductor assembly, packaging and testing capacity is in China and Taiwan. The U.S. lacks any large-scale, commercial state-of-the-art advanced packaging capability, including onshore outsourced assembly test (OSAT) facilities.

5) There are single points of failure in the value chain that could be disrupted by natural disasters, infrastructure shutdowns, or geopolitical conflicts that may cause large-scale interruptions in the supply of essential chips.

6) Geopolitical tensions also may result in trade restrictions that impair access to crucial providers of essential technology, unique raw materials, tools, and products that are clustered in certain countries. Such restrictions could restrict access to important end markets, potentially resulting in a significant loss of scale and compromising the industry's ability to sustain the levels of R&D and capital intensity needed to maintain the current pace of innovation.

7) For radiation–hardened semiconductors, existing U.S. heavy ion radiation test facilities required to test these chips cannot meet current or future "single event effects" (SEE) test demand. Current heavy ion accelerators for SEE testing at U.S. universities and DOE labs have limited capacity and capability, and the supply and demand gap is expected to grow more acute over the near-term horizon. This shortage of test time at these facilities threatens to delay deployment of satellites that will deliver broadband services to underserved communities across the United States, bridging the digital divide.

Industry participants and governments should join in efforts to address these vulnerabilities and to make the value chain more resilient, while also continuing to

[4] Logic semiconductors are highly sophisticated chips that serve as the main processor for electronic products such as PCs, smart phones, etc.

facilitate worldwide access to markets, technologies, capital, and talent. The U.S. government should consider using a combination of smart policies to mitigate these vulnerabilities, including targeted investments to fill high-risk gaps in their supply chains and collaboration with allies and partners globally to strengthen supply chains. For innovation to continue to thrive, the semiconductor industry needs targeted government policies and incentives that strengthen supply chain resiliency and expand market access while balancing the needs of national security.

(IV) The U.S. should adopt smart policies to mitigate future market vulnerabilities and enhance the U.S. economy, national security, and supply chain resilience.

First, one policy area directly within the FCC's responsibilities is national spectrum management. SIA supports the Commission and other federal agencies with spectrum interests to continue their efforts to open additional bands for mobile services. Opening additional spectrum is critically important to ensuring successful and broad deployments of 5G technology, supporting greatly enhanced mobile broadband, massive IoT, and mission critical services. The U.S. semiconductor industry is hard at work playing a key role in the development and deployment of all of these new and innovative services, devices, and applications. Additional spectrum allocations will accelerate deployment across the U.S. and continue U.S. leadership in 5G and beyond.

While most of the following needed policies are outside of the scope of the FCC's direct responsibilities, the Commission should align and support these efforts within the broader government.

Any solution to mitigate future semiconductor supply shortages should be focused. Competitive government incentive programs should support domestic semiconductor research. A more diversified geographical footprint should be achieved by building additional semiconductor manufacturing capacity in the U.S. and expanding production sites and domestic sources of supply for unique and critical materials. Beyond targeted incentives, the government should seek to guarantee a level global playing field, as well as strong protection of IP rights. The government also should act to further promote global trade and international collaboration on R&D and technology standards, particularly with allied countries. In parallel, policymakers should step up efforts to address the shortage of talent that threatens to constrain the industry's ability to maintain its innovation pace through further investment in science and engineering education, as well as immigration policies that enable leading global semiconductor clusters to attract world-class talent. In addition, the government should establish a clear, stable, and targeted framework for targeted controls on semiconductors that avoids broad unilateral restrictions on technologies and vendors while establishing market incentives for more assured sources for military and critical infrastructure needs.

Such well-modulated policies would preserve the benefits of scale and specialization in today's global value chain structure. Supply-chain risk would be addressed via targeted investments to incent incremental capacity growth in the U.S., lending to domestic resiliency while addressing worldwide market needs. This would ensure the industry's ability to continue delivering improvements in semiconductor performance at costs that will make the promise of transformative technologies such as 5G, 6G, AI, IoT, and autonomous electric vehicles a reality in this decade, while providing domestic production capacity necessary for critical applications, especially in the communications space. To sustain strong growth in domestic manufacturing, market incentives are necessary for assured sources and supply chains for domestic and allied needs in, for example, high-performance computing, critical infrastructure, automotive, and 5G-6G infrastructure investments. These assurance standards should enable open and free trade while taking supply assurance and stability, IP protections, and technology concentration into consideration.

Semiconductors are a key enabling technology to many downstream industries in the U.S. economy, with many industries reliant on key semiconductor inputs to manufacture products. For example, the current chip supply shortage is bringing into bold relief how many industries in the United States are in some measure dependent on semiconductors.

Recent power outages in Texas also have illustrated the need for a resilient, stable and secure electrical grid for semiconductor manufacturing. The power outages disrupted production at several fabs, thereby exacerbating the current shortage of chips in the automotive and other sectors. Similarly, semiconductor fabrication requires the use of significant volumes of water, and sufficient supplies of water is a key requirement for stable production.

Failure to sustain or develop elements of the semiconductor supply chain in the U.S. could have catastrophic implications in terms of the ability of the United States to meet its needs for sectors of the economy that depend on these key inputs such as the communications sector. Clearly, as detailed above, there are vulnerabilities in the global semiconductor supply chain that put the U.S. at risk. Prioritizing fixing those risks in the supply chain and working to strengthen them through creating more secure capabilities domestically is critical to ensure a more stable supply of semiconductors to all end-use markets including for the communications sector. Taking these steps will also guarantee a safer and more secure U.S. This objective should be a priority for policymakers.