

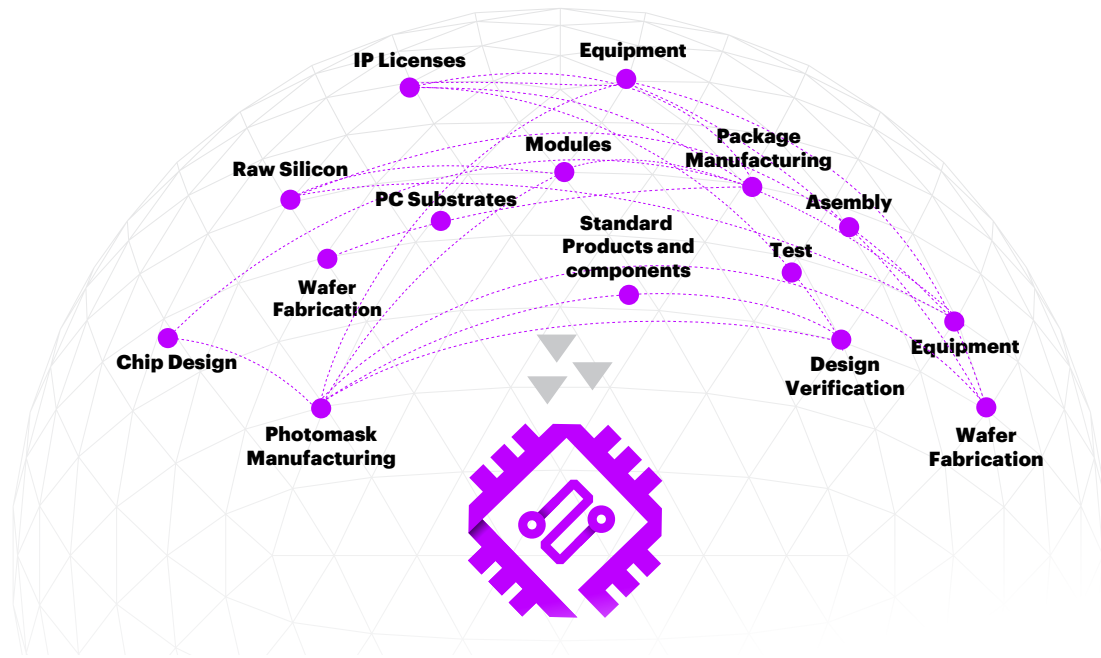
GLOBALITY AND COMPLEXITY

of the Semiconductor Ecosystem



The semiconductor industry is a truly global affair. Around the world, semiconductor chip designers use intellectual property (IP) licenses and design verification to provide designs to wafer fabricators, which use raw silicon, photomasks, and equipment to create chips for package manufacturing to assemble with printed circuit board (PCB) substrates for delivery to end customers. In fact, components for a chip could travel more than 25,000 miles by the time it finds its way into a television set, mobile phone, automobile, computer, or any of the millions of products that now rely on chips to operate (Figure 1).

Figure 1: Components for a chip could travel more than 25,000 miles before completion



The Global Semiconductor Alliance (GSA) and Accenture have teamed up to conduct a joint study on the globality and complexity of the semiconductor ecosystem to explore the interdependencies and benefits of the cross-border partnerships required to produce semiconductors, as well as to illustrate what's needed to keep this global ecosystem operating efficiently and profitably.

Industry executives can use this study to inform their company strategies, as well as to educate non-semiconductor partners, including policy makers, on the nature of their business to promote a better understanding of the important role semiconductors play in everyday life and on the globe-spanning ecosystem that's needed to produce them.

The first phase of our work incorporated two elements to inform the insight in this paper:

01

Analysis of the prevailing global trends in material procurement, supply chain, and manufacturing across the semiconductor industry

02

Interviews with C-suite executives at leading global semiconductor companies to understand and gather examples on how the global nature of the semiconductor industry impacts their strategic direction

Additional work remains in the second phase of this effort, which will include a broader survey to a larger audience.

Semiconductors have become an essential part of everyday life around the world.

A wide range of emerging technologies (including Artificial Intelligence, Automotive Electronics, Industrial Internet of Things, and Augmented / Virtual Reality) are gaining prominence across industries as more and more companies find new ways to use them to create compelling new products and to transform their businesses. And at the heart of all of these technologies are the chips that make them work. In fact, more than ever, the entire tech world depends on the semiconductor industry to provide the computing power necessary for all these technologies to fulfill their potential. That includes millions of individuals around the world.

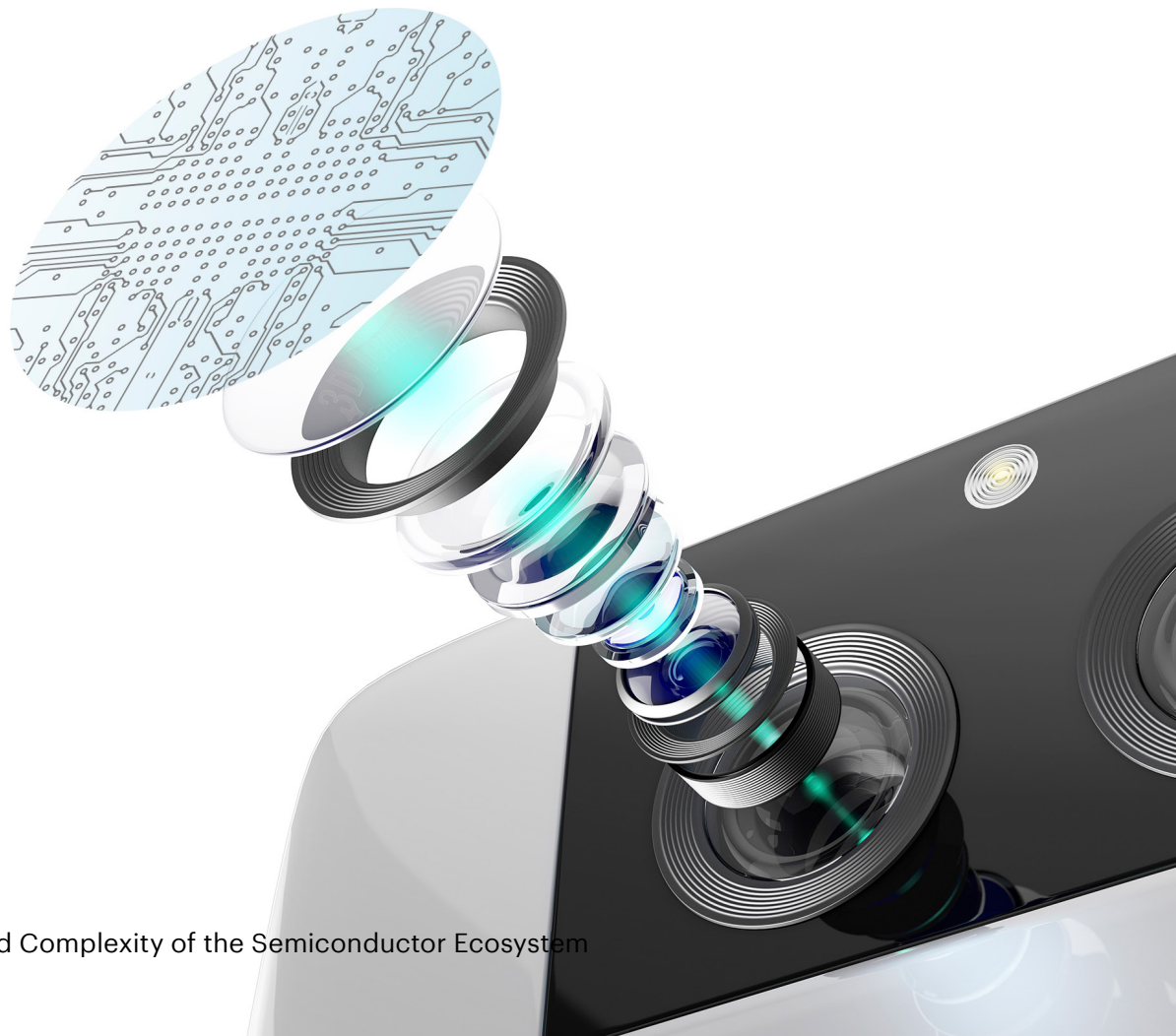


The value of the industry is driven by a diverse worldwide base—electronics demand is so broad-based,” said Rick Clemmer, chief executive officer of Netherlands-based NXP Semiconductors. “Technology is critically important to continue improving GDP.”

As technology becomes more connected, autonomous, virtual, and intelligent, semiconductors play an increasingly significant role in individuals' lives—whether they know it or not. At their essence, semiconductors serve as a translator from the physical world to the digital world, and many products and applications we now take for granted simply wouldn't be possible without them.

Take, for example, something millions of people carry with them every day and rely on to capture and share their memories: their smart phone's digital camera. Semiconductor sensors inside the camera turn the physical-world image of what the lens sees into digital data. Additional software then converts the digital data into an image file that people can post on social media, text or email to friends and loved ones, and store for posterity.

What about smart speakers powered by voice assistants? Or the connected thermostats and lights in the home? Or intelligent systems in cars that continually monitor operations to ensure the vehicle is running correctly? These and many others are also examples of technologies people rely on daily that owe their existence and utility to semiconductors.



Global collaboration is vital for success in semiconductors.

Many materials are required to make a semiconductor chip—among them, silicon, photoresist, and rare metals—and numerous sub-segment technologies are required to turn these materials into finished chips. When everything is said and done, the making of one semiconductor chip requires thousands and thousands of people, most of whom have specialized knowledge and specialized jobs, spanning myriad industries, countries, and regions.

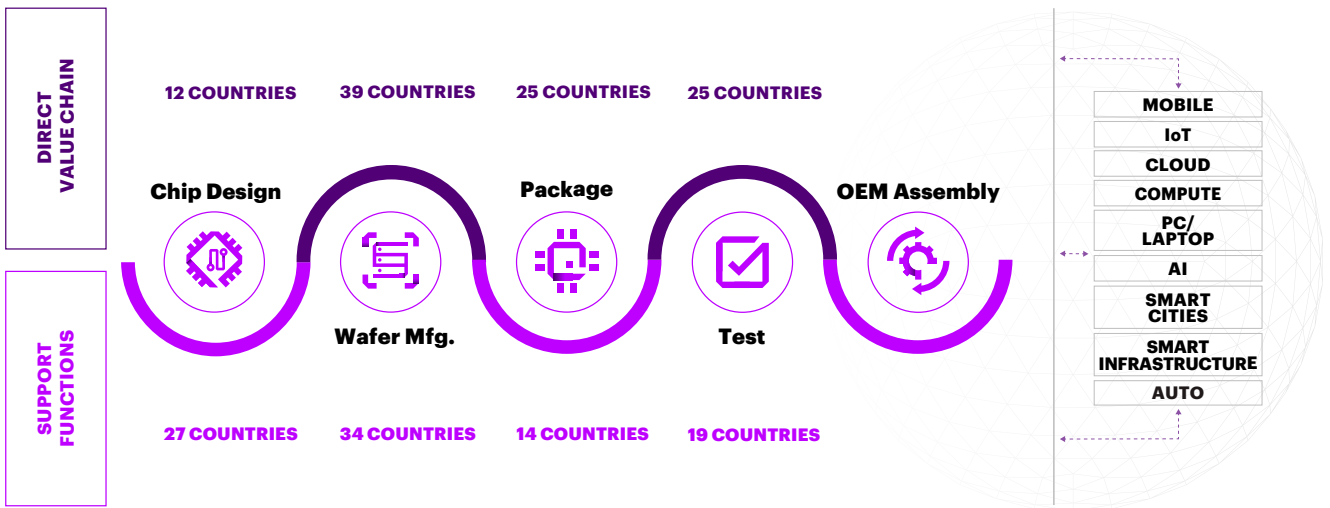
Indeed, the semiconductor industry is a global ecosystem in every sense of the word. According to our research, each segment of the semiconductor value chain has, on average, 25 countries involved in the direct supply chain and 23 countries involved in supporting market functions (Figure 2). In fact, a semiconductor product could cross international borders approximately 70 or more times before finally making it to the end customer.

Wafer fabrication is the most globally dispersed, with 39 countries directly involved in the supply chain and 34 involved in market support (including photolithography equipment, etching and cleaning tools, deposition equipment, and fabrication facility support equipment). Direct involvement in wafer design spans 12 countries, while direct product testing and package manufacturing each are done across 25 countries.



Semiconductors are relevant to everything, which is why scale is so important,” said Tien Wu, CEO of Advanced Semiconductor Engineering (ASE) Inc., headquartered in Taiwan. “A true winner must be truly global.”

Figure 2: The total number of countries participating in semiconductor manufacturing is significant



Global scale has many benefits.

The global expansion of the semiconductor industry over the past two decades is not the result of chance. Rather, the executives we interviewed indicated the semiconductor industry has actively pursued global scale because it benefits not only individual companies, but the industry as a whole—in several important ways.

IT RESULTS IN BETTER PRODUCTS.

In an industry that's the primary driver of technology innovation, sourcing that innovation globally is critical. The ability to take advantage of the best talent, experience, and perspectives—regardless of where they are in the world—enables semiconductor companies to continue generating the advancements that fuel this industry and are increasingly important to the lives of people everywhere.

As Clemmer noted, "Diversity – whether related to country, gender, or thought – is important for any company to ultimately be successful."

IT FILLS CRITICAL BUSINESS NEEDS THAT CAN'T BE MET LOCALLY.

Because the semiconductor industry's requirements are highly technical and specific, the industry's players can't succeed without deep specialization and expertise. In much the same way global trade fuels specialization and increased efficiency at the macroeconomic level, so too does globality fuel the semiconductor industry's ability to achieve its business priorities.

This very survival, however, will be challenged as the underlying technology becomes a larger part of geopolitical conversation. Tariffs are one of the biggest threats to the effective functioning of the semiconductor industry, and any tariffs enacted for the industry will have an impact not only on ecosystem participants, but also on companies and consumers downstream.

Lack of global collaboration will also boost prices, according to Simon Segars, chief executive officer of ARM in the United Kingdom. "If the only thing you can use is what's supplied locally, that will increase prices and reduce a country's competitiveness."

IT HELPS MITIGATE RISK.

Having access to a global supplier network decreases the risk to a company's supply chain, which is important due to the amount of money and business at stake.

One example of how global collaboration mitigates risk is seen in the way it has helped the semiconductor ecosystem minimize the impact of natural disasters. The industry's players have been able to shift around the affected areas as necessary to keep the ecosystem up and running and minimize the disaster's impact.

"The semiconductor industry has demonstrated the value of globality after natural disasters," noted Steve Kelley, president and chief executive officer of United States-based Amkor Technology. "Time and time again, flexible supply chains have allowed us to adapt quickly, maintaining continuity of supply after earthquakes, tsunamis, and floods."

Andy Micallef, chief operations officer at Marvell Semiconductor in the United States, agrees. "Look at incidents over the past 10 years," he said. "Supply interruptions typically rely on global relationships to help each other out."

A highly visible example is the March 2011 9.0 earthquake and tsunami in Japan. Most of the manufacturing plants in the disaster area were severely affected, and buildings and roads suffered significant damage. The impact on the semiconductor industry was significant,

as Japan represented about 20 percent of the worldwide semiconductor market revenue at the time. The response was profound: Semiconductor companies, employees, and equipment suppliers worked together with government agencies to bring production back to pre-earthquake levels in three months. Additionally, the industry's globality afforded companies the chance to evaluate their sourcing options and create a more diverse set of qualified suppliers with backup suppliers to mitigate such risks.

IT ENABLES COMPANIES TO MORE EFFECTIVELY DEAL WITH COMPLEXITY.

Micallef noted that when dealing with complexity, money isn't enough to overcome individual companies' resource constraints. "This industry has a small number of people and a large amount of capital," he noted. "Relationships across the globe are critical."



We work in an industry that powers the future of technology," stated Roawen Chen, Chief Operations Officer of Qualcomm CDMA Technologies at the San Diego-based company. **"What needs to be accomplished is incredibly complex, and our ability to address these complexities is dependent on operationalizing talent across the globe to realize our ambitions. Only then can we consider ourselves successful."**

It's time for a global standard that sets the ground rules for how the industry works together.

While globality is critical to the semiconductor industry, it's not without its challenges. One of the most obvious is politics. Ongoing concerns around international policy have a clear impact on strategic decisions, potentially causing businesses to rethink their strategy or limit their business dealings to partners from a specific region.

Companies need to ensure they can operate in an environment that enables them to take full advantage of their partner relationships. This includes an implicit understanding of the industry's challenges and how companies can advance their capabilities while respecting implied boundaries that come with participation in a global industry, as well as sufficient safety mechanisms to de-risk exposure to globality.

In this regard, a global standard for collaboration and IP protection could go a long way toward addressing the potential complications inherent in an industry where hundreds of companies spanning dozens of countries—each of which has its own rules, goals, and culture—must work together.

According to executives participating in our research, a global standard for how semiconductor companies work together and maintain vital IP protection would continue to foster the widespread and effective collaboration critical to success. They agreed that a global standard would help minimize threats, such as IP theft, that could lead to a scaling back of global collaboration in favor of relationships closer to home that could be more easily controlled.



The fears around security aren't going to go away—in a world of IoT, there are more and more pervasive things that can create and exploit network weaknesses,” said ARM's Simon Segars.

“But I'd like to think we don't end up in a Balkanized world where companies are building regional solutions. This is an area that is ripe for innovation. We as leaders of the semiconductor industry must be able to debate and discuss the need for legal and ethical standards for how we treat each other. We must lobby for recognition of a global standard.”

This initiative was front and center at the World Semiconductor Council (WSC), a global council of semiconductor industry executives from Asia-Pacific, Europe, and North America. On May 23, 2019, the WSC held its 23rd annual meeting of the WSC in Xiamen, China, where the organization issued the following statement:

Intellectual property (IP) is the lifeblood of the global semiconductor industry, and respecting and enforcing intellectual property rights is essential to the industry's global competitiveness. The global semiconductor industry invests over 10% of revenue into R&D, one of the highest proportions of any industry. The trend worldwide in the last decade, and in most WSC member countries, is for significant growth in patent applications and patent grants. Therefore, protection of the IP that results from this R&D (i.e., patents, trade secrets, source code, etc.) is essential to the industry's competitive position, and to preserving incentives for innovation. The WSC encourages the Governments/Authorities Meeting on Semiconductors (GAMS) to ensure that intellectual property is strongly protected and enforced in their domestic laws and regulations.”

Conclusion

As the world's economy has become much farther dispersed and interconnected during the past two decades, the semiconductor industry remains the paragon of what a truly global supply chain looks like, how it operates, and how its players and ultimate end customers benefit. The fact is, the world needs an efficient, competitive, profitable, and resilient semiconductor industry to help power continual technological innovation that benefits consumers, businesses, and nations.

Our research shows that to build on the progress the industry has made, all players must come together to reinforce what it means to be a participant in this critical ecosystem and what it takes to foster the trust and tight collaboration that's vital to the industry's future success. GSA and Accenture look forward to continuing this discussion in the next phase of our joint collaboration, in which our survey will more deeply explore this issue to help executives address the complexity of global relationships and further influence relevant policy.

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About GSA

GSA is Where Leaders Meet to establish a profitable and sustainable semiconductor ecosystem. This expanding ecosystem encompasses semiconductors, software, solutions, systems and services. As a leading semiconductor and technology industry organization, we offer an efficient and strategic platform for thought leadership. GSA has an impressive global footprint representing over 25 countries and 250 corporate members, including 100 public companies. As a result of our unique, neutral platform, our membership ranges from the most exciting, emerging companies to semiconductor industry stalwarts and technology leaders. Our members now represent 70% of the \$450B plus semiconductor industry.

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