OVERVIEW

Over the past year, the Biden Administration has worked with the private sector to understand and address the global shortage of semiconductors. These computer chips are essential building blocks for an increasing number of products, from your cell phone and your car to other critical goods such as medical devices.

The semiconductor shortage has been described as due to a “perfect storm” of factors. Prior to 2020 there were already difficulties in obtaining inputs for production, including semiconductor manufacturing equipment used to make older varieties of chips, and components used in electronic assembly such as diodes, capacitors, and substrates. There was also an underlying growth in demand for chips as industries shifted to more semiconductor-intensive products (e.g., electric vehicles, 5G). The pandemic exacerbated these trends by dramatically increasing demand for products that require semiconductors of all types. Simultaneously, supply was disrupted by a series of black swan events such as factory fires, winter storms, energy shortages, and COVID-19-related shutdowns.

The private sector is best positioned to address the near term challenge posed by the current shortage, via increased production, supply chain management to minimize disruption, and product design to optimize the use of semiconductors. However, given the importance of semiconductors to U.S. economic security, the Biden Administration is doing everything in its power to facilitate solutions and overcome the heightened coordination challenges that arise at moments of tail risk.

Since last Spring, the Administration has hosted semiconductor industry convenings to spur collaboration, created the Supply Chain Disruptions Task Force to facilitate a whole of government approach to the problem, and launched an early alert system to monitor production disruptions in the semiconductor industry.

The Administration has worked with industry players to improve supply chain transparency and establish long-term partnerships. These steps have helped ease the immediate crisis that caused automakers, among other industries, to shut-down production and furlough workers.

But the semiconductor supply chain remains fragile. Demand continues to far outstrip supply.

In September, the Department of Commerce launched a Request for Information (or “RFI”) on the semiconductor supply chain that gave new insight into the complex and global semiconductor supply chain. The Department received more than 150 responses, including from nearly every major semiconductor producer and from companies in multiple consuming industries.

Some key findings include:

- Median demand for chips highlighted by buyers was as much as 17% higher in 2021 than 2019, and buyers aren’t seeing commensurate increases in the supply they receive. This is a major supply and demand mismatch.
• The median inventory of semiconductor products highlighted by buyers has fallen from 40 days in 2019 to less than 5 days in 2021 (see Figure 2). These inventories are even smaller in key industries.
• The RFI allowed us to pinpoint specific nodes where the supply and demand mismatch is most acute, and we will target our efforts moving forward on collaborating with industry to resolve bottlenecks in these nodes.
• The primary bottleneck across the board appears to be wafer production capacity, which requires a longer-term solution.

We’re going to capitalize on this new information to engage industry on node-specific problem solving in the coming weeks. We will also look into claims about unusually high prices in these nodes.

The RFI results make it clear: America needs to produce more semiconductors. Congress must pass funding for domestic semiconductor production, such as the U.S. Innovation and Competition Act, to solve our supply challenges for the long-term.

PROGRESS SINCE EARLY 2021

Utilization: Since the semiconductor shortage started in 2020, semiconductor companies have significantly increased the utilization of their existing capacity. Specifically, from Q2 of 2020 through 2021, semiconductor fabs operated at over 90% utilization, which is incredibly high for a production process that requires regular maintenance and very high amounts of energy (see Figure 1).

Figure 1 – Semiconductor production utilization has been well above typical levels since the beginning of the semiconductor shortage. Source: Semiconductor Industry Association’s 2021 State of the U.S. Semiconductor Industry Report

Investment: Semiconductor companies have put more money, quicker than ever before, into expanding their capacity. In its 2021 report, the Semiconductor Industry Association forecasted semiconductor industry capital expenditure (capex) would reach close to $150 billion in 2021 and over $150 billion in

1 2021-SIA-State-of-the-Industry-Report.pdf (semiconductors.org)
2022. For comparison, prior to 2021, the industry never spent more than $115 billion on annual capex. These numbers reflect recent announcements, like the ones for a new Intel semiconductor facility in Ohio and news from Global Foundries, which includes plans for a new fab in New York. It is important to note these investments will take time to translate into increased production. Some investments previously announced are expected to come online as early as the second half of 2022.

New supply chain partnerships: Semiconductor producers are partnering with semiconductor customers in new and creative ways like never before. Following a White House-led industry convening, Ford and Global Foundries recently announced a partnership to identify ways they can work together to innovate on future chips and meet future demand for vehicles. In November, GM announced a similar partnership with seven different semiconductor producers. These announcements demonstrate chip consumers and producers are coming together to find creative solutions for supply chain issues.

COVID-19 monitoring: COVID-19-related disruptions to semiconductor production were prevalent in 2021. That’s why the U.S. Government set up the Early Alert System for COVID-19-related shutdowns to microelectronics manufacturing around the world. That system is built on three pillars: early detection, enhanced engagement, and transparency. The Department of Commerce, State Department, and Centers for Disease Control and Prevention (CDC) continue to work closely to proactively monitor key manufacturing facilities flagged through that system and work with allies and partners to implement safety protocols that help limit the spread of the virus and minimize disruption to their people and global supply chains. In the end, vaccination is the best way to minimize pandemic related disruptions, which is why the Administration is leading the effort to vaccinate the world, committing to share 1.2 billion doses of safe, effective vaccines. To date, the United States has shipped over 385 million doses to 112 countries.

What we learned from the RFI

The RFI confirmed that there is a significant, persistent mismatch in supply and demand for chips, and respondents did not see the problem going away in the next six months. Median demand for the chips highlighted by the buyers who responded to the RFI was as much as 17% higher in 2021 than 2019, and buyers aren’t seeing commensurate increases in the supply they receive.

The main bottleneck identified is the need for additional fab capacity. In addition, companies identified material and assembly, test, and packaging capacity as bottlenecks.

For the semiconductor products that present the greatest challenge to acquire, median inventory for consumers who responded to the RFI has fallen from 40 days in 2019 to less than 5 days in 2021 (see Figure 2). These inventories are even smaller in key industries. This means a disruption overseas, which might shut down a semiconductor plant for 2-3 weeks, has the potential to disable a manufacturing facility and furlough workers in the United States if that facility only has 3-5 days of inventory.

Figure 2 – Median consumer inventories of semiconductor products that present the greatest challenge to acquire, for chip consumers that responded to the RFI. Source: U.S. Department of Commerce, Responses to Request for Public Comments on Risks in the Semiconductor Supply chain, released September 2021.

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2 [2021-SIA-State-of-the-Industry-Report.pdf](https://semiconductors.org)
Respondents also shared their qualitative perspectives on the semiconductor shortage from 2019 through 2021 and on what they anticipated for the shortage in early 2022. Two of the biggest themes were that semiconductor demand has been higher than originally forecasted and that external factors, particularly COVID-19-related shutdowns of production, caused significant issues.

**Zeroing in on the most disruptive chips**

In addition to the overarching trends described above, we learned the bottlenecks for the RFI respondents are most concentrated in a few specific kinds of semiconductor inputs and applications, including legacy logic chips (used in medical devices, automobiles, and other products), analog chips (used in power management, image sensors, radio frequency, and other applications), and optoelectronics chips (used in sensors and switches).

It is important to note semiconductors are not all created equal. There are many different types of semiconductors. Some utilize technology just discovered, others utilize technology we’ve had for years and years. A semiconductor “node” identifies the specific design of the semiconductor and the manufacturing processes needed to create it. End products like cars require several different, specific semiconductor nodes. That means it’s helpful to think about semiconductors not as one product with one universal supply chain, but as a collection of many different products, each with their own supply chain that can have a more or less severe supply and demand mismatch. In addition, different end products have different constraints (e.g., constraints on chip design, longer product life cycles).

The specific kinds of products we identified as having significant semiconductor supply and demand mismatches are used by critical industries, including medical devices, broadband, and autos. They include:

- Microcontrollers that are primarily made of legacy logic chips, including, for example, at 40, 90, 150, 180, and 250 nm nodes
- Analog chips including, for example, at 40, 130, 160, 180, and 800 nm nodes; and
Optoelectronics chips including, for example at 65, 110, and 180 nm nodes. For these chips, lead times have increased significantly from 2019. Based on information from companies, in 2019, typical total lead times for chips identified as challenging ranged from 84-182 days. In late 2021, typical total lead times for chips identified as challenging ranged from 103-365 days, a 2x increase in some cases.

Why transparency matters and the role of the RFI

Despite the progress made since early 2021, the semiconductor shortage persists. That’s due in part to the complexity of the semiconductor supply chain (see Figure 3). Producers don’t always have a clear sense of demand, and chip consumers don’t always know where the chips they need originate. These barriers make it harder to develop solutions.

That’s why the U.S. government brought industry together and encouraged increased transparency throughout the supply chain. As the latest step in that effort, the Department of Commerce launched a semiconductor RFI in September asking for information from both producers and consumers and worked extensively to ensure industry responded to the RFI.

Responses to the RFI were due in November, and we received more than 150 responses, including from nearly all the major semiconductor producers and from companies in multiple consuming industries.

3 https://crsreports.congress.gov/product/pdf/R/R46581
Both the quantity and quality of information we received was high, and Figure 4 gives more detail about the respondents.

Figure 4 – Breakdown of RFI respondents by role in the supply chain and, for semiconductor consumers, by industry. Source: U.S. Department of Commerce, Responses to Request for Public Comments on Risks in the Semiconductor Supply chain, released September 2021.

Moving forward

We’re going to capitalize on this new information to engage industry on node-specific problem solving in the coming weeks, and we will continue the Early Alert System to monitor and take action related to pandemic-related disruptions to the supply chain.

In addition, we are engaging with companies that did not respond to the RFI, and those companies whose responses were not as comprehensive as their peers, to ensure we have the most accurate picture of what is driving supply chain bottlenecks. We believe we will get the information we need. We will continue to use the tools at our disposal to increase transparency in the supply chain and ensure companies are not taking advantage of the shortage.

Last, but not least, we will continue to advocate for the President’s proposed $52 billion to enhance domestic semiconductor production included in the U.S. Innovation and Competition Act. This semiconductor shortage is the result of a significant mismatch in supply and demand, further exacerbated by the pandemic. The number one issue identified in the RFI is insufficient fab capacity, and that’s what the President’s proposal is designed to accelerate.