

BUILDING A MORE RESILIENT ICT SUPPLY CHAIN: LESSONS LEARNED DURING THE COVID-19 PANDEMIC

An Analysis

November 2020



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Executive Summary

The impacts of the COVID-19 pandemic on the Information Technology and Communication (ICT) sector's supply chains are still unfolding. To understand how IT companies have been impacted, and to identify lessons learned about supply chain vulnerabilities and the potential ways to address them going forward, the Information and Communication Technology (ICT) Supply Chain Risk Management (SCRM) Task Force, a partnership between the IT and Communications Sector Coordinating Councils and the Cybersecurity & Infrastructure Security Agency (CISA) formed a study group (collectively, "the Study Group"). The goal of the Study Group was to uncover the impacts of COVID-19 on the ICT supply chains and make practical recommendations that can support policy and operational decisions to strengthen and build additional resilience into ICT supply chains in the future. These recommendations can support policy and operational decisions intended to strengthen supply chains going forward. The study also provides a high-level visual mapping of how goods and services flow through the generalized ICT supply chain, from the raw materials stage through to sale to the consumer. The map identifies the chokepoints that can occur throughout the supply chain (Appendix A).

The COVID-19 global pandemic caused profound disruptions to the globalized model of supply chains, including those in the IT and Communication sectors. The global supply chain model constitutes sequential, multi-country production, where value is added in fragments along the way and where the country of origin is often difficult to determine. To that end, a product may be designed in New York, built in Vietnam, tested in Taiwan, stored in Hong Kong, and sent to China for final assembly, and distributed globally to end customers for use.

The Study Group found three key issues that impacted the ICT supply chains due to the pandemic:

- 1. The pandemic has underscored the need for an approach that was already underway over the last six years: diversifying supply chains to a broader array of locations and away from single source/single region suppliers.** Indeed, many companies are moving production out of China in order to diversify supply chain locations due in part, to the trade dispute between Washington and Beijing that reached its pinnacle last year. Now, in some cases, COVID-19 is expediting that trend.
- 2. The pandemic exposed how some manufacturing companies were unprepared because of their reliance on lean inventory models, which provide great efficiency and cost effectiveness in normal environments.** However, recent disruptions and the pandemic have illustrated the risks of not holding much inventory of critical components or equipment, and the economic consequences of delayed customer deliveries that can follow as a result.
- 3. COVID-19 also underscored the difficulties that companies face in understanding their junior tier suppliers and where they are located.** While corporations know who they directly purchase equipment or components from (their tier 1 suppliers), they often can lack transparency about their second and third tier suppliers and beyond. Given that a single product can require hundreds of suppliers to make and assemble the finished product, the challenges of understanding these suppliers is a daunting and expensive proposition. When these junior tier suppliers experience slowdowns, shutdowns or interruptions, it cascades through the entire supply chain system, making it difficult for a company to figure out where or why the delay is happening. The pandemic has thus highlighted the need for companies to map these junior suppliers – at least those supplying

critical components or raw materials – in order to understand their “upstream” supply chain risks and take action to address them.

The pandemic has been a wake-up call and companies, after assessing costs and benefits, may begin making shifts to their supply chains in order to reduce future risk. This may include moving in and out of certain regions, developing enhanced but practical approaches to risk mitigation, and diversifying supply sources. Given the global supply chain difficulties ICT companies are currently encountering because the virus adversely affects their ability to compress their cycle time, there are active policy discussions as to whether firms should be provided with various incentives to bring manufacturing home, closer to home, or to never leave in the first place.

Based on the research and analysis conducted as well as the discussions with ICT companies both large and small, the Study Group makes the following practical recommendations that ICT companies may adopt to increase their supply chain resiliency:

Proactive Risk Classification: ICT companies may continue to refine their supply chain risk management approach given the financial burden experienced as a result of supply disruptions during the pandemic. Companies may consider deploying a systematic classification of risks, continually analyze developments and events that are happening around the world and undertake the development of a response strategy to improve supply-chain resilience strategically.

Map the Corporate Supply Chain: ICT companies may want to develop a detailed map of junior-tier suppliers as a critical step to detect hidden relationships that impede adding resilience. After mapping upstream suppliers, purchasers of ICT products must also be aware of the production locations and financial stability of each participant in the value chain that supplies a critical component or constitutes a potential logistical bottleneck.

Broaden Supplier Network and Regional Footprint: To eliminate and reduce the risk of single source for raw materials or critical product components when possible, companies can increase resiliency and redundancy in their networks by dual-sourcing supply from multiple or lower-risk regions.

Potential Development of Standardized Mapping and Other Illumination Tools: While there is a strong consensus about the need to more effectively map the locations of sub-tier suppliers and to identify upstream logistical bottlenecks, currently there is no standard methodology for doing so. The IT and Communications sectors may thus benefit from the development of standardized approaches to supply chain mapping that would place appropriate focus on sub-tier suppliers or logistical bottlenecks that are most critical; would care for legitimate vendor concerns about being pressed to provide proprietary information; and would settle on common formats for providing maps and other information.

Work to Shift the Optimal Amounts of Inventory Held: Many ICT manufacturers try to minimize their inventory of components, thereby holding down costs by keeping stockpile inventories low and delivering goods as needed. This is the opposite of the “just in case” methodology that calls for holding more inventory in reserve. ICT companies may want to explore holding more buffer inventories and also working with their suppliers to hold inventory at their warehouses, through a Vendor Managed Inventory system. Furthermore, ICT manufacturers should continue to ensure that they utilize meaningful metrics, such as orders delivered complete, accurate and on-time, as well as time related metrics like days of inventory and cycle time.

Plan Alternatives in Logistics and Transportation: During the pandemic, almost every mode of transportation in impacted areas was affected. To reduce the impacts of transportation and logistics issues, ICT companies can engage in scenario planning for different types of events and map out the alternatives that can allow for the supply chain to be restored as efficiently as possible. To further assist in these efforts, companies can utilize technology platforms that provide real-time, blockchain visibility into available logistics capacity. Companies can also study logistics patterns to help identify alternative providers for each key route.

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1.0 WHAT HAS COVID-19 EXPOSED ABOUT SUPPLY CHAINS?

The COVID-19 pandemic has revealed three primary stress points on ICT supply chains:

Inventory Management

The typical approach to supply chain management emphasized the need to strike a balance between efficiency and resiliency. While these concepts are often at odds with one another, effective supply chains are those that strike the right balance between the two. Moreover, companies also need to seamlessly integrate supply chains with many different components and a large, human workforce supporting and serving as its backbone. Increased competition and often-compressed profit margins have driven supply chain managers to emphasize cost reduction, just-in-time deliverables (JIT), and days of supply inventory management.¹

JIT allows manufacturing companies to cut costs by reducing the amounts of good and materials a firm needs to hold in stock. Production should be for specific customer orders and the production cycle commences only after a customer has placed an order with the producer, thereby eliminating the need to hold a large inventory.² In fact, in 2008, Tim Cook, then the Chief Operating Officer of Apple, called inventory “fundamentally evil,” and reduced the amount of time inventory was on the company balance sheet “from months to days.”³ Each industry carries varying amounts of inventory. For example, the tech industry typically carries about three to 12 weeks of inventory, while the auto industry has about two to 10 weeks’ worth. While lean supply chains may work in times of normalcy, the pandemic has demonstrated that companies may need to examine their current inventory management practices so that they have the ability to continuously collect data and feedback, evaluate it in real time, react expeditiously to rapidly evolving environments, and develop cushions to absorb abnormal periods of activity or inactivity. Companies may also continue to push for vendor managed inventory, a scenario under which among other things, a supplier is paid a fee to hold extra equipment on hand in their warehouses. Firms look to this practice as Wall Street often punishes those publicly traded firms that hold too much inventory on their books.

Supply Chain Transparency

After the March 2011 earthquake and tsunami in Fukushima, Japan and extensive flooding in Thailand,⁴ many multinationals learned difficult lessons about the unseen weaknesses in their supply chains — weaknesses that resulted in loss of revenue, and in some cases, market capitalization. While most companies could quickly assess the impacts that Fukushima had on their direct suppliers, they were blindsided by the impacts on second- and third-tier suppliers in the affected region. Some companies expanded or initiated supply chain crisis management capabilities to support business continuity and agility to prepare for disruptions. However, many companies, some of which were launched since those global disruptions and others that are unable to invest in business continuity planning, experienced disruptions created by the pandemic. Regardless, every global supply chain operator rushed to ascertain which of their junior-tier suppliers — those with whom they do not deal directly — were based in the affected regions that experienced shutdowns, disruptions to work and transportation, and access to supplies. In order to create supply chain resilience, managers need to be able to map where their tier 1, tier 2, and tier 3 suppliers are manufacturing so they can understand which suppliers are the most affected by disruptions. They also need visibility into tracking junior suppliers’ inventory of finished goods and raw material.⁵

¹ “COVID-19 Era: How Supply Chains Are Adapting to Coronavirus Lockdowns,” *Business Today*; Ushasri T.S. and Jitamitra Desai, June 26, 2020.

² “Our Current Supply Chain is Failing: Why Change Has Got to Come in 2020,” *All Things Supply Chain*, Emilia Ashton, June 29, 2020.

³ “Tim Cook’s Trick for Making iPhones is Now at Risk From the Pandemic,” *The Verge*; Elizabeth Lopatto, March 13, 2020.

⁴ “Hearing on Supply Chain Resiliency,” Eswar Prasad, Brookings Institute, July 2, 2020.

⁵ “How COVID-19 Is Transforming Automotive and Industrial Supply Chains,” *Industry Week*, Salim Shaikh and Ehap Sabri, May 11, 2020.

Purchasers at the end of the value chain, (such as communications service providers, enterprises, systems integrators, and consumers) inherit the upstream supply chain risks associated with manufacturers' supply chains. Various communications service providers told the Study Group that COVID has illuminated not only vulnerabilities within specific vendors' supply chains, but also vulnerabilities – such as single-source tier 2 or tier 3 suppliers – that were shared by multiple vendors. That means that strategies to mitigate supply chain risks by sourcing from multiple tier 1 suppliers may be insufficient to achieve sufficient supplier diversity, and it highlights the importance of mapping upstream supply chains across their entire vendor base.

Single Source and Single Region Suppliers

In many cases, companies struggle with their reliance on a single source for products that they purchase directly. While supply chain managers recognize the risk of an over-reliance on a single source, they nevertheless adopt this strategy in order to secure the necessary supply or to control costs. This lack of flexibility can have devastating effects when a company's sole supplier is unable to provide components. There are often limited options from which a firm can choose, and more and more, those options include *only* those sourced from a single region, continent, or company (see Exhibit 1). When extraction and production is so concentrated, it makes finding alternative workarounds especially difficult. Given that the ICT industry is heavily reliant on sourcing minerals, metals, and other commodities (such as gold, silver, lithium and silicon) extraction and production that is concentrated in one region or on one continent, it makes finding alternative workarounds especially difficult.

EXHIBIT 1 – NUMBER OF COMMODITIES SOURCED FROM QUARANTINED AREAS OF CHINA FOR U.S. AND EUROPEAN COMPANIES IN THE HIGH TECH, SEMICONDUCTOR, AND CONSUMER ELECTRONICS INDUSTRIES⁶

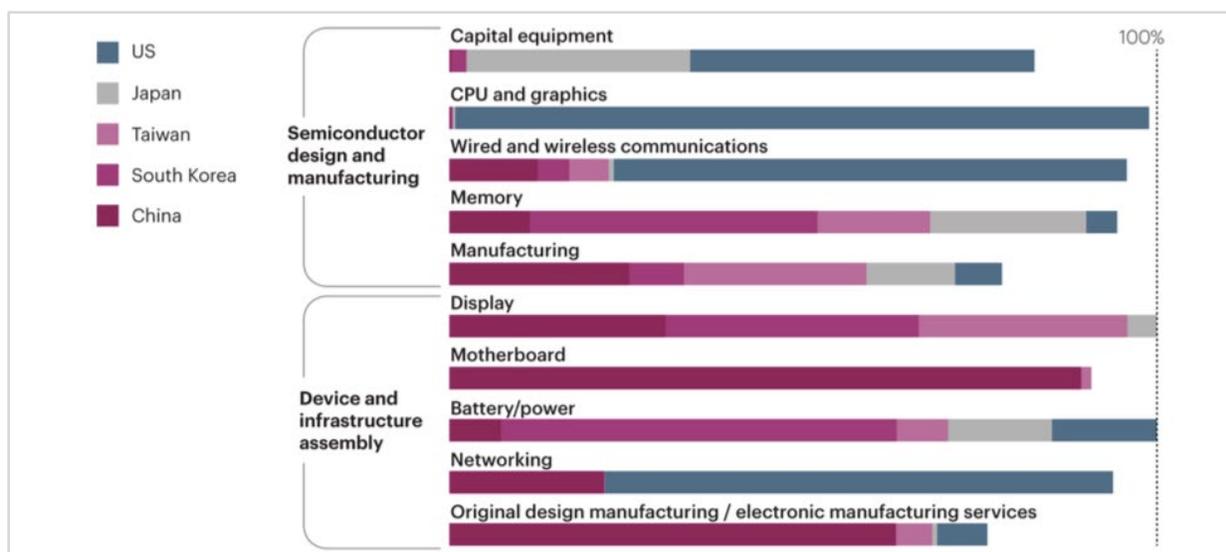
COMMODITY	TOTAL NUMBER
Resistors	590
Capacitors	199
Thermal	60
Printed circuit board assemblies	53
Plastics and resins	50
Integrated circuits	44
Sheet metal	32
Audio devices	30
Memory	25
Hardware	20
Battery components	22
Cables	16
Electrical components	10
Crystals and oscillators	7
Switches	4
Paints	3

Furthermore, for technology and communications companies the risk is especially high as most of the world’s chips, devices, and networking equipment come from just five places in the world (see Exhibit 2), exposing buyers and sellers to the risks of factory shutdowns as well as production and shipping delays. For instance, most semiconductor fabrication plants are located in China and Taiwan and technology/communications companies like Nvidia, Qualcomm, and Apple rely on these facilities to produce the most advanced chips.⁷

⁶ “Coronavirus Is Proving We Need More Resilient Supply Chains,” *Harvard Business Review*, Tom Linton and Bindiya Vakil, March 5, 2020.

⁷ “Covid-19 Disruptions Highlight Risks of Tech’s Concentrated Supply Chain,” Bain & Company; David Crawford, Chris Johnson, Joshua Hinkel, Anne Hoecker; June 10, 2020.

EXHIBIT 2 - THE SUPPLY CHAIN FOR TECHNOLOGY HARDWARE IS CONCENTRATED IN FIVE PLACES⁸



2.0 LESSONS LEARNED FROM PRIOR SUPPLY CHAIN DISRUPTIONS

The COVID-19 pandemic is a true global crisis event; it rapidly decimated global supply chains as the virus spread from one continent to another, and supply chain managers had no real comparable event to look back on for guidance. Nevertheless, there are some valuable lessons that can be learned from previous supply chain disruptions that affected companies on a more regional basis and which supply chain managers often cite as spurring them to make shifts to their supply chain:

In March 2011, an earthquake and subsequent tsunami caused explosions and meltdowns at the **Fukushima nuclear power plant**, causing devastating impacts to the Fukushima prefecture that continue today. The area was home to many high-tech manufacturing and suppliers. Indeed, 22% of the world’s 300 mm silicon wafer supply came from a plant in the prefecture and 60% of critical auto parts were also located in the area. Additionally, the area was the key supplier of lithium battery chemicals, flash memory, and anisotropic conductive film used in LCD flat panel displays.⁹ The disaster and subsequent shutdowns put many companies through a difficult test of their supply networks and systems and brought home the issue of the dangers of single region suppliers. For HP, one company impacted by the disaster, it was a learning experience that prompted their senior vice president of operations to say, “we’ll do a retrospective on what worked best and what didn’t, and how to change things to make our supply chain more resilient.”¹⁰

Days before **Hurricane Katrina** barreled ashore in New Orleans, Wal-Mart’s emergency command center began routing the goods that would be in high demand to the Gulf Coast’s distribution centers. From an emergency operations center in Bentonville, Arkansas, trucks were dispatched after the storm. Information on which roads and bridges were blocked – and the detours around them – was channeled to drivers. Chiquita Brand International reportedly rerouted banana shipments meant for its facilities in Gulfport, Mississippi, toward Freeport, Texas, and Port Everglades, Florida. An important lesson from Katrina is that digital technology made business remarkably efficient at finding ways around obstacles and preventing even severe damage to crucial transportation infrastructure from impeding the flow of goods. Global positioning systems allow logistical

⁸ Ibid.

⁹ “Japan Disaster Shakes Up Supply Chain Strategies,” *Harvard Business School*, Dennis Fisher, May 31, 2011

¹⁰ “Stress Test for the Global Supply Chain,” *The New York Times*, Steve Lohr, March 19, 2011

planners to know where trucks and other vehicles are at all times, and satellite connections enable the flow of information about what routes are available.¹¹

Nokia and Ericsson reacted quite differently when a **Philips facility in Albuquerque, New Mexico, caught fire** in March 2000. The plant made radio frequency (RF) chips, key components for mobile telephones, for both companies. When the fire damaged the plant, Nokia's managers quickly carried out design changes so that other companies could manufacture similar RF chips and contacted backup sources. Two suppliers, one in Japan and another in the United States, asked for just five days' lead time to respond to Nokia. Ericsson, meanwhile, had been weeding out backup suppliers because it wanted to trim costs. It did not have a plan B in place and was unable to find new chip suppliers. Not only did Ericsson have to scale back production for months after the fire, but it also had to delay the launch of a major new product. The end result was that Nokia took market share from Ericsson because it had a more agile supply chain.¹²

According to Hau Lee of the *Harvard Business Review*, agile supply chains can recover quickly from sudden setbacks. In September 1999, an **earthquake in Taiwan** delayed shipments of computer components to the United States by weeks and in some cases, by months. Most PC manufacturers, such as Compaq, Apple, and Gateway, were unable to deliver products to customers on time. One exception was Dell, which revised the prices of PC configurations overnight. This permitted the company to turn customer demand away from hardware built with components that were unavailable towards machines that did not use those parts. Dell was able to do so because it received data on the earthquake damage early, analyzed the extent of its vendors' problems quickly, and executed on the plans it had drawn up to cope with such eventualities immediately. Due to its efforts, Dell gained market share in the aftermath of the earthquake.

3.0 ICT STUDY GROUP QUESTION SET

To obtain a current assessment of the impacts to ICT supply chains due to COVID-19, the Study Group sent a Question Set to companies in the ICT space to survey the impact of the pandemic on their supply chains in terms of operational resiliency and business continuity issues. The 50 companies surveyed from early to mid-August ranged in size from large, publicly traded, global companies to small, privately owned firms. Of the 50 companies, five identified as Broadcasters, 34 as Communications Services Providers (CSP) and 11 as IT Service Providers (ITSP).¹³ The results of the survey are detailed below:

Per Exhibit 3 below, the Study Group asked survey respondents to what degree their organization had been impacted by supply chain issues during the pandemic.¹⁴ 53% of respondents reported moderate impacts to their organizations' supply chains as a result of the COVID-19 pandemic, and 33% of respondents experienced minor impacts. There were no companies that experienced catastrophic impacts that would have crippled their business. Broken out by industry segments, 60% of Broadcasters experienced moderate interruptions to their supply chain while 56% of CSPs and 40% of ITSPs also experienced moderate impacts. Interestingly, two of the ITSP companies reported minimal to no impact to their supply chain due to the pandemic, while only one of the CSPs and none of the Broadcasters had minimal to no impact.

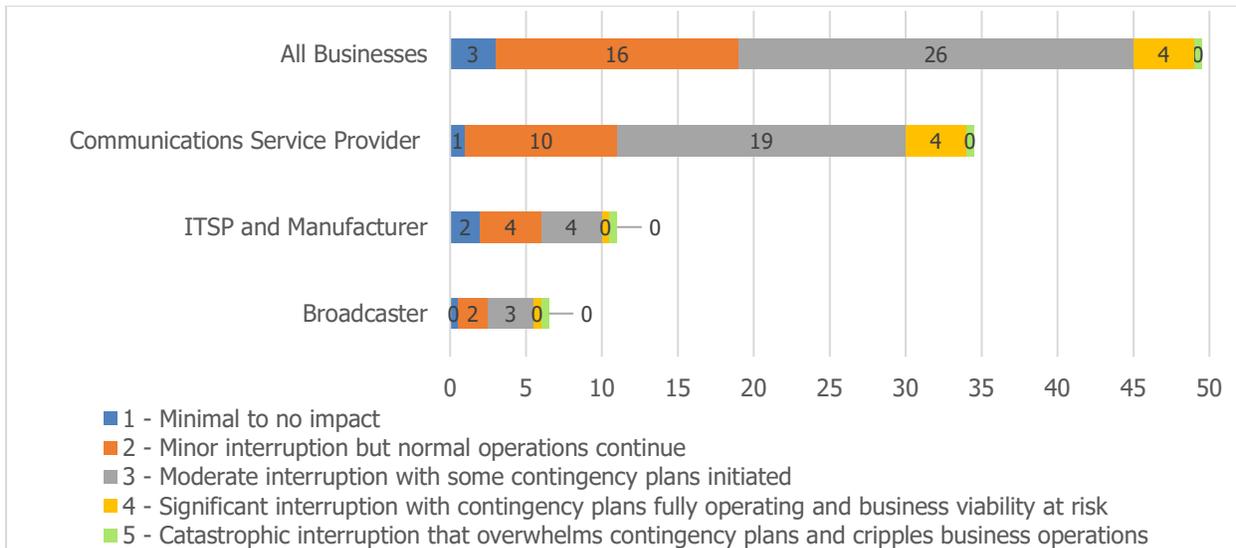
¹¹ "Why Hurricane Katrina Should Make Us Optimistic About Economic Impact of Sandy," *Washington Post*, Neil Irwin, October 31, 2012.

¹² "The Triple-A Supply Chain," *Harvard Business Review*, Hau Lee, October 2004

¹³ Separate categories for ITSPs and Manufacturers have been combined into one category. Two respondents self-reporting a company category of Other were placed in the ITSP and Manufacturer category; two respondents self-reporting company categories of Other were placed in the broadcaster category based on self-reported descriptions.

¹⁴ Based on 49 responses (one company did not respond to this question).

EXHIBIT 3 – NUMBER OF QUESTION SET RESPONSES BY IMPACT RATING AND INDUSTRY CLASSIFICATION



Furthermore, the Table 1 below details the data using a weighted average across the business types.

TABLE 1 – SUPPLY CHAIN IMPACT SCORE BY BUSINESS TYPE

IMPACT SCORE BY BUSINESS TYPE	ALL BUSINESSES	BROADCASTING	COMMUNICATIONS SERVICE PROVIDER	ITSP AND MANUFACTURER
Weighted Average	2.6	2.6	2.8	2.2

Respondents were then asked, given the aforementioned level of impact, what percentage out of 100% was attributed to, or caused by, inventory management, supply chain transparency, and single source/single region or other issues. Broadcaster and CSP respondents cited Inventory Management as the most impactful (40% and 31% respectively), whereas ITSPs cited “Other” reasons (35%) and Single Source / Region Suppliers (29%) as the most impactful supply chain issues. “Other” reasons included items such as impacts to transportation and logistics or suppliers across regions.

The results are detailed in the Table 2 below:

TABLE 2 – AVERAGE PROPORTION OF IMPACT BY ANALYTIC THEME DURING PANDEMIC AND INDUSTRY CLASSIFICATION¹⁵

INDUSTRY	NUMBER OF RESPONDENTS TO QUESTION	INVENTORY MANAGEMENT	SUPPLY CHAIN TRANSPARENCY	SINGLE SOURCE AND SINGLE REGION SUPPLIERS	OTHER
All Businesses	47	30%	27%	29%	14%
Broadcasting	4	42%	22%	20%	16%
Communications Service Provider	32	31%	32%	30%	7%
ITSP and Manufacturer	11	21%	15%	29%	35%

In addition, further detail from interviews and the Question Set revealed that many respondents noticed and experienced the following:

- Global supplier inventory and delivery delays have occurred throughout the pandemic and still exist today, albeit to a lesser extent.
- For those companies that manufacture in China, many had placed large buy-ahead orders in advance of the Chinese New Year holiday, when factories are shuttered. The pandemic struck during the New Year, so many companies had some buffer inventories. Without this advance ordering, supply shortages would have been worse.
- Not all suppliers communicated well with survey respondents, especially those in China, as the pandemic struck there first. Many suppliers “went dark” for several weeks at the onset of the pandemic, as factories were shut down and suppliers were also simply overwhelmed. Suppliers in Europe and the Americas had slightly more time to prepare.
- Throughout the pandemic, many companies increased their inventory orders to buffer against potential future delays related to the pandemic and in some cases, increased customer demand. In many cases, companies will continue to increase inventory orders for many more months given the uncertainty surrounding the pandemic. This has compounded the supply chain shortages and longer lead times that companies have experienced as companies are competing for limited supply.
- Smaller companies often manage inventory through the just-in-time inventory practice due to the costs of holding inventory. During the pandemic, under this practice, their inventories ran short due to fulfillment delays. Larger companies noted that investors can punish companies for holding excess capacity on their books.
- Many smaller companies state that suppliers give preference to orders from larger companies, although this is not confirmed by suppliers.
- Many companies had difficulty fulfilling customer orders on time.
- Sources of certain components, such as semiconductors, are located in Asia creating a risk of geographic concentration. Furthermore, the semiconductor industry has consolidated over the past few years, so alternative sources are limited. As a result, there are fewer chip manufacturers sourcing to companies and, during the pandemic, some could not keep up with demand. ICT companies are also unable to easily “switch” to another semiconductor manufacturer as their products are often highly engineered to certain components, which are difficult to multi-source.

¹⁵ Interos Whitepaper: COVID Resilience Report; <https://www.interos.ai/resource-library/>

- Many suppliers provide companies with incentives to single source their product. Some firms try to strengthen the relationships with their suppliers by re-negotiating their contracts and service-level agreements to secure supply and climb higher on a suppliers' priority list. Often, this comes with a higher price tag. Some companies also adopt a risk-based approach to procurement. If a company has a high volume, high value product, or a product that requires a long lead-time to complete, it tries not to single source. As a result, while some companies try to diversify out of single source/single region suppliers, it is very difficult to do so.
- In many cases, larger, public companies had greater insight into their junior-tier suppliers than privately held firms, but this issue still presents a great challenge and is quite complex for all. Many ICT companies can have hundreds of junior tier suppliers for a single product and they often do not know who are their tier 2, tier 3, or tier 4 suppliers.
- Companies find that some of their tier 1 suppliers do not want to share who their suppliers are for reasons that can seem unfounded. Indeed, some tier 1 suppliers withhold this information by claiming that there are proprietary or regulatory reasons for doing so, which strikes most companies as not credible. On the other hand, it is difficult for original equipment manufacturers (OEMs) to tell a company where every single component of a product is sourced from and at what location because these more junior tier suppliers are frequently changed. For many high volume "commercial off the shelf" (COTS) products, the ability to source components from multiple suppliers is essential for managing cost and agility. To that end, many companies also try to reduce risk by avoiding custom designs that require specialized components and therefore, vendors. In most cases, however, companies desire enhanced communication and information-sharing with their vendors and suppliers as they can often provide assistance for supply chain issues but need the necessary insight in order to help.
- Some governments were unprepared to designate and define how to support operations at critical manufacturing facilities. For example, the Mexican Government's implementation of its COVID lockdown order did not exempt certain critical manufacturing facilities. Inconsistencies in the definition of "essential worker" thus caused key Mexican factories to shut down, creating the need for U.S. Government intervention to help in re-opening some of those shuttered facilities.
- Having contingency plans and business continuity plans in place makes all the difference.

Finally, respondents noted that they may do the following things differently, post-pandemic:

- Increase inventory levels, especially for items that have a longer delivery lead time. Holding excess inventory can be more difficult for smaller companies whose operating budgets are leaner than their larger counterparts.
- Increase stockpiles locally to act as a buffer against supply chain disruptions.
- Pursue greater supplier diversification, where possible. Companies noted that there are real business costs associated with supplier diversification and these pressures can be an important factor regarding supplier sourcing.
- Work with suppliers to better understand their supply chain vulnerabilities and to identify supply chain vulnerabilities that are common to multiple suppliers.
- Increase geographic diversity of suppliers, where possible.

4.0 ADDITIONAL STUDIES ON IMPACTS TO SUPPLY CHAINS DUE TO COVID-19

Additionally, the ICT SCRM Task Force members identified additional related studies that detail impacts to ICT supply chains due to the pandemic:

4.1 Interos Whitepaper: COVID Resilience Report¹⁶

Survey Overview: To assess the sweeping changes underway in supply chain risk management, Interos surveyed 450 executives in the United States across the aerospace and defense, financial services,

¹⁶ Interos Whitepaper: COVID Resilience Report; <https://www.interos.ai/resource-library/>

manufacturing and production, technology, energy and utilities, and other commercial sectors for their “Building Resilience Against Disruption: The Impact of COVID-19 on Supply Chains and How Businesses are Preparing for the Next Shock” Study. The respondents represented risk and compliance officers, logistics, IT, procurement and operations executives at companies exceeding \$1 billion in revenue. Below is a summary of the responses from the 50 tech sector respondents, focusing on the disruptions and vulnerabilities exposed by the ongoing pandemic, and what core changes they are implementing to strengthen their supply chains and build greater resilience.

Changes Prior and Since COVID-19 to Build Supply Chain Resiliency

- *Changes made prior to COVID-19:* 58% made major changes to increase supply chain resilience prior to COVID-19; 18% were planning on making changes, and 20% were planning on making major or minor changes. Only 4% had not made or had not planned on making any changes to build resiliency.
- *Changes made since COVID-19:* 40% have already made major changes, 42% made minor changes, 18% are planning on major or minor changes, and zero respondents reported no plans for changes or changes already made.

Disruptions

- When asked what percentage of their supply chains were disrupted by COVID-19, 22% noted 20-30% of their supply chains were disrupted, followed by 14% selecting 30-40% disruption and 14% selecting 40-50% disruptions, and 12% selecting 70-80% disruption. One respondent noted 100% disruption.
- The main disruptions were logistics. Specifically, 52% noted orders slow to be filled; 42% noted fluctuations in supplier prices; 40% noted an inability to fulfill contracts and another 40% noted the need to identify new suppliers due to health and safety requirements; and 38% noted the need to move to suppliers from other geographic localities due to import/export restrictions.

Vulnerabilities Exposed

- When asked which vulnerabilities were exposed due to COVID-19, 46% selected dependency on unreliable partners or governments, followed by 44% and 40% selecting lack of short-term and long-term planning (respectively); 36% selected regional or geographic concentration and 36% selected lack of understanding of interrelationships with global supply chains; 32% selected single point dependencies or bottlenecks; and 30% tariffs/trade wars. One respondent noted no vulnerabilities were exposed.

Biggest Risks

- 76% identified COVID-19 as the biggest ongoing risk, followed by cyber threats at 44%, restricted or sanctioned entities at 36%, natural disasters at 30%, and single supplier or country concentration risks at 28%. Other risks fell below 20%.
- This follows roughly the same order for future risks, with 66% identifying COVID-19 as the future risk companies are preparing for, followed by cyber risks at 48%, restricted/sanctioned entities at 34%, and geopolitical events at 32% (this was the largest jump from 20% now to 32% in the future).

Thoughts on Onshoring

- **Near-term:** When asked how respondents felt COVID-19 would affect onshoring in their industry (moving production to the U.S) in the next year, 42% noted a major increase; 36% a slight increase, 6% no effect, and 14% anticipate a major decrease.
- **Long-term:** When asked about the long-term (5-10 years) effect on onshoring, the respondents selecting a major increase dropped to 36%, while the number anticipating minor increases went up to 42%; 16% anticipated no effect, 6% a slight decrease and 2% a major decrease (which means just one respondent).

Increasing Resilience

- **Steps already taken:** When asked what actions have been taken to increase resilience against potential supply chain disruptions, every respondent noted that their organization has taken some actions. The actions are listed by top responses: 48% will audit direct suppliers; 46% will monitor suppliers cybersecurity capabilities; 42% will continuously monitor suppliers for disruptions; 40% will audit sub-tiers; 40% will increase onshoring capabilities; and 38% selected each of the following: diversify geographic locations, identify and employ alternative suppliers, and monitor supplier's regulatory compliance.
- **Plans to take Actions:** When asked separately what actions their organizations have plans to undertake, the priorities shifted slightly: 42% selected continuously monitoring suppliers for disruptions as well as increasing onshoring capabilities; 40% selected monitor suppliers cybersecurity capabilities, monitoring suppliers regulatory compliance, and auditing sub-tiers; 38% selected identify and employ alternative suppliers; and 34% selected diversify geographic locations.
 - The biggest shifts were in the drop of auditing direct suppliers from 48% underway to 36% in the future, which could be because they have already implemented the change. The biggest increase was in moving away from just-in-time production which went from only 16% currently taking this action to 38% of respondents with plans to shift away from just-in-time.
- **Challenges with building resilience:** Selected by 56% of respondents, COVID-19 poses the biggest obstacle to building resilience against future disruptions. Budget limitations came in second at 36%, external factors other than COVID-19 at 32%, regulations at 30%, contractual obligations with suppliers at 24%, and lack of leadership and organizational silos were each selected by 22% of respondents.

4.2 Resilience360 and Business Continuity Institute Survey¹⁷

Throughout June and the first week of July 2020, Resilience360 and the Business Continuity Institute (BCI) surveyed over 350 global manufacturers and retailers from 19 sectors in 77 countries. Approximately 9.6% of respondents were from the IT sector and 8.2% were from the manufacturing sector. The results were striking:

- 73% of companies experienced detrimental supply-side disruptions as a result of the pandemic while 64% of respondents reported disruptions on the demand side.
- Approximately 30% of respondents indicated that their company would source less from the Far East. Furthermore, two thirds said they would work to move one or more suppliers closer.
- Fewer than half the organizations (49.5%) reported having a plan in place that sufficiently covered them for the supply chain issues encountered during the pandemic. However, the difficulties that arose as a result of not having sufficient plans in place has prompted many organizations to change their documentation going forward: 53.2% plan to write a comprehensive pandemic plan, and 32.3% will adapt current plans to ensure they cover supply chain issues in enough depth.

Supply Chain Transparency

The BCI Supply Chain Resilience Report 2019 showed that most supply chain incidents are caused by disruptions in a company's tier 2 and tier 3 supplier base. BCI research has shown that the levels of due diligence that organizations have been undertaking on their tier 1 suppliers has increased year-over-year: in 2012, 70.1% of disruptions occurred among tier 1 suppliers; by 2019, this figure had been reduced to 48.9%. The pandemic has underscored the importance of performing supplier due diligence. With extensive global shutdowns, knowing the geographical location of suppliers is extremely important as over half the Fortune 500 have manufacturing facilities located in Wuhan.¹⁸

¹⁷ "COVID-19: The Future of Supply Chain," *Resilience360 and Business Continuity Institute*, July 2020.

¹⁸ "City Lowdown: Wuhan," *Saville Prospects*.

Survey respondents appeared to have conducted due diligence on their suppliers. To that end, 63% of the survey respondents knew the location of their critical and non-critical tier 1 suppliers. However, beyond tier 1, only 36% of respondents knew the location of all their tier 2 suppliers, and 47.4% knew the location of critical tier 2 suppliers. Beyond tier 3, however, most firms do not conduct due diligence primarily due to the lack of manpower and financial resources required to track down these suppliers. Only 11.8% of organizations perform due diligence as deep as tier 4, and 11.3% of organizations research their tier 5 and beyond suppliers.

COVID-19 has apparently prompted organizations to focus more on the problems that can result from supplier location issues, with 60% of organizations intending to conduct a more thorough analysis of their supply chains, post-pandemic. In addition, 45.3% of organizations intend to determine the location of all their tier 2 suppliers compared to the 36% who do so currently. To map the location of their supply chains, 13.5% of respondents use a software tool and 47% use internal systems and/or spreadsheets and 39% do not undertake mapping. Post pandemic, of the companies that did not undertake supply chain mapping previously, 20.7% will now consider a software mapping tool, 49.8% will use internal systems and/or spreadsheets, and 29.5% have no plans to do anything.

Inventory

Just-in-Time (JIT) inventory remains heavily favored by companies, pre-pandemic, with many organizations also moving to on-demand fulfillment. This factor, coupled with the fact that many companies source from the Far East, requires supply chains that function smoothly. There is little leeway for error, so when the pandemic hit, many organizations faced shipment delays, first in Asia, then in Europe, and then in regions of South America. As a result, 57.2% of respondents reported that they would diversify their supplier base post-pandemic, with 29.9% looking to shift away from the Far East, and 13.2% expecting to source less from China. In fact, that organizations are looking to source goods more locally is a trend the study has picked up upon. In mid-March, BCI's first Coronavirus Preparedness Report found that 16.3% of organizations had already moved to source some or all goods more locally. Two months later, that number had jumped to 36.4%. Some companies are also speculating that industry will pivot somewhat away from JIT towards a logistics systems where local warehouses stockpile essential equipment and where products are made with fewer product variants to reduce the number of components required. In fact, 19.6% of respondents indicated that they would hold more inventory post-pandemic.

Logistics

Air cargo transportation was the mode of transportation that was most affected by the pandemic. For those survey respondents that use aircraft cargo transportation, 54.1% reported a significant detrimental impact on their organizations. 22.3% said air cargo was somewhat affected, given airport shutdowns and disruptions to normal air traffic routes. This is confirmed by the International Air Cargo Association, which reported that global air cargo freight capacity is down by 35% and only 20% of belly cargo is still flying.¹⁹ Survey respondents also noted that sea transportation was disrupted, with 25.6% indicating they experienced "severe disruptions" as ships were blocked from accessing ports and with 120 out of 126 countries implementing restrictions on crew changes. Heavy goods and rail transportation saw fewer impacts, with light goods transportation being the least effected (10.7%) as light goods typically have shorter journeys.

4.3 CFO Survey

In PricewaterhouseCooper's (PwC) first "COVID-19 Pulse Survey" survey of 50 Chief Financial Officers (CFO) (80% of which are from Fortune 1,000 companies and 44 of which are based in the U.S., with the rest in Mexico), conducted the week of March 9, 2020, 34% of CFOs said supply chain issues were among their top three concerns in the current climate. A full 30% of the companies in PwC's survey were considering making changes to existing supply chains.²⁰ By the fourth Pulse Survey, conducted between April 20-22, 56% of CFOs were planning to develop additional, alternate sourcing options for their supply chains, a dramatic increase in

¹⁹ "How is the air cargo industry reacting and responding to the COVID-19 pandemic?" *International Airport Review*, Vladimir Zubkov, May 1, 2020.

²⁰ "COVID-19 Pulse Survey," *PricewaterhouseCoopers*, March 16, 2020.

just over one month.²¹ By the sixth Pulse Survey, which surveyed 330 CFOs and finance leaders from June 8-11, 25% of CFOs believed that supply chain strategies were critical to rebuilding or enhancing corporate revenue streams.²²

4.4 McKinsey Global Institute Study²³

The McKinsey Global Institute released the “Risk, Resilience, and Rebalancing in Global Value Chains” study in August 2020. The study explores the “rebalancing act facing companies in good-producing value chains as they seek to get a handle on risk” and focuses on “risks that manifest from exposure to the most profound shocks, such as a financial crisis, terrorism, extreme weather, and, yes, pandemics.” For the study, McKinsey initially surveyed 600 global executives in December 2019 and conducted a follow-up survey in May 2020. Even before COVID-19 struck, businesses were reevaluating risks that were already manifesting throughout the world’s value chains due to China trade tensions and Brexit. Indeed, McKinsey found that:

- In their initial December survey, 70% of executives reported that they were reconsidering their supply chain strategies and global footprint, pre-pandemic.
- In a follow-up survey in May 2020, one-third of respondents cited demand variability and the difficulty of forecasting accurately as key issues.
- 28% of respondents indicated sole sourcing or the use of inputs that could not be sustained was a concern.
- Just over 25% of respondents identified long lead times or “just-in-time” inventories as vulnerabilities.

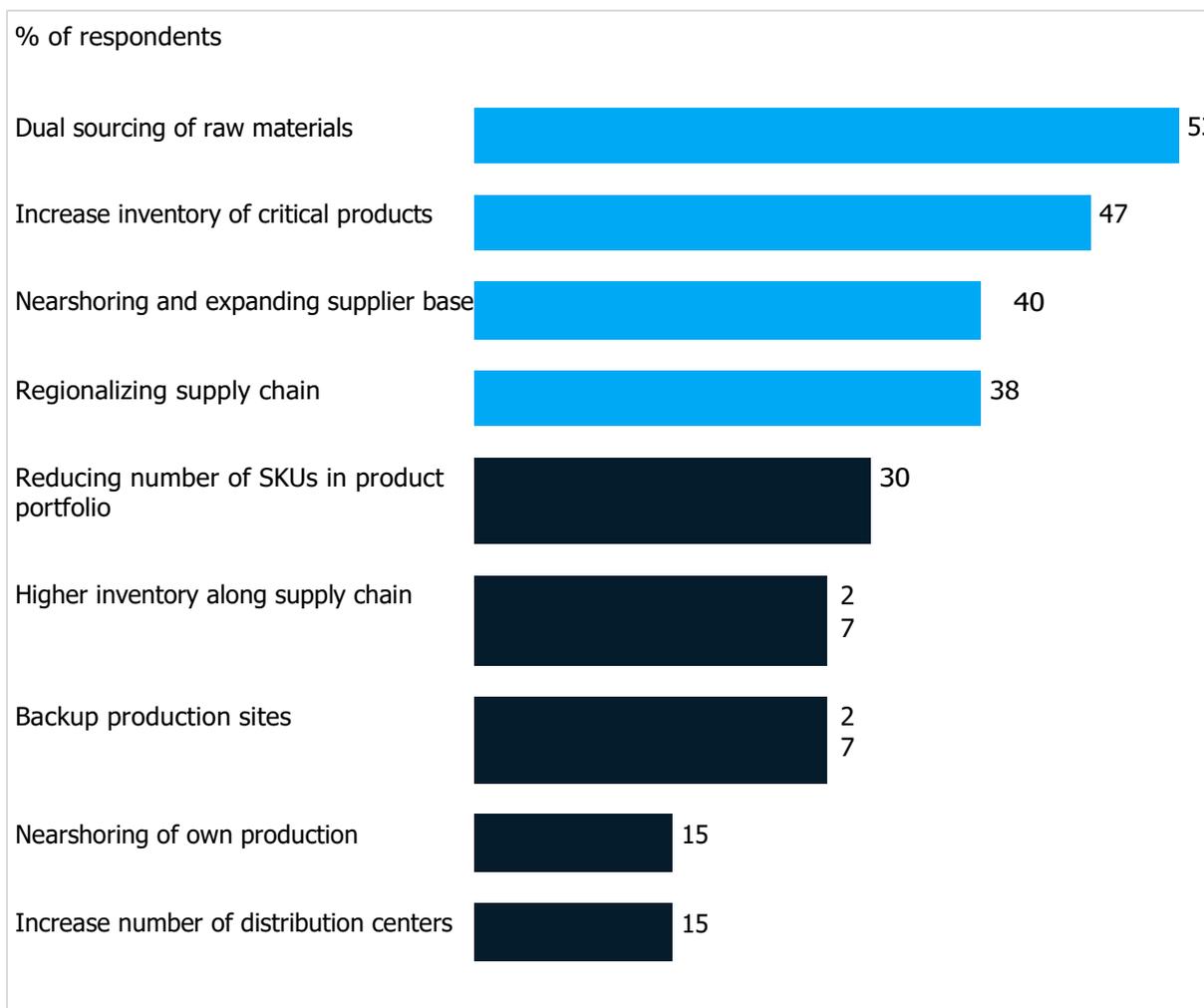
Based on the May 2020 survey, 93% of global supply chain leaders reported that they plan to take steps to make their supply chains more resilient (see Exhibit 4). In addition, 44% of business executives indicated that it was more important to increase resilience than achieve short-term savings.

²¹ “COVID-19 Pulse Survey,” *PricewaterhouseCoopers*, April 27, 2020.

²² “COVID-19 Pulse Survey,” *PricewaterhouseCoopers*, June 11, 2020.

²³ “Risk, Resilience, and Rebalancing in Global Value Chains,” *McKinsey Global Institute*, August 2020.

EXHIBIT 4 – PLANNED ACTIONS TO BUILD RESILIENCE²⁴



There are several key findings in the Report that are noteworthy as it pertains to the ICT supply chains:

Weaknesses often stem from the structure of supplier networks in value chains.

The complexity of a company’s supply chain does not necessarily mean it is a weakness, if it provides redundancies and flexibility. However, complex and vast networks can make it difficult to identify vulnerabilities and interdependencies. Indeed, a large multinational organization can have hundreds of tier 1 suppliers that it purchases components from directly. In turn, each of those tier 1 suppliers relies on hundreds of tier two suppliers. In the end, the whole supplier network for a large company can include tens of thousands of companies around the world when the deepest tiers are included in the network. Importantly, Communications Equipment companies are one of the industries that have the largest number of tier 1 suppliers, with 2.2 times the industry median.

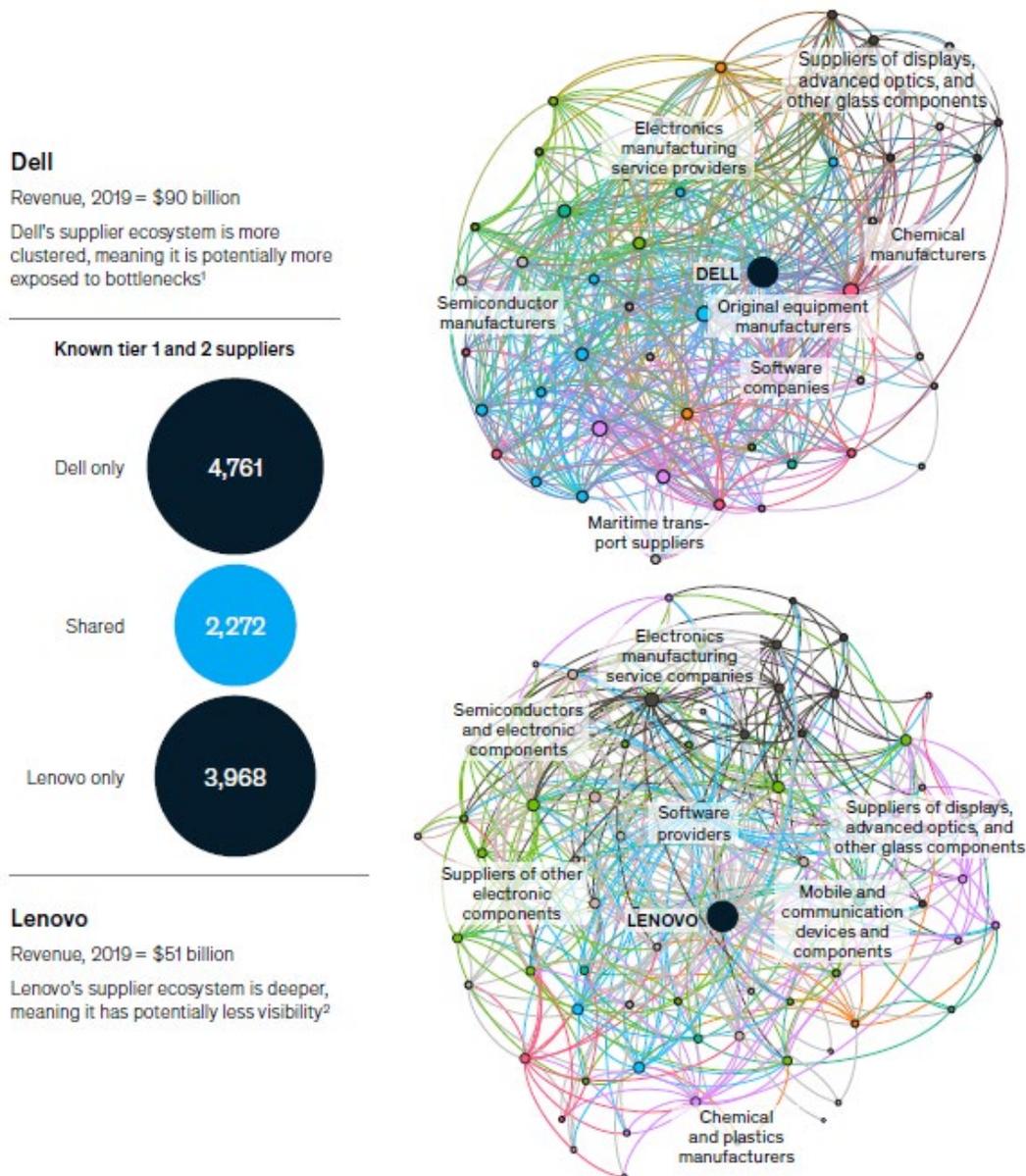
According to the study, “companies often assess their supply chain vulnerabilities exclusively based on cost, focusing on the most expensive inputs or suppliers to which they direct the largest share of spending. But a cost-only lens may miss hidden vulnerabilities in the network. Network analysis can reveal some of the hidden dependencies lurking within supply chains.” The study created a visual representation (see Exhibit 5 below) of the first- and second-tier supply chain ecosystems attached to two major Fortune 500 companies, Dell and

²⁴ “Risk, Resilience, and Rebalancing in Global Value Chains,” *McKinsey Global Institute*, August 2020.

Lenovo. Each company has a small “universe” inhabited by thousands of suppliers. The illustration demonstrates how “complex, multitiered, and multinational these networks are—and it dispels the notion that supply chains can move and reconfigure easily.” It also reveals that even within the same industry, companies may make materially different decisions about how to structure their supply ecosystems, with implications for risk.

The analysis finds that “75 percent of Dell’s 20 most connected suppliers are shared with Lenovo, and 70 percent of Lenovo’s 20 most connected suppliers are shared with Dell. Foxconn, IBM, and Microsoft are hardware and software suppliers to both companies—and are highly connected in both networks. Should one become disrupted, it would not only affect Dell and Lenovo’s existing operations but also limit their ability to secure alternative sourcing.”

EXHIBIT 5 – EXAMPLE OF SUPPLY CHAIN COMPLEXITY²⁵



²⁵ “Risk, Resilience, and Rebalancing in Global Value Chains,” *McKinsey Global Institute*, August 2020.

Operational choices can increase or decrease vulnerability to shocks. The study noted that just-in-time production, sourcing from a single supplier, and relying on customized inputs with few substitutes can intensify any disruptions from external shocks and potentially extend the time it takes for a company to recover from the shock. Furthermore, geographic concentration in supply networks can also reduce resilience. The study found that there are 180 traded products (worth \$134 billion in 2018) for which a single country accounts for the majority of exports.

The study surveyed dozens of experts in four industries (automotive, pharmaceuticals, aerospace, and computers and electronics) to understand how often shocks occur. Survey respondents report that their industries experienced “material disruptions” lasting a month or longer every 3.7 years on average. Shorter disruptions have occurred even more frequently. The study then analyzed 23 industry value chains to determine their exposure to specific types of shocks, per (Exhibit 6) below. The communications equipment value chain has the highest exposure to the collection of shocks that were analyzed. “As a heavily traded, geographically concentrated value chain, it may be caught up in trade disputes—and most of its footprint is in the Asia–Pacific region, which is vulnerable to earthquakes, tsunamis, and typhoons. The centrality of intellectual property and digital assets also heightens vulnerability to cyberattacks.”

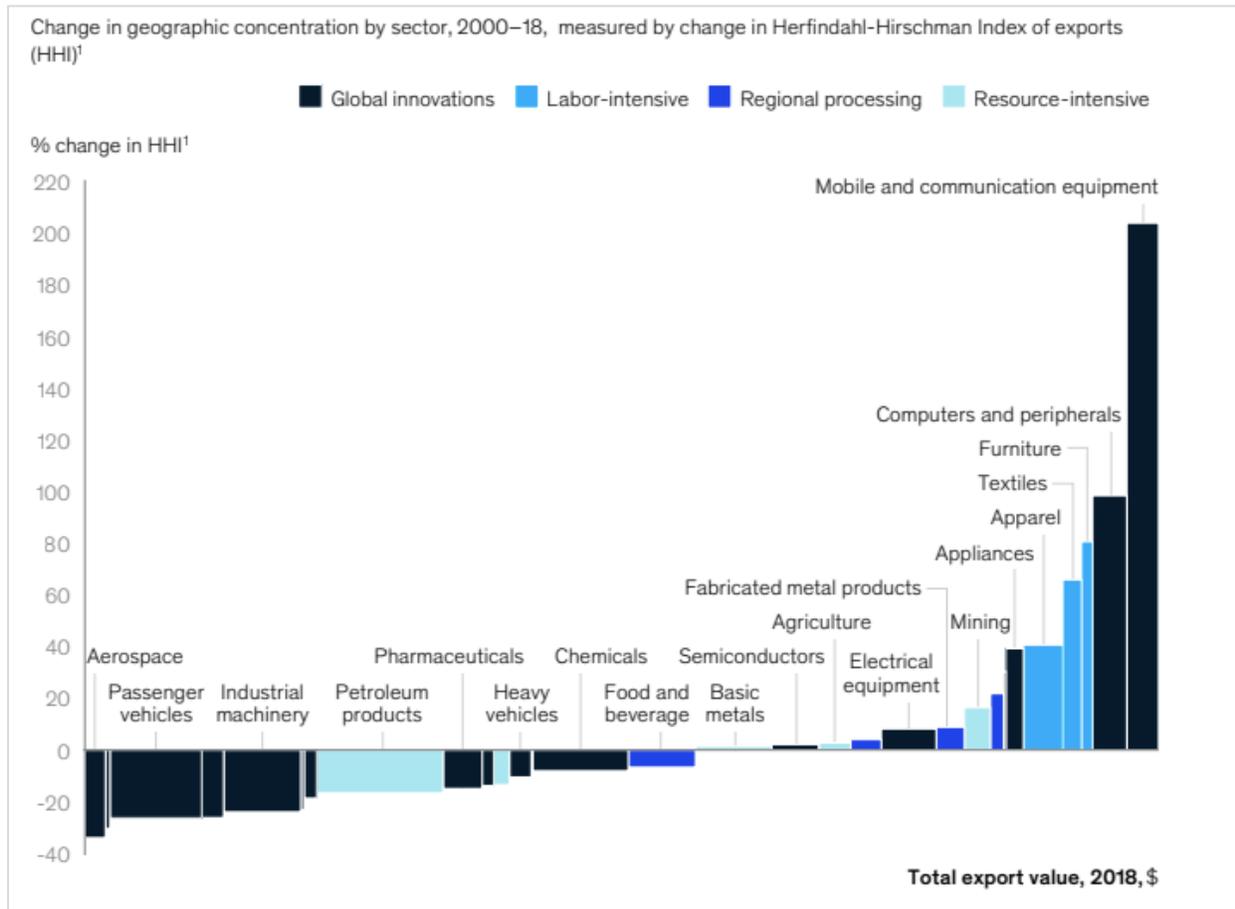
EXHIBIT 6 – VALUE CHAINS’ EXPOSURE TO SHOCKS²⁶

Value chain		Rank of exposure (1 = most exposed)						
		Overall shock exposure	Pan-demic ¹	Large-scale cyber-attack ²	Geo-physical event ³	Heat stress ⁴	Flood-ing ⁵	Trade dispute ⁶
Global innovations	Chemical	11	16	4	6	19	16	8
	Pharmaceutical	19	23	2	17	23	19	4
	Aerospace	8	2	1	18	20	21	5
	Automotive	14	6	9	12	21	18	6
	Transportation equipment	4	5	12	7	13	5	15
	Electrical equipment	16	17	11	9	15	15	10
	Machinery and equipment	18	9	10	20	17	20	7
	Computers and electronics	6	15	5	4	14	14	9
	Communication equipment	1	13	3	2	16	7	2
	Semiconductors and components	9	19	6	1	18	23	1
Medical devices	23	22	8	22	22	22	3	

Furthermore, “companies’ supplier networks vary in ways that can shape their vulnerability. Spending concentrated among just a few suppliers may make it easier to manage them, but it also heightens vulnerability should anything happen to them. Suppliers frequently supply each other; one form of structural vulnerability is a sub-tier supplier that accounts for relatively little in spending but is collectively important to all participants. The number of tiers of participating suppliers can hinder visibility and make it difficult to spot emergent risks.” The study shows that some industries, such as mobile phones and communication equipment, have become more concentrated in recent years (see Exhibit 7 below).

²⁶ Ibid.

EXHIBIT 7 – GEOGRAPHIC CONCENTRATION OF PRODUCTION BY SECTOR²⁷



The interconnected nature of value chains limits the economic case for making large-scale changes in their physical location.

Many of the issues pertaining to resilience in advanced economies revolve around the idea of increasing domestic production. However, supply chains are so interconnected that the economic case for making large-scale changes in their physical location are limited. “Value chains often span thousands of interconnected companies, and their configurations reflect specialization, access to consumer markets around the world, long-standing relationships, and economies of scale.”

The study “set out to estimate what share of global exports could move to different countries based on the business case and how much might move due to policy interventions.” The study considered a number of factors, including if there is already some movement under way. Other considerations included “whether the value chain is capital- or knowledge-intensive or tied to geology and natural resources. All of these make relocation less feasible.” Overall growth, the location of major (and rising) consumer markets, trade intensity, and innovation dynamics were also analyzed. For noneconomic factors, the study considered “governments’ desire to bolster national security, national competitiveness, and self-sufficiency.”

Exhibit 8 below illustrates these metrics for individual value chains and estimates what proportion of production for export has the potential to move to new countries. The study estimates that “16 to 26 percent of exports, worth \$2.9 trillion to \$4.6 trillion in 2018,” could move through reverting to domestic production, nearshoring, or new rounds of offshoring to new locations. Economies of scale and existing advantages leave

²⁷ Ibid.

“very little room” for semiconductor production or communications equipment sectors to move on their own. However, national security and competitiveness concerns could lead governments to take action to move their production.

EXHIBIT 8 – THE POTENTIAL FOR GEOGRAPHIC SHIFTS OF VALUE CHAINS OVER THE NEXT FIVE YEARS²⁸

Value chain	Feasibility of geographic shift		Value of exports with shift feasibility (annual exports) ¹		Total exports, 2018, \$ billion	Drivers of economic shift feasibility					
	Economic factors	Non-economic factors ²	Range, \$ billion	Share of value chain exports, %		Low	High	Low	High	Low	High
Global innovations	Chemicals	●	●	86–172	5–11	1,584	-1.4	72	26	5	57
	Pharmaceuticals	●	●	236–377	38–60	626	0	58	41	5	40
	Aerospace	●	●	82–110	25–33	333	-2.9	53	40	5	34
	Automotive	●	●	261–349	15–20	1,730	-1.6	51	16	5	60
	Transportation equipment	●	●	60–89	29–43	209	0	48	18	5	43
	Electrical equipment	●	●	213–319	23–34	928	-2.5	43	23	5	54
	Machinery and equipment	●	●	271–362	19–25	1,455	-2.2	36	19	6	50
	Computers and electronics	●	●	165–247	23–35	708	-1.9	47	57	5	53
	Communication equipment	●	●	227–363	34–54	673	9.5	51	45	5	46
	Semiconductors and components	●	●	92–184	9–19	995	10.5	62	39	5	81
	Medical devices	●	●	100–120	37–45	268	0.1	47	29	5	40

4.5 The Gartner Study²⁹

Between February and March 2020, Gartner, Inc.’s “Weathering the Supply Chain Storm Survey” gathered data from 260 global supply chain leaders responsible for supply chain and related functions across a broad range of industries, including **high-tech**, industrial and food & beverage. Respondents were located in North and South America and the EMEA and APAC regions. The survey found that 33% had moved sourcing and manufacturing activities out of China or plan to do so in the next two to three years. Survey results show that the COVID-19 pandemic is only one of several disruptions that have put global supply chains under pressure.

“Global supply chains were being disrupted long before COVID-19 emerged,” said Kamala Raman, senior director analyst with the Gartner Supply Chain Practice. “Already in 2018 and 2019, the U.S.-China trade war made supply chain leaders aware of the weaknesses of their globalized supply chains and question the logic of heavily outsourced, concentrated and interdependent networks. As a result, a new focus on network resilience and the idea of more regional manufacturing emerged. But this kind of change comes with a price tag.”

²⁸ Ibid.

²⁹ “Weathering the Supply Chain Storm,” *Gartner, Inc.*, June 24, 2020.

Tariff Costs are the Primary Reason to Move Supply Chains

For decades, China has been the go-to destination for high-quality, low-cost manufacturing, and it has established itself as a key source of supply for almost all major industries. However, Gartner research showed that the margin between those companies planning to add jobs in China versus taking them away narrowed sharply in 2019. The primary reason is the increase in tariff costs. “We have found that tariffs imposed by the U.S. and Chinese governments during the past years have increased supply chain costs by up to 10% for more than 40% of organizations. For just over one-quarter of respondents, the impact has been even higher,” Ms. Raman said. “Popular alternative locations are Vietnam, India, and Mexico. The second main reason for moving business out of China is that supply chain leaders want to make their networks more resilient.”

Balancing Efficiency and Resilience

Only 21% of survey respondents believe that they have a highly resilient network today – meaning that they have good visibility and the agility to shift sourcing, manufacturing and distribution activities around quickly. However, 55% expect to have a highly resilient network in the next two to three years – a reaction to disruptions such as Brexit, the trade war and COVID-19. However, resilience has a price. 58% of respondents agree that more resilience also results in additional structural costs to the network. “We are at a crossroads in the evaluation of global supply chains that pits just-in-time systems designed to improve operational efficiency against just-in-case plans that emphasize planning and preparing for a range of plausible scenarios,” Ms. Raman added. “To find balance, supply chain leaders must engage in risk management to assess their organization’s willingness to take risk onboard and decide how to quantify that risk against other network objectives such as cost effectiveness.”

CASE STUDY: SEMICONDUCTORS³⁰

“Semiconductor components are lightweight, modular, and high-value-added products. This combination lends itself to a heavily traded global value chain. But high barriers to entry also make the industry entrenched. While the United States designs many advanced chips, production is highly concentrated in South Korea and Taiwan, although the United States, mainland China, and other regions also manufacture some chips and electronics. Economies of scale and existing advantages leave very little room for semiconductor production to shift on its own. But national security and competitiveness concerns could lead governments to take action, potentially shifting an estimated 11 to 22 percent of trade flows.

Complex manufacturing of advanced chips is not easy to scale up. A semiconductor fabrication plant can cost \$10 billion or more to build, creating high barriers to entry. The industry requires specialized suppliers and contractors as well as large numbers of highly educated engineers with unique expertise. Two dominant hubs have emerged for making the most advanced chips: Incheon Industrial Park in South Korea, and Hsinchu Science Park in Taiwan. However, different stages of production have clustered in different geographies depending on the skills and labor required. For example, while Asia-Pacific has nearly 80 percent of global wafer manufacturing capacity at an aggregate level, the United States and Europe do have a significant amount of power semiconductor and CPU manufacturing.

Exports of electronic integrated circuits, meanwhile, tend to be concentrated in South Korea and Taiwan, although this may not provide a complete picture of production for domestic consumption or trade of subcomponents across the United States, Europe, and Asia-Pacific prior to final assembly. Outsourced semiconductor assembly and testing capacity is the final and most labor-intensive stage, which has migrated to low-cost countries. The Asia-Pacific region accounts for more than 95 percent of this capacity.”

³⁰ “Risk, Resilience, and Rebalancing in Global Value Chains,” *McKinsey Global Institute*, August 2020.

Moving Closer to the Customer

One-quarter of survey respondents stated that they have already regionalized or localized manufacturing to be closer to demand. Despite the cost of adding more players to the ecosystem and increasing the overall network complexity, regional supply chains can ease delays and shortages in times of disruption – if the model is economically viable. “Many Western organizations will have to explore new forms of automation on the factory floor to decrease the costs of near- or onshore production. Some also favor a partial option, such as manufacturing in Asia and moving only the final assembly closer to the customer,” Ms. Raman concluded.

5.0 TRANSPORTATION SUPPORTING SUPPLY CHAINS IN A PANDEMIC

Economic shutdowns in response to the COVID-19 pandemic limited business operations, manufacturing, and the movement of people and goods throughout the world. Regulatory changes including travel restrictions and stay-at-home orders had a serious impact on ICT firms’ abilities to produce and transport goods. Every mode of transportation that companies use to move their goods, including maritime and air cargo, was impacted, as detailed below. An examination of the impacts to the modes of transportation during the pandemic can offer companies’ useful insights to increase resiliency going forward.

5.1 Country of Origin Travel Restrictions - Overview

China was the first nation to enact regulatory restrictions after COVID-19 was identified in the Chinese city of Wuhan, Hubei province. After the Chinese Lunar New Year holiday, authorities encouraged factories in China to remain closed for two weeks to slow virus spread.³¹ When factories did begin to slowly open in early February, most operated at limited capacity due to safety restrictions for the work environment. Supply of components during this time was highly uncertain due to the lack of visibility and reliable communication with tier 2 and 3 suppliers, some of which used components sourced from Wuhan in manufacturing. In the first few weeks of February, shipping volumes out of Chinese ports started to plummet following national travel restrictions within China as fewer workers could get to their jobs at ports.³² From February 9-14, the wait time for container vessels spiked to more than 60 hours due to labor shortages.³³

Additional travel bans and border closures were implemented throughout March and April in China, Thailand, and Japan, affecting transportation between regions and countries. In the first week of April, global container shipping lines cancelled over 160 sailings, compared to only 45 cancelled sailings the week before.³⁴ Among shipments that did leave port, some were only 35% full when they reach Europe.³⁵ The volume of passenger flights, which also carry cargo, also decreased in China under the Five-One Policy, which restricted airlines to one international route per country, and one flight per country each week from the end of March until early June.³⁶ Exhibit 9 tracks major regulatory barriers placed through June 2020 within the three nations that are the largest maritime ICT component exporters to the U.S.: China, Thailand, and Japan.

³¹ “Coronavirus recovery: Why it’s so hard for China’s factories to get back to work,” *Fortune*, Eamon Barrett, February 18, 2020.

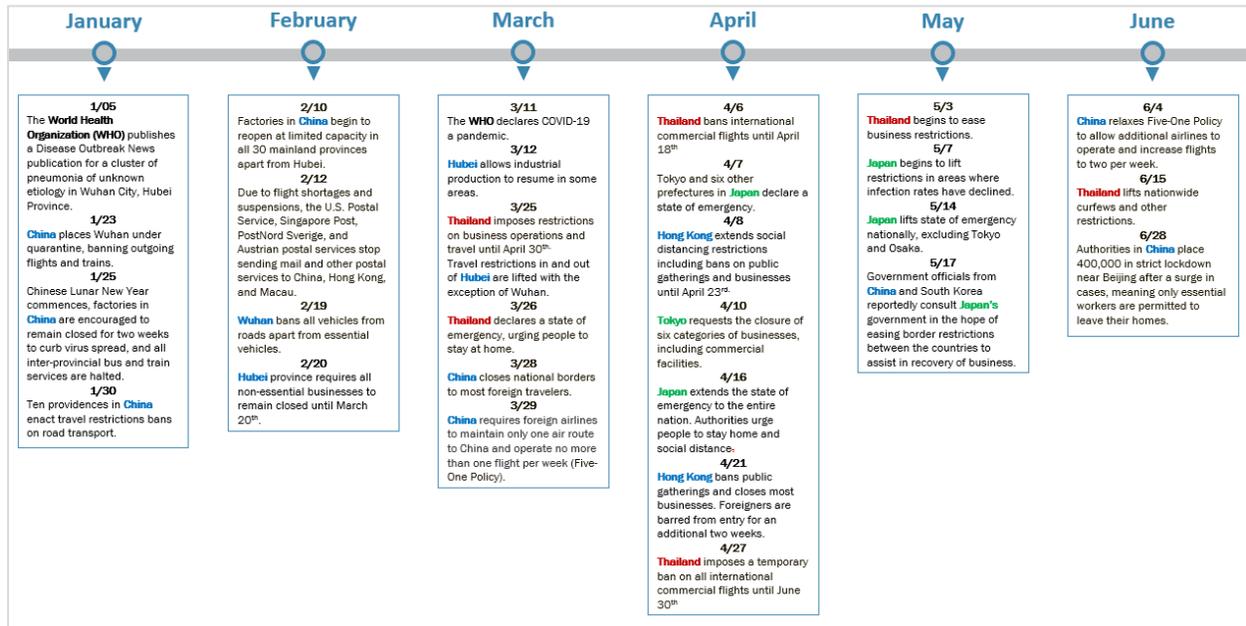
³² “China’s shipping nears a standstill amid coronavirus disruption,” *Wall Street Journal*, Costas Paris, February 14, 2020.

³³ “Coronavirus: China’s ports reach ‘turning point’ as Covid-19 backlog clears,” *Reuters*, February 27, 2020.

³⁴ “Container Shipping Lines Cancel Sailings to Weather Coronavirus Storm,” *Wall Street Journal*, Costas Paris, April 6, 2020.

³⁵ *Ibid.*

³⁶ “China’s Travel Restrictions due to COVID-19: An Explainer,” *China Briefing*, Zoey Zhang, August 28, 2020.



5.1.1 U.S. MARITIME ICT IMPORTS

U.S. reliance on Chinese-sourced ICT equipment and components has increased following initial slowdowns in 2020, indicated by sharply accelerating numbers of ICT product shipments from China in recent months. This has been paired with a rise in imports from Thailand as well, both potentially driven by increased demand for ICT products during the pandemic.

Pre-COVID-19 increases in Chinese ICT exports to the U.S. likely stemmed from the September 2019 tariff exclusion of approximately 400 Chinese products, including ICT goods.⁵³ The COVID-19-induced lockdowns and consequent stoppages of Chinese manufacturing and exports all but eliminated the import of ICT goods to the U.S., with an estimated drop of 6.4% in Chinese exports to the U.S starting in January 2020.⁵⁴ However, exports have climbed in recent months, with July 2020 seeing the second-highest level of exports from China to the U.S on record.⁵⁵

Recent maritime shipping data shows a considerable increase in imports of ICT goods from China, with a tenfold increase in monthly shipments from China between February 2020 and July 2020, along with increases in shipments from Thailand and Malaysia (Exhibit 10). The increasing prevalence of ICT imports may result

³⁷ "CHINESE CITIES CANCEL NEW YEAR CELEBRATIONS, TRAVEL BAN WIDENS IN EFFORT TO STOP CORONAVIRUS OUTBREAK," *WASHINGTON POST*, ANNA FIFELD AND LENA SUN, JANUARY 23, 2020.

³⁸ Japan Ministry of Health, Labor, and Welfare, https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/newpage_00032.html#C-3.

³⁹ "Lockdown upends people's lives," *Bangkok Post*, Thana Boonlert and Aekarch Sattaburuth, June 16, 2020.

⁴⁰ U.S. Embassy and Consulates in China, <https://china.usembassy-china.org.cn/covid-19-information/>.

⁴¹ The Civil Aviation Authority of Thailand (CAAT), <https://www.caat.or.th/en/archives/50437>.

⁴² "COVID-19 and SARS-CoV-2," *Intelligence Alert*, World Aware, March 2020.

⁴³ "Confirmed coronavirus cases top 2.5m worldwide: Live updates," *Aljazeera*, Kate Mayberry, Usaid Siddiqui, and Virginia Pietromarchi, September 9, 2020.

⁴⁴ "WHO defends coronavirus handling; UK toll rises: Live updates," *Aljazeera*, Kate Mayberry, Linah Alsaafin, and Umot Uras, April 8, 2020.

⁴⁵ "Boris Johnson in intensive care over coronavirus: Live updates," *Aljazeera*, Joseph Stepansky, and Tamila Varshalomidze, April 6, 2020.

⁴⁶ "Tokyo issues closure requests for 6 categories," *NHK World-Japan*, April 17, 2020.

⁴⁷ "China cozies up to Japan and South Korea as ties with U.S. sour over coronavirus," *the Japan Times*, Tomoyuki Tachikawa, May 17, 2020.

⁴⁸ "Coronavirus crisis disrupting flow of mail into China," *CBS News*, February 11, 2020.

⁴⁹ "China's Hubei province says it will gradually allow businesses to reopen in the coming days and weeks," *CNN*, Eric Cheung and Steven Jiang, March 11, 2020.

⁵⁰ "China's Hubei to lift production curbs, ease travel restrictions for some regions," *Reuters*, March 12, 2020.

⁵¹ "Wuhan Sharply Tightens Quarantines on Residents: Virus Update," *Bloomberg News*, February 13, 2020.

⁵² "Archived: WHO Timeline - COVID-19," World Health Organization, April 27, 2020.

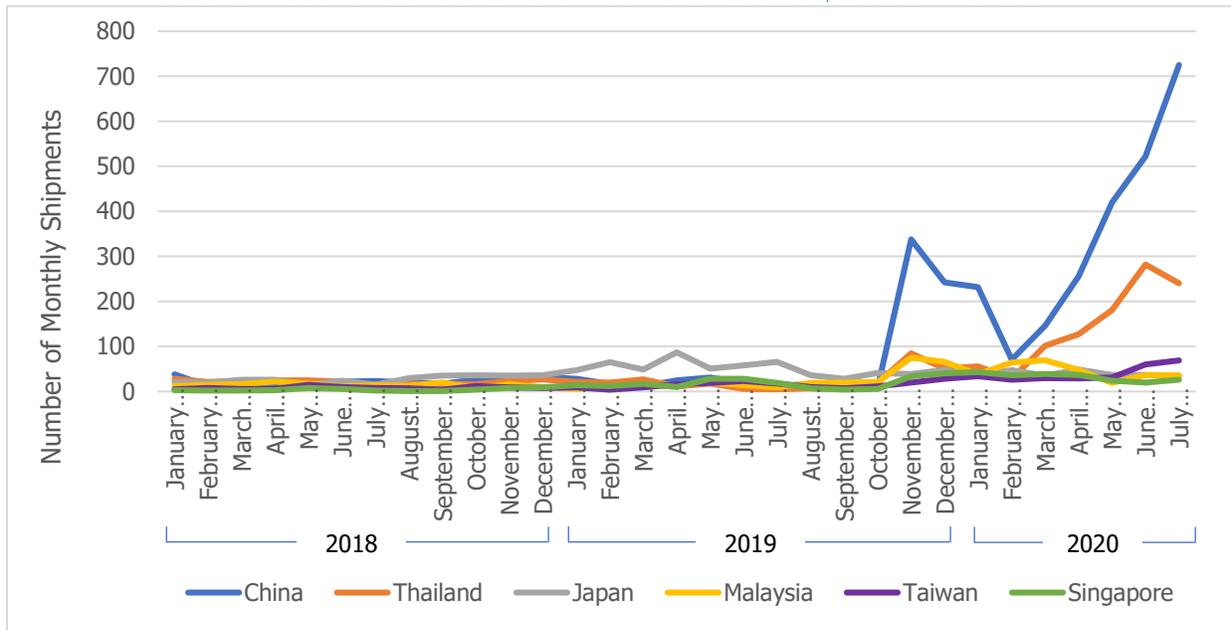
⁵³ "Timeline: Key dates in the U.S.-China trade war," *Reuters*, Heather Timmons, January 15, 2020.

⁵⁴ "China recorded trade surplus after easing of coronavirus lockdown," *Financial Times*, Tom Mitchell and Xinning Liu, April 14, 2020.

⁵⁵ "China's Exports Are Surging Despite Tariffs and Coronavirus," *New York Times*, Keith Bradsher, August 31, 2020.

from surges in demand for ICT products, including for consumer and enterprise hardware, as workforces shift to remote work environments. Furthermore, growth in ICT-related imports suggest heightened reliance on Chinese goods, exacerbating geographical risks to American ICT organizations in the second half of 2020. Nonetheless, the COVID-19 pandemic may influence ICT organizations into moving manufacturing capabilities from China to Southeast Asian countries, rather than moving to the U.S.^{56,57} The increases in shipments from East and Southeast Asian countries in the immediate aftermath of the pandemic heightens the importance to supply chain resilience of identifying alternative sources and inputs for ICT products.

EXHIBIT 10 - U.S. MARITIME ICT IMPORTS BY TOTAL MONTHLY SHIPMENTS, JAN. 2018 - JULY 2020^{58,59}



5.1.2 U.S. MARITIME – CARGO SHIPMENTS

The global shortage of shipping containers caused by the Chinese national lockdown resulted in increased shipping costs and cascading delays of global shipping and congestion at maritime ports, which negatively impacted lead-times for ICT products.

COVID-19's disruptions to national economies has impacted the global flow of shipping containers, affecting elements of global manufacturing and maritime shipping, including warehousing, port operations, and ship sailings. From January 2018 to present, the greatest number of maritime shipments of ICT product originated from China. As a result, COVID-19 related delays in loading and unloading shipping containers at Chinese ports from end of January to mid-February have had cascading effects across supply chains, increasing lead-times for goods, including ICT components and products, and exposing inherent vulnerabilities in sourcing key components or products from single regions.^{60,61} In some cases, delays at docks in China have resulted in

⁵⁶ "Trump's Trade Wars, and Now COVID-19, Are Unraveling Trade as We Know It," *World Politics Review*, Edward Alden, August 18, 2020.

⁵⁷ "No, the Pandemic Will Not Bring Jobs Back From China," *Foreign Policy*, Edward Alden, May 26, 2020.

⁵⁸ U.S. Department of Homeland Security (DHS) Customs and Border Protection (CBP), Automated Manifest System.

⁵⁹ ICT maritime imports and shipments made by 16 major ICT manufacturers and service providers. Companies were chosen by market-share as identified via IBISWorld for the following three-digit North American Industry Classification System (NAICS) codes: 517, Telecommunications; 518, Data Processing; and 334, Computer and Electronic Product Manufacturing.

⁶⁰ "Coronavirus Impact Seen Prolonging U.S. Freight Slump," *Wall Street Journal*, Jennifer Smith, February 27, 2020.

⁶¹ "Global Trade Sputters, Leaving Too Much Here, Too Little There," *New York Times*, Ana Swanson, April 10, 2020.

delays of up to six weeks for hardware including PCs, servers, and network equipment, according to Tirias Research.⁶²

Maritime shipping depends on a balance of incoming and outgoing containers from ports; any disruption to inflows and outflows can cause ripples across industries.⁶³ As port operations stalled during China's national lockdown in the immediate response to COVID-19, shipping containers set to return to service on normal schedules remained delayed in port. The lockdown concentrated the global supply of shipping containers in the country. Higher lead-times for critical components and products directly affect ICT firms' abilities to meet consumer demand. To mitigate delays due to shipping, firms could increase inventory levels. This calls for increasing inventory levels particularly during periods of supply chain disruption.

5.1.3 AIR CARGO CAPACITY

Reduced passenger air traffic has caused decreases in air cargo capacity and resultant increases in air freight costs. Prices will likely remain high until at least April 2021, negatively affecting the ability of organizations to rush shipments of key inventory.

Reduced demand for passenger air travel resulting from the COVID-19 pandemic, subsequent international travel restrictions, and time-sensitive demand for goods including personal protective equipment has increased the cost of shipping freight by air. Combined, these factors make it more costly for ICT organizations to meet consumer demand for ICT products and leave organizations reliant on just-in-time inventory management practices, which is more vulnerable to delays and increased freight costs.⁶⁴ The constraints in air freight have led to delays for components and products including laptops and semiconductors.⁶⁵

To ship by air, the air freight industry relies heavily upon cargo room in the luggage compartments of passenger airliners. When fewer passenger flights are available to move cargo, there is a significant decrease in the capacity of air freight. Passenger airlines account for approximately 45% of air freight capacity in Asia and as much as 80% in transatlantic flights.⁶⁶ In April of 2020, at the apex of the international economic downturn, demand for air freight dropped by 28% and capacity fell by 42% according to the International Air Transport Association.⁶⁷

In addition to fewer passenger flights, prices for air shipments have hit historic highs, with industry executives expecting air freight prices to remain elevated for at least the next year, according to the customs brokerage firm Flexport.⁶⁸ In late June, air freight rates were as high as 44% above the previous year's for flights from Shanghai to North Europe, while rates for freight from Shanghai to North America were 51% above the previous year's rate.⁶⁹ This decrease in consumer demand for air travel and increasing air freight costs led the decline in cargo to and from the U.S., as indicated by Exhibit 11. Decreasing demand for air freight coupled with higher prices negatively affects lead-times for key components, aggravating inventory management of goods during the pandemic.

⁶² "Employers Face Shortages of Tech Gear as Coronavirus Forces Shipment Delays," *Wall Street Journal*, Tom Loftus and Agam Shah, April 8, 2020.

⁶³ "There Aren't Enough Containers to Keep World Trade Flowing," *Bloomberg*, Jen Skerritt, March 18, 2020.

⁶⁴ "Electronics Firms Battered by High Shipping Costs," *Barrons*, Eric J. Savits, April 10, 2020.

⁶⁵ "Employers Face Shortages of Tech Gear as Coronavirus Forces Shipment Delays," *Wall Street Journal*, Tom Loftus and Agam Shah, April 8, 2020.

⁶⁶ "A Perfect Storm: How the Impact of COVID-19 has Driven Airfreight to Historic Levels," *Flexport*, Flexport, April 17, 2020.

⁶⁷ "A Booming Airline Business: Shipping Pigs to China in 747 Jumbo Jets," *Bloomberg*, Ilya Khrennikov and Alexander Sazonov, June 10, 2020.

⁶⁸ "Exploring the Future of Freight During COVID-19," *Flexport*, Flexport, April 8, 2020.

⁶⁹ "Air cargo rates fall, but historic highs likely through summer," *JOC*, Greg Knowler, June 23, 2020.

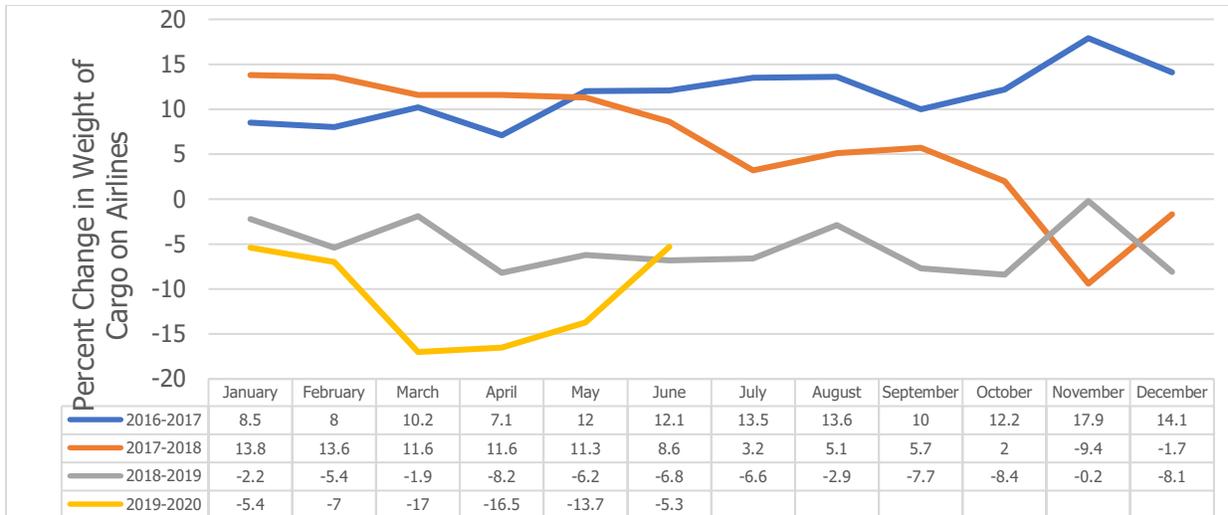


EXHIBIT 11 – TOTAL CARGO TO AND FROM THE U.S.: PERCENT CHANGE FROM THE SAME MONTH OF THE PREVIOUS YEAR JAN. 2016 – JUNE 2020⁷⁰

6.0 ISSUES FACING COMPANIES CONTEMPLATING SUPPLY CHAINS SHIFTS

Beyond the difficulty of making supply chain shifts, it is imperative to recognize that over both the short and long term, communications and technology companies will face multiple tax and financial hurdles, long-term contract commitments, and business uncertainty that will present difficulties in their efforts to quickly modify their supply chains. These factors, coupled with the fact that many of these companies are already facing reduced revenues and increased costs due to the economic downturn, will put intense pressure on companies to weigh heavily the cost/benefit analysis of selective modifications to their supply chains. Companies may be faced with shareholder pressure to demonstrate both the knowledge and foresight to handle both the current crisis as well as future crises, balanced against the need to conserve cash during difficult financial times.

Tax Implications

The Study Group found technology and communications companies will be faced with both financial and transfer tax implications due to supply chain shifts that could substantially affect their balance sheets (Exhibit 12).⁷¹

⁷⁰ Department of Transportation Bureau of Transportation Statistics, Air Carrier Statistics database T-100 International Market (All Carriers), https://www.transtats.bts.gov/Databaselnfo.asp?DB_ID=111.

⁷¹ “COVID-19 and The Technology Industry,” PwC.

ANTICIPATED CHALLENGES	ANTICIPATED CHALLENGES
<p>Financial Reporting:</p> <ul style="list-style-type: none"> ▪ Operational, workforce, and supply chain disruptions may trigger financial reporting implications in current and future period. ▪ Public companies will face increasing pressure to disclose revised guidance related to the COVID-19 impact. ▪ A number of telecom companies have high debt loads, which could put pressure on their debt-reduction program as dividends are maintained. 	<p>Tax and Trade:</p> <ul style="list-style-type: none"> ▪ Supply chain reconfiguration may trigger tax implications. ▪ The “threshold for creating a taxable presence for corporate income tax purposes in a country is lowered, with inventory holding, warehousing functions, and sales activities being particular targets,” according to Ronald van den Brekel and Tim Meijer, both transfer pricing specialists at the professional services firm EY.⁷³ Creating a taxable presence brings on a significant obligation for tax filings as well as the possibility of new taxes in what could be many supply chain locations. ▪ New state and local tax implications may arise for workers who are now remote as a result of the crisis.

Contract Commitments

Furthermore, technology and communication companies have long-term commitments to their suppliers and manufacturers that they cannot likely cancel without financial repercussions. As such, in the short-term, companies will need to determine if a break-up fee is more beneficial than staying the course with existing manufacturers and suppliers. Indeed, Apple CEO Tim Cook said in late February that the company was not looking to make any quick moves out of China in light of virus-related supply-chain interruptions, stating “we’re talking about adjusting some knobs, not some sort of wholesale, fundamental change.”⁷⁴ Detailed below, for example, is an excerpt from Apple’s Q1 2020 10Q SEC filing, which details the billions of dollars’ worth of their contracts that are subject to non-cancelable terms.

⁷² Ibid.

⁷³ “The Impact of BEPS on Tax Compliance,” *International Tax Review*, Ronald van den Brekel and Tim Meijer, March 8, 2016.

⁷⁴ “Apple’s Cook Sees Minor Supply Chain Changes in Wake of Virus,” *Bloomberg*, Mark Gurman, February 28, 2020.

Apple 10Q SEC Filing for Quarter Ending March 28, 2020

Manufacturing Purchase Obligations: The Company utilizes several outsourcing partners to manufacture sub-assemblies for the Company's products and to perform final assembly and testing of finished products. These outsourcing partners acquire components and build product based on demand information supplied by the Company, which typically covers periods up to 150 days. *The Company also obtains individual components for its products from a wide variety of individual suppliers. As of March 28, 2020, the Company expects to pay \$29.3 billion under manufacturing-related supplier arrangements, which are primarily non-cancelable.*

Other Purchase Obligations: The Company's other purchase obligations consist of *non-cancelable obligations to acquire capital assets*, including product tooling and manufacturing process equipment, and non-cancelable obligations related to advertising, licensing, R&D, Internet and telecommunications services, content creation and other activities. *As of March 28, 2020, the Company had other purchase obligations of \$8.7 billion.*

Business Uncertainty

Wall Street and corporate CEOs highly value certainty. According to the *Wall Street Journal*, "more than 40% of the S&P 500 companies have pulled their guidance, as the COVID-19 pandemic has doused U.S. corporations in uncertainty, and their shares together have fallen more than the broader index. Through June 25, 2020, at least 218 companies from a variety of industries have withheld their quarterly or annual guidance. Many cite the uncertainty of the pandemic for their tentativeness, but some point to the likelihood of additional outbreaks, evolving consumer habits, and levers such as the need to boost pay for front-line workers.

Telecommunications, automotive, industrial goods and leisure companies had the highest percentage of guidance withdrawals, from January 15 to June 25."⁷⁵ This unprecedented pulling of guidance demonstrates how difficult it will be for the C-suite to make major decisions regarding supply chain changes during a period of decreased demand, increased costs, and a guide path that is not well lit. Appendix B provides excerpts from corporate SEC filings and earnings calls that detail the business uncertainty facing many ICT companies due to the pandemic's impact on their supply chains. Appendix B details the challenges that ICT companies are currently facing during the pandemic.

7.0 CAN MANUFACTURING COMPANIES BE INCENTIVIZED TO MOVE?

Given what the pandemic has exposed about the vulnerabilities of supply chains when they are located outside of the U.S., there are many ideas under discussion about how best to fortify supply chains so that these complications do not happen so profoundly again. There are numerous factors that companies may take into consideration when they determine where and how to manufacture and source. These include potential increases in customer demand, personnel and input costs, speed to market, cutting-edge technologies, and the availability of specialized workforce skills. All require a financial commitment and while supply chain resiliency plays an important role, it is not the only factor that a company considers when making decisions of what is best for the organization.

A central idea is to entice manufacturing companies and key suppliers to 'come home to the U.S.' or to 'stay home.' In order to achieve this, many believe the best approach would be to offer companies inducements, which could include tax breaks and incentives, as well as the establishment of new rules and carefully structured subsidies to attract business back to the U.S.

On the other hand, many do not believe a rush to create enticements is warranted and believe that over time, the free market will help dictate the best solutions for each company. To that end, a review of thirty different studies by the Upjohn Institute discovered that incentives actually influence a company's decision to invest in

⁷⁵ "More than 40% Companies In S&P 500 Pull Guidance," *Wall Street Journal*, Allison Prang, June 29, 2020.

less than a quarter of all cases. Therefore, in most cases, a company would have made the investment with or without the tax break or other incentive.⁷⁶ In a free market economy, each company will make its own decisions about what is best for their shareholders, thereby reducing the risk of encountering the unintended consequences and competitive disadvantages that can occur as a result of government actions. This may result in a company leaving manufacturing in China, shifting to other countries, coming home to the U.S., or some combination thereof.

Government Action: Legislation and Federal Funding to Promote Onshoring

In March 2020, Congress passed, and the president signed into law, the Coronavirus Aid, Relief, and Economic Security (CARES) Act, a \$2.2 trillion economic stimulus bill to address the economic impact of the COVID-19 pandemic. The CARES Act requires that the Treasury Department condition the loans on certifications that loan recipients will not outsource or offshore U.S. jobs.⁷⁷

In May 2020, the President again promoted onshoring by issuing an Executive Order (EO) delegating authority under the Defense Production Act (DPA) to the U.S. International Development Finance Corporation (DFC) to support domestic industrial base capabilities needed to respond to COVID-19. The EO provided authority to the DFC to make loans that would “create, maintain, protect, expand, or restore *domestic industrial base capabilities*” supporting “the national response and recovery to the COVID-19 outbreak” or “the resiliency of any relevant *domestic supply chains*.”⁷⁸

In July 2020, the House and Senate passed their respective versions of the FY21 National Defense Authorization Act (NDAA), with both bills including provisions to promote onshoring. To that end, the Senate bill would provide new authority to the Department of Commerce to provide grants to “covered entities” to construct, expand, or modernize facilities related to semiconductor manufacturing and research and development. The House bill includes a similar provision. While the two bills must be reconciled in conference, the conferees are expected to preserve the semiconductor provisions in the final bill. Other FY21 NDAA provisions seek to reduce reliance on China for “critical minerals” and “rare earth elements” by bolstering domestic production and supply chains for these key materials and establishing the goal to “[e]nsure, by 2030, secure sources of supply for strategic minerals.”⁷⁹

8.0 THE PATH FORWARD

8.1 Companies May Hold More Inventory

According to the McKinsey Global Institute, the trend is already underway for many sectors to hold more inventory, including the ICT sector. Given that shocks are growing in frequency and intensity, companies may need to revisit past calculations about how much inventory stock to carry and it appears that this is already under way. From 2017 to 2019, most value chains had lower inventory turnover than they did in the period from 2010 to 2012, per Exhibit 13 below:⁸⁰ Furthermore, the findings of the Study Group indicate that both small and large ICT companies will indeed hold more inventory in the future, based on the adverse implications of the shortfalls that they experienced during the pandemic.

⁷⁶ “Everything You Think You Know About Corporate Tax Incentives is Wrong,” *Fast Company*, Amihai Glazer, February 25, 2019.

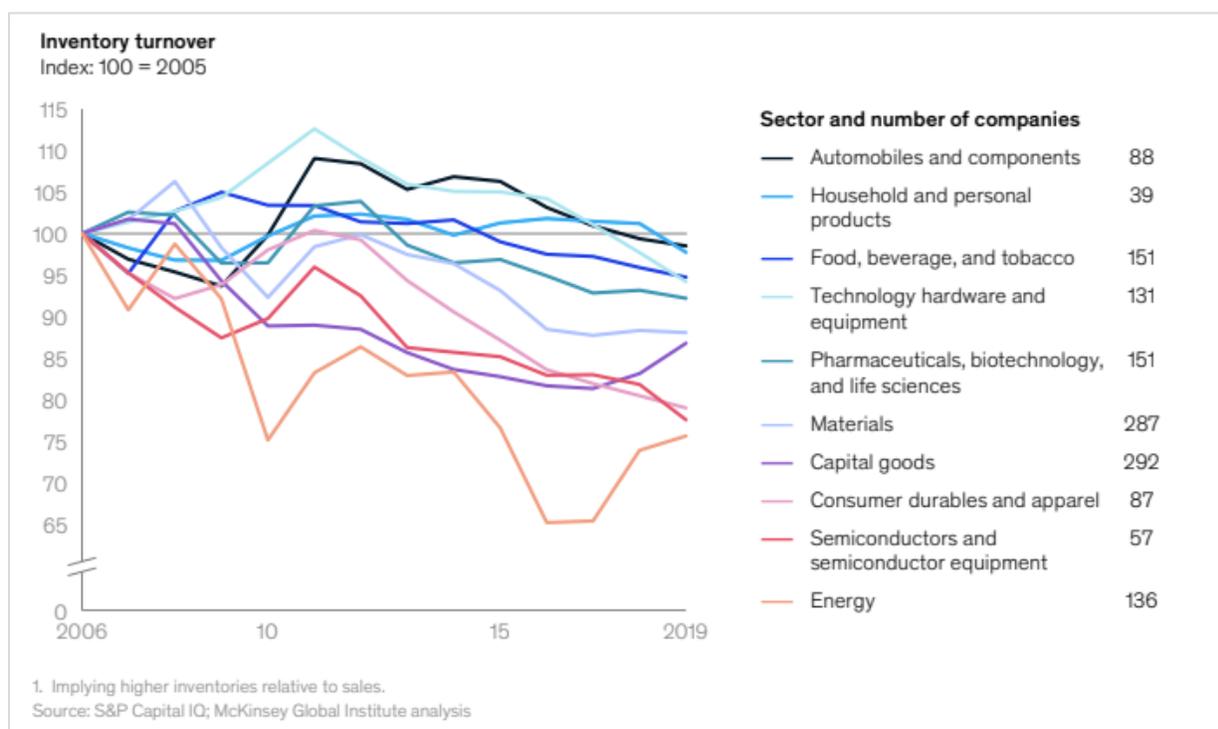
⁷⁷ “Senate Passes \$2 Trillion Economic Stimulus Package,” *Los Angeles Times*, Sarah Wire, March 25, 2020.

⁷⁸ “Executive Order on Delegating Authority Under the DPA to the CEO of the US International Development

Finance Corporation to Respond to the COVID-19 Outbreak,” THE WHITE HOUSE, May 14, 2020.

⁷⁹ “U.S. Decoupling from China and the Onshoring of Critical Supply Chains: Implications for Private Sector Businesses,” *WilmerHale*, Jamie Gorelick and Stephen Preston, August 26, 2020.

⁸⁰ “Risk, Resilience, and Rebalancing in Global Value Chains,” *McKinsey Global Institute*, August 2020.



8.2 A Shift Away from Single-Source and Single-Region Manufacturing, Including in China

Many American firms, including those in the technology and communications space, derive robust, recurring, and new growth revenue from sales in China that account for a substantial amount of their overall corporate revenue. The size of China’s marketplace and the sales growth potential of this market will continue to attract businesses to China from around the globe. As a result, in these cases the companies are manufacturing close to their consumer and it may not make good business sense to move further away from them. For example, in April 2020, at the very moment that the Japanese government announced plans to pay Japanese companies to leave China, 22% of Japanese companies surveyed by the Japan External Trade Organization indicated that they planned to expand their business in China, up 7% from the previous month.⁸²

While it is doubtful that China will fully give up its standing as the world’s electronics center in the short term, it appears that a manufacturing sea-change that had already begun may continue to progress over the coming years. The COVID-19 pandemic and U.S./China trade issues have simply made it too difficult for companies to fully vest their supply chains in one place. Indeed, according to the law firm WilmerHale, “in recent years, a range of U.S. oversight and enforcement authorities have been reviewing Chinese trade issues. Since the COVID-19 pandemic, both US political parties have emphasized concerns about supply chain vulnerability and US dependence on China. We can expect oversight and enforcement leaders to assess potential inquiries through this lens. While recipients of federal funding can always expect scrutiny, the global impact of COVID-19 has made all Chinese operations ripe for investigation. New investigations have emerged, and we expect this trend to continue. Companies doing business in China and offshore can expect scrutiny of how they may have used any CARES Act or other COVID-19-relief funds, given the recent focus on onshoring. Ensuing investigations by executive agencies likely will be rooted in the False Claims Act (FCA) and the Foreign Agents

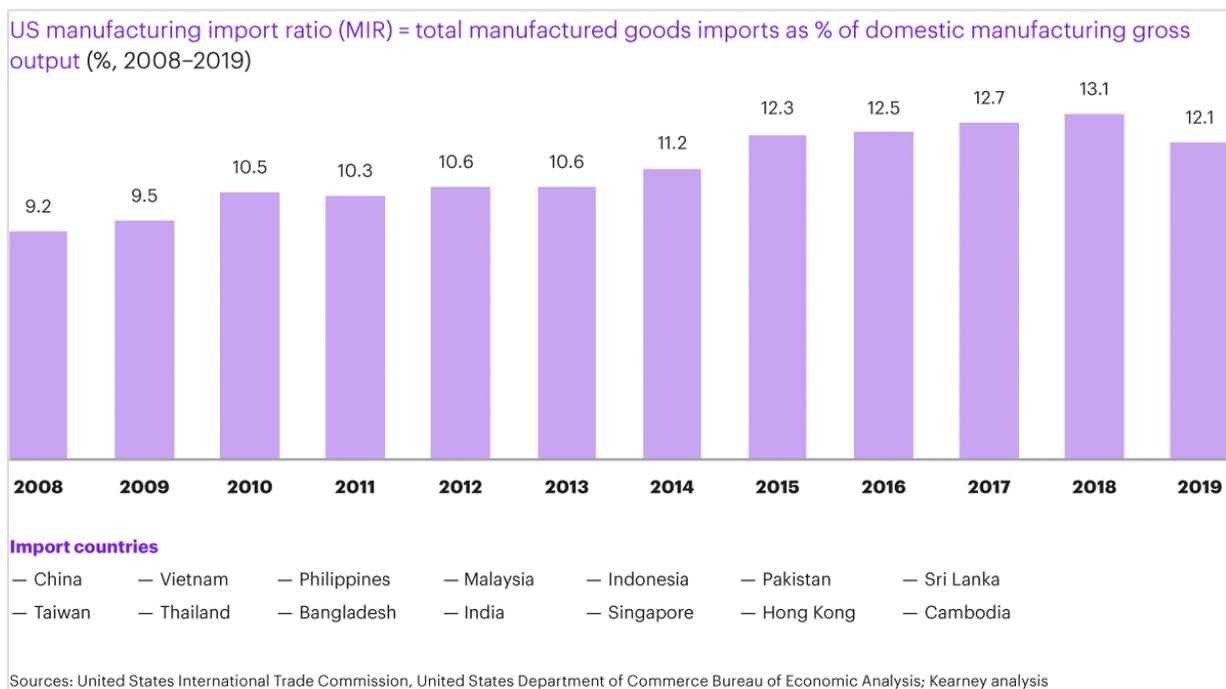
⁸¹ Ibid.

⁸² “U.S. Decoupling from China and the Onshoring of Critical Supply Chains: Implications for Private Sector Businesses,” *WilmerHale*, Jamie Gorelick and Stephen Preston, August 26, 2020.

Registration Act (FARA). Moreover, continued congressional investigations focused on Chinese trade, particularly in the tech and health sectors, are likely on the horizon.”⁸³

In the short term, it will be difficult to duplicate the complex network of suppliers, skilled workers, efficient distribution systems and large domestic market that China provides. A large-scale relocation of manufacturing capabilities will likely take time. Still, the outward-bound trend is accelerating. According to consulting firm Kearney’s 2019 Annual Reshoring Index, 2019 marked “a dramatic reversal of a five-year trend, as domestic U.S. manufacturing in 2019 commanded a significantly greater share versus the 14 Asian low-cost countries (LCCs), with manufacturing imports from China registering a particularly sharp decline.”⁸⁴ In 2019, U.S. imports from the LCCs decreased from \$816 billion in 2018 to \$757 billion in 2019, a 7.2% decrease. In the meantime, U.S. domestic gross output of manufactured goods was \$6.271 billion in 2019, virtually unchanged since 2018. Given that U.S. manufacturing held steady while imports declined, the manufacturing import ration (MIR) was 12.1%, meaning the U.S. market imported 12.1 cents worth of offshore production from Asian LCCs for every \$1 of domestic manufacturing gross output (see Exhibit 14 below). China had the largest decrease in U.S. imports, a full 17% reduction (or \$90 billion) due in large measure to the trade/tariff issues between the U.S. and China.

EXHIBIT 14 - U.S. MANUFACTURING IMPORT RATIO 2008-2019⁸⁵

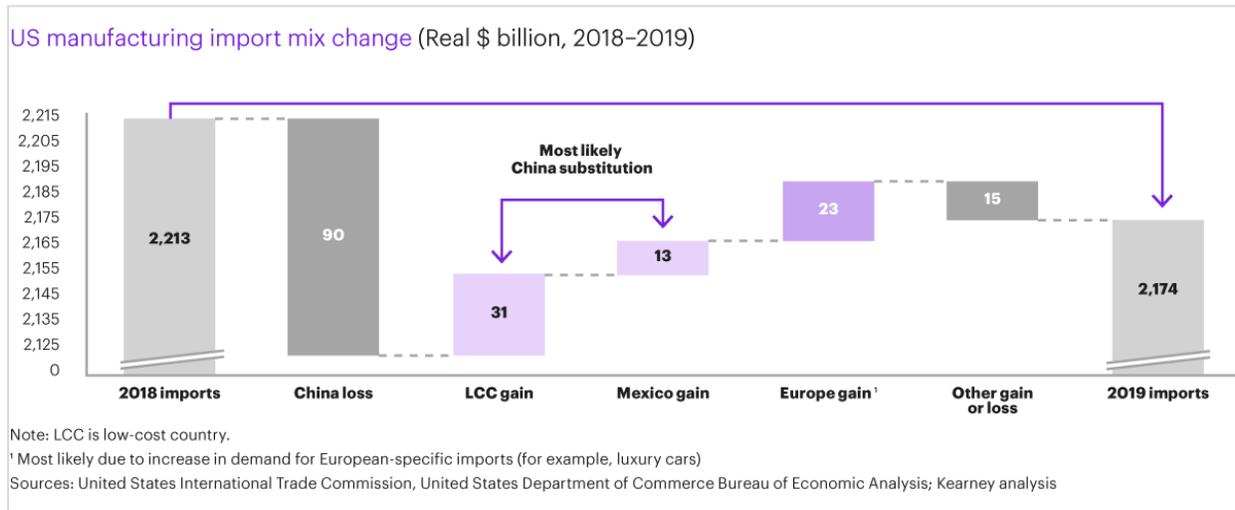


China’s loss has been a gain for the other LCCs and Mexico, as they picked up \$31 million and \$13 million of U.S. manufacturing imports, respectively (see Exhibit 15 below). Since 2013, when China made 67% of all U.S. bound Asian-sourced manufactured goods, it has since seen a steady erosion of its manufacturing strength; by Q2 2019, China’s share of goods was down to 56%.

⁸³ “U.S. Decoupling from China and the Onshoring of Critical Supply Chains: Implications for Private Sector Businesses,” *WilmerHale*, Jamie Gorelick and Stephen Preston, August 26, 2020.

⁸⁴ “U.S. Reshoring Index,” Kearney, April 2020.

⁸⁵ *Ibid.*



Indeed, many device makers serving customers beyond just Apple are leaving China (but not Asia). For example, Meiloon Industrial Co, which makes speakers and counts Harman International Industries among its clients, said it is seeking alternatives to China-based production and was speeding up a move of capacity to places like Taiwan and Indonesia. According to Bloomberg, the following international iPhone companies are making moves away from China:⁸⁷

- **Wistron Corp.**, one of Apple’s manufacturing partners, said half of its capacity could reside outside China within a year. The declaration underscored how the Asian assemblers that keep the world supplied with iPhones and other gadgets are shifting to a higher gear after COVID-19 showed the folly of staking everything on one country. Taipei-listed Wistron is targeting India - where it is already making some iPhones - along with Vietnam and Mexico, setting aside \$1 billion to fund the expansion this year and next.
- iPhone assembler **Pegatron** is also diversifying manufacturing sites, including adding capacity back home in Taiwan. The company hopes to kick-start manufacturing operations in Vietnam in 2021 after setting up a new plant in Indonesia last year, and it is looking further at India as a location for new facilities. The company also said it had agreed to purchase land and a plant in northern Taiwan.
- Apple’s main assembly partner for AirPods, **Inventec**, is preparing to establish a unit in Vietnam.
- More than any other assembler, Hon Hai demonstrates how COVID-19 brought the world’s No. 2 economy to a standstill. Better known as **Foxconn**, it portrays a potential shift in the global production paradigm that has governed the electronics industry well over three decades. The company also has facilities in India, where it began churning out iPhones last year, and Vietnam. “Trade, the virus, all these things will make the world very different in the next decade,” Alex Yang, the company’s investor relations’ chief, told investors in a recent call.⁸⁸

9.0 RECOMMENDATIONS TO BUILD SUPPLY CHAIN RESILIENCY

Based on the research and analysis conducted as well as the discussions with ICT companies both large and small, the Study Group makes the following practical recommendations that ICT companies may want to adopt to increase their supply chain resiliency:

⁸⁶ Ibid.

⁸⁷ “Coronavirus is Expediting iPhone Makers’ Plans to Move Beyond China,” *Bloomberg*, Debby Wu, March 27, 2020.

⁸⁸ Ibid.

9.1 Proactive Risk Classification

In an effort to deal with the current pandemic and future events, the Study Group recommends that technology and communication companies may want to continue to refine their supply-chain risk-management approach. Smaller companies may currently rely mostly on reactive measures to supply chain issues but both small and large companies will likely want to enhance their supply-chain risk management capabilities given the financial burden that has resulted from the supply disruptions they some have experienced. To that end, companies may want to deploy a systematic classification of risks, continually analyze developments and events that are happening around the world and undertake the development of a related response strategy to improve supply-chain resilience strategically.

9.2 Map the Corporate Supply Chain

An essential element to identifying risks, anticipating disruptions, and responding to them is to have a detailed map of your supply chain. However, as the Study Group noted, many large firms have only a murky view beyond their tier 1 and larger tier 2 suppliers and many are unfamiliar with critical component suppliers in deeper tiers. For small and medium sized firms, it is even more difficult to obtain this knowledge. Complete transparency across the whole value chain, from the extraction and production of raw materials all the way through to the sale to the customer, remains elusive for even the most advanced companies. For smaller firms that often lack the resources of their larger counterparts, the feasibility of mapping their supply chains beyond tier 1 is much more problematic.

To evaluate a supply chain, production and supply chain team members can review each product's bill of materials (BOM) to determine if critical inputs are sourced from single source, single region suppliers or if there is a lack of available product substitutions. Understanding the structure of upstream supply chains can allow a purchaser to evaluate both whether a particular vendor may have upstream supply chain risks that the vendor should provide evidence it has, as well as whether multiple vendors may all share the same supply chain risks. This sharing of information requires that vendors have permissions from their suppliers to share their *upstream* suppliers. The Confidentiality, Integrity, and Availability (CIA) requirements to protect such a database would also need to be defined. Nevertheless, creating a risk mitigated index tool for each commodity, component, and assembly, based on uniqueness and location of suppliers is extremely useful.

To that end, developing a detailed map of junior-tier suppliers is a critical step to detect hidden relationships that can create a lack of resiliency. Companies can work with their tier 1 suppliers to create this necessary transparency as these suppliers can have the same concerns about their own vendors. However, some suppliers may not have visibility themselves or may consider their suppliers to be proprietary, and therefore may be unwilling to share this information. In these cases, organizations may need to investigate or hypothesize about who these junior tier suppliers are by gathering information from a variety of public sources or business data providers. After mapping upstream suppliers, purchasers of ICT products also must be aware of the production locations and financial stability of each participant in the value chain that supplies a critical component or constitutes a potential logistical bottleneck, see Appendix A.

9.3 Broaden Supplier Network and Regional Footprint

As the Study Group learned, some manufacturers rely on a single source for raw materials or critical product components. This can be due to the fact that there is only one supplier that makes the necessary component. In other cases, companies seek to simplify purchasing or achieve enhanced pricing by going with a single supplier even though other suppliers may be available. This can create a tremendous vulnerability for a company if this supplier goes down or experiences delays. Furthermore, it may also become a constraint to growth if the supplier cannot meet a company's request for increased production during times of rising demand.

Even if a company has multiple suppliers, another vulnerability may arise if they are located, in a single geography because of the way specializations and business consolidations have occurred. For instance, just five regions (mainland China, Taiwan, South Korea, Singapore, and the United States) account for three-

quarters of global exports in semiconductors. China, Vietnam, the United States, the Netherlands, and South Korea account for three-quarters of exports in telecommunication equipment.

To eliminate some of this risk, when possible, companies can create more resiliency and redundancy in their networks by dual-sourcing supply from multiple or lower-risk regions. This can reduce the risk that a natural disaster or event in one area can create a chokepoint that slows down or stops the entire supply chain. Companies should identify and vet backup vendors and work with them in advance to bring them up to speed so that when a crisis does hit, the supplier is ready to step in to reduce supply chain disruptions. While this can be a costly and time-consuming proposition, the ability to move production across suppliers, vendors, factories, and countries as needs warrant will allow an organization to return to normalcy more quickly after a disruption event.

It is important to remember that larger companies with operations throughout the world have selected their facility locations to serve local marketplaces and exports from that area may be less important. To that end, many global companies with a presence in China are there to sell to the country's rapidly expanding industries and large consumer base, not to produce goods and ship them overseas. However, the need to be closer to the customer and for diversification should induce firms to add redundant sourcing and enhanced capacity.

9.4 Potential Development of Standardized Mapping and Other Illumination Tools

While there is a strong consensus about the need to more effectively map the locations of sub-tier suppliers and to identify upstream logistical bottlenecks, currently there is no standard methodology for doing so. For example, while communications service providers confirmed with the Study Group their need to better understand their upstream supply chain risks (including identifying risks that may be shared across multiple tier 1 suppliers), currently each individual service provider needs to separately engage each of its vendors to agree on what information that vendor will supply and in what format. This creates substantial inefficiencies for both customers and vendors because each customer needs to develop its own set of questions and requests (often not having a strong understanding about the vendor's particular sensitivities about sharing certain supply chain information), and each vendor needs to separately respond to different requests from different customers for whatever information each one considers relevant. The ICT sector may thus benefit from the development of standardized approaches to supply chain mapping that would place appropriate focus on sub-tier suppliers or logistical bottlenecks that are most critical; would care for legitimate vendor concerns about being pressed to provide proprietary information; and would settle on common formats for providing maps and other information.

9.5 Work to Hold Buffer Amounts of Inventory

The Study Group recognizes that many ICT manufacturers utilize just-in-time inventory practices which attempts to hold down costs by keeping stockpile inventories low and delivering goods as needed and which is the opposite of the "just in case" methodology that calls for holding more inventory in reserve. Indeed, investors typically penalize companies for holding excess capacity. Given the resiliency issues that surround just-in-time inventories and which were revealed during the pandemic, the Study Group recommends that companies explore holding more buffer inventories and also working with their suppliers to hold inventory at their warehouses, through a Vendor Managed Inventory system. Furthermore, ICT manufacturers should continue to work to utilize meaningful metrics, such as orders delivered complete, accurate and on-time, as well as time related metrics like days of inventory and cycle time. For ICT service providers and equipment vendors, the pandemic revealed that their ability to rapidly adapt to shifting workers from the office to home and working safely in the field was paramount. To that end, robust contingency planning is crucial for companies.

9.6 Plan Alternatives in Logistics and Transportation

During the pandemic, Study Group members noted that almost every mode of transportation in impacted areas was affected. Cargo ships were stranded in ports or not let into ports, airports were closed, cargo flights were canceled, and trucking firms had difficulty ensuring that employees had access to food and comfort facilities.

To reduce the impacts of transportation and logistics issues, companies can engage in scenario planning for different types of events and map out the alternatives that can allow for the supply chain to be brought more quickly back online. The companies in the Study Group that had robust contingency plans in place that addressed potential transportation and logistics bottlenecks, fared better in bringing their products and services to market than those that did not. To further assist in these efforts, companies can utilize technology platforms that provide real-time, blockchain visibility into available logistics capacity. Companies can also do planning and analysis that can help identify alternative providers for each key route.

10. SUMMARY

The aforementioned supply chain issues identified during the COVID-19 pandemic are complex and lack simple solutions. The United States and other advanced industrial economies have created a highly efficient and effective manufacturing-and-delivery system that provides them with a wide variety of products at relatively low costs. But integral to that system are the dependencies and expectations that the pandemic has called into question. Going forward, U.S. firms in the ICT sector should continue to diversify their supply chains and inventory practices, albeit at a pace that takes into account economic realities. These strategies will likely become clear over time as firms gain more clarity around the impact of the pandemic on their businesses.

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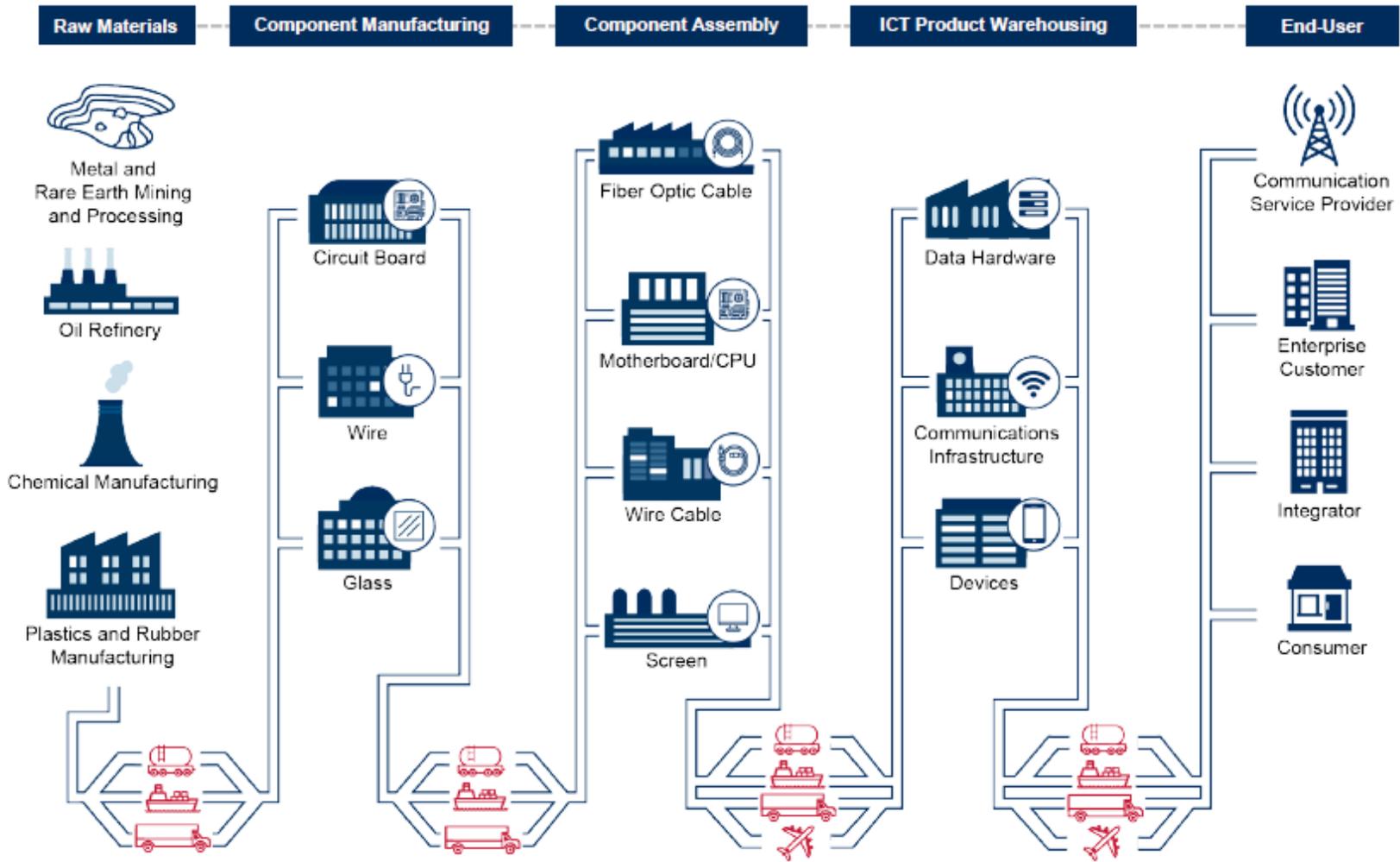
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APPENDIX A: ICT SUPPLY CHAIN SYSTEM MAP



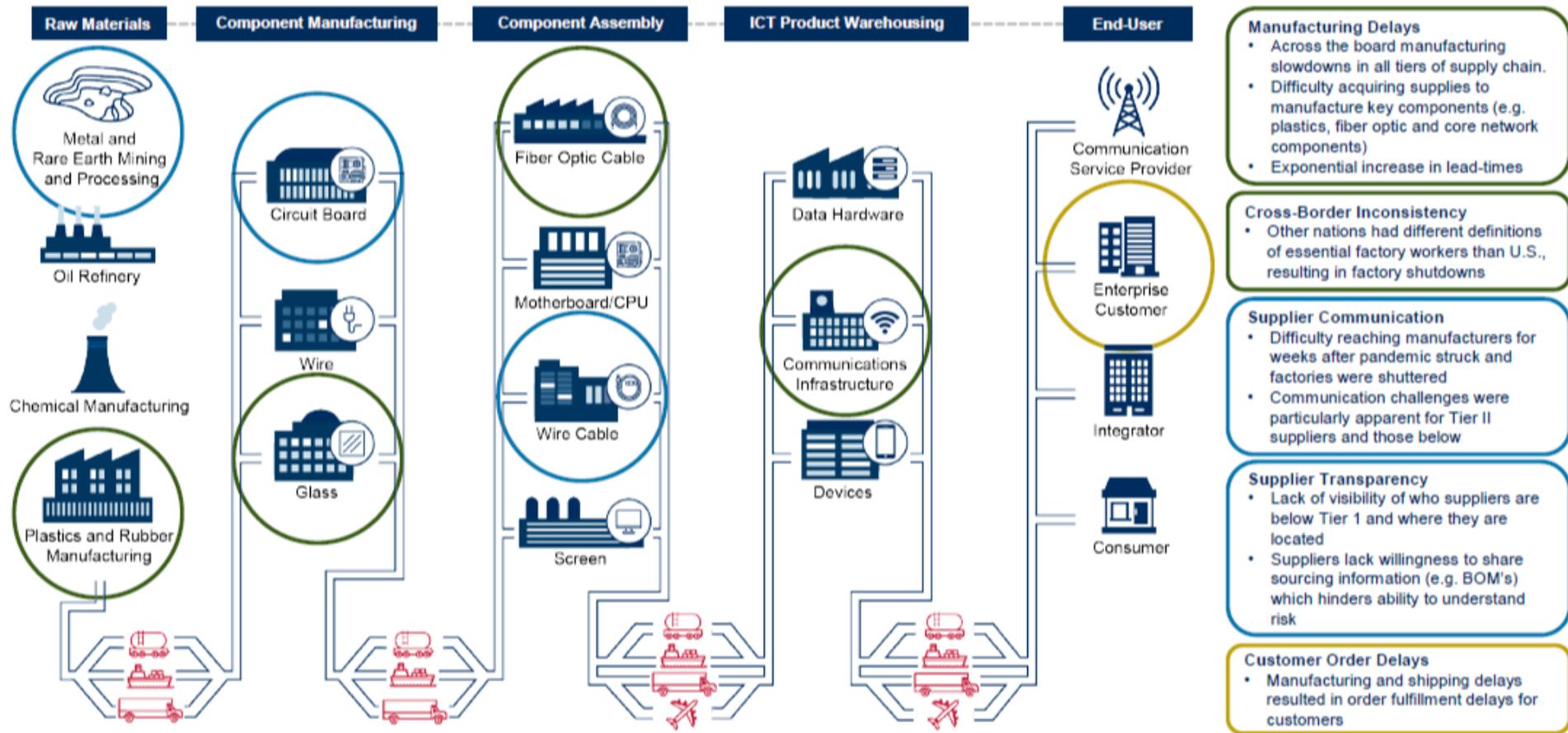
Broadcasting	4	42%	22%	20%	16%
Communications Service Provider	32	31%	32%	30%	7%
ITSP and Manufacturer	11	21%	15%	29%	35%

In addition, further detail from interviews and the Question Set revealed that many respondents noticed and experienced the following:

- Global supplier inventory and delivery delays have occurred throughout the pandemic and still exist today, albeit to a lesser extent.
- For those companies that manufacture in China, many had placed large buy-ahead orders in advance of the Chinese New Year holiday, when factories are shuttered. The pandemic struck during the New Year, so many companies had some buffer inventories. Without this advance ordering, supply shortages would have been worse.
- Not all suppliers communicated well with survey respondents, especially those in China, as the pandemic struck there first. Many suppliers “went dark” for several weeks at the onset of the pandemic, as factories were shut down and suppliers were also simply overwhelmed. Suppliers in Europe and the Americas had slightly more time to prepare.
- Throughout the pandemic, many companies increased their inventory orders to buffer against potential future delays related to the pandemic and in some cases, increased customer demand. In many cases, companies will continue to increase inventory orders for many more months given the uncertainty surrounding the pandemic. This has compounded the supply chain shortages and longer lead times that companies have experienced as companies are competing for limited supply.
- Smaller companies often manage inventory through the just-in-time inventory practice due to the costs of holding inventory. During the pandemic, under this practice, their inventories ran short due to fulfillment delays. Larger companies noted that investors can punish companies for holding excess capacity on their books.
- Many smaller companies state that suppliers give preference to orders from larger companies, although this is not confirmed by suppliers.
- Many companies had difficulty fulfilling customer orders on time.
- Sources of certain components, such as semiconductors, are located in Asia creating a risk of geographic concentration. Furthermore, the semiconductor industry has consolidated over the past few years, so alternative sources are limited. As a result, there are fewer chip manufacturers sourcing to companies and, during the pandemic, some could not keep up with demand. ICT companies are also unable to easily “switch” to another semiconductor manufacturer as their products are often highly engineered to certain components, which are difficult to multi-source.

¹⁵ Interos Whitepaper: COVID Resilience Report; <https://www.interos.ai/resource-library/>

APPENDIX A: ICT SUPPLY CHAIN SYSTEM MAP - PRODUCTION CHOKEPOINTS DURING PANDEMIC



APPENDIX B: ICT COMPANY CORPORATE FILINGS

Detailed below are excerpts from recent ICT company corporate SEC filings, investor calls, and open source research that highlight the impact to corporate supply chains due to the pandemic. Relevant quotations have been categorized by analytical themes outlined in the ICT Risks and Opportunities Study or other common subjects discussed. These companies, and the associated excerpts, are included here for illustrative purposes only. The inclusion or exclusion by the Study Group of a company does not indicate or imply any special considerations with respect to supply chain security or vulnerability.

Apple Inc.	
10-Q	THEME
“Although most components essential to the Company’s business are generally available from multiple sources, certain components are currently obtained from single or limited sources... The Company uses some custom components that are not commonly used by its competitors, and new products introduced by the Company often utilize custom components available from only one source. ” ⁸⁹	Single Source / Region
“Following the initial outbreak of the virus in China, the Company experienced disruptions to its manufacturing, supply chain and logistical services provided by outsourcing partners, resulting in temporary iPhone supply shortages that affected sales worldwide.” ⁹⁰	Single Source / Region
SUPPORTING QUOTATIONS	THEME
“Worldwide iPhone supply will be temporarily constrained. While our iPhone manufacturing partner sites are located outside the Hubei province — and while all of these facilities have reopened — they are ramping up more slowly than we had anticipated... These iPhone supply shortages will temporarily affect revenues worldwide.” ⁹¹	Single Source / Region
“With respect to the supply chain, we do have some suppliers in the Wuhan area. All of these suppliers, they are our alternate sources. And we’re obviously working on mitigation plans to make up any expected production loss. We factored best thinking in the guidance that we provided you. With respect to supply sources that are outside the Wuhan area, the impact is less clear at this time.” ⁹²	Single Source / Region

⁸⁹ Apple Inc. Quarterly Report. March 28, 2020.

<https://www.sec.gov/ix?doc=/Archives/edgar/data/320193/000032019320000052/a10-qq220203282020.htm>

⁹⁰ Ibid

⁹¹ Apple Inc. Investor update on quarterly guidance. February 17, 2020. <https://www.apple.com/newsroom/2020/02/investor-update-on-quarterly-guidance/>

⁹² Ibid.

Calix Inc.	
10-Q	THEME
<p>“COVID-19 has impacted the Company's supply chain operations through restrictions and shutdown of business activities by suppliers whom the Company relies on for sourcing components and materials and ... manufacturing, warehousing and logistics services.”⁹³</p>	Other General Impact
<p>“Specifically, the manufacture of our products requires optical-electronic components, chipsets and materials with critical dependencies on manufacturing located in China. Business disruptions due to factory shutdowns and other containment measures have decreased productivity from these suppliers, resulting in competing demand and longer lead times for components and materials needed for the manufacture of our products. In addition, shortages of fiber optics and other materials may delay planned fiber network buildouts by CSPs, which in turn could delay or lower demand for our products.”⁹⁴</p>	Single Source / Region
<p>“Up until 2018, substantially all of our products were manufactured in China. In the first half of 2019, we completed activities to realign our supply chain operations to move substantially all of our product manufacturing to locations outside of China.”⁹⁵</p> <p>“The manufacture of our products requires components and materials sourced from suppliers in China, including optical-electronic components and materials manufactured in China. We continue to face increasing competition for components and resources from third-party manufacturing and supply partners as more companies seek to transition manufacturing operations out of China due to the ongoing uncertainty of the escalating tariff wars.”⁹⁶</p>	Single Source / Region
<p>“Lead times for certain key materials and components incorporated into our products are currently lengthy and further exacerbated by the COVID-19 pandemic, requiring our manufacturers to order materials and components several months in advance of manufacture, which impacts the lead time for our products. If we overestimate our production requirements, our manufacturers may purchase excess components and build excess inventory, and we could be required to pay for these excess parts or products and their storage costs.”⁹⁷</p>	Inventory Management
SUPPORTING QUOTATIONS	THEME
<p>“In this supply constrained environment that we continue to be challenged with as supply chains that move through Asia and various levels of disruption... We are expediting to make sure that we meet our customers' needs. And so in the near term, there are significant expedite charges that show up in shipment in OCOGS and therefore in COGS and have a downward effect on margin.”⁹⁸</p>	Inventory Management

⁹³ Calix Inc. Quarterly Report. June 27, 2020. https://s22.q4cdn.com/999083100/files/doc_financials/2020/q2/3b1406e7-c01a-414e-8d27-557b18accf26.pdf

⁹⁴ Ibid.

⁹⁵ Ibid.

⁹⁶ Ibid.

⁹⁷ Ibid.

⁹⁸ Calix Inc. Q1 2020 Earnings Call. April 29, 2020. <https://investor-relations.calix.com/financials/quarterly-results/default.aspx>

Dell Technologies	
10-Q	THEME
<p>“The strength, scale, and resiliency of our global supply chain have afforded us flexibility to manage through this challenging time. We adapted to events unfolding real-time by applying predictive analytics to model a variety of outcomes to respond quickly to the changing environment. We were able to keep factories open by working through various local governmental regulations and mandates. During this time, we established robust safety measures to protect the health and safety of our essential team members.”⁹⁹</p>	Other (Mitigation)
<p>“Dell Technologies maintains limited-source supplier relationships for processors, because the relationships are advantageous in the areas of performance, quality, support, delivery, capacity, and price considerations. In recent periods, we have been impacted by processor and other supply constraints in certain product offerings. Delays in the supply of limited-source components, including as a result of COVID-19, are affecting the timing of shipments of certain products in desired quantities or configurations.”¹⁰⁰</p>	Single Source / Region
<p>“The decreases in our non-GAAP gross margin and non-GAAP gross margin percentage were attributable to component costs that were deflationary in the aggregate for ISG and CSG (although to a lesser extent than in the first quarter of Fiscal 2020), increased supply chain costs to expedite product delivery for CSG sales in the COVID-19 environment, and a shift in product mix due to strong CSG performance.”¹⁰¹</p>	Other (Mitigation)
<p>“The decrease in operating cash flows during the first quarter of Fiscal 2021 was attributable to unfavorable working capital impacts related to the COVID-19 pandemic on timing of collections and maintenance of higher inventory levels for continuity of supply.”¹⁰²</p>	Inventory / Other (Mitigation)
<p>“We utilize several suppliers to manufacture sub-assemblies for our products. Our efficient supply chain management allows us to enter into flexible and mutually beneficial purchase arrangements with our suppliers in order to minimize inventory risk. Consistent with industry practice, we acquire raw materials or other goods and services, including product components, by issuing to suppliers’ authorizations to purchase based on our projected demand and manufacturing needs.”¹⁰³</p>	Inventory / Other (Mitigation)
SUPPORTING QUOTATIONS	THEME
<p>“We’ve had floods, volcanoes, multiple viruses to contend with before, ongoing tariff discussions between the United States and China that our supply chain is battle-tested... Within 48 hours of China shutting down, we had an assessment of our 1,500 second or secondary and tertiary tier supply base. That’s unheard of. We knew exactly our inventory positions, their production views in a short period of time, and we began to make real-time decisions.”¹⁰⁴</p>	Supply Chain Transparency
<p>“We put automation in our supply chain planning, delivery, procurement, manufacturing and warehousing. We now have a common data lake and the data transparency for us to look at what’s happening real time end to end from what’s coming out of our suppliers to what we’re shifting to our customers and everything in between.”¹⁰⁵</p>	Supply Chain Transparency

⁹⁹ Dell Technologies, Quarter 1 Earnings Report. May 1, 2020.

<https://www.sec.gov/ix?doc=/Archives/edgar/data/1571996/000157199620000034/delltechnologiesq1fy21.htm#sCC9734CF0660541094A8658BA1EB2E07>.

¹⁰⁰ Ibid.

¹⁰¹ Ibid.

¹⁰² Ibid.

¹⁰³ Ibid.

¹⁰⁴ Dell Technologies. Investor Call. June 23, 2020. <https://investors.delltechnologies.com/events/event-details/investor-call-hosted-morgan-stanley>

¹⁰⁵ Ibid.

<p>"I'll give you an example of the nimbleness and the speed of which our supply chain can operate. We have 1 facility in the network of 25 that was challenged for a variety of reasons. We moved the entire production within 36 hours to a site on a different continent."¹⁰⁶</p>	<p>Single Source / Region</p>
<p>"There was a surge of buying, obviously, our factory and supply chain wasn't set up to handle. I think we threw out the number on our earnings call, Toni, of 37% year-over-year growth in latitude notebooks, for instance, right? I mean, and so we did see some extended lead times come out as we were managing the demand dynamic and the supply dynamic."¹⁰⁷</p>	<p>Other (Demand)</p>

FireEye Inc.	
10-Q	THEME
<p>"Our third-party manufacturers typically fulfill our supply requirements on the basis of individual orders. We are subject to a risk of supply shortages and changes in pricing terms because we do not have long-term contracts with our third-party manufacturers that guarantee capacity."¹⁰⁸</p>	<p>Inventory Management / Other (Demand)</p>
<p>"Our platform relies on key components, including a motherboard and chassis, which our third-party manufacturers purchase on our behalf from a sole source provider. The manufacturing operations of some of our component suppliers are geographically concentrated in Asia, which makes our supply chain vulnerable to regional disruptions."¹⁰⁹</p>	<p>Single Source / Region</p>
SUPPORTING QUOTATIONS	THEME
<p>"We are not -- we did -- if you looked at our balance sheet, we did increase our inventory a little bit over the -- year-over-year, and that was really just to make sure that if there was any challenges going forward that we'd have a little bit more supply. But so far, our contract manufacturer is operating at full capacity and the component parts -- we have multiple suppliers there. And so, we haven't really seen any challenges there."¹¹⁰</p>	<p>Inventory Management</p>
<p>"I think from us, specifically, we don't manufacture anything in China. We don't have any significant components from China. So, from a supply chain perspective, we don't really have any risks there."¹¹¹</p>	<p>Single Source / Region</p>

¹⁰⁶ Ibid.

¹⁰⁷ Dell Technologies. Virtual Fireside Chat. June 16, 2020. <https://investors.delltechnologies.com/events/event-details/virtual-fireside-chat-hosted-bernstein>

¹⁰⁸ FireEye Inc. Quarterly Report. June 30, 2020. <https://www.sec.gov/ix?doc=/Archives/edgar/data/1370880/000137088020000027/a10-qxfeyex20200630.htm>

¹⁰⁹ Ibid.

¹¹⁰ FireEye Inc. Q1 2020 Financial Results. April 28, 2020. <https://investors.fireeye.com/news-events/events-and-presentations>

¹¹¹ FireEye Inc. JMP Securities Technology Conference. February 24, 2020. <https://investors.fireeye.com/news-events/events-and-presentations>

The Hewlett-Packard Company (HP)	
10-Q	THEME
<p>“Net revenue decreased by \$1.1 billion, or 16.0% (decreased 14.6% on a constant currency basis), for the three months ended April 30, 2020, as compared to the prior-year period, as each of our segments experienced a net revenue decline. From a segment perspective, the net revenue decline was primarily driven by decreases in Compute, Storage and HPC & MCS. The net revenue decline in Compute was pronounced as we experienced supply chain constraints and with customer acceptance challenges due to lockdown actions taking place across the globe related to COVID-19 and competitive pricing pressures.”¹¹²</p>	Other (Regulatory Impact)
<p>“Storage net revenue was primarily impacted by uneven demand, supply chain and customer acceptance constraints related to COVID-19 along with lower revenue from the expiration of a one-time legacy contract. HPC & MCS also experienced COVID-19 related challenges, in particular with performing on-site installations and meeting customer acceptance milestones given lockdown constraints and delays with order fulfillment.”¹¹³</p>	Other (Demand)
SUPPORTING QUOTATIONS	THEME
<p>“HP is also facing challenges on the supply side, as factories in Southeast Asia have been shut down due to the pandemic. This is expected to put strain on the amount of available equipment until factories are fully up and running.”¹¹⁴</p>	Single Source / Region
<p>“One bright spot is in demand for personal computers, which have increased as consumers transition to working from home.”¹¹⁵</p>	Other (Demand)
<p>“There is ‘no doubt’ that COVID-19 is impacting the business, and that the revenue decline was a result of ‘macroeconomic and supply chain’ challenges associated with the pandemic.”¹¹⁶</p>	Other (Misc. Challenges)
<p>“Starting in late March, we also experienced disruptions to operations in South-east Asia and other parts of the world as the pandemic spread. We took swift action to adjust to these developments and our manufacturing capabilities were largely back to full capacity by early May.”¹¹⁷</p>	Single Source / Region
<p>“With the China factory shutdown early in the quarter as we headed to the back half, it just, by math, sort of creates a higher inventory in the back half of the quarter as well as all the in-transit. We did pursue some level of strategic buying on the Personal Systems side also in the quarter to set ourselves up for the second half. Looking forward, I would say that we are anticipating some level of higher inventory than what we traditionally held not to the levels that we are at today. And that’s really more of a function of, in the short term, pursuing some resiliency particularly around ink or other products that we want to hold a higher balance with.”¹¹⁸</p>	Inventory Management

¹¹² HP. Quarter 2 2020 Earnings Report. June 5, 2020.

<https://www.sec.gov/ix?doc=/Archives/edgar/data/1645590/00016455902000025/hpe-20200430.htm>

¹¹³ Ibid

¹¹⁴ Global Capital. HP returns with IT equipment securitization. June 16, 2020.

<https://www.globalcapital.com/article/b1m3360pxlxb1/hp-returns-with-it-equipment-securitization>

¹¹⁵ Ibid

¹¹⁶ Marian McHugh, HP’s revenue sinks amid supply chain challenges, May 28, 2020, from

<https://www.channelweb.co.uk/news/4015767/hp-revenue-sinks-amid-supply-chain-challenges>

¹¹⁷ Ibid

¹¹⁸ HP, Quarter 2 2020 Earnings Call Transcript, May 27, 2020, from the HP investor relations website,

<https://investor.hp.com/financials/financial-summary/default.aspx>

Intel Corporation	
10-Q	THEME
“Our PC-centric business was up, driven by strength in notebook platform demand, strong platform ASP, higher modem and Wi-Fi sales, partially offset by desktop demand.” ¹¹⁹	Other (Demand)
“We expect continued negative COVID-19 related impacts on demand for our IOT portfolio in the second half of 2020” ¹²⁰	Other (Demand)
<p>“We have taken several actions throughout the pandemic to address our supply chain. For example:</p> <ul style="list-style-type: none"> • Where feasible and practicable, we increased inventory of raw materials as well as our supply of our finished goods coming out of China in early February. It is our practice to plan for scenarios where supply will be restricted or compromised in our supply chain for 30-60 days or more. • We activated backup planning to reroute and obtain charter flights if needed into and from China, securing capacity early. As the virus spread, we leveraged the successful methodology used in China for other parts of Asia and Europe. • We evaluated the end-to-end supply line needs for all products ramping this year, worked on securing supply lines and deployed our business continuity plans to mitigate potential risks.”¹²¹ 	Inventory / Other (Mitigation)
“While we have been able to operate our factories on a relatively normal basis to date, shelter-in-place orders and other measures... have resulted in reduced workforce availability at some of our sites, construction delays, and reduced capacity at some of our vendors and suppliers . Restrictions on our access to or operation of our manufacturing facilities... can impact our ability to meet customer demand.” ¹²²	Other (Regulatory Impact)
“Current and future restrictions or disruptions of transportation, such as reduced availability of air transport, port closures, and increased border controls or closures, can also impact our ability to meet demand and could materially adversely affect us. Our customers have experienced, and may continue to experience, disruptions in their operations and supply chains, which can result in delayed, reduced, or canceled orders, or collection risks, and which may adversely affect our results of operations.” ¹²³	Other (Regulatory Impact)
SUPPORTING QUOTATIONS	THEME
“Shortly after our January call, we started to see the impact of COVID-19 in China, forcing many of our ODM partners to extend Chinese New Year factory shutdowns. ” ¹²⁴	Single Source / Region
“Any kind of dislocation that we're looking at right now is more a function of just the supply chain challenges that some of the OEMs had, particularly in the first half of the first quarter. But we've been watching that pretty closely because we want to make sure that this kind of buildup at our customer level makes its way through to the end customer.” ¹²⁵	Other (Demand)

¹¹⁹ Ibid

¹²⁰ Ibid

¹²¹ Intel Corporation. Quarter 1 2020 Earnings Report. March 28, 2020.

<https://www.sec.gov/ix?doc=/Archives/edgar/data/50863/000005086320000017/a0328202010qdocument-u.htm#s549a9573c248495fa64eb1791ee60e71>

¹²² Ibid.

¹²³ Ibid

¹²⁴ Intel Corporation. Q1 2020 Intel Corp Earnings Call. April 23, 2020. <https://www.intc.com/investor-relations/events-and-presentations/events-calendar/event-details/2020/Q1-2020-Intel-Corporation-Earnings-Conference/default.aspx>

¹²⁵ Ibid

Microsoft Corporation	
10-Q	THEME
<p>“We acquire some device and datacenter components from sole suppliers. Our competitors use some of the same suppliers and their demand for hardware components can affect the capacity available to us... Xbox consoles, Surface devices, datacenter servers, and other hardware are assembled in Asia and other geographies that may be subject to disruptions in the supply chain, resulting in shortages that would affect our revenue and operating margins. These same risks would apply to any other hardware and software products we may offer.”¹²⁶</p>	Single Source / Region
<p>“In the third quarter of fiscal year 2020, COVID-19 had minimal net impact on our revenue... In the More Personal Computing segment, Windows OEM and Surface benefited from increased demand to support remote work and learn scenarios, offset in part by supply chain constraints in China that improved late in the quarter.”¹²⁷</p>	Single Source / Region
SUPPORTING QUOTATIONS	THEME
<p>“Although we see strong Windows demand in line with our expectations, the supply chain is returning to normal operations at a slower pace than anticipated at the time of our Q2 earnings call. As a result, for the third quarter of fiscal year 2020, we do not expect to meet our More Personal Computing segment guidance as Windows OEM and Surface are more negatively impacted than previously anticipated. All other components of our Q3 guidance remain unchanged.”¹²⁸</p>	Other (Demand)

¹²⁶ Microsoft Corp. Quarterly Report. March 31, 2020. https://www.sec.gov/ix?doc=/Archives/edgar/data/789019/000156459020019706/msft-10q_20200331.htm

¹²⁷ Ibid.

¹²⁸ Microsoft Corp. Microsoft update on Q3 FY20 guidance. February 26, 2020. <https://news.microsoft.com/2020/02/26/microsoft-update-on-q3-fy20-guidance/>

Oracle Corporation	
10-K	THEME
<p>“We purchase materials, supplies, product subassemblies and full assemblies from a number of vendors. For most of our hardware products, we have existing alternate sources of supply or such sources are readily available. However, we do rely on sole sources for certain of our hardware products.”¹²⁹</p>	Single Source / Region
<p>“There are some technologies and components that can only be purchased from a single vendor due to price, quality, technology, availability or other business constraints. As a result, our supply chain operations could be disrupted or negatively impacted ... We may be unable to purchase these items from the respective single vendors on acceptable terms or may experience significant shortages, delays or quality issues in the delivery of necessary technologies, parts or components from a particular vendor.”¹³⁰</p>	Single Source / Region
<p>“We outsource the manufacturing, assembly, delivery and technology or component design of certain of our hardware products to a variety of companies, many of which are located outside the U.S. From time to time, these partners experience production problems or delays or cannot meet our demand for products. To reduce this risk, we continue to explore additional third-party manufacturing partners to drive supply chain continuity, but finding additional manufacturing sources in a timely and cost-effective manner is difficult.”¹³¹</p>	Single Source / Region
<p>“A significant portion of our critical business operations are concentrated in a few geographic areas, some of which include emerging market international locations that may be less stable relative to running such business operations solely within the U.S.”¹³²</p>	Single Source/ Region
SUPPORTING QUOTATIONS	THEME
<p>“As the quarter progressed, we saw drop-off in deals, especially in the industries most affected by the pandemic. As countries begin reopening their economies, many of these discussions have already resumed.”¹³³</p>	Other (Demand)

¹²⁹ Oracle Corporation. Quarter 4 2020 Earnings Report. June 22, 2020. https://www.sec.gov/ix?doc=/Archives/edgar/data/1341439/000156459020030125/orcl-10k_20200531.htm

¹³⁰ Ibid

¹³¹ Ibid

¹³² Ibid

¹³³ Oracle Corporation. Quarter 4 2020 Earnings Call Transcript. June 22, 2020. <https://www.fool.com/earnings/call-transcripts/2020/06/16/oracle-corp-orcl-q4-2020-earnings-call-transcript.aspx>

Seagate Technology	
10-Q	THEME
<p>“We rely on sole direct and indirect suppliers or a limited number of direct and indirect suppliers for some or all of these components that we do not manufacture... Many of such direct and indirect component suppliers are geographically concentrated, making our supply chain more vulnerable to regional disruptions...we have experienced and continue to experience disruptions in our supply chain due to the impact of the COVID-19 pandemic. If our direct and indirect vendors for these components are unable to meet our cost, quality, supply and transportation requirements, continue to remain financially viable or fulfill their contractual commitments and obligations, we could experience disruption in our supply chain, including shortages in supply or increases in production costs, which would materially adversely affect our results of operations.”¹³⁴</p>	Single Source/Region
SUPPORTING QUOTATIONS	THEME
<p>“I mean having factories in China, large supply chain in China, where the thing started, at least from an awareness perspective, that's where we had to lock things down the quickest, in the factories.”¹³⁵</p>	Single Source/Region

Lumen (previously CenturyLink)	
10-Q	THEME
<p>“Moreover, we must meet certain specified infrastructure buildout requirements in 33 states. In order to meet these specified infrastructure buildout requirements, we may be obligated to make substantial capital expenditures. Due to governmental restrictions and potential supply delays related to the COVID-19 pandemic, we cannot provide any assurances that we will be able to timely meet our mandated buildout requirements.”¹³⁶</p>	Other (Regulatory Impact)
SUPPORTING QUOTATIONS	THEME
<p>“For the first quarter 2020, capital expenditures were \$974 million. This compares to first quarter 2019 CapEx of \$931 million. We increased our CapEx spend as we prepare for the COVID-19 crisis by investing in inventory in the event of any supply chain disruption. However, to date, we have not seen disruptions for network equipment.”¹³⁷</p>	Inventory Management / Other (Mitigation)

¹³⁴ Seagate Technology. Quarterly Report. April 3, 2020.

<https://www.sec.gov/ix?doc=/Archives/edgar/data/1137789/000113778920000035/stx-20200403.htm>

¹³⁵ Seagate Technology. Stifel 2020 Virtual Cross Sector Insight Conference. June 9, 2020. <https://investors.seagate.com/events/event-details/2020/Stifel-2020-Virtual-Cross-Sector-Insight-Conference/default.aspx>

¹³⁶ CenturyLink. Quarterly Report. March 31, 2020.

<https://www.sec.gov/ix?doc=/Archives/edgar/data/18926/000001892620000016/ct12020033110q.htm>

¹³⁷ CenturyLink. Q1 2020 Earnings Call. May 6, 2020. <https://ir.centurylink.com/events-and-presentations/event-details/2020/CenturyLink-1Q20-Earnings-Call/default.aspx>

Charter Communications, Inc.	
10-Q	THEME
<p>“As the COVID-19 pandemic continues to significantly impact the United States, we have continued to deliver services uninterrupted by the pandemic. Because we have invested significantly in our network and through normal course capacity increases, we have been able to respond to the significant increase in network activity from the private and public response to COVID-19 ... We have invested significantly in our self-service infrastructure, and customers have accelerated the adoption of our self-installation and digital self-service capabilities. Our front-line service infrastructure in call centers and field operations continues to experience higher service transaction volume and is performing well. Much of that increase in activity has been driven by increased demand for our connectivity services to residential, healthcare, government and educational customers.”¹³⁸</p>	Inventory Management / Other (Demand)
SUPPORTING QUOTATIONS	THEME
No additional results found	N/A

Corning Inc	
10-Q	THEME
<p>“The COVID-19 pandemic is adversely affecting, and is expected to continue to adversely affect, our operations and supply chains, and we have experienced and expect to continue to experience unpredictable reductions in demand for certain of our products.”</p> <p>“While we expect the impacts of COVID-19 to have an adverse effect on our business, financial condition and results of operations, we are unable to predict with certainty the extent or nature of these impacts. The severity of the impact will depend on our ability to adjust to this uncertainty as well as a number of other factors, including, but not limited to, the duration and severity of the pandemic and the extent and severity of the impact on the Company’s customers, disruptions and restrictions on availability of labor, as well as temporary disruptions to our supply chain, all of which are uncertain and cannot be predicted. The Company’s future results of operations and liquidity could be adversely impacted by reduced revenues, delays in payments of outstanding receivable amounts beyond normal payment terms, supply chain disruptions and uncertain demand, and the impact of any initiatives or programs that the Company may undertake to address financial and operations challenges faced by its customers..”¹³⁹</p>	Other (Demand)
SUPPORTING QUOTATIONS	THEME
No additional results found	N/A

¹³⁸ Charter Communications, Inc. Quarter 2 2020 Earnings Report. July 31, 2020.

<https://www.sec.gov/ix?doc=/Archives/edgar/data/1091667/000109166720000158/chtr-20200630.htm>

¹³⁹ Corning Inc., Quarter 2 2020 Earnings Report, June 30, 2020, from

<https://www.sec.gov/ix?doc=/Archives/edgar/data/24741/000002474120000055/glw-20200630x10q.htm>

AT&T Inc.	
10-Q	THEME
No significant results found.	N/A
SUPPORTING QUOTATIONS	THEME
<p>“In terms of any supply disruption due the COVID-19. We continue to monitor and closely monitor the impact on our suppliers, but I can tell you that we haven't seen any significant, or at all, any impact. We are -- for the last few years, we worked with our suppliers on geographically diverse supply chain.”¹⁴⁰</p>	Single Source / Region

¹⁴⁰ AT&T Inc. Cowen TMT Conference. May 28, 2020. <https://investors.att.com/~media/Files/A/ATT-IR/events-and-presentations/Final%20Cowen%20transcript%2052820.pdf>