The Global Semiconductor Shortage:

Impact on U.S. Broadband and Recommendations for Policymakers

December 2021

The demands of the pandemic thrust broadband networks onto center stage, and the spotlight on them is growing ever brighter as the Biden Administration prioritizes the expansion of broadband access and Congress provides historic levels of funding to achieve it. But this bipartisan policy goal is at the mercy of an unsettling global trend: a limited supply of chips necessary to deploy broadband services.

This semiconductor shortage will lead to longer production cycles and increased costs for network equipment, which in turn could negatively impact broadband deployment to unserved communities and thereby jeopardize a centerpiece of the Administration's infrastructure plan at a particularly critical moment. Although broadband providers have managed thus far to withstand the pressure of this ever-constricting supply chain, the risk of delays for publicly-funded near-term deployment is significant.

It is therefore essential that policymakers turn their focus to the needs of broadband providers and ensure their continued access to semiconductors. This paper proposes concrete policy measures to that end. Absent such action, the Administration's broadband infrastructure buildout ambitions hang in the balance.

Contents

Introduction

As the COVID-19 pandemic upended both daily life and global supply chains, hundreds of millions of Americans relied upon broadband connections more than ever for telework, education, access to health care, and staying connected to family and friends. Recognizing that many of these changes will be long-lasting, policymakers in the United States and globally are now making transformative investments in telecommunications infrastructure. In the United States, Congress recently appropriated $65 billion for broadband as part of a historic bipartisan infrastructure package.[1]

The prompt and successful use of these funds for network deployment – and thus the fulfillment of a consensus policy priority – will critically depend upon the availability of semiconductors. Semiconductors are a key enabling technology used in every type of electronic device, from consumer products such as phones, cameras, gaming consoles, and automobiles to industrial systems, networking equipment, critical infrastructure, and national security systems. In addition to being at the heart of every part of daily life, semiconductors are also critical to the future growth of the U.S. economy by enabling emerging technologies such as artificial intelligence, autonomous systems, and quantum computing.

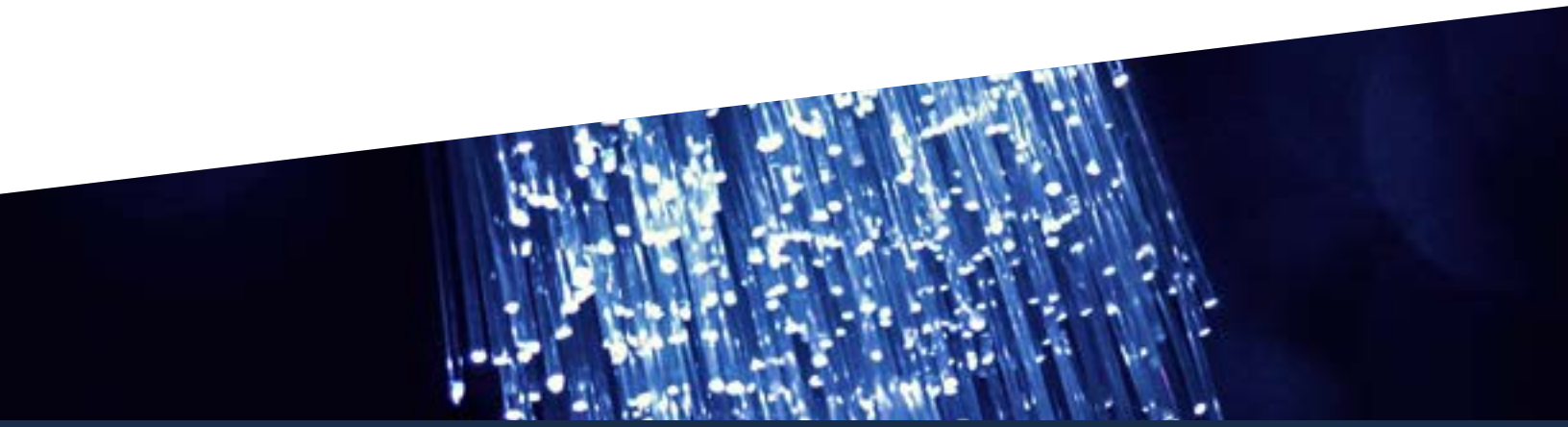
The widespread impact of semiconductor technologies is amply demonstrated in the broadband and broader communications industry, where common devices such as modems, routers, and mobile base stations rely on semiconductors to provide connectivity to homes and businesses. Indeed, just one in-home broadband device often includes as many as seven different "systems on a chip" (SoCs).[2] Meanwhile, to provide broadband to one household, a network operator must rely upon over seven thousand different chips in its servers, switches, and routers.[3] As a result, hundreds of millions of dollars spent each year by U.S. broadband providers for their equipment ultimately goes toward procuring the chips necessary to deploy broadband services.

To provide broadband to a single household, a network operator must rely on over 7,000 chips.

Unfortunately, the semiconductor supply chain – which has become highly globalized over time – has been doubly disrupted by COVID-19-related shocks and a series of other trade and climate-related issues. In the communications sector, these constraints have created a significant and ongoing global shortage that is exacerbated by the simultaneous surge in demand for connectivity devices and services as a result of the pandemic. In the near term, the demand for semiconductor-powered devices is expected to continue rising sharply, and the long-term trend toward greater demand is very clear.

Since semiconductors are critical components for both broadband network infrastructure and for customer equipment, the chip shortage's impact on broadband has been particularly acute. The timing of the shortage is highly problematic, potentially delaying critical network deployment and upgrade activity that would mitigate strains on network capacity arising from increased telework and remote learning activity in the wake of the pandemic. Meanwhile, heightened infrastructure buildout and upgrade work resulting from unprecedented new federal investment is also in jeopardy of being delayed, thereby undermining key national priorities.

This paper demonstrates how the success or failure of the Administration's broadband policies is directly tied to the global supply of semiconductors. It describes the impact of the semiconductor shortage on the communications sector, consumers, and the nation as a whole at a moment when the global demand for broadband is greater than ever. It assesses current and proposed actions being taken by the federal government to address the shortage generally, and identifies potential pitfalls that could result from prioritizing certain sectors – or the wrong sectors – for preferential treatment. Any semiconductor policy action taken by the federal government must ensure that broadband – which has proven to be essential during this unprecedented digital transition in our national life – can continue to be deployed as rapidly as possible.



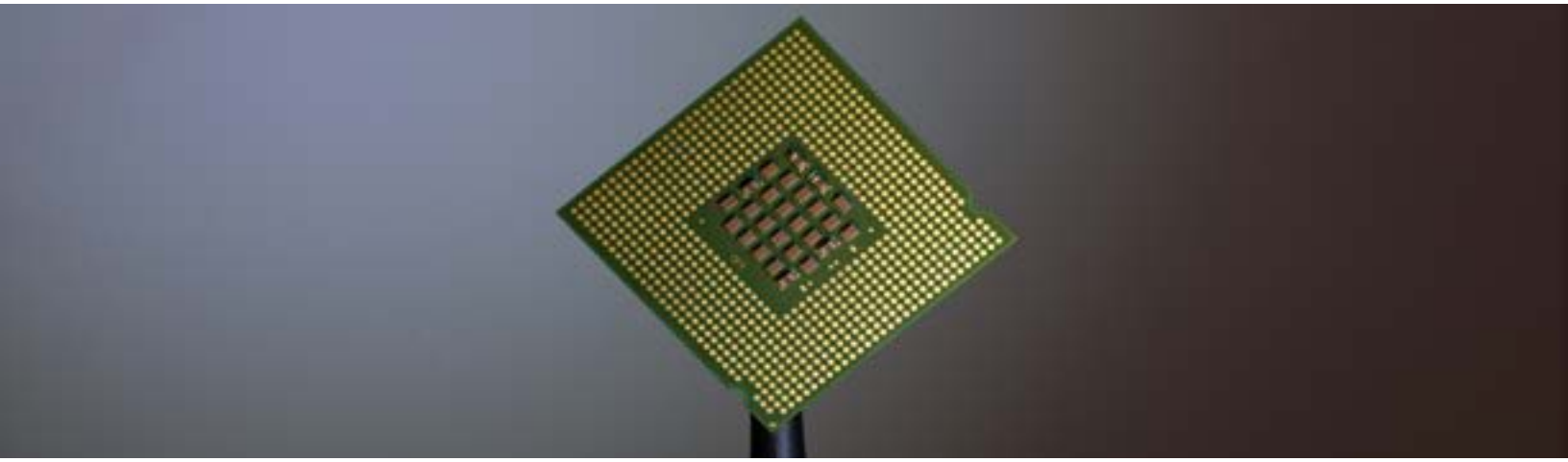
Impact on the U.S. Broadband Sector

The semiconductor shortage has impacted a wide variety of industrial sectors from automobiles to personal electronics. However, few sectors have been impacted more greatly than the communications sector, which accounted for ***up to 50 percent of all global semiconductor end-use*** in 2019.[4] As the Telecommunications Industry Association (TIA) recently observed, the shortage has impacted "nearly every element of the communications sector; from the telecommunications infrastructure side with routers, switches, and base stations down to laptops, desktops, and mobile phones."[5]

The impact begins with delays, which have resulted from a combination of factors including pandemic-related shutdowns, global transportation and logistics issues, and occasionally even the weather.[6] The production cycle for some telecommunications products has ***tripled*** in length – increasing from 16 to 18 weeks before the pandemic to 50 weeks or more in 2021.[7] When adding the time required for vendors to manufacture and ship devices after semiconductors have been acquired, some mobile network operators have reported delays of over 60 weeks for delivery of routers.[8]

The demand has also led to higher input costs, which will also pose a challenge to the sector in 2022 and beyond as the supply chain begins to sort itself out for the long-term. For example, Taiwan Semiconductor Manufacturing Company (TSMC) has imposed a 20 percent increase on the price of all of the chips it fabricates.[9] The semiconductor industry has also been beset by price gouging, with some equipment vendors being forced to purchase chips on the spot market to meet demands for products that their traditional suppliers are unable to deliver. In some cases, parts are reportedly being sold for ***more than 100 times their normal price.***[10]

A $2 chip going for $200 on the spot market has a much larger impact on a $150 networking device than on a $30,000 vehicle with many non-electronic elements.



Moreover, the effect of inflated prices is not felt equally across all sectors due to the differing relative share of end products that is attributable to chip costs. For example, if a chip normally costing two dollars is currently being sold for $200 on the spot market, this would have a much larger impact on a networking device that normally costs $150 in comparison to an automobile that costs $30,000 or more and contains many non-electronic elements. This gives auto manufacturers an advantage in the spot market since it is easier for them to pay the asking price for a scarce component and pass along the added cost to their customers.

Overall, the supply shortage has resulted in estimated price increases of at least ten to twelve percent for some network equipment, increasing operators' deployment costs.[11] The shortages in semiconductors and the associated delays could thus result in at least hundreds of millions of dollars in impact to the broadband industry this year alone, with other industry estimates indicating potentially billions of dollars in impact.[12]

While some companies, including some smartphone manufacturers, have sheltered themselves by stockpiling semiconductors, this practice is amplifying shortages and is not a viable long-term solution since the strain will continue for the foreseeable future.[13] For example, Cisco CEO Charles Robbins envisions the chip shortage lasting ***until at least mid-2022***, while IBM president Jim Whitehurst believes the shortage could last into 2023.[14] Meanwhile, some communications companies are now being forced to make purchase commitments two or three years in advance in order to assure a sufficient supply chain.[15]

Impact on Consumers and the Nation

The direct effects on the U.S. communications sector laid out above will also have significant broader impacts on consumers and the nation as a whole. These impacts could include delayed broadband deployment to unserved communities, costlier and/or delayed network upgrades, delayed rollout of 5G technology, adverse impacts on national security, and reduced availability of consumer devices.

Delayed broadband deployment

Longer production cycles and increased costs for network equipment could hamper broadband deployment to unserved communities, jeopardizing a key goal of the Biden Administration at a particularly critical moment. Recognizing the modern importance of broadband, Congress recently enacted a historic bipartisan infrastructure bill that includes $65 billion for broadband, of which over $42 billion goes to the National Telecommunications and Information Administration (NTIA) for deployment grants.[16] This is the largest one-time federal investment in broadband networks in the nation's history, with the nearest analogue being the federal government's rural electrification efforts almost a century ago. It is nearly ten times larger, for example, than the current annual subsidies provided for deployment via the FCC's Universal Service Fund.[17]

This level of federal investment in broadband deployment is both necessary and welcome, particularly in relation to increasing access and digital adoption rates in disadvantaged communities. New and upgraded networks in these communities are often prerequisites to commencement or acceleration of digital literacy and digital skills initiatives. However, it will also result in a significant increase in demand for network equipment over the next several years as funding recipients use federal dollars to build out networks in communities that desperately need them.

Longer production cycles could jeopardize Biden Administration broadband goals.

Even when the large annual private-sector investment into broadband is factored in – for example, the U.S. broadband industry invested nearly $80 billion in capital expenditures in 2020 *alone*[18] – the additional federal spending in the recent infrastructure bill would still have a very material impact on the overall market even if spread over multiple years. Moreover, the FCC has started releasing tens of billions of dollars made available from the FCC's Rural Digital Opportunity Fund auction.[19] The combination of the resulting demand for equipment and the global semiconductor shortage could therefore place significant strain on the ability of operators to continue deployments, regardless of whether they receive federal funding.

Costlier or delayed network upgrades

Many broadband providers must upgrade their networks every 18 months to accommodate ever-increasing demand for bandwidth capacity and throughput.[20] Under normal circumstances, these network upgrades require large-scale purchases of equipment and (in turn) the semiconductors on which the equipment relies. The importance of performing these routine upgrades has only been magnified by the demands on network capacity resulting from the pandemic.

The scarcity of chips is having a significant impact on operators' ability to perform these upgrades. By one estimate, ***74 percent of broadband operators have reported challenges in obtaining equipment,*** from cables and routers to materials and mobile devices.[21] Meanwhile, broadband providers report an average 55-week wait for fiber with some delays running as high as 90 weeks.[22] It is thus already apparent to many operators that their next upgrade cycle could be delayed as a result of the semiconductor shortage.

A dynamic in which there is a scarcity of semiconductors that are a core component of broadband infrastructure, a surge in cost for those core components, and far greater competition for acquiring chips, threatens to imperil both the timing and the cost of broadband providers' planned deployment and upgrades. According to one estimate, in 2021 alone more than *five million* American homes and businesses may have had to wait for new or upgraded broadband equipment due to delays associated with ongoing semiconductor shortages.[23]

More than five million American homes and businesses may have had to wait for new or upgraded broadband due to chip delays.

Delayed 5G rollout

Continuing chip shortages may cause a temporary delay of the global 5G rollout if they are not mitigated, even as U.S. markets continue to expand.[24] Rollout of 5G networks and even expansion of existing 4G networks will be very difficult without a steady and reliable production of these microchips. For example, the global chip shortage has already delayed the expanded rollout of 4G networks in Japan and is set to slow 5G rollout in other advanced nations.[25]

Adverse effects on national security

A failure to focus on the communications industry's semiconductor issues is already having national security implications. For example, small and mid-size operators across rural America are encountering supply chain problems as they race to "rip and replace" equipment from Huawei and ZTE with funding from the FCC's Secure Networks Reimbursement Program.[26] The Competitive Carriers Association (CCA) has warned that a reduction in access to semiconductors could lead to "cascading impacts" on small and rural carriers that would impact upcoming deadlines in the Reimbursement Program.[27]

Reduced consumer device availability

Semiconductor shortages may also negatively impact the consumer device sector and are not limited to leading-edge devices.[28] The average American home uses 25 connected devices, all of which themselves rely on chips to operate.[29] Apple CEO Tim Cook identified the ongoing chip shortage as impacting most of the company's products, exacerbated by continuing consumer demand.[30] Telecommunications devices such as 5G-ready smartphones and other important consumer devices that include legacy chips such as alarm and security services that rely on broadband networks are also experiencing shortages.[31] Other Internet of Things (IoT) devices including gaming consoles and low-powered devices are also facing shortages.[32]

The Policy Landscape

Policymakers across the federal government have focused their attention on the global semiconductor shortage, with various approaches currently being implemented or under consideration. In particular, there has been significant discussion regarding the possibility of granting certain sectors, especially the automotive sector, preferential access to semiconductors using policy tools. As described below, these approaches risk undermining the communications sector's access to semiconductors at a moment when broadband is critical.

Biden Administration

In February, President Biden issued Executive Order 14017 ("America's Supply Chains"), requiring a comprehensive review of semiconductor supply chains and the creation of policy recommendations to sustainably re-shore supply chains, develop domestic supplies, cooperate with allies to identify alternative supplies, and build supply chain resiliency.[33] Pursuant to the supply chain executive order, the Department of Commerce, in conjunction with the Department of Homeland Security (DHS) will publish a report on information and communications technology sector (ICT) supply chains "for critical sectors and subsectors of the information and communications technology industrial base" by the end of February 2022.

Meanwhile, the Federal Communications Commission released a public notice seeking comment on the impact the global semiconductor shortage has had on the U.S. communications sector. The FCC noted that reliable access to semiconductors is essential for continued advancement and rollout of 5G wireless services, Wi-Fi, Open Radio Access Networks, satellites, and communications capabilities that are vital to national security.[34]

Congress

Congress is considering several actions to address the shortage. Most notably, the CHIPS for America Act was included as part of the FY21 National Defense Authorization Act. It would establish a federal financial assistance program to encourage investment in U.S. semiconductor fabrication, assembly, testing, advanced packaging, and research and development (R&D). However, as of early December 2021, Congress has not yet funded the law.

The U.S. Innovation and Competition Act (USICA), which received bipartisan support in the Senate and now awaits a vote in the U.S. House, would provide over $50 billion in funding for the CHIPS Act – a historic level of investment in semiconductors, albeit one that will take several years to bear fruit. On the other hand, Congress has just appropriated $42 billion to NTIA for a broadband grant program. While this funding is very welcome, the supply crunch facing the sector could imperil the timing and robustness of this substantial investment if the supply chain issues are not addressed appropriately.

Risks of auto sector prioritization

As with the communications sector and other sectors, the chip shortage is undeniably having an adverse impact on the U.S. auto industry. However, the auto industry typically depends upon older chip technologies that are being phased out by many semiconductor foundries, further exacerbating the impact of the sectoral shortage. As chip foundries focus on next-generation microelectronics with higher demand and higher price points, the high opportunity cost for foundries to return to older and less cost-efficient production models may cause the auto industry shortages to continue for some time.

In addition, the auto sector shortage has been exacerbated by incorrect predictions of demand, such as the unexpected spike in auto sales in the second half of 2020. During a slowdown in automotive demand for chips in early 2020, several semiconductor production facilities adjusted their product lines to ensure profitability and meet continued demand from smartphone manufacturers.[35] Unlike in other industries, it can be very cost prohibitive for semiconductor manufacturers to change their production models to produce chips that may be more suited for the auto industry, further stressing supply chains.[36]

Intervention to favor the supply of chips to the auto sector would have a long-term and market-distorting effect.

There has been speculation that the President might use the Defense Production Act (DPA) to grant preferential access to semiconductors to automakers, but this action has not occurred as of early December 2021.[37] However, even the speculation may already be having a harmful effect on the communications sector. By some accounts, semiconductor manufacturers concerned about staving off potential action under the DPA may be prioritizing the delivery of chips to the automotive sector even without a directive from the federal government.[38]

Aside from exacerbating short-term impacts, policy intervention to favor the supply of chips to the auto sector would also have a long-term market-distorting effect. The communications industry has typically relied on a longer-term approach to its supply chain instead of the "just-in-time" approach more common in the auto industry. The communications sector has therefore priced in potential supply chain issues by contracting with suppliers well in advance, in some cases years in advance.[39] Government action to similarly backstop the auto sector supply chain – for free – would therefore undermine the willingness of the auto sector (and others) to make necessary investments to secure and diversify their supply chains going forward.

Recommendations

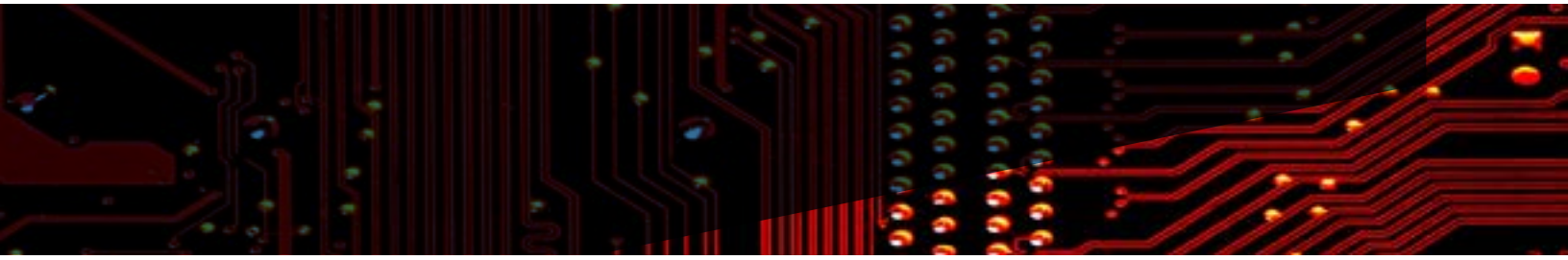
The COVID-19 pandemic has highlighted the criticality of broadband at a moment when the U.S. economy is undergoing a tectonic shift. In most parts of the United States, including in rural areas, broadband access is already as important – if not more important – than roads and automobiles.[40] The national shift to telework during the pandemic has led to significant declines in commuting while broadband usage has spiked.[41] At a time when costs to operators for equipment may be rising due to semiconductor shortages, federal investment such as the $42 billion recently approved by Congress will help bridge the gap and ensure that as many Americans as possible are connected quickly – provided that other policies do not stand in the way.

Short Term

In the near term, the federal government should not intervene in the semiconductor marketplace to favor the auto sector over other sectors such as telecommunications. In short, the situation for the telecommunications sector is just as critical and consequential as it is for the auto sector. If either Congress or the President were to take unprecedented industrial policy action to prioritize chips for the auto sector, the resulting semiconductor scarcity will severely impact network deployments as described above. Poorly constructed industrial policy could ultimately exacerbate existing shortages, since retooling advanced chip production lines to meet the legacy needs of the auto industry may be cost-prohibitive if not outright impossible, as noted above.

There is a real possibility of such action occurring due to a simple lack of awareness among policymakers of the impact of the semiconductor shortage on broadband infrastructure. For example, the Biden Administration's newly-established U.S.-E.U. Trade and Technology Council will address various technology risks posed from China, as well as the supply chain. It could be used to favor the auto sector despite including key telecommunications issues such as IoT and ICT security in its statement-of-work.[42]

Government intervention – if any – should focus on more specific problems such as preventing price gouging in the spot market for semiconductors. However, if any broader industrial policy actions are ultimately taken, they should ensure that the telecommunications sector receives similar preferential treatment to prevent harm to millions of Americans from being unserved by broadband for longer than necessary. One option may be to include provisos that balance the manufacturing of both legacy semiconductors used by the auto sector as well as the cutting-edge semiconductors used by the telecommunications sector.



Long Term

Looking further ahead, the U.S. telecommunications sector has called for increased funding for domestic production capabilities. Congressional support for funding the CHIPS Act would be a strong step in the right direction for the long-term health of the global supply chain for microelectronics and would mitigate national security risks to the U.S. The bill is widely supported by the U.S. semiconductor industry and would represent a significant step toward increasing the U.S. share of global semiconductor manufacturing.[43] It would also promote supply chain resiliency and diversification in a sector where Secretary of Commerce Gina Raimondo has said the U.S. has "fallen very far behind."

In the end, enabling a better functioning marketplace is the best way to ensure that the critical national need for broadband is adequately met, including maximizing the value of federal broadband funding. It will also avoid introducing distorting effects that would undermine the incentive for companies to invest in secure and diverse supply chains. Meanwhile, long-term investments in U.S. competitiveness such as the CHIPS Act will ensure that the supply of semiconductors for every sector of the economy becomes more robust and diverse over time.[44]

About the Authors

Dileep Srihari

Dileep Srihari is Senior Policy Counsel in Access Partnership's Washington, DC office. He focuses on data policy, cybersecurity, and telecommunications infrastructure issues, including diversification and security of the information and communications technology (ICT) supply chain. He joined Access Partnership from the Computing Technology Industry Association (CompTIA), where he represented companies through policy development and advocacy before Congress, the Executive Branch and agencies including the Federal Communications Commission. He also spent eight years at the Telecommunications Industry Association (TIA) where he worked with ICT vendors on spectrum and broadband infrastructure deployment policy.

Dileep was earlier an attorney at WilmerHale with a practice that included appellate litigation and regulatory advocacy on topics including wireless interference protections, television program access and process safety management. He previously worked on Capitol Hill for then-Senator Hillary Rodham Clinton of New York. He holds an undergraduate degree in Computer Science and Electrical Engineering from Cornell University and a law degree from the Georgetown University Law Center.

Erik Jacobs

Erik Jacobs is Policy Manager, U.S. and Asia on Access Partnership's Policy Innovation team where he works on issues relating to national security, infrastructure policy, semiconductor policy, and U.S.-Asia relations. Prior to joining Access Partnership, Erik served as a policy advisor in the White House Office of Science and Technology Policy (OSTP) and as policy coordinator at the U.S. Department of Energy. His policy work focused on the industries of the future, including artificial intelligence, the Committee on Foreign Investments in the United States (CFIUS), emerging technology-related national security policy, and U.S.-Japan issues. Erik holds a B.A. degree from Temple University and an M.A. degree in Asian Studies from Georgetown University. He speaks English and Japanese.

Isabella Perera

Isabella Perera is a Manager on Access Partnership's Policy Innovation team where she works on issues relating to open network infrastructure, cybersecurity, and semiconductor policy. Prior to joining Access Partnership, she worked as a Senior Technology, Media, and Telecommunications Analyst in Accenture's Strategy & Consulting practice. In this role, she supported both domestic and international companies to build data governance, privacy, and digital transformation programs. She holds a B.S. degree from Georgetown University's Walsh School of Foreign Service and has experience both studying and working in China. She speaks English, Mandarin Chinese, and Spanish.

1 Infrastructure Investment and Jobs Act, Pub. L. No. 117-158 (Nov. 15, 2021).

2 Authors' interviews with leading service providers and trade associations, Nov. 2021. An in-home broadband device might include SoCs for several different functions, including DSL/DOCSIS/Fiber/Fixed Wireless, WiFi, and Internet of Things (IoT) applications or protocols such as Bluetooth Low Energy, MATTER, Thread, Zigbee, and/or Z-Wave in addition to any chips needed for overall device integration.

3 According to one estimate, 66% of companies reported supply chain delays for customer premises equipment, 21% reported delays for routers, and almost 10% reported delays for switches or servers. Authors' interview with a leading service provider, Dec. 2021.

4 The White House, *Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth: 100- Day Reviews Under Executive Order 14017,* June 2021, at 24 (mobile phones accounted for 26 percent of global semiconductor end use in 2019 while ICT infrastructure accounted for 24 percent), *available at* https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf (citing Varas et al, *Strengthening The Global Semiconductor Supply Chain In An Uncertain Era, Boston Consulting Group and Semiconductor Industry Association,* Apr. 2021).

5 Comments of the Telecommunications Industry Association (TIA), filed June 10, 2021 in Federal Communications Commission Docket No. 21-195, *Wireless Telecommunications Bureau Seeks Comment on Potential Impact of Global Semiconductor Shortage*, at p. 4, https://ecfsapi.fcc.gov/file/106100453603850/2021.06.10%20TIA%20Comments%20on%20FCC%20Semiconductor%20Shortage.pdf.

6 *See, e.g.,* Chris Baraniuk, *Why is there a chip shortage*, BBC.com, Aug. 27, 2021, https://www.bbc.com/news/business-58230388.

7 Comments of the Telecommunications Industry Association (TIA), filed Oct. 25, 2021 in Dep't of Transportation Docket No. DOT-OST-2021-0106, *America's Supply Chains and the Transportation Industrial Base,* at p. 2, https://tiaonline.org/wp-content/uploads/2021/10/2021.10.25-DOT-chips-filing-final.pdf; authors' interviews with industry association and leading telecommunications providers, Oct.-Nov. 2021.

8 Thomas Seal, Takashi Mochizuki, and Debby Wu, *Sixty-Week Delay on Router Orders Shows Scale of Chip Crisis*, Bloomberg, Apr. 7, 2021, https://www.bloomberg.com/news/articles/2021-04-08/next-victim-of-chip-shortage-will-be-your-home-internet-router.

9 Yu Nakamura, *TSMC hikes chip prices up to 20% amid supply shortage.* Nikkei Asia, 26 Aug. 2021, https://asia.nikkei.com/Business/Tech/Semiconductors/TSMC-hikes-chip-prices-up-to-20-amid-supply-shortage.

10 Authors' interviews with a leading telecom trade association, Nov. 2021.

11 Authors' interviews with a leading telecommunications provider, Dec. 2021.

12 Comments of NCTA – The Internet & Television Association, filed June 10, 2021 in FCC WT Docket No. 21-195, at p. 7, https://ecfsapi.fcc.gov/file/1061045988333/061021%2021-195%20NCTA%20FCC%20Semiconductor%20Supply%20Chain%20Comments.pdf; *see also* Shepardson, David, *FCC studying impact on chips shortage on U.S. communications sector*, Reuters, May 11, 2021, https://www.reuters.com/article/us-usa-semiconductors-fcc/fcc-studying-impact-on-chips-shortage-on-u-s-communications-sector-idUSKBN2CS2NS (referencing NCTA comments on this point); authors' interview with a leading telecommunications provider, Dec. 2021.

13 Browne, Ryan, *The global chip shortage is starting to hit the smartphone industry*, CNBC, July 29, 2021, https://www.cnbc.com/2021/07/29/the-global-chip-shortage-is-starting-to-hit-the-smartphone-industry.html.

14 BloombergTV interview, *Cisco CEO Sees Supply Chain Easing Mid-2022*, Sept. 16, 2021, https://www.bloomberg.com/news/videos/2021-09-16/cisco-ceo-sees-supply-chain-easing-mid-2022-video; BBC News, I*BM says chip shortage could last two years*, May 13, 2021, https://www.bbc.com/news/business-57105368.

15 Authors' interview with leading telecommunications industry association, Nov. 2021.

16 *See* Infrastructure Investment and Jobs Act, H.R. 3684 (117th Cong.), enrolled bill at p. 925 (making $42.45 billion appropriation to NTIA), https://www.congress.gov/bill/117th-congress/house-bill/3684/text/.

17 Universal Service Administrative Co., *High Cost Program Overview*, https://www.usac.org/high-cost/program-overview/ (visited Nov. 10, 2021) ($4.5 billion annual budget for deployment in rural areas where the market alone would not support deployment).

18 U.S. Telecom, *2020 Broadband Capex Report*, https://ustelecom.org/wp-content/uploads/2021/09/USTelecom-2020-Broadband-Capex-Report.pdf.

19 *See* FCC Press Release, *RDOF Winning Bids Ready to be Authorized*, Nov. 10, 2021, https://www.fcc.gov/document/rdof-winning-bids-ready-be-authorized; *see also* FCC, *Auction 904: Rural Digital Opportunity Fund*, https://www.fcc.gov/auction/904.

20 Michael Powell, NCTA President & CEO, *Boom or Bust: Getting Broadband Infrastructure Programs Right*, Mar. 19, 2021, https://www.ncta.com/whats-new/boom-or-bust-getting-broadband-infrastructure-programs-right ("in the cable industry, we rebuild our networks roughly every 18 months").

21 Authors' interview with leading telecom trade association, Nov. 2021.

22 *Id*.

23 NCTA, *How the Semiconductor Chip Shortage Could Delay Broadband Connectivity*, May 20, 2021, https://www.ncta.com/whats-new/how-the-semiconductor-chip-shortage-could-delay-broadband-connectivity.

24 See E&T Staff, *Global 5G roll-out could be hampered by chip shortage, Engineering and Technology*, October 21, 2021, https://eandt.theiet.org/content/articles/2021/10/global-5g-rollout-could-be-hampered-by-chip-shortage/.

25 *Chip shortage stymies Rakuten's Japan mobile coverage,* Nikkei Asia, Oct. 23, 2021, https://asia.nikkei.com/Business/Telecommunication/Chip-shortage-stymies-Rakuten-s-Japan-mobile-coverage.

26 Jodi Xu Klein, *US rural carriers, scrambling to replace Huawei and ZTE gear, now face supply chain delays*, South China Morning Post, Dec. 2, 2021, https://www.scmp.com/news/china/article/3158086/us-rural-carriers-scrambling-replace-huawei-and-zte-gear-now-face-supply.

27 Comments of Competitive Carriers Association re: Federal Communications Commission Docket No. 21-195, filed June 10, 2021, *Wireless Telecommunications Bureau Seeks Comment on the Impact of the Global Semiconductor Shortage on the U.S. Communications Sector*, https://ecfsapi.fcc.gov/file/106101742803170/CCA%20Comments%20to%20Chip%20Shortage%20PN_6-10-21.pdf.

28 Price, Sydney, *Cable operators, telcos battle on pricing, p'hone subsidies as mobile adds soar, S&P Global Market Intelligence*, Oct. 21, 2021, https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/cable-operators-telcos-battle-on-pricing-phone-subsidies-as-mobile-adds-soar-67156398 (noting that "effects of the semiconductor shortage are impacting phone supply, which could over time impact upgrade numbers as popular devices take longer to restock").

29 Deloitte, *How the pandemic has stress-tested the crowded digital home*, June 2021, at p. 3, https://www2.deloitte.com/content/dam/insights/articles/6978_TMT-Connectivity-and-mobile-trends/DI_TMT-Connectivity-and-mobile-trends.pdf.

30 E&T Auto Team, *Apple says chip shortage set to further effect growth*, The Economic Times. Oct. 29, 2021. https://auto.economictimes.indiatimes.com/news/auto-components/apple-says-chip-shortage-set-to-further-affect-growth/87359427.

31 Debby Wu, Takashi Mochizuki, and Vlad Savov, *Chip Shortage Spirals Beyond Cars to Phones and Game Consoles*. Bloomberg. Feb. 5, 2021, https://www.bloomberg.com/news/articles/2021-02-05/chip-shortage-spirals-beyond-cars-to-phones-and-game-consoles; Steve Lohr, *In Race for 5G, Alarm and Security Devices Get Stuck in the Middle*, The New York Times. Sept. 24, 2021, https://www.nytimes.com/2021/09/24/technology/att-5g-race.html.

32 E&T Staff, *Global 5G roll-out could be hampered by chip shortage, Engineering and Technology,* October 21, 2021, https://eandt.theiet.org/content/articles/2021/10/global-5g-rollout-could-be-hampered-by-chip-shortage/.

33 President Joseph R. Biden Jr., *Executive Order on America's Supply Chains*, February 24, 2021, https://www.whitehouse.gov/briefing-room/presidential-actions/2021/02/24/executive-order-on-americas-supply-chains/.

34 FCC Public Notice, *Wireless Telecommunications Bureau Seeks Comment on the Impact of the Global Semiconductor Shortage on the U.S. Communications Sector,* DA 21-550, May 11, 2021, at p. 2, https://docs.fcc.gov/public/attachments/DA-21-550A1.pdf.

35 Authors' interview with a leading telecommunications provider, Nov. 2021.

36 *See, e.g., 8-inch wafer ICs in short supply as foundry revenue leaps 23.8%*, Astute, Nov. 23, 2020, https://astute.global/8-inch-wafer-ics-in-short-supply-as-foundry-revenue-leaps-23-8-yoy/.

37 Trevor Hunnicutt, Andrea Shalal, and David Shepardson, *Facing chips shortage, Biden may shelve blunt tool used in COVID fight,* Reuters, May 5, 2021, https://www.reuters.com/business/autos-transportation/exclusive-facing-chips-shortage-biden-may-shelve-blunt-tool-used-covid-fight-2021-05-05/.

38 Authors' interview with a leading telecommunications provider, Nov. 2021.

39 *Id.*

40 Sue Halpern, *The One-Traffic-Light Town With Some of the Fastest Internet in the U.S.*, The New Yorker, Dec. 3, 2019, https://www.newyorker.com/tech/annals-of-technology/the-one-traffic-light-town-with-some-of-the-fastest-internet-in-the-us (describing transformative impact of universal broadband access in Jackson and Owsley counties in Kentucky, including areas with "not the greatest roads" and "places we couldn't get a vehicle to," and students continuing to learn from home when snowfall closed mountain roads); Ben Casselman, *Rural Areas Are Looking for Workers. They Need Broadband to Get Them*, N.Y. Times, May 17, 2021, https://www.nytimes.com/2021/05/17/business/infrastructure-rural-broadband.html (describing how broadband access is now more critical to rural communities than roads and bridges).

41 *See, e.g.,* Andy Kiersz and Madison Hoff, *The Pandemic Ended the Daily Commute, Business Insider*, Jul. 25, 2021, https://www.businessinsider.com/pandemic-ended-american-daily-commute-to-work-transit-rush-hour-2021-7 (referencing data from the Bureau of Labor Statistics' American Time Use Survey); Alan Breznick, *OpenVault: Higher Broadband Use Emerging as New Normal*, Light Reading, June 1, 2021, https://www.lightreading.com/cable-tech/openvault-higher-broadband-use-emerging-as-new-normal/d/d-id/769915.

42 *Chip shortage addressed by US-EU tech alliance*, BBC, June 17, 2021, https://www.bbc.com/news/technology-57512511.

43 Letter from Associations and Unions to Speaker Pelosi *et al*, July 22, 2021, https://www.semiconductors.org/wp-content/uploads/2021/07/CHIPS-coalition-letter-july-22-2021-FINAL.pdf (includes Semiconductor Industry Association and other tech associations), *see also* Semiconductor Industry Association, *SIA Welcomes Today's White House Meeting on Semiconductor Supply Chain*, Sept. 23, 2021, https://www.semiconductors.org/sia-welcomes-todays-white-house-meeting-on-semiconductor-supply-chain/.

44 Nicole Goodkind, *Biden administration sounds the alarm on the semiconductor crisis, Fortune*, July 16, 2021, https://fortune.com/2021/09/28/commerce-gina-raimondo-manufacturing-crisis/.

Access Partnership
1730 Rhode Island Ave. NW, Suite 512
Washington, DC 20036

T: +1 202 503 1570

AccessAlerts
Access Partnership

accesspartnership.com