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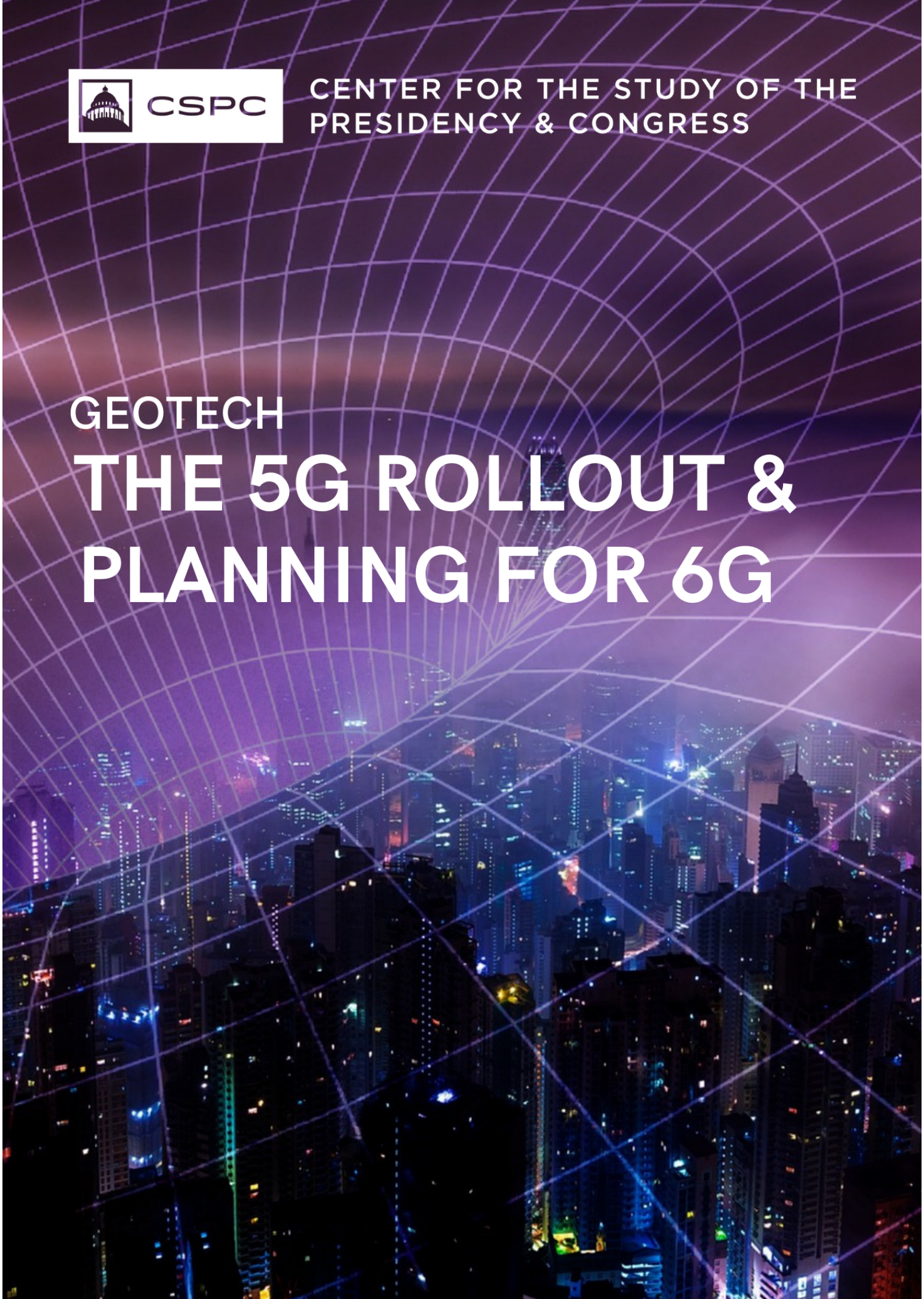
CENTER FOR THE STUDY OF THE PRESIDENCY & CONGRESS

GEOTECH

THE 5G ROLLOUT & PLANNING FOR 6G



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GEOTECH: THE 5G ROLLOUT & PLANNING FOR 6G

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Introduction

In Geotech competition, one of the most important areas of concern is leadership in 5G and 6G technologies. Current and future 5G networks, as well as future 6G technologies and standards, provide the connectivity underpinning digital societies and connected technologies of the Internet of Things (IoT).

The development and rollout of 5G networks is not simply about providing faster downloads for smartphones—though that is an advantage. 5G networks' high speed and quick response means that they are primed to provide networked connectivity in fields such as transportation, agriculture, manufacturing, healthcare, and defense. Just as the previous leap from 3G to 4G unlocked the potential of the smartphone and an ecosystem of app-based enterprises and services, 5G will provide revolutionary real-time connectivity to important existing sectors.

Take agriculture, for example, and one can see the potential of 5G technology to change an entire industry—both in its operations and along the course of its supply chain. From sensors in fields providing real time soil, moisture, and nutrient data to farmers and connections to autonomous farm equipment, to connected systems in warehouses and food distributors connected to the shelves in supermarkets, 5G will allow us to unlock and transmit data for important supply chains, critical infrastructures, and advanced platforms. Beyond the impact on specific industries, 5G networks can help to bridge the digital divide, bringing high speed connectivity to under- and un-connected households in both rural and urban America. Those are just some of the potential revolutionary impacts that technology and industry experts foresee. Just as one would have been hard-pressed to anticipate the success of 4G smartphone apps like ridesharing when holding a 3G flip phone, some future 5G-based successes are just emerging in innovators' imaginations.

As policymakers have increasingly focused on Geotech competition and the importance of 5G networks, we have seen efforts to speed the rollout of 5G networks and invest in future 6G leadership—yet legislative efforts have also been stalled. Rapid build outs of 5G networks have come after FCC streamlining of regulation and billions of dollars of infrastructure investments and spectrum purchases by telecoms, yet the rollout in the United States was marred by the poor coordination regarding interference with aircraft—something that was not an issue in other high-tech countries where 5G rollouts took place.

Analyses of the players in 5G and 6G, as well as government policies, continues to illustrate the importance of the broader innovation ecosystem that we have discussed in our previous Geotech reports. The disruptions of the pandemic and resulting shocks to supply chains have illustrated the fragility of one part of this ecosystem, while also raising concerns about our dependence on foreign suppliers. These security concerns must be balanced with the realities, revenues, and benefits of a globally connected supply chains and American and allied companies leading the way in cutting edge technologies. Policies ranging from R&D support to immigration policy, from intellectual property rules to STEM in education all affect this innovation ecosystem. Intellectual property rules are an area of particular concern for 5G

innovation leadership. Paradoxically, the Biden administration has encouraged leadership in international standards-setting organizations (SSOs) by weakening protection for standards-essential patents (SEPs)—patents vital for an innovation leader to participate in setting an international standard.

The western response to Russia's invasion of Ukraine has also demonstrated a newfound willingness to use Geotech tools and potentially reshaping the global technology competition—the prospect of wholly cutting off Russia from the global high-tech marketplace accelerates the divide between authoritarian and liberal societies' digital domains. Strategic competition over technology will only accelerate, even as connections are splintered. Here cooperation with allies is vital as supply chains are reshaped and resecured, competition to set international standards intensifies, and being the first in future technologies present opportunities to leapfrog competitors' products and aims.

During the pandemic, we have come to understand the importance of our connectivity—both for commerce and personal entertainment. As we adapt to the realities of a transformed, increasingly competitive world, with ever more networked devices, secure, reliable connectivity is vital. As the backbone of future digital connectivity and the foundation of future digital innovation, it is important not only to protect the security of 5G networks but also to ensure that the U.S. and its allies lead in the innovations going into 5G networks and future technologies such as 6G. There is already a race to 6G leadership underway, and governments and companies around the world are engaged in the initial steps to develop 6G technology and set future standards in that field. These first steps towards 6G and the ongoing race for 5G leadership are closely intertwined—what we do now in 5G sets the course for 6G. Looking back, lessons from the 4G to 5G race can inform us of successes and failures. Looking ahead, policy choices like investments in future R&D, support for architectures like Open RAN, and protection of intellectual property all have ramifications not just today but also years ahead.

Throughout 2021 and early 2022, CSPC continued its Geotech engagement with policymakers, private sector leaders, and academic experts regarding strategically critical technologies, policies to promote innovation leadership, geopolitical and strategic competition, and trends in commerce, trade, and technology. A major segment of this research has included 5G networks and related supply chains such as semiconductors and other microelectronics. This report reflects, and respects, the off-the-record nature of these discussions, combined with open-source research and the analysis of CSPC staff, advisors, and fellows.

The report finds promise in the efforts underway, but concern about their slowing pace. Decisions made now have an impact years in the future when it comes to the shape of these innovations and the nature of technology leadership. Given the importance of 5G networks and future 6G leadership, the challenge is urgent, but we must be careful in our choices, focusing on the security and reliability of a critical technology.

Key Factors to Consider

Supply Chain Concerns

5G and telecom networks were one of the original areas identified as a Geotech concern, when lawmakers identified the risk posed by Huawei's dominance and China's efforts in this field. As noted in previous CSPC Geotech reports, the concerns about supply chains prompted by the pandemic have resulted in Executive Branch efforts to address critical supply chains and a flurry of legislative proposals. The private sector has also moved on its own to address these shortcomings, with its own investments in domestic or "near-shoring" of production. Still, the reality of the modern global economy requires understanding of the international nature of business.

Of course, the semiconductor supply chains are of key concern for 5G and future 6G technologies. The 2022 Accenture report on semiconductor supply chains noted:[1]

> The second largest market for chips is for those used in cell phones, wireless infrastructure and modems. The growth of network equipment in developing economies, the migration from 4G to 5G and growth in the smartphone market has boosted production by 24.1%. 5G is expected to be a major demand driver since new capabilities are needed for 5G smartphones.

The security and health of semiconductor supply chains is key to our 5G deployment and future 6G leadership. Policymakers should emphasize investments in the silicon semiconductor supply chain and its broader innovation and R&D ecosystem.

Open RAN Technologies

As previous CSPC Geotech reports have noted, Open RAN presents an alternative model to current network infrastructure with single-vendor architectures. As stated by the Open RAN Policy Coalition, "The key concept of Open RAN is 'opening' the protocols and interfaces between the various subcomponents (radios, hardware and software) in the [Radio Access Network (RAN)]."

By allowing for a diversity of network equipment vendors for various components and software, 5G and future 6G network operators could enjoy the same diversity of vendors that is seen in in other IT fields. This represents an opportunity to disrupt the business model used by Huawei, but other U.S. and allied firms will also have to adapt to this Open RAN model as well. At the same time, open architectures provide an avenue for new market entrants and innovators to enter the 5G and 6G marketplace.

[1] https://www.accenture.com/us-en/insights/high-tech/semi-value-chain

While concerns about 5G have often focused on the power of Chinese firms in the network equipment vendor marketplace, a shift to Open RAN puts the power in the hands of the purchasers—the network operators. With U.S. and allied telecom operators leading in revenue, their preferences can help to promote competition among 5G equipment vendors and shape their demand.[2]

U.S. Legislative Efforts & 5G

As policymakers have recognized the importance of Geotech competition, there has been movement in Congress to address concerns related to supply chains and economic security, while also looking to foster future innovations with investments and support for R&D. Many of these measures have been authorized, but actually appropriated funds to implement programs and address Geotech goals have not materialized. While there has been a flurry of activity and the introduction of a range of important measures, progress has been slowed by the partisan and procedural dynamics of Congress.

Bipartisan Innovation Act

A priority of both the Biden administration and Democratic leadership in Congress, the Bipartisan Innovation Act (BIA) is the latest moniker for what is coming together from the Senate-passed U.S. Innovation & Competition Act (USICA) and the House-passed America COMPETES Act. As of this report's writing in mid-March of 2022, the next step is for a House-Senate conference to resolve differences in the legislation. That continues to reflect a suggested timetable of conference and passage by the Memorial Day holiday, in late-May, despite some in the administration suggesting that it could come sooner. That timeframe, of course, depends on what consensus there is on moving forward with similarities in the legislation and agreeing over differences in conference.

While USICA was heralded as a bipartisan bill with the support of 19 Republican Senators, House Republican leaders have voiced their concerns about the America COMPETES Act and their lack of input on the component legislation. More hawkish Republicans have also complained that some of the measures are not as stringent as is needed. These will weigh on the conference process given narrow majorities. With support for bipartisan legislation addressing competition with China and innovation leadership, Democratic leaders run the risk of over-messaging this legislation as one addressing climate, inflation, and other progressive priorities. Part of this is due to the more expansive House legislation, as well as a pivot away from other stalled Democratic legislative proposals in 2021. Growing partisanship about these measures would threaten the pace of passage.

[2] Sachin Katti interview with Manuka Stratta. December 3, 2020. CSPC Report, "5G and Beyond to 6G: Opportunities for the Biden Administration & 117th Congress, July 2021." https://www.thepresidency.org/5g-and-beyond-to-6g

Specific measures in the legislation important to 5G and future 6G leadership include:[3]

- CHIPS for America Fund - $52 billion for incentives to invest in and develop domestic semiconductor fabrication and stand up the National Semiconductor Technology Center.

- Public Wireless Supply Chain Innovation Fund - $1.5 billion for development and deployment of Open RAN network equipment.

- COMPETES Act includes direction to the FCC to establish a 6G task force to provide Congress recommendations on 6G, its benefits, and international standards-setting.

- $100 million for five years for telecommunications workforce support, and the House COMPETES Act language also includes efforts to further diversify the telecommunications workforce.

- Both pieces of legislation also create critical supply chain resilience programs in the Department of Commerce, with more expansive proposals in the COMPETES Act for supply chain monitoring and other Department of Commerce authorities.

Some of these measures, notably the direction to the FCC regarding a 6G task force, reflect how other stand-alone legislative proposals have been incorporated into these larger proposals. For example, the FUTURE Act, sponsored by Reps. Mike Doyle (D-PA), Bill Johnson (R-OH) and Lucy McBath (D-GA), had instructed the FCC to establish a "6G task force."[4]

Securing Existing Networks

While most attention has been focused on the proposals pending progress on the Bipartisan Innovation Act, Congress and the Biden administration acted to secure our existing networks. On November 11, 2021, President Biden signed the bipartisan Secure Equipment Act, which bans the Federal Communications Commission (FCC) from considering products from companies that are considered national security threats.[5] Companies such as Huawei and ZTE would both fall into this category, after they were flagged as a security threat and therefore US telecommunications companies would not be able to purchase any products from these companies using federal funds.

On March 25, 2022, the FCC added three foreign companies to the list of communication equipment and services that pose a threat to U.S. national security. AO Kaspersky Lab of Russia,

[3] https://www.speaker.gov/sites/speaker.house.gov/files/America%20COMPETES%20Act%20of%202022%20HR%204521.pdf
[4] https://www.congress.gov/bill/117th-congress/house-bill/4045?r=37&s=1
[5] https://thehill.com/policy/cybersecurity/581184-biden-signs-into-law-bill-to-secure-telecommunications-systems-against?rl=1

China Telecom (Americas) Corporation, and China Mobile International USA, Inc. were added to covered list of threats to national security pursuant to the Secure and Trusted Communications Networks Act of 2019.[6] They join Huawei, ZTE, Hytera Communications Corporation, Hangzhou Hikvision Digital Technology Company, and Dahua Technology Company on the covered list.[7]

As policymakers consider current and future telecom security proposals, some telecom providers, especially rural ones, may face difficulties in removing unsecure hardware.

5G & Aviation Crisis Demonstrates Need for Better Tech Coordination

The late-2021 and early-2022 succession of deadlines and stop-start deployments of 5G near U.S. airports reflected a breakdown in U.S. tech policy. Where the world once looked to U.S. leadership in aviation, telecoms, and setting standards for advanced technologies, squabbling between leading U.S. telecoms and airlines—and their seemingly-blindsided regulators—resulted in headlines around the world questioning U.S. tech and regulatory prowess.

The issue with 5G and aircraft operation involved the radio altimeter, which uses radio signals bounced off the ground to determine an aircraft's altitude with greater precision than barometric altimeters, which are set and adjusted according to the ambient air pressure. These radio altimeters are used for instrument-guided approaches using airplanes' onboard equipment and ground-based radio beacons that constitute instrument landing systems (ILS). These systems allow for landings in low-visibility and other types of inclement weather, while also helping with pilots' workload in busy airspace and feeding data to other automated systems.

In the technical weeds, these radio altimeters operate at 4.2-4.4 GHz, while the 5G networks activated by U.S. telecoms AT&T and Verizon operate at 3.7-3.98 GHz. Despite the "guard band" frequency gap put in place by the FCC between those bands of spectrum—and outstanding questions regarding any real-world or lab testing examples of interference and which models of altimeter might be affected—FAA, aircraft manufacturers, airplane sensor manufacturers, and the airline industry have all continued to voice their concerns.

This reflects bureaucratic breakdowns, as well as the concerns about regulatory capture of key agencies. First, it must be acknowledged that the safety margins for operating aircraft exist for a reason and have contributed to making U.S. air travel among the safest in the world. Second, alongside our prioritization of safe and efficient air travel, policies to promote and speed the deployment of 5G have also been pursued by successive administrations and FCC leadership from both parties. Finally, as both the FCC moved ahead with spectrum auctions, the FAA noted concerns from both Boeing and the ICAO (the UN's international aviation authority) as early as

[6] https://www.fcc.gov/document/fcc-expands-list-equipment-and-services-pose-security-threat
[7] https://www.fcc.gov/supplychain/coveredlist

2018—though the FAA says these concerns were not relayed to the FCC by the NTIA (the body responsible for resolving spectrum disputes.)[8]

This reveals breakdowns in the process around advanced technologies. In 2020, as AT&T and Verizon were spending billions on spectrum to roll out important 5G networks and expand coverage, the interagency process for proactively addressing this issue failed. Regulatory bodies failing to coordinate on technological and transportation issues of national importance. As wireless innovation continues, issues like spectrum allocation will been critical, while modernizing transportation infrastructure will require vision—and the commitment of resources: time and money—from all stakeholders involved.
From this experience we see, first, the need for more real-world testing and interoperability checks before deployment takes place. This is not only an issue for wireless telecom and aviation, but also future technologies. Future 5G and networked technologies will incorporate software and hardware from many vendors in connected technologies from autonomous vehicles to networked factory floors. Standards of interoperability and non-interference are vital for these technologies to meet their potential.

Breakdowns in the regulatory process also reflect both the risks of leaving important positions unfilled, or with only acting administrators, as well as the need for better interagency coordination—likely from the White House—to resolve stakeholders' interests and potential conflicts long before eleventh-hour fixes. If American standards in fields like technology and aviation—as well as perceptions of our general technical and administrative competence—are to be an example to the world, this 5G and aviation "crisis" is hardly a positive one. Hopefully it can be a learning experience for future technology deployment and infrastructure modernization vital to our technological and economic competitiveness.

Addressing Counterproductive Intellectual Property Policies

Previous CSPC Geotech reports have identified the importance of protecting U.S. intellectual property as essential to the foundation of a strong innovation ecosystem. Specific policies around standards-essential patents (SEPs) are of particular importance for 5G and telecom leadership, as well as how U.S. firms participate in setting international standards and participating standards-setting organizations (SSOs). In the January 2022 CSPC Geotech report, we noted:[9]

> As we find ourselves in a heated Geotech competition, IP policies underpin our innovation ecosystem and the R&D of market-based innovation leaders—many of which are U.S.-based—via the revenues derived from their IP and its licensing. Given that revenue from intellectual property feeds R&D—and since R&D

[8] https://www.aviationtoday.com/2022/01/04/latest-c-band-5g-delay-allows-att-verizon-address-aircraft-radar-altimeter-concerns/
[9] https://www.thepresidency.org/accelerating-the-race-for-innovation-leadership-report

> decisions are made by corporate leaders years, if not a decade, in advance—strategic, long-term, and consistent approaches to IP policy are needed.
>
> In discussions with current and former policymakers and private sector innovation leaders, CSPC Geotech research has identified areas where U.S. IP policy suffers from what former USPTO Director David Kappos describes as "cognitive dissonance", where U.S. innovation leadership in global standards is discouraged; U.S. IP is devalued; and a negative example is set for global partners and competitors.[10] Addressing these issues, incorporating national security stakeholders in IP policy decision-making, and addressing shortcomings in the patent system related to strategic critical technologies will ensure that our IP system helps to protect our national security and economic prosperity.

In that report we noted concern about how the Biden administration Department of Justice (DOJ) has moved to weaken protections for standards-essential patents (SEPs). The current announcement and effort by the DOJ to revisit the 2019 joint policy statement of the DOJ, U.S. Patent and Trademark Office (USPTO) and National Institute for Standards and Technology (NIST) threatens to devalue the SEPs that telecom providers put forward when contributing their intellectual property to international standards.

This policy is counterproductive in several ways. First, it devalues U.S. intellectual property at a time when our competitors seek to steal U.S. IP or reshape/abuse IP rules in their favor. The effort also comes when USPTO and NIST do not have their confirmed leadership in place, allowing DOJ to make policy without the input from important stakeholders regarding patent policy and the broader security implications. Finally, at a time when the administration aims to encourage U.S. participation in international SSOs, weakening SEPs dissuades companies from putting their IP into international standards.

Beyond these immediate factors, counterproductive policies regarding intellectual property threaten the broader innovation ecosystem that feeds U.S. and allied technology leadership. Revenue from patent licensing, like essential patents, funds the long-term pipelines for R&D, allowing for not only the research in next-generation technologies but also the jobs and livelihoods of the engineers, researchers and others who make up our irreplaceable innovation workforce.

Our intellectual property policies should be constructed and reformed in ways that reflect the changing nature of global technology competition and the importance of protecting and valuing the fruits of our innovators' and entrepreneurs' expertise and labor. Given the importance of these technologies for our national security and economic prosperity, they should be crafted in ways that account for all key stakeholders' inputs to reflect the national security and technology competition factors at stake. When we are positioning ourselves to for a technology competition, poorly crafted policies are ill-afforded.

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[10] https://www.youtube.com/watch?v=BT22qJCh5yA

Global Developments on 5G and Future 6G

Prague Security Conference & Multilateral Supply Chain Security

A key multilateral effort for securing 5G networks is the ongoing efforts of the Prague 5G Security Conferences. U.S. and key allied policymakers have continued to voice their support for these efforts. The 2021 conference focused on identifying risks and opportunities with 5G networks and their relationships with other emerging and disruptive technologies (EDTs). Looking ahead, the agenda of the 2022 conference is to focus on protecting the supply chains for 5G networks and EDTs. This is an opportunity for the United States and like-minded allies to begin to set frameworks for supply chain security and coordination of efforts. While current approaches have largely focused on keeping out Chinese or other untrustworthy providers, this is an opportunity to look ahead for cooperation on future standards and supply chain security.

Bilateral Efforts & Allies' Efforts

U.S.-Japan cooperation presents a promising opportunity for continued 5G partnerships and future 6G leadership. An important first step was the April 2021 announcement of joint $4.5 billion investment in 6G and 5G Open RAN research, development, and testing by President Biden and former Japanese Prime Minister Suga.[11]

The Japanese Ministry of Internal Affairs and Communications (MIC) announced a 6G consortium that will include U.S. partners. The "Beyond 5G Promotion Consortium" white paper released in mid-March[12] provides detail regarding goals and partnerships to help set early standards for 6G and its use in a range of real-world applications, including unmanned systems.[13] Japan has also engaged with other partners, including research partnerships with Finland.[14]

Japan's broader 6G efforts reflect an early-stage process to solicit inputs from key industry players and foster public-private partnerships. A range of major Japanese firms from a cross-section of sectors such as Toyota, NEC, NTT, Rakuten, Panasonic, and others are working with the MIC and Japanese officials to identify technical standards for future 6G technologies.[15]

[11] https://asia.nikkei.com/Business/Telecommunication/US-and-Japan-to-invest-4.5bn-in-next-gen-6G-race-with-China
[12] https://b5g.jp/en/output.html
[13] https://asia.nikkei.com/Business/Tech/Semiconductors/Japan-to-partner-with-U.S.-on-6G-standards-for-unmanned-tech
[14] https://www.itpro.co.uk/infrastructure/network-internet/359818/japan-teams-with-finland-on-6g-development
[15] https://www.rcrwireless.com/20220318/5g/toyota-nec-other-firms-join-japan-6g-initiative-report

Quad partner India has its own goals for 5G and 6G, and efforts to coordinate supply chain security are important for working with Delhi's own telecom goals and those for the developing world. The Minister for Electronics and IT, Ashwini Vaishnaw announced in February 2022 that India was reaching the final stages of 5G deployment and would be looking towards 6G standards soon. [16] In working with India, it will be important to understand the "Made in India" goals of the Modi government, as Delhi seeks space for India's firms to lead in their own aspects of 6G technology and standards-setting.[17]

South Korea, too, is pushing ahead with its 6G efforts. South Korea's programs have promised to invest $194 million by 2025 across focus areas in 6G R&D covering high speed communications, optical and wireless networks, and terrestrial and satellite low-earth orbit (LEO) options.[18] U.S.-ROK cooperation on 5G and 6G networks was reiterated in the fact sheet on the U.S.-ROK partnership released by the White House in May of 2021.[19] The election of Yoon Suk-yeol as South Korea's next president also presents an opportunity for better coordination of technology and economic security policies with Seoul—both in bilateral and multilateral ways.

Europe is also moving ahead with its approach to 6G. At the Mobile World Congress in March 2022, Commissioner for the Internal Market, Thierry Breton, outlined Europe's approach to "digital policies to speed the post-COVID recovery" including efforts to lead in 6G technologies. Highlighting a range of programs in EU member countries, this reflects a commitment of €2 billion for public-private 6G research efforts in the EU.[20] While the U.S.-EU tech dialogues hit speedbumps on issues of data privacy and competition regulation, efforts to collaborate on 6G R&D and developing common standards are important for both Washington and Brussels to ensure 6G leadership and security.

China's 6G Efforts & the Huawei Model

China's 6G efforts reflect continued emphasis on technology leadership and developing Made in China solutions. These efforts have only accelerated as U.S.-China trade and technology tensions rose, and the example set by the sanctions levied on Russia for its assault on Ukraine will likely hasten China's efforts to decouple its economy. Telecom networks and 5G were areas where China's model for tech development and market control was identified early on, particularly with Huawei. China has long seen the connectivity of 5G as vital to its future economic development and harnessing of tools like big data, artificial intelligence, and machine

[16] https://economictimes.indiatimes.com/industry/telecom/telecom-news/own-5g-network-in-final-stages-india-now-part-of-6g-development-ashwini-vaishnaw/articleshow/89442341.cms
[17] https://economictimes.indiatimes.com/industry/telecom/telecom-news/own-5g-network-in-final-stages-india-now-part-of-6g-development-ashwini-vaishnaw/articleshow/89442341.cms
[18] https://www.fiercewireless.com/tech/south-korea-kickstarts-6g-plans
[19] https://www.whitehouse.gov/briefing-room/statements-releases/2021/05/21/fact-sheet-united-states-republic-of-korea-partnership/
[20] https://digital-strategy.ec.europa.eu/en/news/europe-sets-out-6g-vision-mobile-world-congress-barcelona

learning. In January of 2022, Xi Jinping issued his own statements on the importance of these networks for security and prosperity and the need to secure China's own supply chains and leadership in strategically critical technologies.[21]

Leadership in 6G is part of this next agenda. Chinese labs have pushed ahead claiming early 6G breakthroughs,[22] and a survey found that China accounts for 40 percent of 6G patents.[23] 6G is also a priority for Beijing and its national champion firms. While hobbled by current tech restrictions, Huawei is looking for 6G as an area to re-establish leadership.[24]

The January 2022 CSPC Geotech report noted the following about China's tech model in the developing world:

> While U.S.-China economic interdependence will remain for the foreseeable future, competition in the developing world is already underway. Many indicators suggest that China is in the lead, with an Atlantic Council Study finding that 50 percent of Africa's 3G and 70 percent of its 4G networks are built by Huawei.[25] This report noted the continued infrastructure dependence of African countries on Chinese providers and the abundance of Chinese state aid in facilitating network build outs. CSPC's assessment concurs with this report, as well, in noting that the advantages already enjoyed by Huawei require a "leapfrogging" approach focused on future technologies including satellite-based options, Open RAN 5G where possible, 6G deployment, and long-distance/undersea cable connections and nodes.
>
> China is applying the same playbook that it used to success in Africa in Latin America. In some instances, China has linked vaccine diplomacy with Huawei access—notably in Brazil.[26] Brazil is a key future marketplace for 5G and its standard influences others in Latin America. Huawei has already established itself throughout Latin America, and U.S. diplomats' efforts at vendor bans have been met with a cold shoulder. The challenge is to again lead in the next generation of technologies to leapfrog the current advantage of Chinese firms.
>
> Geotech diplomacy and Geotech development assistance efforts are in their nascent stages, and will require greater engagement, resourcing, and leveraging of public-private partnerships. Multilateral efforts working with allies and partners

[21] https://www.scmp.com/business/china-business/article/3163534/his-own-words-chinas-president-outlines-vision-digital
[22] https://www.scmp.com/tech/big-tech/article/3162411/chinese-lab-says-it-made-breakthrough-6g-mobile-technology-global
[23] https://asia.nikkei.com/Business/Telecommunication/China-accounts-for-40-of-6G-patent-applications-survey
[24] https://asia.nikkei.com/Spotlight/Huawei-crackdown/Huawei-vows-to-lead-in-6G-as-U.S.-and-Japan-challenge-China
[25] https://www.atlanticcouncil.org/blogs/africasource/the-digital-infrastructure-imperative-in-african-markets/
[26] https://www.mcclatchydc.com/news/nation-world/national/national-security/article249986534.html

> can also provide opportunities for greater resource and burden-sharing, as well as avoiding perceptions of American domineering in regions with sensitive historical memories. A model from Oceania is the recently announced partnership with Australia and Japan to provide improved undersea network cable connections to a range of Pacific Island partners. This follows similar efforts by Australia to remove Huawei from planned connections to the Solomon Islands and avoid the connection of Chinese-built and operated infrastructure to Australia's core communications networks.[27]

Continued analysis of China's approach to the developing world's technologies and suggests that this model will continue to be applied to future 5G and 6G technologies. Strategies for future technology standards will have to look to address the "Huawei model" or "China, Inc." for telecom infrastructure in the developing world.

Conclusion & Recommendations

From our discussions and research on 5G technology and the future of 6G technology, it is clear that the race is already underway for the next generation of communications technology. While we are not done with the 5G rollout by any stretch of the imagination, decisions made today regarding 5G deployment and investments in future technologies should recognize the importance of 6G leadership for economic prosperity and national security.

Congress stands on the cusp of passing legislation that many industry and technology experts welcome. Moving quickly to make investments in R&D and building public-private partnerships can accelerate U.S. 6G efforts, provide opportunities to strengthen relationships with key allies, and foster innovation leadership. Investments in semiconductor research and production build on existing U.S. strengths to push for the next generation of connectivity, while protecting critical supply chains.

We also see the danger of counterproductive or poorly coordinated policies. The brouhaha over 5G and airports demonstrated a worrying breakdown in tech policy coordination, and it threatened public trust over new technologies and government policies. Counterproductive intellectual property policies threaten to devalue our innovators' work, while threatening future innovations and discouraging participation in the critical process of setting international technology standards.

We have seen how in the jump from 4G to 5G, how we fell behind, and how we have managed to close some of the gap. Many of the lessons reflect the realization of the competition we face, as well as a willingness to breakdown many of the barriers to deploying 5G networks. Similar lessons can be applied to how we look to 6G and aim to avoid again realizing that our critical technology was in the hands of a heated competitor and potential adversary. At the same time,

[27] https://www.abc.net.au/news/2021-12-12/new-undersea-cable-internet-pacific-australia-us-japan/100694212

how could we balance these security concerns with the realities of global marketplaces and the pipeline of global revenue to R&D at home? We understand how cooperation with allies and partners is key to setting international standards, as well as addressing concerns about the future networks and partnerships with the developing world.

Taking all of this into account, the most important lesson is that the decisions we take now, whether we move quickly or not, all affect the trajectory of future technologies and prospects for future innovation leadership. Moving today to provide the resources and build the partnerships for 6G leadership can ensure that the vital backbone for future connectivity is secure and reliable.

Recommendations

- **Fully Resource Key R&D & Innovation Programs:** where Congress has authorized resources to fund R&D in key technologies or support critical supply chains, it should move quickly to appropriate the funds.

- **Quickly establish testbeds and public-private partnerships:** for promising technologies and architectures, such as Open RAN, it is important to establish testbeds to ensure hardware-software interoperability and other testing of various vendors' equipment. Similarly public-private partnerships on 6G can begin important channels of communication and coordination on what the future 6G technology landscape will look like and what policies can foster 6G innovation leadership.

- **Protect and Foster Critical Supply Chains:** microelectronics and semiconductors are critical supply chains for 5G and 6G technologies. The United States is a leader in semiconductor design, and working with key allies, we can incentivize reshaped and more secured semiconductor supply chains. Investments in the broader silicon-semiconductor ecosystem can ensure U.S. and allied leadership in a critical technology and its related supply chain.

- **Secure Critical Technologies:** with 5G and 6G technologies, along with other strategically critical technologies, it is important for the United States and its allies to coordinate on investment review, export controls, and other tools to ensure that our cutting-edge technology does not find its way into the hands of competitors and potential adversaries.

- **Avoid Counterproductive IP Policy:** the Biden administration's DOJ review of the 2019 policy statement on standards-essential patents (SEPs) threatens to devalue U.S. IP, will discourage vital participation in standards-setting, and is born of a process that did not take all economic and security stakeholders into account.

- **Deepen 6G Cooperation with Allies:** already 6G cooperation is on the agenda of tech collaboration between Washington and key allies. These efforts should be continued and deepened, not only with engagement by the administration and regulators, but also interparliamentary dialogues, public-private dialogues, and other channels of communication and coordination on 6G policy.

- **Build on the Prague 2022 Agenda for Supply Chain Security:** the momentum established by the Prague 5G Security Conferences and the ongoing commitments from participants is a promising foundation for a meaningful multilateral approach to future telecom supply chain security. Engagement and encouragement by public and private sector leaders for this process is key to its success.

- **Develop Counter Models for Developing World Tech:** with competition in the developing world for rolling out future technology solutions, the U.S. and its allies should pursue alternative partnership models that counter China's model while also encouraging leapfrog approaches in technology.