

## **U.S. Senate Committee on the Judiciary Hearing: “5G: National Security Concerns, Intellectual Property Issues, and the Impact on Competition and Innovation”**

### **Questions from Chairman Graham**

#### Questions for Dr. James A Lewis, Ph.D.

We discussed security in the context of utilizing equipment from trusted vendors. However, there are only two companies working on the next generation foundational technology in the chipset market —Huawei and Qualcomm. What steps should be taken to ensure there are “trusted vendors” of the foundational technology for 6G?

For telecommunications systems, there remain only five major producers. In order of market share, they are Ericsson, Huawei, Nokia, ZTE and Samsung. There are no American producers as the last, Lucent, went out of business more than a decade ago. However, U.S. component manufacturers dominate the 5G market. None of the five major suppliers could make 5G network equipment without Intel, Qualcomm, Xilinx and Cisco equipment. American technology remains essential for 5G mobile telecommunications. A Huawei executive, for example, has stated that only 30% of Huawei equipment uses Chinese technology.

Semiconductors are the most important components of 5G technologies and American companies are still the major suppliers. China’s efforts to become self-reliant in semiconductors are not advanced enough to support 5G, and despite massive spending, this will not change in the foreseeable future.

American companies have been strong performers in developing 5G technologies, but the United States and its allies face a fundamental challenge from China. The focus of competition is over 5G’s intellectual property, standards, and patents... It is crucial that the U.S. develop supportive policies for research, education, and intellectual property protection to support its semiconductor industry, and push back against foreign efforts to use anti-trust or patent laws to hobble U.S. competition.

**Questions for the Record from Senator Charles E. Grassley**  
**U.S. Senate Committee on the Judiciary**  
**“5G: National Security Concerns, Intellectual Property Issues, and the Impact on**  
**Competition and Innovation.”**  
**Submitted on May 14, 2019**

**Dr. James A. Lewis**

1. You mentioned in your written testimony how, when looking at certain Chinese products and companies, it’s not an issue of “whether one trusts the Chinese company, but whether one trusts the Chinese government.”
  - a. To what extent are companies like Huawei and ZTE intertwined with the Chinese Communist Party?

Two Chinese companies, Huawei and ZTE, are subject to control by the Chinese government. Huawei and ZTE have been heavily subsidized by the Chinese government both to obtain market dominance and to gain intelligence advantage. Huawei, after a murky start involving industrial espionage and extensive government financial support, makes competitive equipment that it can offer at discounted prices. Huawei’s leadership has connections to the PLA and the Chinese intelligence service.

Huawei, and ZTE, are in no position to refuse a request from the Chinese government, and a good indicator of Chinese government intentions for foreign customers can be found in the treatment of its own population, which is subject to pervasive surveillance. There has been extensive reporting on the dangers of relying on Chinese telecommunications equipment. Data from countries that have purchased Chinese telecommunications equipment suggest that the espionage risk is real and cannot be mitigated effectively.

China's 2017 national Intelligence Law makes it compulsory for all Chinese companies to comply with requests for assistance from the Ministry of State Security - there is no appeal. The 2017 law only codified existing practices and it raises concerns about the use of any Chinese technology which remains connected over the internet to its manufacturer in China. The products of a Chinese company could be completely trustworthy, but a decision by the Chinese government could change overnight. In the context of China's increasingly aggressive global espionage campaign, which relies heavily on both human and cyber espionage, there are reasonable grounds for the distrust of Chinese products. The issue is not whether one trusts the Chinese company, but whether one trust the Chinese government.

- b. How do we balance concerns of protecting American interests from communist regimes, while still maintaining a relationship with a strong world power, such as China?

We need to bear in mind that it is the CCP, and not the Chinese, that is the source of hostility to the United States. Chinese leaders worry about the precedent of the Soviet collapse and under Xi have put in

place pervasive surveillance, appeals to Maoism, and heightened nationalism to avoid a similar fate. Economic growth is part of this effort, buttressed by Chinese expectations of resuming their rightful place in the world. Xi needs growth and control for domestic reasons, and this will make it difficult, but not impossible, to restore the formerly close commercial and technological partnership with China. If the ruling party chose another path, it would make it easier to integrate China into the community of nations, but they will not choose a path that risks leading to their own demise.

Moreover, opening the hood of the 5G supply chain reveals complex interconnections. Chinese products cannot work without crucial American components. These American components use Chinese parts. There are complex commercial relationships and partnerships among American, Japanese, Taiwanese, Chinese, and Korean companies. The global 5G equipment supply chain is extraordinarily complex, and interlinkages with Chinese suppliers are inescapable. Both Nokia and Ericsson have established joint ventures with Chinese-based subsidiaries, joint-venture partners, and Chinese companies (many with links to the government) to develop and manufacture 5G equipment and compete for network deployment contracts with Chinese telecoms. Many American manufacturers have design and manufacturing centers in China or are partnered with Chinese firms who provide components or software for their 5G equipment. The same is true for Chinese companies: Huawei has worked with over 270 international partners to develop its 5G applications.

2. In your written testimony, you stated that China seeks to end its dependence on the U.S. when it comes to the semiconductor industry.
  - a. With China's propensity to engage in intellectual property theft and espionage, what steps is the U.S. Government taking to guard against foreign companies using their semiconductor and other products to infiltrate and steal U.S. national security and national interest information and products?

Semiconductors are the backbone of the digital economy. The U.S. semiconductor industry and national security are closely linked. The United States will need to engage China to change its mercantilist behavior while simultaneously taking steps to strengthen the U.S. semiconductor industry. Changing Chinese behavior will be difficult but not impossible if the United States and its allies take a consistent approach. In the near term, policy should focus on blunting Chinese investments in production and design technology regulations and increased counterespionage programs. U.S. technological strength can be reinforced by investing more in basic science and government research and taking a more assertive approach to contesting foreign regulations used to gain unfair advantage.

3. Could you describe the key factors needed to ensure 5G standards are secure and robust? To what extent is there a federal role here?

5G will require hundreds of standards to be developed. In the context of 5G and its implications for espionage and innovation, standards have become a national security issue. Defining global 5G standards will produce immense economic advantage. 5G standards are developed by international groups. The most important group is 3GPP (3rd Generation Partnership Project),

but the ITU and 5GPPP also play important roles. These groups use open processes where companies and government agencies involved in telecommunications can participate.

In June 2018, 3GPP announced the first tranche of agreed 5G standards. Chinese companies are attempting to dominate standards development (to mandate the use of Chinese technologies), but in the June 2018 agreement, collaboration among Western companies ultimately determined the outcomes in the standards-making process. The United States will need a unified approach among like-minded companies and states who are willing to invest in 5G. Part of creating this approach may be to define voluntary agreements on security standards for secure 5G networks.

4. What additional steps could the federal government take to promote the development of 5G technology? To what extent could additional, targeted R&D investments increase the speed of 5G rollout?

American and “like-minded” companies routinely outspend their Chinese competitors in 5G R&D and hold 10 times as many 5G patents. With that said, the market distorting effects of government-subsidized Chinese companies reduce market share and revenues for other Western firms. One result is that these firms are unable to afford the same investment in research and development. While China’s innovation capabilities improved under Hu Jintao, they are not up to world standards in many areas, so shifting R&D investment away from Western firms will reduce the overall “output” of the global innovation system.

Technological innovation has become a major part of the competition among states, but this competition sits uneasily atop an intermeshed global innovation environment where international research and business partnerships are the norm. Science has become international, as scientists are more productive using research conducted by multinational teams of specialists. Commercial partnerships are the rule—and essential—for producing advanced technology.

The United States will need a unified approach among like-minded companies and states who are willing to invest in 5G. Another part will be to find ways to encourage undecided countries to spend on secure 5G. 5G leadership has to be part of a larger technology competition policy in the United States that builds the engineering and tech workforce and supports both private and public R&D. It is worth noting that the market-based model (with supportive government policies) has been the most innovative and productive, a point that sometimes gets lost in the general anxiety over China’s rise.

5. What are the potential risks of Huawei playing a role in developing 5G standards? How can these risks be mitigated?

China has politicized the standards-making process. Beijing expects Chinese companies to vote for Chinese standards whether or not they are the best. When Lenovo, a leading Chinese IT company, voted for a proposed standard from Qualcomm in 3GPP instead of one proposed by Huawei, it faced intense criticism in China. Chinese companies are attempting to dominate standards

development (to mandate the use of Chinese technologies), but in the June 2018 agreement, collaboration among Western companies ultimately determined the outcomes in the standards-making process. China “lost” the first rounds of the standards battle, in that 3GPP remains an international process not dominated by China that selects standards on the basis of quality and not national origin.

6. What considerations, if any, should federal regulators, like the Federal Trade Commission and the Department of Justice, take into account when protecting competition for companies developing 5G technology?

Chinese firms are becoming competitive in memory chips but face difficulties in manufacturing CPUs or other specialized chips that are globally competitive in price and performance.<sup>24</sup> China still relies on U.S. suppliers for high-end products. Making advanced semiconductors requires more than sophisticated production machinery and advanced design. It requires “know-how,” knowledge and skills built up with years of experience. Even if China gains access to advanced manufacturing equipment, there is still a need for know-how when it comes to making high quality chips with consistent performance at a competitive price. Most Chinese firms still lack this know-how, and the effort to acquire it explains why China’s semiconductor strategy turned a few years ago to efforts to buy entire Western firms outright to gain access to the best practices, which are developed through a blend of experience and expertise over many years. Western regulatory measures, such as the Committee on Foreign Investment in the United States (CFIUS), were successful in blunting these Chinese efforts, and the recent Foreign Investment Risk Review Modernization Act of 2018 (FIRRMA) legislation only strengthens this.

7. What steps, if any, could federal agencies take to incentivize additional domestic market participants in the 5G technology space?

The United States needs to act to ensure that American companies do not face unfair obstacles from antitrust or patent infringement investigations undertaken by any country to obtain competitive advantage. Fair competition is essential for innovation because it incentivizes companies to build better products and offer better services; technological innovation drives economic growth in ways that no other activity can match.

8. What role does patent protection play in incentivizing the development of 5G technology?

Patents implement standards. Patents provide ownership of the intellectual property required to make or use a technology based on a standard and create a revenue stream (through licensing). For 5G, this revenue stream will be measured in the billions of dollars. The companies that patent technologies that meet 5G standards will gain larger shares of revenue and have an important advantage in further innovation.

American companies are global leaders in 4G technology, helped to set the standards, and own many of the patents needed to build 4G equipment and networks. American technology is essential for 4G mobile telecommunications and an important source of income and exports. Partially in reaction to this American success, 5G is a focus of intense international competition over standards and patents.

## Questions for Dr. Lewis

1. Today's mobile 5G ecosystem is built upon a foundation of 5G R&D and standards setting that enables the entire wireless environment. The other elements—mobile phones and other wireless devices, 5G infrastructure, and mobile semiconductors—each present their own challenges and opportunities for U.S. leadership in 5G, and therefore U.S. national security. By far the most important part of the 5G ecosystem is the foundational technology layer. Cutting-edge innovations in mobile communications underpin all 5G networks and devices, and are essential to driving the technology forward. Qualcomm is the only U.S. company making significant technical contributions to foundational 5G wireless technology and is the recognized global leader in 5G R&D. All other aspects of the 5G environment are built on top of the technological foundation, and U.S. national security depends on U.S. innovators leading in the technology development and standard-setting that underpins the entire ecosystem. Infrastructure such as cell towers and base station, mobile devices like phones, connected cars, and other IoT devices, and the chips that connect them to the Internet form the next layer of the ecosystem. Today, no U.S. companies are competitive in the infrastructure market, only one U.S. company, Apple, is competitive in the device market, and while some U.S. companies, including Qualcomm, are competitive in the chip market, no single company can claim undisputed leadership. It is therefore imperative that the U.S. continue to lead in the foundational R&D layer of the 5G ecosystem. How should Congress and the Administration support U.S. companies engaged in foundational 5G R&D to ensure continued global leadership and protect national security?

American and “like-minded” companies routinely outspend their Chinese competitors in 5G R&D and hold 10 times as many 5G patents. With that said, the market distorting effects of government-subsidized Chinese companies reduce market share and revenues for other Western firms. One result is that these firms are unable to afford the same investment in research and development. While China's innovation capabilities improved under Hu Jintao, they are not up to world standards in many areas, so shifting R&D investment away from Western firms will reduce the overall “output” of the global innovation system.

Technological innovation has become a major part of the competition among states, but this competition sits uneasily atop an intermeshed global innovation environment where international research and business partnerships are the norm. Science has become international, as scientists are more productive using research conducted by multinational teams of specialists. Commercial partnerships are the rule—and essential—for producing advanced technology.

The United States will need a unified approach among like-minded companies and states who are willing to invest in 5G. Another part will be to find ways to encourage undecided countries to spend on secure 5G. 5G leadership has to be part of a larger technology competition policy in the United States that builds the engineering and tech workforce and supports both private and

public R&D. It is worth noting that the market-based model (with supportive government policies) has been the most innovative and productive, a point that sometimes gets lost in the general anxiety over China's rise.

2. 5G is the foundational technology that will power the Internet of Things—basically everything connected to everything by wireless Internet. Connected cars, connected homes, connected medical devices, connected everything. A very small number of companies in the world are engaged in the underlying research and development to invent and perfect the technologies that will create this new wireless ecosystem, and only one U.S. company, Qualcomm, is competitive in 5G R&D. While our overseas competitors strengthen their position in 5G, we have been weakening our innovation ecosystem. For example, it's harder to obtain patents on computer software in the United States than it is in Europe or China, even though we know that innovative algorithms are essential to technologies like artificial intelligence, smart cities, smart homes, and secure networks. What policies should this Committee examine to ensure that innovative companies in the United States can compete in the 5G race?

The United States needs to act to ensure that American companies do not face unfair obstacles from antitrust or patent infringement investigations undertaken by any country to obtain competitive advantage. Fair competition is essential for innovation because it incentivizes companies to build better products and offer better services; technological innovation drives economic growth in ways that no other activity can match. 5G leadership has to be part of a larger technology competition policy in the United States that builds the engineering and tech workforce and supports both private and public R&D.

3. Intellectual property protections are the lifeblood of our innovation economy. In exchange for publicly disclosing an invention we grant to inventors the constitutionally protected right to exclude others from making, using, selling, or importing that invention for a limited period of time. The countless inventions that together make up "5G" all require patent protections to ensure their inventors can collect royalties to recoup the significant investment of time and resource spent on R&D to develop 5G technologies. Yet over the past decade, the strength of the U.S. patent system has declined. A strong, balanced, and predictable patent system is a necessity for U.S. inventors engaged in transformational R&D on 5G and beyond. What steps should Congress take to strengthen our IP protections to incentivize continued U.S. leadership in 5G and other next-generation technologies?

When China opened its economy to Western companies, companies believed that the risk from technology transfer was acceptable, that there was a necessary cost of doing business in the world's fastest growing market, and that they could minimize any loss. Near-term gains for individual firms outweighed long-term costs, and there was an assumption that Western

companies could compensate for IP losses by “running faster.” Western companies employ a number of stratagems to reduce the risk of IP loss. These include holding back key processes from Chinese employees and allowing access only to low-end technologies, retaining advanced functions outside of China, and adopting a range of security measures. Western concerns were increased by the absence of adequate IP protection. Fear over the loss of IP is a disincentive to invest in China. An informal poll of Western semiconductor firms found that many had decided against locating in China because of IP theft concerns, and those that chose to locate in China have taken steps to safeguard their IP, particularly for design and manufacturing processes.

4. Over the past few years we’ve seen antitrust authorities around the world bring enforcement actions against innovative U.S. companies dozens of times. These proceedings have focused in large part on intellectual property licensing activity, with foreign governments accusing U.S. companies of anticompetitive activity because their domestic companies are unwilling to pay appropriate royalties for important intellectual property. It’s a thinly veiled way of forcing U.S. companies to transfer their technology to foreign competitors who simply can’t compete fairly on technological merit. U.S. Assistant Attorney General for the Antitrust Division, Makan Delrahim, has commented that antitrust is not an appropriate legal mechanism for resolving licensing disputes, and has warned against the United States inappropriately regulating legitimate business dealings through the antitrust laws. At the same time, AAG Delrahim has championed a multilateral framework on procedure, an international agreement regarding principles of fairness for antitrust proceedings, to ensure that U.S. companies are treated fairly in foreign antitrust proceedings. How does unfair antitrust enforcement chill innovation in 5G and other areas? What should the United States do to protect innovative companies from unfair antitrust attacks?
5. U.S. leadership in the underlying technologies that make up 5G is a matter of national security. The Committee on Foreign Investment in the United States recognized as much when it found that a “[r]eduction in Qualcomm’s long-term technological competitiveness and influence in standard setting would significantly impact U.S. national security.” U.S. supply chain security in wireless starts with the technology and standards that form the foundation of 5G. Without U.S. leadership in the underlying 5G standards, foreign governments and businesses, including adversaries, will have virtually unfettered control over all aspects of the 5G ecosystem. How does standard-setting processes relate to U.S. national security, and what steps should Congress take to ensure continued U.S. leadership in 5G standard-setting in the interest of national security?

Standards describe performance requirements and technologies that will define 5G networks. They outline how the technology should work and set levels of performance and compatibility among technologies made by different companies. 5G will require hundreds of standards to be developed. In the context of 5G and its implications for espionage and innovation, standards



have become a national security issue. Defining global 5G standards will produce immense economic advantage. 5G standards are developed by international groups. The most important group is 3GPP (3rd Generation Partnership Project), but the ITU and 5GPPP also play important roles. These groups use open processes where companies and government agencies involved in telecommunications can participate. China has politicized the standards-making process. Beijing expects Chinese companies to vote for Chinese standards whether or not they are the best. When Lenovo, a leading Chinese IT company, voted for a proposed standard from Qualcomm in 3GPP instead of one proposed by Huawei, it faced intense criticism in China.

6. The development of a 5G ecosystem requires communications standards, which are a collection of technical specifications developed by various engineers around the globe that define the contours of the technology. Standards are set by standards development organizations (SDOs) and their members. Because leadership in wireless standards requires both a willingness to make high-risk, long-horizon investments in R&D, as well as engineering expertise in the highly complex field of wireless communications, a relatively small number of companies make major contributions to wireless standards. Within SDO, innovative companies that develop standardized technologies are far outnumbered by “implementers” who participate in the standard to help select, learn and ultimately deploy the evolving technology. This disparity can lead to business disputes over licensing fees, with implementers hoping to pay lower royalties to innovators for the use of their standard-essential patents, and innovators expecting a fair return that incentivizes their significant investments in R&D. How do we ensure that SDOs—which are private entities—are adopting the best technology and affording fair treatment to the innovative companies and inventors who develop core technologies like 5G?

In June 2018, 3GPP announced the first tranche of agreed 5G standards. Chinese companies are attempting to dominate standards development (to mandate the use of Chinese technologies), but in the June 2018 agreement, collaboration among Western companies ultimately determined the outcomes in the standards-making process. China “lost” the first rounds of the standards battle, in that 3GPP remains an international process not dominated by China that selects standards on the basis of quality and not national origin. The United States will need a unified approach among like-minded companies and states who are willing to invest in 5G. Part of creating this approach may be to define voluntary agreements on security standards for secure 5G networks.

**James A Lewis, Ph.D. –**  
**5G: National Security Concerns, Intellectual Property Issues,**  
**and the Impact on Competition and Innovation**  
**Questions for the Record**  
**Submitted May 21, 2019**

**QUESTIONS FROM SENATOR COONS**

1. Tomorrow's 5G ecosystem is built upon a foundation of 5G research and development and standards setting that enable the entire wireless environment. The other elements—mobile phones and other wireless devices, 5G infrastructure, and mobile semiconductors—each present their own challenges and opportunities for U.S. leadership in 5G, and therefore U.S. national security. I understand that China and South Korea are outpacing the U.S. in securing patents on 5G technology, and that China is specifically promoting 5G as part of its ambitious “Made in China 2025” plan. How should Congress and the administration support U.S. companies engaged in foundational 5G R&D to ensure continued global leadership and protect national security?

American and “like-minded” companies routinely outspend their Chinese competitors in 5G R&D and hold 10 times as many 5G patents. With that said, the market distorting effects of government-subsidized Chinese companies reduce market share and revenues for other Western firms. One result is that these firms are unable to afford the same investment in research and development. While China's innovation capabilities improved under Hu Jintao, they are not up to world standards in many areas, so shifting R&D investment away from Western firms will reduce the overall “output” of the global innovation system.

Technological innovation has become a major part of the competition among states, but this competition sits uneasily atop an intermeshed global innovation environment where international research and business partnerships are the norm. Science has become international, as scientists are more productive using research conducted by multinational teams of specialists. Commercial partnerships are the rule—and essential—for producing advanced technology.

The United States will need a unified approach among like-minded companies and states who are willing to invest in 5G. Another part will be to find ways to encourage undecided countries to spend on secure 5G. 5G leadership has to be part of a larger technology competition policy in the United States that builds the engineering and tech workforce and supports both private and public R&D. It is worth noting that the market-based model (with supportive government policies) has been the most innovative and productive, a point that sometimes gets lost in the general anxiety over China's rise.

2. Chinese companies are reportedly voting as a block within standards developing organizations for nationalistic purposes. Without U.S. leadership in 5G standards, foreign governments, including adversaries, may have unprecedented control over all aspects of the wireless ecosystem. How do standard-setting processes relate to national security, and how

do we ensure that private standard development organizations are adopting the best technology and affording fair treatment to innovative U.S. companies and inventors who develop core technologies related to 5G?

Standards describe performance requirements and technologies that will define 5G networks. They outline how the technology should work and set levels of performance and compatibility among technologies made by different companies. 5G will require hundreds of standards to be developed. In the context of 5G and its implications for espionage and innovation, standards have become a national security issue. Defining global 5G standards will produce immense economic advantage. 5G standards are developed by international groups. The most important group is 3GPP (3rd Generation Partnership Project), but the ITU and 5GPPP also play important roles. These groups use open processes where companies and government agencies involved in telecommunications can participate. China has politicized the standards-making process. Beijing expects Chinese companies to vote for Chinese standards whether or not they are the best. When Lenovo, a leading Chinese IT company, voted for a proposed standard from Qualcomm in 3GPP instead of one proposed by Huawei, it faced intense criticism in China.

In June 2018, 3GPP announced the first tranche of agreed 5G standards. Chinese companies are attempting to dominate standards development (to mandate the use of Chinese technologies), but in the June 2018 agreement, collaboration among Western companies ultimately determined the outcomes in the standards-making process. China “lost” the first rounds of the standards battle, in that 3GPP remains an international process not dominated by China that selects standards on the basis of quality and not national origin. The United States will need a unified approach among like-minded companies and states who are willing to invest in 5G. Part of creating this approach may be to define voluntary agreements on security standards for secure 5G networks.

3. While our overseas competitors strengthen their position in 5G, we have been weakening our innovation ecosystem. Computer software patents are harder to obtain in the U.S. than in Europe or China, even though we want to incentivize technology like artificial intelligence and smart infrastructure. Thus, I am concerned that the current state of the law puts us at a critical disadvantage on the global stage. What policies should this Committee examine to ensure that innovative companies in the United States can compete in the 5G race?

Patents implement standards. Patents provide ownership of the intellectual property required to make or use a technology based on a standard and create a revenue stream (through licensing). For 5G, this revenue stream will be measured in the billions of dollars. The companies that patent technologies that meet 5G standards will gain larger shares of revenue and have an important advantage in further innovation. The United States needs to act to ensure that American companies do not face unfair obstacles from antitrust or patent infringement investigations undertaken by any country to obtain competitive advantage. Fair competition is essential for innovation because it incentivizes companies to build better products and offer better services. The United States does not need to copy China’s government-centric model for 5G (and for technology in general), but it does need to invest

in research. 5G leadership has to be part of a larger technology competition policy in the United States that builds the engineering and tech workforce and supports both private and public R&D. Government action can provide the public goods needed for American companies to flourish in the market.

**James A. Lewis**  
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**Questions for the Record**  
**Submitted May 21, 2019**

**QUESTIONS FROM SENATOR BOOKER**

1. The current 5G discussion is heavily focused on building a trusted 5G infrastructure, which is certainly necessary. However, there has been less focus on the task of guaranteeing that the apps and services utilizing the 5G networks are also secure, and on what steps we should take to ensure security is built in from the ground up and commensurate with the threats we face. A clean and truly secure 5G network should prevent malware from transporting across protected devices and prevent unauthorized command and control from exploited connected devices. The United States should continue to encourage architecture that guards against these threats and address lateral threat movement within the network.

What actions should the Department of Homeland Security (DHS) take to ensure 5G networks will appropriately secure the applications and services riding on the networks—accounting for malware prevention and unauthorized command and control from exploited connected devices—not just the infrastructure of the networks themselves?

2. In building a risk-based approach to supply-chain security, how should we gauge the threats around specific categories of equipment? For example, the 2019 National Defense Authorization Act (NDAA) included rules of construction addressing the interconnected nature of telecom networks and the fact that different components have varying abilities to route traffic or to read the underlying data they carry.

An easy way to envision supply-chain threats is to imagine that the person who built your house decides to burgle it. They know the layout, the power system, the access points, may have kept a key, and perhaps even built in a way to gain surreptitious entry. Building and maintaining core network equipment provides a similar advantage.

Major telecom “backbone” equipment is usually directly connected to the manufacturer over a dedicated channel, reporting back on equipment status and receiving updates and software patches as needed, usually without the operator’s knowledge. Equipment could be sold and installed in perfectly secure condition, and a month later, the manufacture could send a software update to gain access to information or to disrupt service. The operator and its customers would have no knowledge of this access and control.

Much of the 5G discussion has focused on supply chain issues and the risk of using Chinese telecom equipment. There are three parts to this discussion. First, many technologies use the internet to connect to their manufacturer even after sale for maintenance, updates, and status reports. We are all familiar with how our phones or computers are updated, often without our knowledge. An increasing number of products will remain connected to the manufacturer after sale, allowing both improved services, but also creating new opportunities for malicious actions,

particularly when the manufacturer comes from a hostile foreign power.

3. Various panel members testified that the Chinese have been exerting political pressure and conducting block voting within standards-setting organizations like the European Telecom Standards Institute (ETSI), the International Telecommunication Union (ITU), the 3rd Generation Partnership Project (3GPP), and also at major telecommunications conferences. At the same time, Huawei's massive research and development budget has clearly contributed to their lead in 5G patent applications. According to one study, China's share of "standard essential patents" was at 34 percent, compared with 14 percent for the U.S. Indeed, Huawei alone is responsible for 15 percent of 5G patent applications.

- a. Please explain how controlling the standards for a technology translates to controlling the market for that technology.

Standards describe performance requirements and technologies that will define 5G networks. They outline how the technology should work and set levels of performance and compatibility among technologies made by different companies. 5G will require hundreds of standards to be developed. In the context of 5G and its implications for espionage and innovation, standards have become a national security issue. Defining global 5G standards will produce immense economic advantage.

Patents implement standards. Patents provide ownership of the intellectual property required to make or use a technology based on a standard and create a revenue stream (through licensing). For 5G, this revenue stream will be measured in the billions of dollars. The companies that patent technologies that meet 5G standards will gain larger shares of revenue and have an important advantage in further innovation.

- b. Which is a bigger problem for the United States when it comes to setting 5G standards—politically motivated voting patterns or the flood of foreign patent applications?

5G standards are developed by international groups. The most important group is 3GPP (3rd Generation Partnership Project), but the ITU and 5GPPP also play important roles. These groups use open processes where companies and government agencies involved in telecommunications can participate. China has politicized the standards-making process. Beijing expects Chinese companies to vote for Chinese standards whether or not they are the best. When Lenovo, a leading Chinese IT company, voted for a proposed standard from Qualcomm in 3GPP instead of one proposed by Huawei, it faced intense criticism in China.

In June 2018, 3GPP announced the first tranche of agreed 5G standards. Chinese companies are attempting to dominate standards development (to mandate the use of Chinese technologies). However, China "lost" the first rounds of the standards battle, in that 3GPP remains an international process not dominated by China that selects standards on the basis of quality and not national origin.

- c. Can the United States effectively address the Chinese block-voting problem without committing substantially more resources to research and development and thereby increasing our volume of patent applications?

In the June 2018 agreement, collaboration among Western companies ultimately determined the outcomes in the standards-making process. Despite Chinese efforts, the unified approach used by the United States and like-minded companies and states willing to invest in 5G resulted in the implementation of standards based on quality. Part of strengthening this approach may be to define voluntary agreements on security standards for secure 5G networks.

4. Last week, the Trump Administration placed Huawei and approximately 70 of its affiliates on an “Entity List,” meaning that U.S. suppliers may require a license to conduct business with Huawei’s companies. Yesterday, May 20, in compliance with the President’s orders, Google banned Huawei—the second-largest smartphone manufacturer in the world—from using anything but the open-source version of Android, cutting Huawei off from critical proprietary Google mobile services like Maps, Search, Play Store, Gmail, etc. If the ban were applied strictly, it could drive one of China’s highest-profile companies out of business. However, late yesterday afternoon, the Commerce Department granted Huawei a 90-day reprieve from the import ban. This rapid succession of decisions and partial reversals has significant implications for national security, employment, and trade relations for the United States and China.
  - a. Qualcomm, a U.S. company, got two-thirds of its sales from China in its most recent fiscal year. Similarly, Intel, the largest U.S. maker of chips, got more than 60 percent of its sales from the Asia-Pacific region last year, with most of that coming through China and Taiwan. How will potential sanctions against Chinese companies affect U.S. companies like Qualcomm, Intel, Broadcom, and Xilinx that provide necessary components to Huawei equipment? How will China’s recent commitment to spend more than \$100 billion dollars for developing homegrown chip manufacturers affect the U.S. position?

It's worth noting that while the U.S. is the unique supplier of the most advanced technologies necessary for 5G, many subcomponents come from Chinese firms. The positive expectations for China as an economic partner mean that there is a deeply intertwined global supply chain, with American, European and Japanese companies manufacturing in China, Chinese companies relying on US. technology, and U.S and European technology that may itself incorporate Japanese or Chinese components. Nor does every Chinese company create risk. This depends on what they make and whether their product connects back to China. It would be very difficult - and perhaps impossible - to bifurcate the global supply chain into "Chinese" and "Western." This complex, interconnected supply chain is a source of risk - the Chinese worry about it as well - and we need to develop policies and techniques other than a radical split to manage this risk.

- b. What does it mean that Huawei, the second-largest smartphone manufacturer, will potentially be cut off from Google, the largest provider of mobile operating systems? Will the actions of this week be the catalyst that forces Huawei to develop its own mobile operating system? If so, how will that affect U.S. leverage in future potential standoffs?

- c. Are the references to a tech “Cold War” overwrought? How could these situations escalate?

It is easy for the U.S. to look backwards and dredge up Cold War terms and concepts that are inappropriate for a new kind of conflict in a new century – we do not need another Solarium Commission, this is not an arms race, nor in fact, is it a Cold War. What we discuss in Washington is too often like ancestor worship rather than strategy. The chief similarity between the Cold War and the conflict with China is that it is a battle for global influence where both China and the U.S. have advantages and disadvantages. China’s greatest advantage is that it is willing to spend money while the U.S. is not. China’s political system is not particularly attractive and Han nationalism limits China’s influence, but many countries will, in the near term, want to work with China.

- 5. Many argue that consolidation in the telecommunications industry has made European—and not American—companies the leading Western manufacturers of the antennas, boxes, routers, switches, and beam-generating equipment that form the backbone of 5G technology. At the same time, U.S. regulators appear close to reaching a final decision on T-Mobile and Sprint’s proposed merger. Proponents of the merger argue it could lead to more spending on infrastructure; however, carrier consolidation has historically posed problems for equipment manufacturers (i.e., as carriers consolidate the customer base for equipment, manufacturers sell less equipment).
  - a. Would the proposed merger between T-Mobile and Sprint be a good thing for non-Chinese equipment vendors?
  - b. Does consolidation in the telecommunications hardware supply chain constitute a vulnerability for the United States?