The Fast Approaching 5G Revolution:
Disruptions and Opportunities

Event Summary Report

POTOMAC INSTITUTE FOR POLICY STUDIES

A POTOMAC INSTITUTE FOR POLICY STUDIES' REPORT

The Potomac Institute for Policy Studies and Venable LLP

The Fast Approaching 5G Revolution: Disruptions and Opportunities

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6 JUNE 2018

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Executive Summary

On June 6th, 2018, the Potomac Institute for Policy Studies and Venable LLP co-sponsored a seminar to discuss the rapidly approaching 5G Revolution. The event was moderated by Dr. Michael Fritze, Director of the Potomac Institute's Vital Infrastructure, Technology and Logistics (VITAL) Center, which focuses on supply chain security and critical infrastructure resilience. The program began with a keynote address from Mr. Terry Halvorsen, Executive Vice President of Samsung, Inc., and featured panelists Mike Stone, Kiersten Todt, Brian Hendricks, RADM Jamie Barnett USN (Ret), and Barbara Hoffman, all of whom have extensive and mixed backgrounds working in telecommunications and cybersecurity in both government and industry roles. The panelists gave predictions and analysis of the far-reaching implications that will result from the impending widespread use of this technology. They also outlined the challenges the US is currently facing in the roll-out of this revolutionary technology.

The 5G network will bring revolutionary impacts to a wide range of industries and activities. A key takeaway from the seminar was that 5G will be a critical enabler of the innovative technologies poised to be released in the coming years. With the installation of hundreds of thousands of small antennae sites enabling wireless communication, connectivity through the Internet of Things (IoT) will reach levels unparalleled to date. Speeds and bandwidth will be exponentially greater than what the current 4G infrastructure is capable of providing. 5G will cause a 10,000-fold increase in data able to be collected, analyzed, and acted upon. With this increased capability will come an increase in the amount of useful and actionable information, fueling the growth of the already burgeoning IoT revolution. The 5G network will allow real-time analysis via a multitude of sensors, facilitating machine to machine communication. This capability will allow the flourishing of near-

term future technologies such as autonomous cars and "smart" cities. The 5G network's capability to intake, process, and store data at a much higher rate than is currently the norm will mean that early adopters of 5G technology will have a competitive advantage in the global market for years to come.

The seminar panelists emphasized that the development and implementation of a 5G operating infrastructure has become a high-stakes race, one that the United States is currently losing to China. Whoever wins the race to 5G will be in control of the global economy for years to come, and will be able to further their advantage while other nations struggle to update their digital infrastructures, widening the gap and diminishing the competitive abilities of once-comparable nations. The U.S. government and U.S. commercial industry must enter into a symbiotic relationship in order to remain competitive with foreign entities. Government leadership to initiate and incentivize the development of a domestic 5G infrastructure will catalyze industry research and development, and subsequent production and connectivity. Immediate action is required if the U.S. is to make up the gap with China in the development of this emerging critical infrastructure, given the threat to the U.S. hold on the digital economy for the next five to ten years if China wins the race to 5G. An asymmetric advantage and shift in power at that level could wipe the slate clean and allow for new social, political and cultural norms to take effect in the economy of the future, which will be highly digitally dependent.

According to the panelists at this event, there are immediate issues that must be addressed by government and industry to ensure U.S. 5G leadership. Implementing shared 5G hardware infrastructures, increasing spectrum access and availability, and overcoming jurisdictional bureaucracy will be key in the successful development and implementation of a 5G network and subsequent 5G-connected technology. Policy questions, especially around data privacy, will skyrocket with the increased

amount of data collection and analysis enabled by the 5G revolution. The best approach to confronting and resolving issues around data privacy is to be proactive as 5G technology is developed, rather than to be reactive in the aftermath of implementation. This seminar provided a platform for insightful discussion pertaining to the rapidly approaching reality of a 5G-connected world and the impacts at the level of the individual, nation-states, and global community from the 5G revolution.

KEY TAKAWAYS:

• 5G will be a revolutionary technology development. It will be a critical enabler catalyzing the transition to and widespread adoption of coming technological innovations affecting everyday life, such as autonomous vehicles and "smart" cities.

• The 5G race is one the United States is currently losing to China. The winner will dominate the digital economy for the next 5-10 years. An asymmetric advantage such as this makes room for the rise of new economic, social, cultural and political norms.

• The United States cannot afford to fall behind of changes in digital infrastructure as it has in the past, because the impacts of such negligence will significantly more impactful on U.S. economic dominance in years to come with the burgeoning digital economy, of which 5G will also be a critical enabler.

• Neither the U.S. Government nor U.S. Industry alone can achieve what must be done to push through the finish line of 5G development and implementation. Business and government must work together to determine the sharing of infrastructure and overcome jurisdictional bureaucracy if the United States is to remain competitive with foreign entities in the adoption of 5G.

- 5G will enable IoT Connectivity, and will increase the number of connected devices per person by several orders of magnitude. 5G will lead to an exponential increase in the amount of data collected, analyzed, and available thanks to 5G sensing, speed, and connectivity, which will in turn revolutionize global markets.

- The United States must be proactive rather than reactive with the data rights and privacy concerns that will arise as a result of increased data generation, collection, and analysis enabled by the implementation of 5G networks.

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Keynote: Terry Halvorsen

Executive Vice President of Samsung and CIO/IT and Mobile B2G and former CIO of the Department of Defense and former CIO of the Department of the Navy

With a blended background of government as well as industry cyber experience, Terry Halvorsen provided the keynote address on the "5G Revolution." Halvorsen began by explaining that 5G is more than just the technology enabling connectivity, but rather an ecosystem of communication. At a technical level, 5G hardware technology involves small antennae with narrow-focused beams that disseminate and allow for greater, more widespread coverage at higher speeds. Deploying more antennae during initial installation is a preemptive measure that if taken, will help to mitigate the adverse effects (such as inclement weather) on these smaller, more susceptible antennae. The 5G ecosystem refers to the vast jump in capabilities (from current 4G networks) that will have far-reaching implications, including real-time communication enabling rapid machine to machine communications, critical to the functioning of technologies that will soon become commonplace, like autonomous cars.

5G will have speeds, bandwidths and latencies that are orders of magnitudes better than those currently offered by 4G. Halvorson emphasized that the revolutionary aspect of 5G will come with the coupling of this new technology with all other devices in the Internet of Things. In terms of the U.S.'s burgeoning technological infrastructure, 5G will serve as this increasing digital network's new backbone, with the true enabling capabilities embedded in millions of sensors. The uptick in machine-to-machine communication will augment and enable inventions such as "smart" cities to become a reality.

Halvorsen stressed that we are in the midst of a worldwide 5G race. The country that develops and implements 5G first will dominate the digital economy

for the next five to ten years. However, the implications of this race go beyond solely economic consequences. The next economic leader enabled by 5G could cause social, cultural and political norms to change rapidly in a global context.

The race to 5G connectivity will require collaboration and cooperation between government and industry for the U.S. to even be competitive, let alone win. Halvorsen emphasized the idea of government involvement, not ownership, in the race to establish a U.S. 5G capability, and stressed that the government's role would be to monitor growth of the technology in a stable and secure manner.

Halvorsen acknowledged there will be complex policy questions that arise concerning data and privacy laws with the explosion of data generated, collected, and analyzed through 5G connectivity, calling issues encountered to date "the tip of the iceberg." He suggested these will need to be addressed proactively instead of retroactively. Halvorsen ended by reiterating two key points: that an increase in the amount of data generated will correlate with an increase in useful, or intelligent, data, and that our individual lives will be altered in all sectors through the data revolution enabled by 5G, including our health, financial behaviors, transportation, and more.

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Panel Discussion: The 5G Revolution

Mike Stone

Global Head of Digital Transformation, KPMG, former CIO, UK Ministry of Defence and President Service Design at BT (Previous service, Brigadier General, British Army)

Mike Stone described his role in this panel as offering the perspective of a former CEO and CIO. Stone emphasized that 5G is real and just around the corner, and that China is ahead of the U.S. and stands to lead the digital economy for the foreseeable future if the U.S. does not catch up. Japan and Korea are closer to the U.S. in terms of development of the technology, but may still be ahead. He remarked that there has been talk of implementing 5G in the U.S., but not any significant action to back it up.

Stone emphasized the extent to which 5G offers exponential change, comparing it to the change brought on by the development of railroads. He said that the major factor that has constrained machine-to-machine communication to this point has been lack of speed and lack of ability to provide security without compromising latency, but 5G can support this type of communication. Additionally, with 5G, nearly all of the data in the future will be mobile. This can allow developments such as connected agriculture, transportation, workforce, etc. As a result, there will be a vast increase in data as well as a change in types of data usage and applicability.

A major benefit of 5G as Stone sees it is increased connectivity and communication in disaster areas. Networks frequently go down when a crisis occurs due to infrastructure damage and the number of people trying to access lines of communication. With the remote delivery options of 5G, the same kind of network collapse would not occur, and could facilitate dramatically better disaster predication, preparation, and response.

Stone concluded by mentioning that issues would arise with organization of data, spectrum availability, and security of the 5G network. However, security has the potential to be simply a challenge rather than an issue, as long as it is planned and implemented from the beginning rather than as an afterthought. As always, he communicated the importance of baking security into the design of 5G-enabling hardware and software to ensure resilience from the time that they are deployed to when they are retired and replaced. Stone gave the example that security was not a concern when the Internet was developed because it wasn't considered necessary, but with the advantage of hindsight, we understand its importance. With 5G, security issues can be planned for before they arise and have catastrophic impacts.

In response to a question about the acquisition process as a barrier to implementation, Stone discussed how the acquisition process got in the way and how the UK sought to change the acquisition process to better begin planning for outcomes and needs. Regarding a question about what 5G means for rural coverage, Stone envisioned an opportunity in 5G for the U.S. to think differently from earlier technologies in terms of enabling communities that are currently digitally disadvantaged.

Kiersten Todt

Resident Scholar, Institute for Cyber Law, University of Pittsburgh, Washington, D.C., and former Executive Director of the National Cybersecurity Commission

Kiersten Todt discussed the revolutionary social, economic, and political impacts anticipated from 5G technology. Her talk focused primarily on the needed partnership between private industry and the government in order to effectively usher in 5G network capability and technologies. She contended that in order to fully take advantage of its development, the public and private sectors will need to act preemptively to prepare for the impli-

cations of 5G. Because of the colossal impact 5G will have, it is imperative that the United States remains competitive in this area; this means not only assessing the impact 5G will have across sectors, but also the infrastructure requirements for using it. She highlighted the United States' missed opportunity for securing IoT dominance in 2016 and cautioned that the nation cannot afford to again miss an opportunity for technological dominance with 5G networking. Failure to act on the opportunities afforded by 5G in a timely, proactive manner would result in the United States falling woefully behind its economic competitors, namely China. She called on the U.S. act now in order to ensure the timely development and installation of 5G. The need for infrastructure sharing by major carriers will require the United States to not only apply relevant policies once the technology is established, but to continuously evolve them well after the technology's deployment. Simply waiting for the technology to develop as opposed to leading its development will not be sufficient for the United States to remain competitive among powerful nations in the mid to long term. Todt emphasized the importance of the creation of "norms" by the private and public sector, and for assessment of the potential benefits and pitfalls of 5G technology. Because of the rapid development of artificial intelligence, the process of analyzing large quantities of data will inevitably change, and it is imperative that there be discussions of what this means for privacy issues, regulation, and human subjectivity in its operation.

During the Q&A section, Todt addressed problems that could arise with mobilizing the preemptive development of 5G technology. Comparing 5G to the large, collective goal to send the United States to the moon, she argued there is less of a "distinct" goal with 5G, which highlights the necessity for industry and the government to define the 5G revolution and the necessary

Brian Hendricks

Head of Policy and Governmental Relations, Nokia America Regions and former General Counsel to the Senate Committee on Commerce, Science and Transportation

Speaking from his current perspective at NOKIA and past experience working as General Counsel to the Senate Committee on Commerce, Science, and Transportation, Brian Hendricks focused largely on the technical infrastructure that needs to be built with guidance from the government to enable a robust national 5G network. Hendricks explained that 5G has much greater capability than 4G, and that this capability will transform and enable new sectors of the economy. Currently, creating intelligent infrastructures and devices is too often limited by the capacity and latency of the existing Long-Term Evolution (LTE) networks. Opportunities for deployment are further curtailed by the transmitter's need for energy to connect to the new networks. In contrast, 5G offers the possibility of lower power, lower latency, and higher bandwidth connections, offering speeds up to ten gigabits per second. This will enable brand-new applications, and will increasingly enable direct machine-to-machine communications.

However, there are serious concerns that governments in China and South Korea are outperforming the U.S. in laying the groundwork for 5G development. Hendricks explained that a large-scale national 5G push is necessary for the U.S. to catch up and that there is a massive first-mover advantage that the U.S. is in danger of losing.

The first area that Hendricks described as an impediment to bringing up 5G technology was spectrum allocation. 5G is an inherently multi-band technology, because different frequencies have different technical capabilities. High-frequency, short-wavelength technology allows for very high rates of data throughput but is less persistent in the atmosphere and less able to penetrate obstacles in the urban environment. Therefore, low-frequency,

long-wavelength spectrum is also required to perform longer-range communication between regional nodes. Between these lies the very important mid-band range, of which the US has assigned very little compared to other countries, and is quite slow to assign by public auction when desired. Other alternative models for spectrum usage, such as spectrum access management, which allow the same spectrum to be shared by many users who hop on and off, would allow U.S. carriers to better utilize existing spectrum, but these technologies have failed to be rolled out according to initially optimistic timelines, further hindering 5G development.

In addition to spectrum access, Hendricks discussed a dramatic expansion in physical infrastructure that will be required for 5G deployment. Hendricks estimated that an additional 150,000 traditional cell towers will be required, but that these will need to be supplemented with 450,000 additional millimeter-wave short-range communication hubs. Construction of this infrastructure in the US is complicated by the diverse number of local governments which can cause significant legal overhead in planning the construction of new widespread development. Hendricks recommended adopting more uniform regulatory rules that would allow for easier, streamlined land use and site approval decisions. Hendricks gave the example that China deployed LTE in 18 months. The U.S. has very different land use rules and he estimated that 5G implementation could occur on a 6-24 month timescale depending on how effectively we can overcome these issues.

For all of his policy recommendations, Hendricks communicated that dedicated legislation is neither achievable nor necessary in the needed timeframe the U.S. has to maintain first-mover advantage. Instead, he recommended working through regulatory processes and in tandem with direction from the FCC, NIST, and other executive agencies that work in communications and standard-setting. Hendricks saw failure to discuss and cooperate in this regulatory environment as the main obstacle to the US deployment of 5G systems.

Jamie Barnett, Rear Admiral USN (Ret.)

Partner in the law firm of Venable LLP, Washington DC office and Chair of Telecommunications and former Chief of the FCC's Public Safety and Homeland Security Bureau

Jamie Barnett talked about the revolutionary impacts of 5G technology and the challenges and opportunities for security that would arise with the adoption of 5G. There will be more data about everyone with the constant connectivity of 5G, including where a person goes, who they're with, what their habits are, etc. Smartphones and 4G changed the way humans do things like shop and date, and 5G will have applications not yet imagined, all creating additional data. That data will also be global, although one may only be a citizen of one country. This leads into questions about how data brokers will handle this information, and how the government will use it. He remarked on the Global Data Protection Regulations (GDPR) put in place by the EU regarding privacy, data, storage length, and consumer consent and withdrawal of consent, and how these protections could change with the massive influx of data from 5G.

In terms of the security of the network itself, 5G has the opportunity to be much more secure than 4G if security is built in appropriately to the architecture of the technology. In a 5G network, Distributed Denials of Service (DDOS) attacks could be more powerful, but the response from within the network could also be more powerful, akin to an immune system with antibodies.

Barnett also spoke about the innovations 5G would bring, particularly how 5G will be able to power the technologies that are expected to become mainstream, but are for now only concepts or prototypes, such as self-driving cars. With the reduced latency of 5G, stopping distances could be many times shorter than was previously possible with a 4G connection, which makes these technologies much more viable for widespread public use. However, 5G technology may raise new issues that will change how policy is shaped. If a

car is networked and it causes an accident, it could require a different method of assigning fault than currently seen in legal proceedings. Barnett also mentioned the disruption to employment and workforce that could occur as a result of 5G implementation, particularly within communication companies.

Barnett concluded by remarking that the 5G era will create an asymmetric advantage for whoever gets to it first, particularly on the battlefield. The US government built the foundations of the Internet, which resulted in military and economic dominance, but this type of advantage is at risk with 5G technology. In response to a question on spectrum availability, Barnett said that the telecommunications industry had not taken full advantage of many of the frequencies it already owns. He suggested that new technology solutions for spectrum sharing, allocation and utilization are needed.

Barbara Hoffman

Vice President of Samsung for Global Strategic Operations B2G and former Deputy CIO of the Department of Navy and Principal Deputy for the CIO for Information Enterprise (PD-DCIO-IE)

Barbara Hoffman outlined the revolutionary benefits that 5G will provide to our nation and the urgency in acquiring this technology. 5G is adaptive and responsive, and will enable real time network analysis capabilities that will have vast impacts across the United States on communications, security, analysis, and decisionmaking.

Hoffman emphasized that 5G technology will have an impact on a wide range of critical infrastructures, including but not limited to transportation, agriculture, medical, energy, finance, and emergency responses, which will increase our quality of life. Industries like air travel will have the capability to reduce wait time via real time data. Rural areas will be better connected. Due to increased speed of collection and analysis of patient data, sched-

uling, and billing in real time will dramatically improve health services. First responders will be able to communicate in real time or send in drones into dangerous situations for improved emergency response. Hoffman emphasized that with 5G connectivity and sensing, most if not all industries will save money, time, and lives as a result of a reduction in human error.

Hoffman described the new Internet of Things as comprised mostly of an internet of sensors. The key capability that this technology provides is real time analysis and data collection, which is enabled by a multitude of sensors. 5G will be backwards compatible, and will improve overall connectivity on everyday devices, which will allow for less clogged networks.

Hoffman called on the U.S. to continue incentivizing and building momentum in implementing this technology. If industry and government can unite, the United States' likelihood of winning the "race" to 5G substantially increases. According to Hoffman, younger generations are already expressing concern that the United States is not doing enough to hold its place in the global technological competition and global digital economy. Finally, she emphasized the urgency of the problem, and predicted significant negative repercussions if the U.S. does not make forward progress on implementing 5G within the next eighteen months.

Discussion

The period for questions, answers, and discussion opened with a broad question regarding new security challenges accompanying the 5G revolution. The panel responded by outlining a number of pressing challenges, and provided expert advice on how to go about addressing them. The first challenge discussed was network slicing, wherein which an actor segments parts of the network for very specific applications, resulting in third parties that may end up controlling access points to the network. The second challenge discussed was the need for dynamic encryption. With increased communication enabled by the 5G network, especially machine-to-machine communication, more dynamic and complex encryption will be necessary to secure all communications. It was noted that just as policy surrounding data privacy must evolve along with 5G, mitigation of security challenges and counter measures must be identified along with the network's development. According to the panelists, security cannot be an afterthought for the implementation of this revolutionary technology. The U.S. government and industry have a shared duty to develop security standards and protocols upfront to ensure their implementation across sectors and networks. With data security being a specific point of interest for some audience members, panelists cited the European Union's GDPR as an example of data usage standards. This type of shared standards can also be applied for supply chains security protocols. Panelists stressed that when planning for security is done early and baked into the plans for the 5G infrastructure, there are more opportunities to counter potential threats, switching from an atmosphere of threat response to one of threat prevention. It was reiterated from a point of security challenges that whoever is able to implement widespread 5G network capability first will win a large asymmetric advantage not only in terms of economic profit, but in terms of their overall data security. The lag time between the first national implementation of a 5G network and subsequent national roll-outs is crucial. Those secondary and tertiary nations will have much less of an advantage,

even though they will be benefitting from the same technology as the first nation to implement 5G. Other security issues surrounding the development of 5G are associated with supply chain security in relation to components going into the 5G operating infrastructure, and mechanisms for securing and protecting critical information as it travels through the 5G network.

The next period of discussion dealt with competition and incentivizing the development of 5G, as well as the capture of 5G research for use standing up a domestic 5G network. Many startups in 5G research, development, and production are valued at two or three times higher in China than in the U.S. and other countries, so the incentive for U.S.-based start-ups to transition their technologies to foreign buyers is high. This means that the U.S. is falling even further behind in the race to get 5G up and running. There is a need to incentivize startups to keep their technologies in the U.S. to build up domestic 5G capability, and to incentivize further research and development efforts. The panelists responded that part of solving the problem of incentivizing domestic 5G development is to show the long-term implications of moving one's U.S. based company offshore to places like China. In the long-term, the picture is not nearly as rosy for companies that transition tech offshore, as China will offer lots of money to buy them out up front, but will later restrict the distribution of IP or force data to be stored onshore. Policymakers need to better educate the startup community about considering the long-term viability of working in the Chinese economic environment to encourage them to keep their technologies in the U.S.

Further questions stemmed from the shift from 4G to 5G and from separate carrier networks to a single network with expanded bandwidth shared by many carriers big and small. Questions surrounded footing the cost of building needed physical infrastructures, and shared construction and operating regulations. For current 4G network technology, there are 4 major carriers: Verizon, AT&T, Sprint, and T-Mobile. Wherever these carriers go, they need 4 different antennae at each point, cell tower, etc. With the move

to a single 5G network, the question of who owns and or is responsible for building out this network complicates the shift from the current system to the system of the future. Terry Halvorsen of Samsung responded to this concern with the prediction that the four major carriers will be able to negotiate a shared use plan without much steering from the U.S. government. Brian Hendricks of Nokia noted that conversations and development of 5G are moving forward not just through the efforts of the four major carriers, but through smaller players looking to benefit from wider and faster connectivity, especially in rural areas. In order to capitalize on this momentum, however, Hendricks highlighted the need for a major cultural shift in regard to stakeholder and community perspective on sharing spectrum.

On the note of rural coverage, panelists highlighted the positive impact 5G will have on rural coverage, with smaller carriers having greater spectrum access than they currently have to today's 4G networks. According to the panelists, 5G will bring more connectivity to rural areas, because installment of the required hardware has lower barriers to entry in terms of installation and maintenance (e.g. 5G does not necessitate the digging up of ditches to lay down cable). However, there is the risk that the digital divide could grow with the adoption of 5G technology if spectrum sharing does not become more of a focus. According to the panelists, neglecting the need for increased spectrum sharing will have far larger consequences for those already without access than those with even limited access. Panelists warned that current millimeter wave spectrum will not be a silver bullet, and that land use for placing antennae cannot be a variable that determines who gets access to the 5G network.

Following up on the subject of 5G implementation as a race from earlier in the program, discussion shifted to how the US is going to become first in 5G if it is already behind and Congress continues to move at a very slow pace. Panelists were quick to say that action on the critical issue of how to expedite American development of 5G should not neces-

sarily be executed through Congress, and should instead be done through working with the Federal Communications Commission (FCC). They also cited a role for the National Institute of Standards and Technology (NIST), the overarching Department of Commerce (DOC), and ally nations in speeding up the development and deployment of 5G technology.

Discussion also circled around the question of cost, and need for increased government support of the development of 5G technologies. It is more expensive for U.S.-based companies to develop their 5G technologies in the U.S. because there is a lack of government subsidies for that type of R&D. Meanwhile China is moving quickly in its development of 5G technologies, in part because they are heavily subsidizing its development. Because industry will most always follow the lowest cost of bringing up a technology if they can, many companies are developing their technology in China, where those technologies will transition either to China itself, or their allied nations. As a result, IP will not reach the U.S. before China stands up its own 5G network. Panelists stressed the need for rapid, heightened government investment in 5G research and development, with heavy incentives built in to transition those technologies for domestic use. In part, a paradigm shift in how the U.S. is valuing the impact of 5G technology, and subsequently the way it is subsidizing research is needed. This will ensure that the U.S. not only does not fall further behind its competitors, but secures the title of "first to 5G", solidifying its dominance over the burgeoning digital economy for years to come.

Building off of this discussion of cost and investment, Kiersten Todt discussed a major problem that has prevented the U.S. from being further along in its development of a reliable 5G capability. This is the generational gap in the understanding of today's and tomorrow's technologies. She warned that neither U.S. business nor government have effectively disseminated awareness among policy makers to enable the right leadership to step up and prioritize the development of 5G technology. She stressed that with the advent of an update to one of our nation's critical

infrastructures like telecommunications that more than just technical policy has to be considered. She went on to say that the U.S. won't ever have a digital Pearl Harbor event because it is far too psychologically removed from the potential effects of that type of event. In her view, per earlier discussion during the panel, there needs to be a front-end, preventative way to communicate the catastrophic effects of falling behind in 5G.

Discussion then settled on immediate action items, termed the "low-hanging fruit" by audience members. The first question considered the opening up of mid-range spectrum as a first step towards enabling the shift to 5G. Panelists responded that the U.S. does not just need to open mid-range spectrum, but needs more spectrum coverage across the board. In addition, they stressed the need for an update expediting the spectrum auctioning process. Again, panelists compared the U.S. progress in this arena to that of China, citing that China has already coordinated its approach to spectrum auctioning, so they can handle spectrum distribution in parallel with their rollout of new infrastructures. Terry Halvorsen indicated that industry actually has yet to utilize all of the spectrum currently available to them today. In addition to improving government processes for auctioning of spectrum, he highlighted that the USG needs to incentivize industry to make more use of the spectrum they already have available to them. Given that 5G is inherently made to share spectrum, as U.S. industry rolls out the hardware, companies need to set up their operations to maximize spectrum sharing capabilities. Panelists iterated that the reality of the future is spectrum sharing, and while under the current model, it is understandable that the industry players do not want to accept that, they will need to with the coming 5G revolution.

In conclusion, the panelists reiterated the urgency of incentivizing the development of 5G in the U.S., and the need for immediate action to incentivize investment in 5G technology, develop standards for its installment along with the technology, and increase spectrum sharing procedures to enable market access for any and all carriers.

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• Advance knowledge of critical infrastructure and supply chain security challenges and solutions across the US Government and industry to include policy makers, the Department of Defense, and the manufacturing industrial base.

• Bridge the gap between commercial and defense supply chain security practices.

• Strengthen policy to ensure continued security of our nation's critical infrastructure and supply chains.

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