

# Increasing U.S. Exports of 5G Technology in Emerging Markets

*Strategies to enhance U.S. 5G export potential  
while facilitating international development*



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April 2021*

Prepared for:



## **ACKNOWLEDGMENTS**

I would like to thank several people for their support, guidance and insight throughout the process of this project. First, thank you to the U.S. Trade and Development Agency for permitting me, a summer intern from the Office of Public Affairs, to continue working with the Agency in a new capacity to tackle the new frontier of 5G and the Agency's role within it. Thank you to the 5G team, who so graciously met with me every two weeks over the course of this process, listened to my ideas, offered feedback and brainstormed new ideas with me. I am so grateful for your time and guidance. A special thank you to my supervisor on the PA team, Paul Marin, for advocating on my behalf for an APP client within the agency and connecting me with the 5G team.

I also want to thank my two APP advisors – Professor Scheppach and Professor Ruhm. Professor Scheppach, you provided me with critical corrective feedback and guiderails early on which helped this project reach where it is today. While much has changed since I submitted my first assignment in August 2020, your accessibility and commentary throughout the fall contributed immensely to the growth of the project. Professor Ruhm, I felt my focus and goals for this project align this semester and your feedback helped me identify how to resolve some of the greatest issues I was still facing. Thank you for your honest feedback, flexibility and patience.

I also want to thank my Batten friends and cohort for commiserating throughout the process and offering a refreshing peer perspective. Finally, thank you to my parents, without whom I would not be at the University of Virginia or the Frank Batten School at all. Thank you for all the opportunities you have enabled me to seize and the strong work ethic you have instilled in me.

## **DISCLAIMER**

The author conducted this study as part of the program of professional education at the Frank Batten School of Leadership and Public Policy, University of Virginia. This paper is submitted in partial fulfillment of the course requirements for the Master of Public Policy degree. The judgments and conclusions are solely those of the author, and are not necessarily endorsed by the Batten School, by the University of Virginia, or by any other agency.

## **HONOR PLEDGE**

On my honor, as a student, I have neither given nor received aid on this assignment.

- Margaret Servais

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## EXECUTIVE SUMMARY

Telecommunications companies began deploying the fifth generation (5G) of cellular network technology in 2019 (Galazzo, 2021). While 5G is the linear next step in the progression of broadband cellular networks, its impact is exponential. 5G networks allow data to transmit 100 times faster than 4G networks and can service thousands of more devices – altogether enabling the continual use of advanced technologies such as augmented reality, artificial intelligence and the internet of things for the first time (Ghosh, 2020; Seal, 2020). In terms of societal impact, studies estimate the global 5G value chain is expected to create over \$3 trillion in economic output and create 22.3 million jobs in 2035 (Campbell, et al., 2019). Estimates on the projected impact of 5G on the U.S. economy find an impact of approximately \$500 billion on GDP specifically and up to \$786 billion in 5G-enabled economic output by 2035, as well as the creation of roughly 3 million jobs (Roy, 2018; Lu, 2018). By 2025, an estimated 1.8 billion 5G connections are expected around the world (GSMA, 2020).

5G presents incredible opportunities for economic growth and development. While the U.S. is a leading producer of 5G network components, it falls short in exporting those technologies into markets that need them most. This report assesses the United States' comparatively low rate of exports of fifth-generation (5G) cellular network technology into low- and middle-income (emerging) markets around the world. It evaluates how the U.S. Trade and Development Agency (USTDA) can facilitate the increase of U.S. 5G exports into these markets while also contributing to critical infrastructure development of receiving nations.

This report presents and assesses four potential alternatives for USTDA in increasing U.S. exports to emerging markets in the 5G sector:

1. The Status Quo
2. Creating a 5G industry partnership
3. Enhancing the 5G project pipeline
4. Initiating a 5G public relations campaign

Upon evaluating the outcomes of each alternative by their effectiveness in increasing U.S. exports of 5G technology, development impact on receiving nations, financial cost and risk to the Agency, this report ultimately recommends Option 2, creating a 5G industry partnership. This option proves to be the most robust in increasing exports of U.S. 5G technology and enhancing development in receiving nations while incurring only moderate costs and moderate risks.

## PROBLEM STATEMENT

5G refers to the fifth generation of cellular network technology which enables mobile internet connection. Today, nearly half of the global population utilizes mobile internet connection or 3.8 billion people (Bahia and Delaporte, 2020). Mobile internet access enables wide social and economic developments for nations and societies through increased access to information, education and employment, as well as healthcare and other critical services and infrastructure (Wu, et al., 2015). One study found that a 10-percentage point increase in broadband coverage is associated with a 1.21% growth in GDP in developed economies and 1.38% GDP growth in emerging economies (Minges, 2015). Overall, mobile broadband access is associated with positive impacts for economies, including GDP and employment growth, as well as benefits for businesses in the form of improved productivity and for consumers through enhanced access to services and applications (Deloitte, 2018).

5G is a critical frontier for information and communications technology (ICT) development yet many nations lack the technical expertise, industry or resources to secure 5G infrastructure on their own. Facilitating and providing the foundational infrastructure for 5G rollout into emerging nations presents a massive market opportunity for both firms and governments. The U.S. is a market leader in the production of 5G components parts and technologies and is well-positioned to provide such critical infrastructure to emerging markets. **However, too few U.S. suppliers of 5G technology are exporting in emerging markets.** The U.S., despite being a market leader in production, is facing a market gap in exports into these critical markets, facing strong competition from other developed nations such as China. The U.S. faces substantial opportunity costs – both to domestic export rates and international development assistance to partner nations – if it does not leverage its existing technical expertise and private-sector competitiveness to more effectively support global 5G development.

## CLIENT OVERVIEW

The client for this project is the U.S. Trade and Development Agency (USTDA). USTDA is an independent federal agency established in 1992 to promote U.S. private sector participation in development projects in developing and middle-income countries around the world (P.L. 102-549). See Appendix A for a definition of developing and middle-income countries according to The World Bank, which will be referred to throughout this report as emerging countries and markets.

### USTDA'S MISSION

The U.S. Trade and Development Agency helps companies create U.S. jobs through the export of U.S. goods and services for priority infrastructure projects in emerging economies. USTDA links U.S. businesses to export opportunities by funding project preparation and partnership building activities that develop sustainable infrastructure and foster economic growth in partner countries. Source: [www.ustda.gov](http://www.ustda.gov)

USTDA carries out its mission by supporting feasibility studies and other project assistance activities for the planning, development and management of and procurement for development projects in partner markets (P.L. 102-549). USTDA activities serve the purpose of promoting the use of U.S. goods and services in such projects (P.L. 102-549). The Agency's current toolkit includes funding training grants, project preparation assistance - including feasibility studies and technical assistance - pilot projects and reverse trade missions (see Appendix B for a complete description of each tool). The Agency's work is divided across four regions - the Indo-Pacific; Latin America and the Caribbean; the Middle East, North Africa, Europe and Eurasia; and sub-Saharan Africa - as well as across five sectors - Agriculture, Energy, Healthcare, ICT and Transportation.

USTDA can play a critical role in the 5G sphere. The Agency's mission uniquely positions it to effectively address the export gap of U.S. 5G technology into emerging markets. By leveraging its well-established toolkit, relationships and expertise, USTDA can connect U.S. firms to 5G infrastructure projects in emerging markets - directly helping address the problem by facilitating the increase of U.S. 5G exports abroad. The Agency can simultaneously scale up the reach of U.S. 5G technology abroad, support U.S. jobs and exports while enhancing critical infrastructure development in partner countries.

5G rollout both domestically and abroad is a strategic priority of the United States Government<sup>1</sup>. With 5G infrastructure development already well underway around the world, there is an urgent need for the U.S. to enhance its progress in this space. USTDA is perfectly positioned to play a critical role in connecting U.S. competitiveness for 5G technology to its rollout in emerging markets – both facilitating U.S. exports and job growth as well as critical infrastructure development in priority markets.

## BACKGROUND ON THE PROBLEM

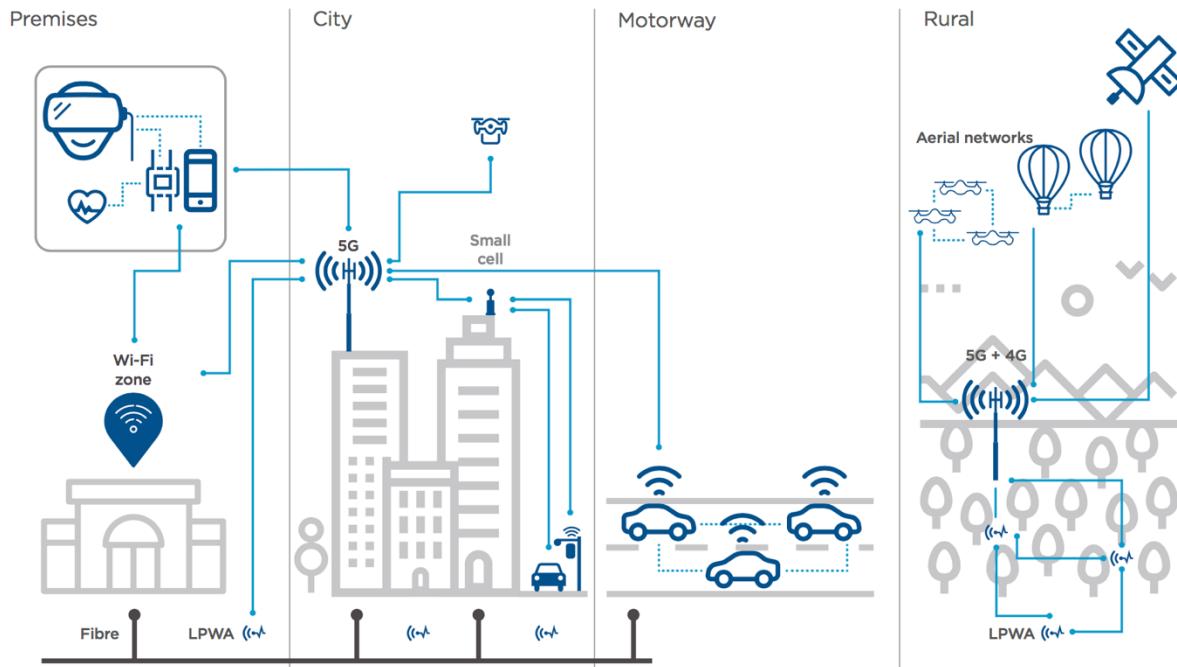
### What is 5G

5G is the fifth generation of cellular network technology, building on the fourth generation (4G) which launched toward the end of 2009 (Galazzo, 2021). Mobile network technology began with the first generation (1G) as far back as 1979 in Japan and 1983 in the U.S. (Galazzo, 2021). To convey the significance of 5G – and increasing U.S. 5G exports to enhance competitiveness and global development – it is important to understand the technology and infrastructure behind it.

Cellular networks are composed of two primary components – the Radio Access Network and the Core Network (AMTA, 2020). The Radio Access Network (RAN) includes physical infrastructure, including towers, base stations and small cells, which connect wireless devices and mobile users to the main Core Network (AMTA, 2020). The RAN is connected to the Core Network, the cloud-based backbone of the communications infrastructure, which manages all mobile exchanges and data and connects the various parts of the cellular network (CISA, 2020; AMTA, 2020). The foundation of cellular network infrastructure is the physical components of the RAN. In the context of 4G and 5G, the RAN consists of 4G macro cells (or cell towers), 5G small cells and 5G macro cells (AMTA, 2020). 5G is innovatively designed to be integrated into and layered on top of existing 4G infrastructure. 5G replaces many hardware components of networks with software, virtualizing networks with the common language of Internet Protocol (Wheeler 2019).

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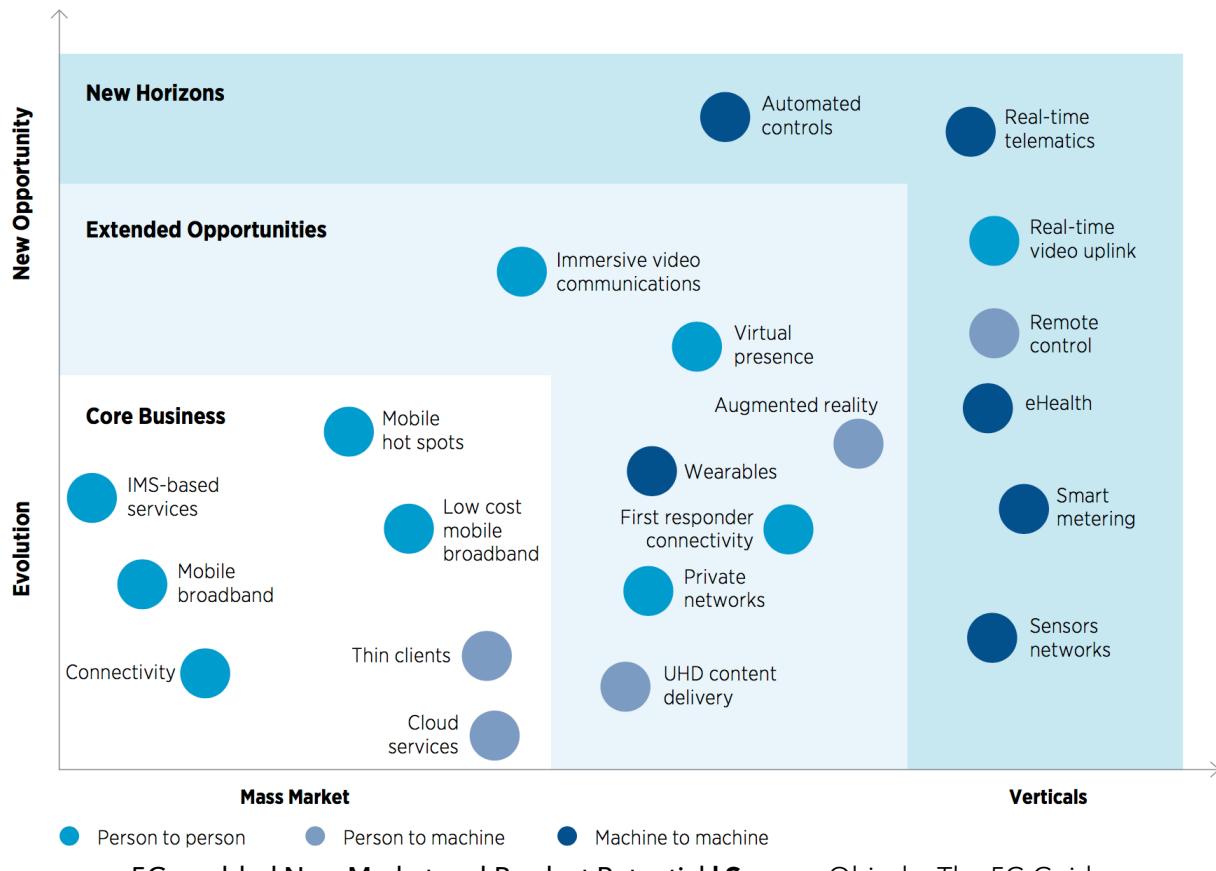
<sup>1</sup> See text of the Secure 5G and Beyond Act of 2020 which called for a federal plan for addressing 5G rollout domestically and abroad. Accessible from: <https://www.congress.gov/bill/116th-congress/senate-bill/893/text>.



Rendering of 4G & 5G Infrastructure | **Source:** Obiodu, The 5G Guide

A 5G network can be divided into three slices and its rollout in two phases. The first slice is enhanced mobile broadband (eMBB) which uses parts of existing 4G LTE infrastructure to enable higher download speeds for devices (Triolo et al., 2018). The second slice is ultra-reliable low-latency communications (uRLLC) which is designed for applications that require little or no lag in communication, such as autonomous vehicles, and will require considerable investments in new equipment (Triolo et al., 2018). The final portion is massive machine-to-machine communications (mMTC) which is designed to manage billions of new sensors to communicate among themselves (Triolo et al., 2018). mMTC enables the internet of things (Shea, 2019). The 5G rollout process is two-pronged. First, there is non-standalone (NSA) 5G which adds eMBB to an existing 4G network and utilizes existing infrastructure (Triolo et al., 2018). Second, there is standalone (SA) 5G which involves the uRLLC and mMTC portions and requires investments in new infrastructure including antennas and base stations (Triolo et al., 2018).

## 5G WILL SUPPORT EXISTING AND NEW PRODUCTS AND MARKETS (NOT EXHAUSTIVE)

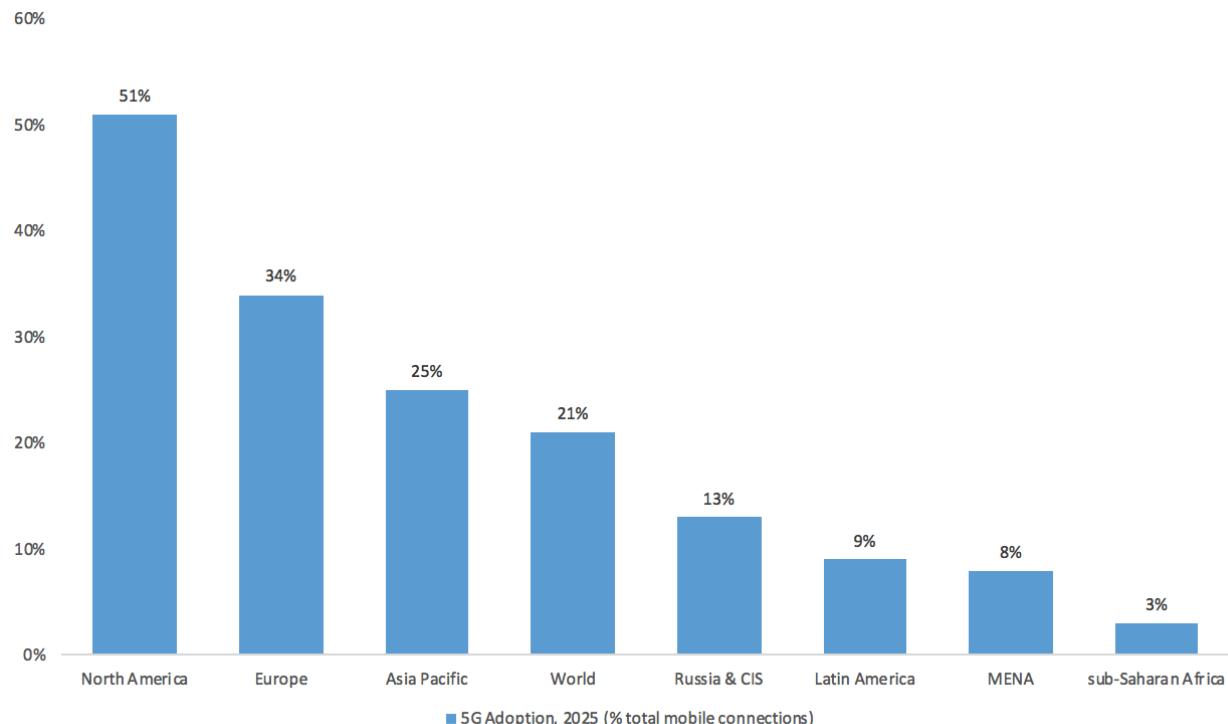


5G-enabled New Market and Product Potential | Source: Obiodu, The 5G Guide

## Why 5G Matters

While 5G is the titular next phase of cellular network technology, its capabilities dwarf that of previous generations. 5G enables data to download at rates up to 100 times faster than 4G and data transmission time, or latency, is 25 times lower (Ghosh, 2020). Additionally, 5G will have the expanded bandwidth to seamlessly handle 10 times more devices per square kilometer than 4G – supplying connectivity to millions of devices, up from just a few thousand under 4G (Ghosh, 2020; Seal, 2020). The advanced speed and capacity of 5G networks will enable, for the first time, the consistent use of advanced technologies such as augmented reality, artificial intelligence and the internet of things. Just as 4G was the basis for the app economy – which was worth over \$568 billion in the U.S. alone in 2018 – 5G will provide the foundation for the virtual economy of technologies that will be built on top of it (Deloitte, 2018; Lewis, 2018). Expansion of past iterations of ICT infrastructure is associated with non-trivial positive effects on GDP growth, a trend which is most significant in emerging economies (Minges, 2015). A similar – if not more significant –

trend is likely to be realized with 5G. As will be discussed further in the Costs to Society section, 5G rollout in the U.S. alone is projected to contribute to the creation of roughly 3 million jobs and \$786 billion in economic output by 2035 (Lu, 2020).



#### 5G Adoption as share of regional mobile connections by 2025

| **Source:** GSMA, The Mobile Economy Latin America 2020

5G poses near exponential opportunities – as well as risks – for economic development in emerging countries and U.S. leadership on the global stage. The United States must pursue policy strategies to address the 5G export gap in emerging markets to advance U.S. competitiveness in the ICT sector and to counteract less secure development from untrusted vendors. The scope of the issue is global and the problem is significant to society in two ways. First, there is a massive opportunity cost for countries that do not gain access to secure 5G technology. 5G can transform the economies of emerging nations with access to virtual industries from telehealth to smart infrastructure and advanced defense. A 5G-dependent society – with all of the sensitive data the network houses – is vulnerable to destabilizing cyber espionage, disruptions and other illicit behavior. The provision of 5G infrastructure from trusted vendors, such as from the U.S. and its allies, is critical for secure development. Second, this problem is geopolitically important for the U.S. The U.S. has much to gain (or lose) by entering the 5G market abroad (or failing to) as competing countries, namely China, lay the 5G groundwork in priority markets. If this problem is addressed there is the opportunity to transform emerging markets and

catalyze rapid economic development. It is further significant for the U.S. in maintaining geopolitical balance with China. If the U.S. does not leverage its competitiveness in 5G for economic development in emerging countries, China will dominate the playing field and establish near-monopoly power in critical markets.

## 5G Technology Market Structure

Understanding the groundbreaking potential of 5G, this section offers an overview of what firms currently lead in the production of 5G technology. 5G components can be broken into two divisions, 1) core telecommunications network equipment and 2) mobile network equipment components (Lewis, 2018). Appendix C visually breaks down the products in these sectors and the leading firms in each market.

The first sector produces equipment for the core component of telecommunications networks, the RAN. There no longer are any U.S. manufacturers of RAN equipment (Lewis, 2018). The market is instead dominated by four foreign companies, two of which are U.S. allies and two of which compete with U.S. interests. The leader in this sector of the market is the Chinese firm and the world's largest telecommunications company, Huawei, with roughly 28% of the market. Ericsson, based in Sweden, follows Huawei with approximately 26% of the market followed by Nokia (Finland) with about 24% and then ZTE (China) with 14% (Lewis, 2018).

Despite the absence of American manufacturers for the core network equipment, U.S. companies have a lead in market share for most 5G equipment components. Looking at small cell power amplifiers, for example, U.S. firm Texas Instruments leads in the market followed by Dutch NXP Semiconductor then all American firms, Qorvo, Broadcom and Anadigics (Lewis, 2018). The U.S. also leads in network processors with four out of the five market leaders (Intel, Broadcom, Qualcomm and Texas Instruments) sandwiching one Chinese firm, HiSilicon, ranking third. U.S. firms are the top three market leaders in servers (Dell, HPE and IBM) followed by two Chinese firms, Lenovo and Inspur (Lewis, 2018). Dell alone has roughly 29% of the market share which is more than three times the share of any of the other top five firms (Lewis, 2018). Appendix C depicts the breakdown of the market for other equipment components.

This current breakdown of the 5G technology market – with European and Chinese firms leading in the core infrastructure and the U.S. leading in component parts – adds complexity to the problem of too few U.S. 5G exports into emerging markets. The U.S. needs to leverage its competitiveness in component parts and also consider

allying with European security partners to offer complete 5G infrastructure from the ground up. U.S. firms can also consider layering on top of base infrastructure laid by an untrusted vendor but must be cognizant of associated risks and confident in risk mitigation capabilities.

## Why the U.S. Lags in 5G Exports to Emerging Markets

How does this market breakdown in terms of production play out in terms of exports? The leading producer of core infrastructure – Huawei – is the corresponding leader of 5G infrastructure rollout around the world. Currently, the U.S. lags significantly behind China in the rollout of 5G equipment in emerging markets, with China already engaging in projects in over 50 low- and middle-income nations (Cave, et al., 2019).

By numbers, Huawei claims it has shipped over 100,000 5G base stations worldwide, far outpacing competing firms, and has operations in over 170 countries (Townsend, 2019; Cheng & Feng, 2019). Chinese state banks have been known to give Huawei an upper hand in tenders with foreign buyers by extending affordable loans to smaller and developing countries to incentivize the purchase of Huawei equipment (Cheng and Feng, 2019). Researchers with the Australian Policy Institute's International Cyber Policy Centre have compiled a public database mapping the global expansion of 23 key Chinese technology firms. Their research has mapped 88 5G networks initiated by Chinese firms in 45 countries (Cave, et al., 2019). When filtering the database for Huawei and the type of overseas presence with a "5G relationship" there are 61 results. This suggests Huawei has at least 61 active or completed projects in the 5G sphere in over 35 nations on five continents (pictured below). When filtering the search to include activities in 5G and ICT more broadly, the number jumps to 171 projects in over 75 countries. Appendix D shows the database map filtered for Huawei projects in 5G and ICT, visually demonstrating the scope of Huawei's international presence in the 5G and ICT arena.



Map of Huawei 5G-related projects worldwide

| Source: ASPI International Policy Centre, <https://chinatechmap.aspi.org.au/#/map/>

The scholars behind the database found that, in many developing countries, growth is being largely driven by loans provided by the China Exim Bank – which is owned by the Chinese Government (Cave, et al., 2019). The loans must be paid back by recipients and are offered to foreign governments. It is widely reported that the contractors which loans are used to pay for must be Chinese firms (Cave, et al., 2019). In many cases the researchers evaluated, Huawei was awarded the contract while in other instances a Chinese state-owned enterprise managed the contract with Huawei serving as a “sub-awardee” to provide specific equipment and services (Cave, et al., 2019).

Consequently, firms from the U.S. and other nations face an uneven playing field for 5G project bids that involve Chinese firms. This contributes to China’s considerable lead in the global rollout of 5G as well as the U.S.’ comparative lag – highlighting the need for actors, such as USTDA, to help level the playing field for U.S. suppliers and close the export gap.

## Importance for National Security

While less significant for this report and the client, one argument frequently raised to justify the expansion of U.S. competitiveness in the global rollout of 5G is national

security. ICT is a strategic industry – particularly 5G with its advanced and novel capabilities – and having the leading player be closely linked to a competing government presents a risk to U.S. interests. Companies that provide critical mobile network infrastructure will have access to potentially compromising data and information. Huawei lacks transparency in its ownership structure and has alleged ties to the Chinese government (Cheng and Feng, 2019). Countries which depend on technology from Huawei may be vulnerable to illicit behavior from the Chinese government including surveillance and espionage. China has been known to engage in cyber espionage and is likely to exploit openings it attains in supplying 5G infrastructure (Lewis, 2018). Consequently, companies – and countries – which procure their core network equipment from untrusted vendors, such as Huawei, are susceptible to those vendors potentially engaging in illicit behavior. With 5G extending into almost every industry, such threats could compromise a country's most sensitive information, from private citizen data and healthcare information to financial details and defense or government intelligence. Expanding U.S. exports of 5G technology into priority emerging markets serves to not only enhance development and U.S. competitiveness but can play a role in minimizing risks to national security.

## **CONSEQUENCES OF THE PROBLEM**

Considered here are the direct and indirect financial costs borne by the United States and emerging countries if U.S. exports of 5G equipment are not increased. These costs are presented in dollar amounts.

### **Direct Costs - U.S.**

The primary direct cost for the U.S. in failing to increase exports of 5G equipment and technology into emerging countries is lost revenue and job creation. One estimate suggests widespread deployment of 5G wireless technology could create up to 3 million jobs and contribute roughly \$500 billion to GDP (Roy, 2018). Another study supports similar estimates, projecting that 5G-enabled employment in the U.S. could amount to 2.8 million jobs by 2035 (Lu, 2018). That same study finds a larger financial impact of 5G proliferation on the U.S. economy, amounting to \$786 billion in 5G-enabled economic output by 2035. The study estimates the U.S. will lead on the global stage in terms of its share of the 5G value chain, specifically projecting the U.S. to have 26.7% of the 5G research and development value chain and capital expenditure. The scope of this projection implies an expansion of U.S. 5G technologies into foreign markets. Based on the current trends of U.S. 5G exports

into foreign markets, this number likely does not consider the potential for the U.S. to more assertively enter emerging markets, lending those exports instead to China and down-weighting the potential impact on the U.S. economy. Even considering 2.8 million jobs and \$786 billion in economic growth as an underestimation of the future impact of 5G proliferation on the U.S., these numbers demonstrate the scale of the cost to the United States for not actively entering the 5G scene abroad. Millions of jobs and billions of dollars present a substantial direct cost for the U.S. if it were to not bolster its exports of 5G technology to emerging markets worldwide.

### **Indirect Costs - U.S.**

The indirect costs of failing to increase U.S. exports of 5G technology into emerging markets are similarly significant. For the U.S., indirect costs amount to the opportunity cost of future transactions which could occur between the U.S. and a recipient country once the U.S. has already established a connection to that market through the sale of 5G technology. The presence of U.S. vendors for direct 5G technology and equipment opens the door for additional American firms to enter that market, especially in the telecommunications sphere. The cost of these downstream indirect transactions spurred by 5G exports is not insignificant. A recent report examines the scale of the wireless and telecommunications industry in the United States as defined by jobs created, contribution to the GDP and generation of economic output (Roy, 2018). The report breaks down the contribution to GDP by direct activity, induced activity and indirect activity. Indirect activity is defined as the economic contribution from adjacent industries which support the wireless industry, such as the production of component parts for cellphones or laptops. Of the wireless industry's contribution to U.S. GDP, the report finds 19% of that contribution is from indirect activity. If reserving half of the projected 5G enabled economic output to 5G exports (\$393 billion) and applying the 19% contribution from indirect activity, the U.S. would bear just over \$74 billion in indirect costs by 2035 for not increasing exports internationally and specifically into emerging markets.

### **Direct Costs - Emerging Countries**

In emerging countries, the primary direct costs of the lack of U.S. 5G exports are slower growth in economic output and income. A 2019 report from HIS Markit, commissioned by Qualcomm Technologies, Inc., found that 5G will enable \$13.2 trillion of global economic output in 2035 (Campbell, et al., 2019). Further, the global 5G value chain alone is expected to create \$3.6 trillion in economic output and create 22.3 million jobs in 2035 (Campbell, et al., 2019). Additionally, 5G investment and deployment will propel long-term returns to global real GDP. From 2020-2035, the stream of annual contributions of 5G to real global GDP produces a net present value

of \$2.1 trillion, or the equivalent of Italy's economy which is the eighth largest in the world (Campbell, et al., 2019). While the target emerging countries within this problem context account for only a fraction of the total market share, the aforementioned growth estimates are staggering. Even if the target countries account for 25% of the market, the cost of delaying 5G deployment would amount to \$3.3 trillion in economic output and 5.5 million jobs. One estimate even has USTDA's regions of focus accounting for approximately 60% of 5G connections by 2035 or contributing nearly \$8 trillion economic output and 13 million jobs. The cost of not receiving 5G for emerging markets, especially from U.S. vendors, is thus significant and underscores the cost of this issue to society.

### **Indirect Costs - Emerging Countries**

The indirect costs for emerging countries from a lack of U.S. 5G exports into those markets primarily consist of the costs of potential breached networks and maintenance of networks provided by alternative vendors. If emerging markets are in the position to acquire 5G technology but do not have access to U.S. vendors, they will procure the technology from elsewhere and the most likely alternatives are Chinese firms, namely Huawei. Telecommunications networks from Huawei cost between 20-30% less than products from competing vendors (Lewis, 2018). However, where buyers save in upfront cost, they sacrifice in security. Huawei technology is known to be less secure than competing vendors and could subject buyers to potential espionage or illicit behavior from the Chinese government. Indirect costs for countries in not procuring U.S. 5G network technology are the costs associated with dealing with potential security breaches in networks or paying for enhancements to basic security. The average cost for a data breach in 2020 was \$3.86 million, which includes costs related to the labor and opportunity cost of time spent dealing with the breach in addition to lost revenue from bad publicity or pausing business amidst the breach (Swinhoe, 2020). This is the average cost of a data breach for individual firms. This cost would grow enormously when magnified to increase across sectors, countries and continents, underscoring the importance of addressing the problem of low U.S. 5G exports into these markets.

## EXISTING EVIDENCE ON POTENTIAL SOLUTIONS

While 5G is a fairly new technological development, there is a growing body of research on the impacts of 5G rollout around the world, its implications for development and how countries can facilitate its expansion. This section offers a review of leading research on both the impact of global 5G development, especially in emerging markets, as well as methods for increasing 5G technology exports.

### Evidence on Development Impacts of 5G

A leading source on trends in the ICT sector, including 5G, is the GSMA Association out of the United Kingdom which represents a consortium of over 750 mobile network operators around the world. Each year, the organization produces The Mobile Economy report which breaks down the impact of telecommunications and mobile networks on the global economy. The most recent report for the Mobile Economy 2020 presents the significance of the mobile network sector through numbers alone - there were 5.2 billion unique mobile subscribers in the world in 2019, with a projected seven percentage point increase to 5.8 billion subscribers by 2025. In terms of economic impact, the mobile industry contributed \$4.1 trillion to the global GDP (4.7%) in 2019 and is expected to contribute \$4.9 trillion by 2025. This industry also directly supported 16 million jobs in 2019 and an additional 14 million jobs indirectly. The report finds 5G alone will contribute \$2.2 trillion to the global economy between 2024 and 2034. All of these data point to a common conclusion among ICT literature - 5G will have groundbreaking effects on the global economy. The methodology for this report and others from GSMA is robust. Representing over 750 firms, GSMA has access to comprehensive firm-level data for conducting analyses with a large sample size. Additionally, its global reach enhances the response rate and reliability of survey results. While the data and analyses are reliable, there is a potential for bias in the framing of takeaways considering the organization's representation of critical, profit-driven stakeholders in the mobile industry.

Important for this report, studies in this field also present a strong consensus on policy tools and strategies for enhancing the global rollout out of 5G. Among the solutions include encouraging governments at all levels to simplify and standardized planning procedures and regulations for mobile network deployment and expansion. This includes simplifying regulations for site acquisition, providing reasonable expectations for voluntary network-sharing deals and pursuing policies that minimize

costs for mobile operators and spur investment (The Mobile Economy, 2019). Governments also play a critical role in restoring and maintaining public trust in digital services. This includes implementing new or revised data privacy laws which balance the protection of individual privacy with enabling effective and innovative operations on the part of the digital service providers. Concerning 5G specifically, governments and regulators must ensure spectrum policy is suitable for 5G expansion (The Mobile Economy, 2019). Operational 5G networks require access to sufficient radio spectrum frequencies. Critical spectrum was secured for mobile uses at the 2019 World Radiocommunication Conference and governments must ensure the protection of that allocation (The Mobile Economy, 2019). Further, governments should avoid inflating spectrum prices for 5G or retaining spectrum which has been reserved for mobile (The Mobile Economy, 2019). Such spectrum policies should support long-term 5G investment. These policy recommendations are highly market-driven and present an industry bias. Governments will need to weigh other considerations, such as equity and access to mobile networks, in addition to market-favorable policies for the enhancement of the global 5G rollout.

## Evidence on How to Close 5G Export Gaps

A body of research highlights an uneven playing field in the manner through which developed countries facilitate tenders between emerging economies and their private sector. Specifically, a 2015 study from the Center for Strategic and International Studies evaluates the development project strategies of China as a primary contender to the U.S. in the development sphere. In the late 20th and early 21st centuries, China turned to developing countries to provide raw materials needed for its rapid industrialization and economic boom, most notably in sub-Saharan Africa. To acquire benefits, China utilizes private sector development in the form of export-import financing in addition to concessional loan provisions which support the development of infrastructure. Specifically, China often guarantees loans and financing to recipient countries by using natural resources, such as minerals and oils, as collateral. Further, many development deals are struck between emerging countries and Chinese companies which are state-owned enterprises or have close ties to the government. Chinese private sector development projects additionally often do not have human rights conditions and tenders to award Chinese firms contracts often accompany appealing assistance packages (Savoy 2015). These efforts have been successful, especially as it relates to development in sub-Saharan Africa, as Chinese trade with Africa has soared to \$185 billion in 2018, up from \$155 billion in 2017 and just \$12 billion in 2003, outpacing the United States as the leading trade partner with Africa (*Data: China-Africa Trade, 2019; Savoy 2015*).

China is the world leader in expanding its private sector into emerging markets, leveraged by appealing loans, physical collateral and proximity of firms to the Chinese government. China's primary approach to increasing its 5G exports is offering generous state-backed loans to buyers with an implicit requirement of seeking a Chinese firm to complete the tender (Lewis, 2018). This strategy is enhanced by the lower-cost yet comparable quality of Chinese ICT products. China has skewed the field in its favor through state-directed decision-making and it is difficult for many nations to deny the provision of critical infrastructure at a lower price with generous loans.

Identifying China's strategy for international development can help inform that of the United States. While beyond the scope of this paper, the following considers a high-level, interagency response to increasing U.S. 5G exports based on existing evidence from peer nations. There are two primary approaches: 1) develop a comprehensive industrial policy for the digital age similar to Germany's *Industrie 4.0* and 2) bolster domestic ICT research and development alongside actively partnering with 5G suppliers from allied countries.

The first approach to increasing U.S. exports of 5G technology into emerging markets based on existing evidence from peer nations is to adopt a comprehensive industrial policy. Several advanced economies have adopted industrial policies to maintain their competitiveness and resilience in high-tech industries, such as China's Made in China 2025 strategy, the UK's Industrial Strategy and Japan's Society 5.0 (Doshi, 2020). Of focus here is Germany's *Industrie 4.0* which it adopted in 2011 to remain a global manufacturing leader with a commitment to economic and social transformation through innovation and policy experimentation (Horst, 2018). The effort has resulted in German organizations actively collaborating with partners in both developed and emerging countries to enable a seamless transition towards partnerships in next-generation industries, such as 5G (Horst, 2018). This strategy has allowed German firms to enter emerging markets early and establish relationships before the export of specific ICT infrastructure. This proactive approach enables firms to make connections, build trust and provide preliminary services to host countries early on, thereby having an established rapport by the time the host country seeks to procure 5G technology. Analysis suggests Germany's strategy has been successful at preparing the German economy for the fourth industrial revolution. One study finds evidence of growth in all of Germany's *Industrie 4.0*-related sectors (Holz, 2017). For instance, hardware solutions rose by over 14% from 2016-2017 and software solutions grew by 23% and IT solutions grew by 22% over the same period (Holz,

2017). Industrie 4.0's success in developing collaborations between German firms and entities in emerging markets provides an excellent blueprint for the U.S. and how it can strategically and sustainably enter target markets early to build relationships for future 5G rollout.

In addition to taking policy cues from the evidence from Germany and initiating a robust yet flexible industrial policy, the United States should pursue an effective approach from its past and consider partnering with trusted foreign suppliers to increase its 5G exports in emerging markets in addition to bolstering industry R&D. As the 5G market breakdown highlights, the U.S. cannot meet global 5G rollout on its own and when the U.S. has successfully challenged Chinese industrial policy in the past, it has done so with allies (Lewis, 2018). Pursuing this approach in the 5G realm could begin with the passage of legislation such as the bipartisan "Utilizing Strategic Allied Telecommunications Act" proposed by Senators Mark Warner (D-VA) and Richard Burr (R-NC). The act tackles both short- and long-term challenges in the ICT development sphere. In the near term, the bill creates a \$500 million Multilateral Telecommunications Security Fund to support the procurement of non-Chinese ICT equipment internationally (Barfield, 2020). The bill envisages the U.S. pursuing partnerships with foreign governments (likely Finland and Sweden among others) to offset the massive subsidies Huawei and ZTE receive (Barfield, 2020). In the longer term, the act establishes a \$750 million program to sponsor research and development on technology related to 5G, such as virtualization and IoT. The bill builds on evidence of past success with federal intervention in industry – namely the creation of the semi-conductor consortium SEMATECH in the 1980s to bolster the U.S. semiconductor industry against Japanese competition (Doshi, 2020). SEMATECH reduced R&D costs for the industry from 30% more R&D dollars for the generation of each new generation of semiconductor chips down to percent costs in the low single digits, allowing U.S. firms to remain the global market leaders (Hof, 2011). This act offers a strong, two-pronged approach to addressing the problem of low U.S. 5G exports in emerging markets by combining the demonstrated efficacy of bolstering industry R&D to elevate U.S. suppliers on the world stage with direct funding to assist the procurement of U.S. 5G technology in partnership with critical allies.

## CRITERIA FOR EVALUATION

This report assesses the viability of the outcome of each alternative based on four evaluative criteria – Effectiveness, Development Impact, Cost and Risk (defined below). Each evaluative criterion has been assigned a numeric weight out of 100% to indicate its comparative significance to the client. Effectiveness and Development Impact are the most important to the client each with a weight of 35%. Cost and Risk are each weighted at 15%.

Outcomes are assessed on a scale of Low/Moderate/High for each criterion, where High is the strongest outcome for Effectiveness and Development Impact (outcomes with high levels of effectiveness and development impact are most desirable) and Low is the strongest outcome for Cost and Risk (outcomes which are low cost and low risk are the most desirable).

	<b>Low</b>	<b>Moderate</b>	<b>High</b>
<b>Effectiveness</b>	Weakest Outcome	Moderate Outcome	Strongest Outcome
<b>Development Impact</b>			
<b>Cost</b>	Strongest Outcome	Moderate Outcome	Weakest Outcome
<b>Risk</b>			

For ease of comparing outcomes in the Outcomes Matrix section, the Low/Moderate/High rankings have been assigned underlying numeric values (1, 2 or 3) where a 1 corresponds with the weakest outcome and a 3 corresponds with the strongest outcome. These values are multiplied by the weight of each evaluative criterion to achieve a final numeric value for each outcome across the criteria.

	<b>Low</b>	<b>Moderate</b>	<b>High</b>
<b>Effectiveness</b>	1	2	3
<b>Development Impact</b>			
<b>Cost</b>	3	2	1
<b>Risk</b>			



## Effectiveness

**Weight:** 35 percent

**Goal:** Effectiveness captures the extent to which the outcome of an alternative addresses the problem by increasing the rate of U.S. exports of 5G technology into emerging markets. This criterion evaluates how “successful” an alternative and its outcome will be in truly addressing the problem definition and raising U.S. 5G exports.

**Metric:** Effectiveness will be measured in financial terms (U.S. dollars) of exports of U.S. 5G-related technology. Specifically, this criterion will assess the extent to which an alternative changed the dollar amount of U.S. 5G exports into emerging markets on an annual basis, compared to the projected export rate each year under the status quo (letting present trends continue). An effective policy will lead to a net increase in exports (USD) of U.S. 5G technology into these target markets over and above baseline projected increases associated with the status quo.



## Development Impact

**Weight:** 35 percent

**Goal:** This criterion assesses the extent to which an outcome contributes to the development of partner emerging countries. It evaluates how the outcome of each alternative succeeds in achieving USTDA’s goal of enhancing infrastructure development in emerging nations and if development impacts are realized.

**Metric:** This criterion will be measured by the change in the number of individuals who have improved access to digital communication as a result of 5G infrastructure projects USTDA facilitates, over and above expected increases associated with the status quo. This criterion will compare how many more people in emerging countries gain improved access to digital communication after the alternative is implemented compared to a projected increase in access for that year letting present trends continue. A successful outcome will lead to a net increase in individuals with improved access to digital communication over and above status quo projections.



## Cost

**Weight:** 15 percent

**Goal:** Cost evaluates the financial expenditures that the outcome of an alternative would require. The criterion assesses how directly (financial) costly the outcome of an alternative would be. Overall costs are fairly fixed and the impact of outcomes on required labor and associated labor costs is negligible. Labor costs have accordingly been omitted from the cost analysis.

**Metric:** The direct cost of an outcome will be measured by the total U.S. dollar amount spent. A successful outcome in terms of cost will minimize direct financial expenditures.



## Risk

**Weight:** 15 percent

**Goal:** Risk is the extent to which an alternative and its outcome raises concerns for the agency in terms of implementation (financing, timing), reputation (due diligence), regulatory precedent and, in the near term, impacts of COVID-19. An outcome must minimize potential risks to the agency. This includes an outcome that is easy to implement (requiring appropriate financing and time), incurs minimal threat to the Agency's reputation (meets all due diligence requirements), adheres to relevant regulations and faces limited impacts from COVID-19.

**Metric:** Risk will be measured across four categories: implementation, reputation, regulatory and COVID-19. Implementation risks will be assessed through the expected financial cost of an outcome compared to available resources to ensure that financing (looking to how the outcome fairs on the cost criteria above) as well as the feasibility of the expected timeframe for an outcome. Reputational risks will be measured through the projected performance of the outcome on due diligence processes and the extent to which the outcome would successfully meet all requirements. Regulatory risk will be measured by the extent to which an outcome requires existing Agency tools that already adhere to regulatory guidelines. Finally, COVID-19 risks will be measured by the level of potential exposure to the virus the outcome poses for actors involved as well as the ability of the outcome to be

performed under COVID-19 guidelines and restrictions (including the ability to execute the alternative virtually or in accordance to distancing and masking protocols). A successful outcome will minimize risk across all categories.

## ALTERNATIVES

### Alternative #1 – Status Quo

**Overview:** The first alternative is the status quo or maintaining USTDA activities on exporting 5G technology into emerging markets. The Agency would continue to implement its existing project tools for 5G-related projects in its target markets, such as hosting 5G reverse trade missions and workshops or providing grants for 5G feasibility studies or technical assistance. Status quo activities include the Access Africa Digital Infrastructure Reverse Trade Mission and the U.S.-ASEAN (Association of Southeast Asian Nations) 5G Vertical Applications Workshop.

**Who & What:** USTDA and existing tools; USTDA will continue leveraging its existing network of partner country governments and industries as well as U.S. companies to initiate 5G-related projects as well as pursue 5G opportunities outside the scope of its current network but within the scope of its existing toolkit. The status quo will most actively involve members of the Information Communications Technology (ICT) sector team and the 5G sub-sector team in addition to all regional teams.

**When:** Ongoing; USTDA will continue utilizing its existing tools and engaging in its current approach to 5G projects and exports, as well as assessing outcomes, on an annual basis.

**Where:** The U.S., emerging countries and online; The status quo of USTDA's current 5G initiatives will occur, as of right now, largely online via virtual workshops, webinars, grant signings and meetings. Post COVID-19, these events may occur both in the U.S. - through reverse trade missions - and in the host countries where projects are to be implemented.

### Alternative #2 – Industry Partnership: Secure 5G Initiative

**Overview:** This alternative proposes developing a new tool for USTDA to utilize in the 5G sphere – the creation of an industry partnership focused on increasing the

export of U.S. 5G technology into emerging markets. This initiative would emulate the success of the Agency's existing industry partnership Access Africa, which focuses on supporting quality information and communications technology infrastructure (ICT) throughout Africa.

**Who:** Beyond the USTDA ICT/5G and regional teams, the partnership would consist of relevant U.S. government entities in the 5G and export space – such as the Department of Commerce, U.S. Chamber of Commerce the U.S. Export-Import Bank – as well as U.S. 5G industry leaders including IBM, Dell, Intel, Qualcomm, Texas Instruments and others.

**What:** Representing wide expertise in both the private and public sector, the partnership would design activities to enhance 5G potential in partner countries and meet partner country needs to accelerate development in this space. Activities would include existing USTDA tools such as trainings, workshops, reverse trade missions and technical assistance.

**When:** Ongoing; The initiative would go into immediate effect and carry out regular activities. Outcomes should be assessed after the first five years of implementation and every two years after that.

**Where:** U.S., partner countries and online; Initiative activities in the near future will occur largely online via virtual workshops, webinars, grant signings, meetings, etc. Post COVID-19, these events may occur both in the U.S. – such as reverse trade missions – and in the host countries where projects are to be implemented.

### Alternative #3 – Project Pipeline Feeding Strategy

**Overview:** This alternative seeks to create a strategy for USTDA to have an enhanced and more consistent flow of project proposals in the 5G space. Currently, the Agency relies on receiving information from existing contacts or partners. This alternative would instead leverage existing contact lists and databases to engage in proactive outreach for potential opportunities in addition to creating and promoting a 5G-specific project proposal page and form.

**Who & What:** This strategy would involve not only the 5G subsector team but regional teams as well for the promotion of a 5G proposal submission form. The Office of Public Affairs would work in tandem with the 5G sub-sector team and regional teams on outreach to relevant contacts. This option involves a two-part

strategy to increase the 5G project pipeline. First, the Office of Public Affairs, the 5G subsector team and regional teams would consolidate contact information for former partners on previous projects which may have or be interested in a 5G-related project. If the contact is interested but doesn't have an immediate project, they would be added to a 5G-related mailing list. Additionally, the Office of Public Affairs would create a 5G-specific page on the website for 5G project proposals. The office would periodically promote this page on social media. The 5G team and regional teams would additionally promote this page through their contacts and networks.

**When:** Ongoing; The strategy would go into immediate effect and outcomes should be assessed every three years.

**Where:** Virtual; Outreach would be conducted over the phone and email (and potentially, eventually, in-person) and the project proposal page would be online.

#### Alternative #4 – Public Information Campaign

**Overview:** This alternative seeks to leverage USTDA's existing contacts and social media presence to engage in a public information campaign – for both U.S. suppliers and partner country buyers – on the benefits of U.S. 5G exports into these markets.

**Who:** This alternative would remain within USTDA. The Office of Public Affairs would carry out the public information campaign in consultation with the ICT/5G sector teams and regional teams in addition to the Office of Program Monitoring and Evaluation for accessing data on previous 5G project impacts to include in informational publications.

**What:** This alternative involves a promotional campaign within the Office of Public Affairs to inform U.S. firms of the job and export benefits of selling their 5G products to emerging markets and to inform partner countries of the development benefits of procuring U.S. 5G infrastructure. This campaign will consist of online informational flyers and fact-sheets on the benefits of U.S. 5G exports, tailored to U.S. firms or partner country audiences, as well as press releases and posts on social media.

**When:** Annual; the information campaign will be ongoing to remain current with the latest data, findings and project success stories. Outcomes should be assessed every two years.

**Where:** The information campaign will be virtual.

## ANALYSIS & EVALUATION

### Alternative #1 – Status Quo

STATUS QUO	EFFECTIVENESS	DEV. IMPACTS	COST	RISK
1 <i>maintaining USTDA activities on exporting 5G technology into emerging markets</i>	Moderate (0.7)	Moderate (0.7)	Low (0.45)	Low (0.45)



**Effectiveness – Moderate** | The status quo ranks “Moderate” on effectiveness as it would result in an estimated \$12.1 million in annual exports of 5G-related ICT technology in the first year with a 19% annual growth rate. This projection was formed based on the estimated 19% average annual growth rate (AAGR) of exports over five years of Agency projects in the cellular network space started between 2008-2013. This range of years was chosen, in part, to encompass the launch of the previous generation of cellular network technology, 4G, in 2009 as a corollary to the current launch of 5G. This average annual growth rate was applied to the \$10.2 million average annual export total of cellular network projects initiated in these five years from 2008-2013. This estimated baseline export rate multiplied by the 19% average annual growth rate indicates an estimated \$12.1 million in 5G-driven exports in the first year under the status quo.

**Development Impact – Moderate** | This policy alternative ranks “Moderate” on Development Impact with a projected outcome of a 5.5% increase in the number of individuals with improved access to digital communication in target markets on an annual basis with a 46% Compound Annual Growth Rate (CAGR). This calculation is drawn from the projected increase in individuals with improved access to digital communication under USTDA’s recent 5G project with PLDT in the Philippines and the share of that growth from the projected improved access across regions USTDA works in. PLDT currently offers 5G to 8.3 million (about 8%) of its 70 million customers and plans to expand its 5G reach over the next two years, reaching about 39% of remaining clients in the first year and 61% in the second year (Camus, 2020; Talavera, 2020). This corresponds with providing an average 30.85 M people with improved digital (5G) access each year or 61.7 million over two years with a nearly 200% CAGR. By one estimation, the Indo-Pacific region alone is expected to net 518 million new 5G connections by 2022. At 67.1 million new 5G users by 2021, the USTDA-facilitated project with PLDT will have contributed to nearly 12% of that total regional growth and 11% of the total projected increase of 5G connections across all regions USTDA

serves. The regional increase of 5G connections is also expected to experience a 46% CAGR. This amounts to a baseline annual average of nearly 31 million individuals gaining improved access to digital communications or a 5.5% increase in individuals with improved digital access on an annual basis under the status quo, subject to an average 46% CAGR.

**Cost - Low** | This option ranks as “Low” on cost with low overall financial expenditures of roughly \$1.9 M in the next year. This option would only require maintaining current levels of expenditures on 5G-related activities. The Agency’s 2021 Congressional Budget Appropriation amounted to \$79.5 million (H.R. 7608). ICT-related expenditures amounted to about \$17.3 M of the annual budget or 25%, demonstrating a 10.3 percentage point increase from 2019 and a 13.8 percentage point increase from 2018. Applying the roughly 50% growth rate in terms of percent of total expenditures ICT consumes, the ICT sector could account for \$29.8 M in expenditures over the next year or 37.5% of the 2021 budget. Within this, 5G accounted for roughly 7% of ICT expenditures in 2020 at \$1.27 M (Appendix II). Applying the overall ICT expenditure growth rate of 50%, 5G expenditures in 2021 would amount to roughly \$1.9 M. At the same time, the Agency announced its highest return on investment for FY 2020 where every tax dollar spent resulted in \$112 in U.S. exports for a 1:112 ROI. This demonstrates the overall low-cost nature of the Agency’s current activities.

**Risk - Low** | The status quo ranks “Low” on risk as this option requires no change to current operations which pose minimal risks to the Agency (it is assumed high-risk activities would not be already operational and therefore not included in status quo activities). Implementation risks are low as the available financing and implementation timeline for 5G-related activities the Agency has already engaged in were sufficient to carry out the activities. Reputational risks are also low as activities sufficiently adhered to due diligence expectations. One status quo activity, a training grant offered to Cisco in a successful bid to roll out 5G in the Philippines, is highlighted on the Agency’s website, demonstrating its *positive* effects on the Agency’s reputation. Regulatory risk is low as this option does not require activities outside of the Agency’s existing toolkit which adhere to regulatory guidelines. Finally, COVID-19 risks are low as the Agency was able to carry out most standard activities in a virtual environment and the ability to host in-person activities is expected to be achievable in the near future.

## Alternative #2 – Industry Partnership: Secure 5G Initiative

INDUSTRY PARTNERSHIP	EFFECTIVENESS	DEV. IMPACTS	COST	RISK
2 <i>creation of an industry partnership for increasing the export of U.S. 5G technology into emerging markets</i>	High (1.05)	High (1.05)	Moderate (0.3)	Moderate (0.3)



**Effectiveness - High** | This option scores a "High" on effectiveness, leading to an estimated 24% increase in annual exports over and above present trends or an estimated total of \$15 million 5G-related exports in 2022 and a 47% average annual growth rate. Letting present trends continue, the Agency is expected to see an average 19% annual increase in cellular project-related exports. The implementation of an industry partnership in the 5G sphere would increase the Agency's 5G project pipeline with direct and regular communication with industry stakeholders as well as increased programming which helps facilitate project initiations. The estimated additional 24% increase in exports is drawn from the comparable situation when the Agency joined Power Africa in 2013, an industry partnership focused on increasing access to electricity throughout sub-Saharan Africa and led by the U.S. Agency for International Development (USAID). While the Agency leads its own industry partnership in the ICT sphere, which is the strongest proxy for a 5G initiative, data on its export impacts are limited given its recent launch in 2019. Power Africa was chosen as the second closest comparison given the plethora of available data eight years into the initiative. Comparing the average annual export rate for the 5 years before the launch of Power Africa and the average annual export rate for the 5 years following its launch, demonstrated a 24% increase in annual exports, on average. Applying this growth rate to the 5G context and the baseline projected growth rate of 19% results in a new AAGR of 47% with this alternative of an industry partnership and \$15 million in exports in the first year.

**Development Impact - High** | The development impact of this initiative would be high with a projected 8% annual increase in the number of individuals with improved access to digital communication. Similar to effectiveness, the number of projects facilitated through this initiative would be expected to increase considerably leading to an increase in the number of individuals with improved access to digital communication. The projected growth rate in people with access to improved digital communication under a 5G industry partnership can be paralleled with the change in growth rate for the development impact of the Agency's long-standing industry partnership, Power Africa, as measured by the number of people with first-time

access to electricity. Before Power Africa's launch in 2013, 668 million people in sub-Saharan Africa lacked access to electricity or 74% of the population. Over the next 7 years, Power Africa closed that gap by providing 88 million people access to electricity, cutting the lack of access to roughly 52% of the population. Now, over 47% of sub-Saharan Africa has access to electricity, up from the just 26% seven years before, demonstrating an 83% increase in access. Annually, this corresponds with a 12% increase in the number of individuals with access to electricity under the Power Africa industry partnership. According to a 2018 report, USTDA contributed to the provision of 1,422 MW of power or 6.2% of the total wattage of electricity Power Africa has supplied. USAID, as the lead development agency behind Power Africa, has correspondingly supplied over 66% of the MW of electricity under Power Africa. Applying both agencies' share of supplied electricity to Power Africa's overall development impact of an 83% increase in individuals with access to electricity demonstrates just under a 1% annual increase in individuals with access for USTDA and an 8% annual increase for USAID. This result can be used as a proxy for the development outcome of a 5G industry partnership with USTDA as the lead agency. Considering USTDA is over 200 times smaller than USAID by annual appropriations yet its contribution to Power Africa is only 11 times smaller, this analysis will maintain the 8% annual increase in development impact for the lead agency of an industry partnership.

**Cost - Moderate** | An industry partnership ranks "Moderate" on Cost as it is anticipated to raise costs through increased programming with an estimated total cost of \$14,09,926 in 2022 or an 11% annual growth rate. The Agency's launch of Access Africa in 2019 and the subsequent change in ICT programming and associated costs serves as a reasonable proxy for expected changes in programming and costs for a 5G industry partnership. In 2018, the Agency hosted 5 ICT-related activities in sub-Saharan Africa totaling \$2.8 M, or an average of \$567,000 per event. In 2019, after the launch of Access Africa, the Agency saw ICT-related activities nearly double with 8 events totaling roughly \$4.7 M or \$585,000 per event. In 2020, the event count declined – unsurprisingly given the advent of COVID-19 – to 5 events, meanwhile prices increased totaling just under \$3.5 M or an average of \$696,000 per event. While this growth cannot be singularly attributed to the launch of Access Africa, the program *did* spur an increase in ICT programming and this growth can be attributed to it in part. The growth rate in average costs associated with ICT activities was roughly 11% over the three years. In 2020, the Agency spent \$1.27 M on 5G activities alone and only had two of them. Applying this proxy 11% annual growth rate from the Access Africa launch to a 5G industry partnership launch, we would see

\$1.4 M in expenditures over the next year. This is likely a very conservative estimate given the already very high cost of 5G-related activities.

**Risk - Moderate** | The risk of this alternative is moderate to low (for robustness, it has been ranked as moderate in the outcomes matrix, though a low rating is considered in the sensitivity analysis described in the Recommendation section and Appendix E). The implementation risks are moderate as the intended outcome of a 5G industry partnership is to initiate more activities and ultimately projects, which will require sufficient financing and timelines for implementation. The implementation of the partnership itself will also require financing and time, but this risk is minimized as the Agency has a successful framework for creating and maintaining an ICT sector industry partnership through Access Africa, as well as an existing network of industry leaders to contact for involvement. Access Africa provides the Agency with a useful baseline for financing and a timeline for the development and rollout of an industry partnership in this sector. The reputational risks of this outcome are moderate. There is an inherent risk in initiating a partnership that entrusts actors outside of the Agency itself with planning and carrying out Agency activities. More stakeholders contributing to project generation increases the importance of ensuring due diligence standards are met. USTDA already has established rapport with many of these stakeholders, however, from Access Africa and past partnerships, which helps minimize the risk of stakeholder deviation from standards or expectations. The regulatory risks are low. Access Africa offers a precedent for creating an industry partnership in accordance with regulations that USTDA can replicate for this initiative. Further, activities that result from the partnership would remain within the Agency's existing toolkit. Finally, risks from COVID-19 are low. Planning and recruiting membership for this initiative will take a considerable amount of time. Any activities the initiative hosts would, at the very earliest, be at least a year out from now. The impact of COVID-19 by that point should be nominal and virtual or hybrid options - which have proven successful in the past - could be offered.

## Alternative #3 – Project Pipeline Feeding Strategy

PROJECT PIPELINE	EFFECTIVENESS	DEV. IMPACTS	COST	RISK
3 <i>leverage existing contact lists and databases to engage in proactive outreach; 5G-specific project proposal page</i>	Moderate (0.7)	Moderate (0.7)	Low (0.45)	Low (0.45)



**Effectiveness – Moderate** | The effectiveness of this option would be moderate. This option likely would contribute to an increase in potential 5G-related projects and subsequent exports above the status quo, estimated at roughly an additional \$7.25 million in 5G-related exports in the first year or a 62% increase from the status quo. It is difficult to quantify the effect of targeted outreach on ultimate project facilitation; however, a close proxy is looking at Reverse Trade Missions (see Appendix I for description) which the Agency hosts. Between 2012-2017, ICT RTMs contributed approximately \$146.6 million in exports or \$29 million per year. RTMs, however, are the direct meeting of the end participants of projects (U.S. industry representatives and government and industry stakeholders in partner countries) and therefore are more likely to lead to project agreements than USTDA, the middle man, engaging in contact with only one side or the other. This diminished chance of project facilitation from USTDA outreach will be cut to 25% of the average exports from RTMs. The estimated projected increase in exports from targeted outreach is, therefore, \$7.25 million in the first year.

**Development Impact – Moderate** | The development impact of this alternative would be moderate at an estimated 6% increase in the number of people with improved access to digital communication. The increase in 5G-related projects – and resulting development impacts – of this strategy are expected to fall between the status quo and an industry partnership. This option inherently seeks to increase 5G projects over and above the status quo with a more targeted approach to recruiting proposals. At the same time, this internal effort will not achieve the same scope, leverage or visibility for project initiation as an industry partnership. As such, the development impact of this strategy is projected to fall between the 5.5% increase in individuals with improved access to digital communication under the status quo and the 8% increase under an industry partnership. This option is structurally and strategically more comparable to the status quo than an industry partnership, leading the outcome closer to that effect at a 6% expected increase in the number of individuals with improved access to digital communication under a project pipeline.

**Cost - Low** | The cost of this alternative is low. This option requires no additional financial resources, though it would require time and manpower. The creation of a 5G project proposal page is within the current capabilities of the website for no additional fee. Targeted outreach would require manpower, and in turn, potential compensation for overtime unless responsibilities could be sufficiently allocated within current role designations of the 5G team, regional teams and Public Affairs team. Team members are already busy with their current responsibilities and may resist this new load. However, if sufficiently organized and allocated among the teams, the lift could be minimal. This could especially be the case if each team member were expected to conduct outreach to only a handful of their contacts per week (such as five per week). The creation and promotion of the 5G page would be straightforward and require little time, likely receiving considerable support.

**Risk - Low** | The collective risks of this outcome are low. Implementation risks are minimal as financing is achievable with no additional financial cost for outreach or the webpage. The timeline is also flexible and the rate of outreach can be increased or decreased to meet time demands (such as decreased if the team is otherwise engaged or increased if there is a need for activities). The reputational risks are moderate. While any activity which results from this targeted outreach would be subject to standard due diligence practices, this method of sourcing activities relies on somewhat more informal channels (reaching out to past professional contacts and their contacts) and could require more rigorous due diligence into potential grantees. The webpage, however, could contribute to positive effects on the Agency's reputation in publicly demonstrating the Agency's commitment to and prioritization of 5G. While the method of this alternative is a new strategy for sourcing project proposals, the outcome of activities would utilize the Agency's existing tools and therefore be compliant with regulations. Team members would only need to ensure their outreach adheres to protocols. Finally, the impact of COVID-19 is minimal. Outreach, which is conducting online, would not be restricted by the pandemic. Activities that result from this strategy would also occur many months, if not years, in the future, at a time that the pandemic will likely have negligible effects on activities and travel.

## Alternative #4 – Public Information Campaign

PUBLIC INFO CAMPAIGN	EFFECTIVENESS	DEV. IMPACTS	COST	RISK
4 <i>leverage existing contacts &amp; social media to engage in a public information campaign on benefits of U.S. 5G exports</i>	Moderate (0.7)	Moderate (0.7)	Low (0.45)	Low (0.45)



\*The analysis of this option is less certain and concrete given the indirect role of a PR campaign in project facilitation, export realization and development.

**Effectiveness – Moderate** | This alternative earns a moderate level of effectiveness due to the importance of word of mouth in identifying projects while also acknowledging the difficulty of attributing increases in projects and exports to PR. It is difficult to identify how many projects have been facilitated due to public information campaigns and outreach. Therefore, the direct efficacy of this alternative is minimal. However, the Agency currently identifies potential projects largely through project sponsors approaching them. If the Agency were to launch a targeted awareness campaign on the importance of 5G and how USTDA can help both U.S. 5G suppliers and partner countries facilitate infrastructure projects in the 5G space, it may lead to more contact from new project sponsors.

**Development Impact – Moderate** | This option is moderate in development impact due to the indirect relationship between outreach and project facilitation and subsequent development impacts yet the expectation for a marginal increase in activities with this campaign over and above the status quo. It is difficult to accurately project how many projects may result from increased outreach with the Agency's networks and social media following. However, adding a targeted public information campaign to status quo activities – which are already projected to increase exports and development impacts – is expected to only have a positive impact on realized activities and resulting development impact. Therefore, the outcome of this is Moderate as growth in development impacts, even if marginal, is expected.

**Cost – Low** | This option scores a “low” on cost indicating low financial expenditures. This alternative would not require considerable additional funds as this campaign can largely be executed with the existing time and manpower of the Office of Public Affairs. Additionally, the content for an effective campaign would not require the purchase of new media creation tools or platforms and could be executed given design tools the Agency is currently in possession of. While a more advanced

campaign could see the use of additional tools, this potential added cost could be evaluated at a future date, after the implementation of a first-round campaign.

**Risk - Low** | This risk of this alternative is low. In terms of implementation, this option requires little to no additional financing (low-cost in terms of expenditures and manpower) and could be implemented over a timeline that works best for the Agency. The reputational risk is very low with this option contributing significantly to enhancing USTDA's reputation in the 5G space. This initiative would likely positively contribute to the perception of the Agency as it would increase awareness of the Agency's success in the 5G sphere as well as highlight the agency as a thought-leader on the development and export benefits of 5G. In terms of regulatory risks, this alternative imposes few to none as social media engagement is well within the Agency's permissible activities, if following its own social media guidelines. Finally, COVID-19 imposes no risks to the outcomes of this alternative as it would be entirely virtual.

\*Despite weaker efficacy and development impacts, this option is nonetheless a low-cost and highly feasible option that can only help Agency efforts in this space. Increased awareness of 5G opportunities will not decrease project facilitation and exports or development impact and therefore is a worthwhile addendum to any other option that is pursued.

## OUTCOMES MATRIX

This section compares the performance of the outcomes of all four alternatives across the four criteria. As previously indicated, for ease of comparing outcomes, the Low/Moderate/High rankings have been assigned underlying numeric values (1, 2 or 3) where a 1 corresponds with the weakest outcome and a 3 corresponds with the strongest outcome.

	Low	Moderate	High
Effectiveness	1	2	3
Development Impact			
Cost	3	2	1
Risk			

The numeric values of the ranking for each alternative across the criteria (1, 2 or 3 depending on whether the alternative received a Low, Moderate or High) were then multiplied by the weight of each criterion (35% each for Effectiveness and Development Impact, 15% each for Cost and Risk) to achieve the values depicted in the outcomes matrix below.

		EFFECTIVENESS	DEV. IMPACTS	COST	RISK	TOTAL
1	STATUS QUO	Moderate (2*0.35 = 0.7)	Moderate (2*0.35 = 0.7)	Low (3*0.15 = 0.45)	Low (3*0.15 = 0.45)	2.3
2	INDUSTRY PARTNERSHIP	High (3*0.35 = 1.05)	High (3*0.35 = 1.05)	Moderate (2*0.15 = 0.3)	Moderate (2*0.15 = 0.3)	2.7
3	PROJECT PIPELINE	Moderate (2*0.35 = 0.7)	Moderate (2*0.35 = 0.7)	Low (3*0.15 = 0.45)	Low (3*0.15 = 0.45)	2.3
4	PUBLIC INFORMATION CAMPAIGN	Moderate (2*0.35 = 0.7)	Moderate (2*0.35 = 0.7)	Low (3*0.15 = 0.45)	Low (3*0.15 = 0.45)	2.3

## RECOMMENDATION

Ultimately, I recommend pursuing option #2 – creating a 5G industry partnership. This option performed the best on average across the criteria and most notably along the two most significant criteria: effectiveness and development impact. While Option #1, the status quo, would steadily increase 5G activity, this level of activity on its own is insufficient to address the export lag and the other alternatives demonstrate ways to improve on this baseline growth. Option #3, the project pipeline strategy, would be less financially costly and lower risk, namely to reputation, than the industry partnership. These benefits, however, are marginal and do not outweigh the project pipeline's comparatively weaker outcomes in terms of realized exports and development impacts. Option #4, the public information campaign, is the easiest to implement outside of the status quo. While it has an indirect, and likely very marginal, positive relationship with project realization, exports and development, it would increase the attention the Agency receives. This alternative would spur engagement among USTDA's existing networks as well as new audiences on 5G and other issues. Considering its low-risk and low-cost nature, this alternative is worth considering as an addendum to the recommended industry partnership. Ultimately, option #2, the industry partnership, has the most direct projected impact on increasing 5G activities,

projects and exports and corresponding development impacts. While this option is the costliest, costs are associated with increased 5G programming which corresponds with enhancing project facilitation and, in turn, increased exports and development impacts. Additionally, the large increases in funds directed to the ICT sector in recent years and the recognition of 5G as a critical sector will offset the financial burden. Risk would be moderate as it would extend responsibility outside of the Agency directly, requiring trust and commitment from external partners. However, USTDA has a strong precedent for industry partnerships with the success of both Power Africa and Access Africa and established rapport with many prospective partners. The other options should be considered as future or additional courses of action; yet, the industry partnership is the strongest alternative to pursue in the immediate term to enhance USTDA's presence and effectiveness in facilitating U.S. 5G exports into emerging markets.

### Sensitivity Analysis

To verify the robustness of the outcome and recommendation, I conducted three sensitivity analyses, modifying the ranking of options based on reasonable justifications for change or uncertainty (Appendix X). These included weighing the effectiveness of Option #1: Status Quo as High to arguably more sufficiently recognize the current continual and increasing growth of 5G activities. This modification would decrease the gap with the recommendation, Option #2: 5G Industry Partnership, but it Option #2 still proves to be the strongest across the board. The same result was seen in adjusting Option #3: Project Pipeline to have High effectiveness as well. A third sensitivity analysis lowered the Risk of Option #2 from Moderate to Low, giving more weight to the strong and successful precedent set by Access Africa and Power Africa to lower the risk in launching a new initiative. Unsurprisingly, this served to improve the strength of Option #2 even more. Altogether, the sensitivity analyses justified the recommended alternative of Option #2: a 5G industry partnership.

# IMPLEMENTATION

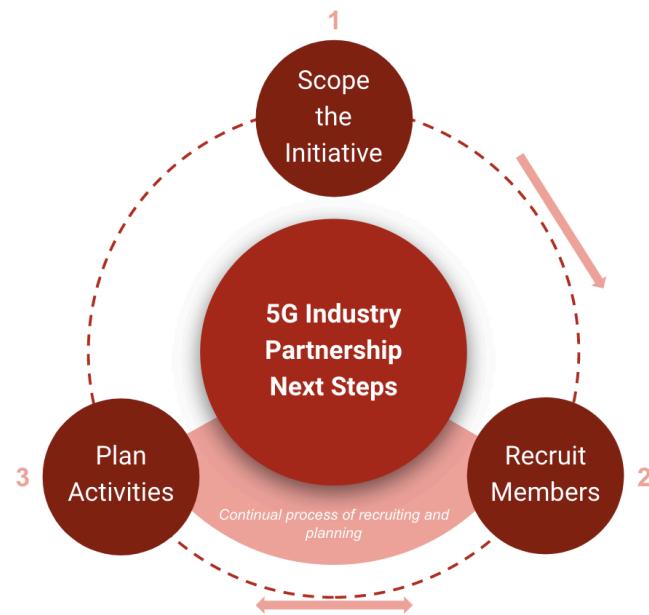
## Challenges to Implementation

Some issues this option faces in terms of implementation include ensuring buy-in from relevant stakeholders and reaching out to a variety of stakeholders, especially during the initial buildup. Additionally, the timeline for implementation and next steps will need to be rigorously adhered to, particularly the first step of scoping the initiative. The following steps of recruitment and planning will need to maintain a flexible structure, allowing recruitment to be constant alongside planning. Finally, there are challenges to ensuring minimal risk. Engaging with new partners outside of the direct control of the Agency presents a multitude of reputational and due diligence challenges the Agency will have to be prepared to face and mitigate.

## Stakeholders

The stakeholders involved in moving this recommendation forward include the 5G team within USTDA as well as regional teams and partners in the interagency, U.S. ICT firms and local stakeholders in the region or nation of focus. While my client, the 5G subsector team, will take the largest lift in moving this alternative forward, it also requires buy-in from the regional teams in first scoping the initiative (explained in more detail in the following section) and, once it is narrowed, working with that specific team to leverage their local network in the region. These internal stakeholders will be easy to gain support from as they are aware of the significance of 5G and the massive potential for realizing U.S. exports and development benefits in emerging partner countries. Beyond USTDA, the most critical stakeholders are the U.S. industry leaders, followed by the U.S. Government peer agencies. USTDA has already worked on projects with several leading U.S. firms in the 5G space, a handful of which are already members of the existing ICT industry partnership, Access Africa. These firms that have worked with USTDA are likely to be willing to get involved in this initiative as well. With an established relationship that has demonstrated to be results-driven and successful in the past, these entities likely would not shy away from the opportunity to engage with USTDA in such a critical field. If there is hesitation from partners already involved in Access Africa and who see the initiatives as overlapping, the distinct nature of this initiative can be emphasized in addition to the pressing nature of 5G and massive associated business opportunities. Additional stakeholders include other U.S. 5G firms that USTDA has not engaged with and stakeholders in partner countries. If other firms the Agency has a pre-existing relationship with sign on, this may help in recruiting new members, in addition to the

nature of the partnership in helping firms leverage their abilities in the 5G sector in new markets. Local stakeholders may be hesitant at first if they have not worked with USTDA in the past but success from Access Africa as well as the revolutionary potential of 5G can be utilized to encourage participation. USTDA can leverage its relationship and parallel mission with peer government entities, such as the U.S. Chamber of Commerce or U.S. Export-Import Bank, for involvement.



### Steps for Moving Forward

The first step moving forward with this alternative is scoping the initiative (graphic above). Scoping the initiative refers to determining whether this should be implemented on a national, regional or multi-regional scale. For instance, USTDA's existing ICT industry partnership, Access Africa, is a regional initiative focusing on partnering with stakeholders to engage in activities and projects in sub-Saharan Africa. Scoping will require identifying both markets that are viable for the creation of such a partnership – such as markets with a robust enough ICT sector – as well as where there is the strongest need and potential for success. The regions to investigate the viability of include: the Indo-Pacific, sub-Saharan Africa, the Middle East, North Africa, Europe and Eurasia; or Latin America and the Caribbean. Once the region or market has been selected, the second step is to reach out to relevant stakeholders, both government entities and business partners. This outreach should occur simultaneously and begin with firms the Agency already has an established relationship with, such as IBM, Intel, Qualcomm and Microsoft in addition to partners in the interagency. Outreach to established connections should be followed with outreach to additional relevant firms as well as stakeholders in the region of focus to

build local support for the initiative. Once a solid membership is created, the next step will be to establish standing communication and meetings between representatives of the members to plan activities and share knowledge of potential projects or initiatives. The group should set a timeline to host its first activity within one year of the initiative's creation.

## Potential Risks

Potential risks associated with the implementation of this alternative include legal risks, reputational risks and due diligence risks. The largest legal risk to be mindful of is ensuring the terms of the partnership in no way imply the creation of a Federal Advisory Committee as regulated by the Federal Advisory Committee Act (DOI). The creation of an Advisory Committee is outside the necessity of this initiative and all partners should be aware of this intention upon recruitment (GSA). The protocol and organizational structure of Access Africa can be referred to for ensuring this distinction. A second risk is associated with the reality that this initiative closely engages stakeholders from outside of the Agency in carrying out activities and achieving Agency goals. The Agency takes on reputational risk in maintaining a public, working relationship with these entities and needs to ensure they can be trusted. If one of the firms comes under scrutiny for issues outside of the initiative, the Agency will need to ensure it is not harmed due to associated with that firm. Relatedly, projects that result from the activities the partnership hosts – the ultimate goal – must be assured to pass all relevant due diligence considerations. The Agency can minimize these risks by conducting a thorough review of entities before inviting them into the initiative as well as conducting its standard, high-level due diligence for any project it helps facilitate.

Implementing a 5G-focused industry partnership will require considerable stakeholder engagement, time, brainstorming and risk analysis. While there are challenges associated with each of these components, USTDA is equipped to overcome them with planning and mitigation efforts – including thorough research on partners prior to official engagement, thoughtful scoping of the initiative and using Access Africa as a guiding model.

## CONCLUSION

5G cellular network technology presents a remarkable new frontier for global communications, industries, economies and societies. The opportunities are near limitless as 5G marks a critical turning point in the (r)evolution of technology and promises to create millions of jobs, contribute trillions to global GDP and further connect our increasingly interconnected world.

The opportunities 5G presents give even more gravity to the risk of not seizing those openings and contributing to the proliferation of 5G technology around the world. In few regions is this more essential than in emerging markets. The United States, while being a leading producer of many 5G network components, is not leading in leveraging its competitive edge to export 5G technology into these critical markets. This presents an opportunity, however, for the U.S. Trade and Development Agency to utilize its unique mission to strategically link U.S. ICT equipment suppliers with 5G infrastructure projects in emerging markets. The Agency is positioned to both facilitate the increased export of U.S. 5G technology into emerging markets as well as contribute to vital economic development in receiving nations.

After proposing four potential alternatives for USTDA to pursue and evaluating each by their effectiveness (impact on 5G exports), development impact, cost and risk to the Agency, the creation of a 5G industry partnership is recommended.

Supplementary documents to this report contribute to the first step in scoping the initiative and determining the most viable markets. The Agency should simultaneously begin outreach to partners in the inter-agency and ICT private sector. Once a critical mass of membership is achieved, activities can be planned.

Altogether, 5G is a priority sector for international trade, development and value creation. As this report highlights, there is a unique and critical role for USTDA in this space and, equipped with strategies such as the ones included herein, USTDA can continue to make a meaningful impact on both American jobs and exports and infrastructure development around the world.

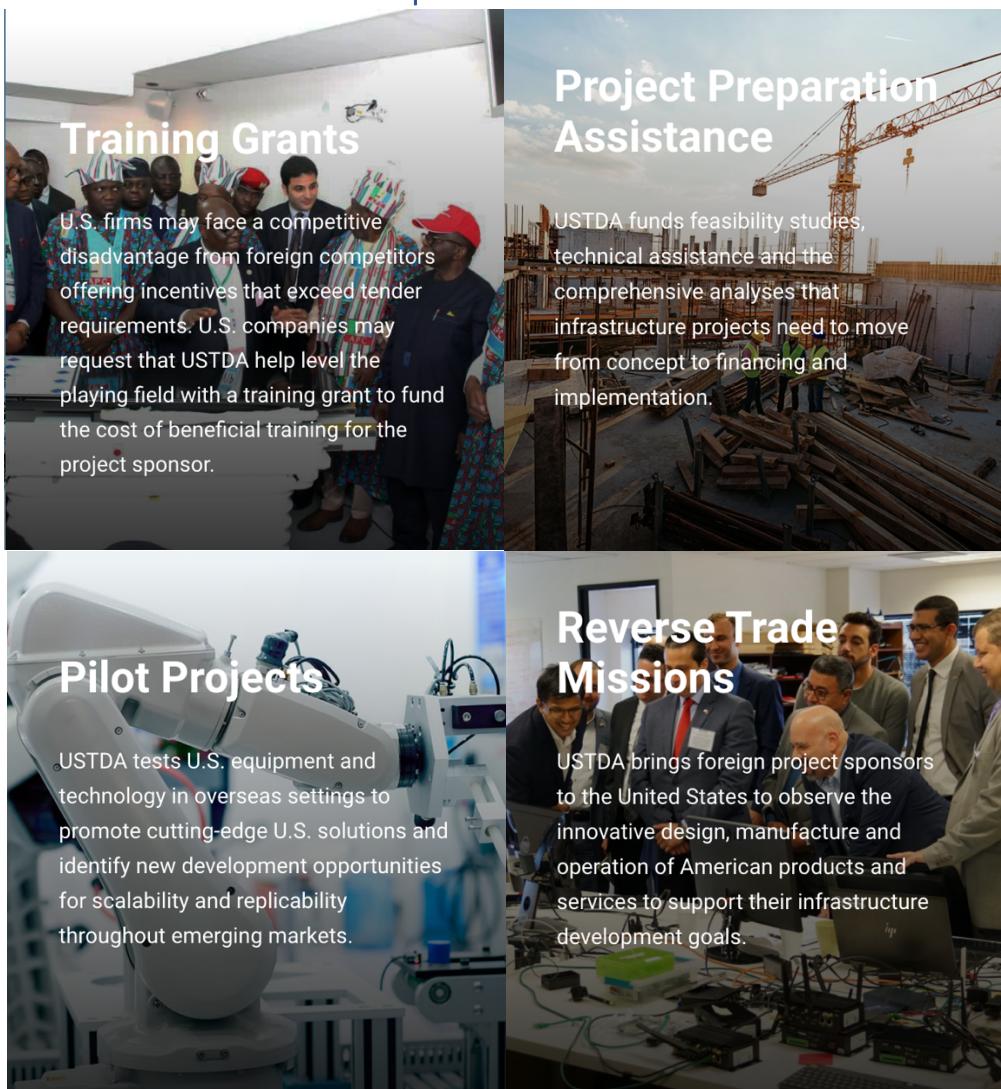
## APPENDICES

### Appendix A – Developing and Middle-Income Countries: Definition

The world's Middle Income Countries (MICs) are a diverse group by size, population, and income level. They are defined as lower middle-income economies - those with a GNI per capita between \$1,036 and \$4,045; and upper middle-income economies - those with a GNI per capita between \$4,046 and \$12,535 (2021). Middle income countries are home to 75% of the world's population and 62% of the world's poor. At the same time, MICs represent about one third of global GDP and are major engines of global growth.

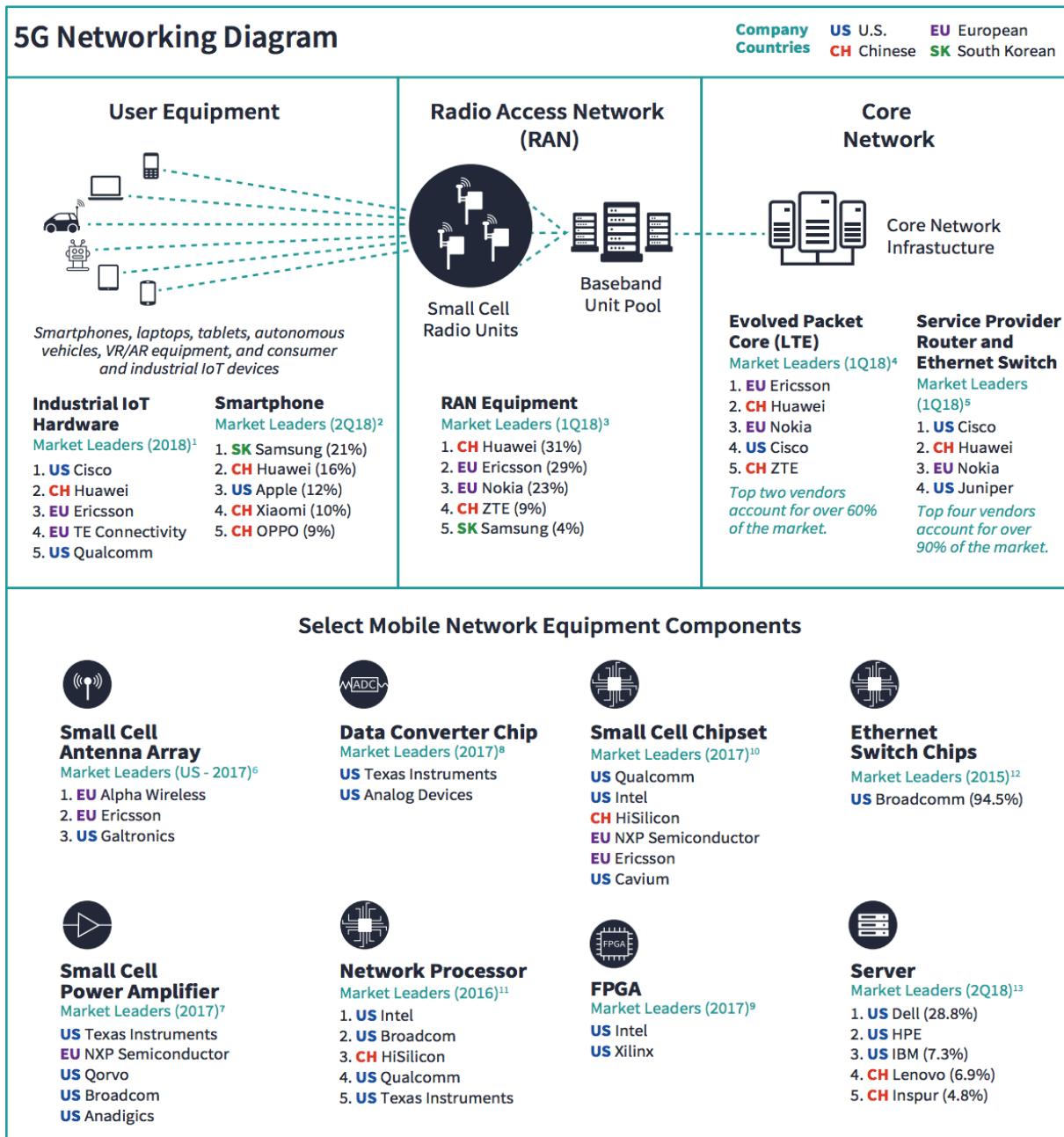
**Source:** The World Bank, <https://www.worldbank.org/en/country/mic/overview>

### Appendix B – USTDA Tools with Descriptions



**Source:** USTDA, <https://ustda.gov/about/>

## Appendix C – 5G Market Breakdown



**Source:** Lewis, J. A. (2018, December 6). *How 5G Will Shape Innovation and Security*. Center for Strategic and International Studies. <https://www.csis.org/analysis/how-5g-will-shape-innovation-and-security>.

## Appendix D – Map of Huawei 5G and ICT Projects



**Source:** ASPI International Policy Centre, <https://chinatechmap.aspi.org.au/#/map/>

## Appendix E – Sensitivity Analyses

	EFFECTIVENESS	DEV. IMPACTS	COST	RISK	TOTAL
<b>1 STATUS QUO</b>	High (3*0.35 = 1.05)	Moderate (2*0.35 = 0.7)	Low (3*0.15 = 0.45)	Low (3*0.15 = 0.45)	<b>2.65</b>
<b>2 INDUSTRY PARTNERSHIP</b>	<b>High</b> (3*0.35 = 1.05)	<b>High</b> (3*0.35 = 1.05)	<b>Moderate</b> (2*0.15 = 0.3)	<b>Moderate</b> (2*0.15 = 0.3)	<b>2.7</b>
<b>3 PROJECT PIPELINE</b>	Moderate (2*0.35 = 0.7)	Moderate (2*0.35 = 0.7)	Low (3*0.15 = 0.45)	Low (3*0.15 = 0.45)	<b>2.3</b>
<b>4 PUBLIC INFORMATION CAMPAIGN</b>	Moderate (2*0.35 = 0.7)	Moderate (2*0.35 = 0.7)	Low (3*0.15 = 0.45)	Low (3*0.15 = 0.45)	<b>2.3</b>

Analysis #1: Raising Status Quo Effectiveness to "High"

		EFFECTIVENESS	DEV. IMPACTS	COST	RISK	TOTAL
1	STATUS QUO	Moderate (2*0.35 = 0.7)	Moderate (2*0.35 = 0.7)	Low (3*0.15 = 0.45)	Low (3*0.15 = 0.45)	2.3
2	INDUSTRY PARTNERSHIP	High (3*0.35 = 1.05)	High (3*0.35 = 1.05)	Moderate (2*0.15 = 0.3)	Moderate (2*0.15 = 0.3)	2.7
3	PROJECT PIPELINE	High (3*0.35 = 1.05)	Moderate (2*0.35 = 0.7)	Low (3*0.15 = 0.45)	Low (3*0.15 = 0.45)	2.65
4	PUBLIC INFORMATION CAMPAIGN	Moderate (2*0.35 = 0.7)	Moderate (2*0.35 = 0.7)	Low (3*0.15 = 0.45)	Low (3*0.15 = 0.45)	2.3

Analysis #2: Raising Project Pipeline Effectiveness to "High "

		EFFECTIVENESS	DEV. IMPACTS	COST	RISK	TOTAL
1	STATUS QUO	Moderate (2*0.35 = 0.7)	Moderate (2*0.35 = 0.7)	Low (3*0.15 = 0.45)	Low (3*0.15 = 0.45)	2.3
2	INDUSTRY PARTNERSHIP	High (3*0.35 = 1.05)	High (3*0.35 = 1.05)	Moderate (2*0.15 = 0.3)	Low (3*0.15 = 0.45)	2.85
3	PROJECT PIPELINE	Moderate (2*0.35 = 0.7)	Moderate (2*0.35 = 0.7)	Low (3*0.15 = 0.45)	Low (3*0.15 = 0.45)	2.3
4	PUBLIC INFORMATION CAMPAIGN	Moderate (2*0.35 = 0.7)	Moderate (2*0.35 = 0.7)	Low (3*0.15 = 0.45)	Low (3*0.15 = 0.45)	2.3

Analysis #3: Lowering Industry Partnership Risk to "Low"

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