

THE FIGHT FOR 5G: COMPETING WITH CHINA FOR 5G EXPORTS IN THE MIDDLE EAST AND NORTH AFRICA

Prepared for International Trade Administration

Prepared by Gary Christensen



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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 judgements and conclusions are solely those of the author, and are not necessarily endorsed by the Batten School, University of Virginia, or by the International Trade Administration.

Honor Statement

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

A handwritten signature in black ink, appearing to be 'Cory Robinson', written in a cursive style.

Key Acronyms

| | |
|-------|---|
| 3GPP | 3rd Generation Partnership Project |
| BRI | Belt and Road Initiative |
| CCP | Chinese Communist Party |
| CTIA | Cellular Telecommunications and Internet Association |
| DCF | Development Finance Corporation |
| DSR | Digital Silk Road |
| EXIM | US Export Import Bank |
| FCC | Federal Communications Commission |
| GSMA | Global System for Mobile Communications |
| ICT | Information and Communications Technology |
| ITA | International Trade Administration |
| ITU | International Telecommunications Union |
| MENA | Middle East and North Africa |
| NIST | National Institute of Standards and Technology |
| NSF | National Science Foundation |
| O-RAN | Open Radio Access Network |
| PRC | People's Republic of China |
| SDO | Standard Development Organization |
| SEP | Standard Essential Patent |
| TANC | The Office of Trade Agreements Negotiation and Compliance |
| USTR | The Office of the United States Trade Representative |



INTERNATIONAL TRADE ADMINISTRATION

Client Overview

The International Trade Administration sits within the Commerce Department.

Mission Statement: Foster economic growth and prosperity by increasing non-agricultural exports of US goods and services, strengthening the international competitiveness of US industry, promoting trade and investment, and ensuring fair trade and compliance with trade laws and agreements.

April 7, 2023

International Trade Administration

Herbert C. Hoover Building, 1401 Constitution Ave. NW, Washington, DC 20230

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Executive Summary

In this new era of great power competition, the fight for 5G has become a heated proxy battle between the US and China. The Middle East and North Africa (MENA) is now the front lines of the war for digital dominance between the United States and its allies and the People's Republic of China (PRC) because of its projected digital sector growth, and its strategic importance in geopolitics. This is China's Digital Silk Road strategic goal to increase global influence through technology investments and economic partnerships has taken hold in MENA by offering an array of affordable 5G options. As the US aims to promote an open, interoperable, reliable, secure internet and boost the economic benefits to US telecommunications firms, immediate actions are required.

Issue: US telecommunications companies are failing to adequately compete with Chinese firms for 5G exports in the Middle East and North Africa. The current global leaders in deploying 5G equipment are China's Huawei and ZTE, followed by Europe's Ericsson and Nokia. Huawei leads the world in 5G network equipment sales with about 26 percent of global sales, almost equal to its two biggest competitors, Ericsson and Nokia combined. In 2009, the top ten internet companies by revenue were American; by 2018, four of the top ten were Chinese (Medin & Gilman, 2019). Huawei 5G technology is used and tested in more countries than any other provider, with operations in 68 countries. In addition, Chinese firms collectively lead in 5G-related patents, standard development leadership roles, and technical contributions over every other country. Huawei also spends more on 5G research and development than any other provider globally.

The GSM Association, which represents the interests of mobile network operators worldwide, estimates that MENA 5G subscriptions will reach 270 million by 2027. Samsung and Apple have 36 percent and 7 percent market share in MENA, respectively. Chinese smartphone producers Huawei, OPPO, and Xiaomi combine for 28 percent of the MENA market share. For non-phone related 5G, Huawei owns about 70 percent of the data center and 5G fixed wireless access equipment in MENA (GSMA, 2022). If the status continues, US firms will lose the 5G race resulting in negative economic, geopolitical, and national security implications for the United States and its allies in the MENA region and globally.

Approach: This report investigates how Chinese telecommunication companies such as Huawei have gained substantial competitive advantages over US and European firms in the field of 5G and provides policy options to the International Trade Administration and broader US Government to boost the 5G export competitiveness of US firms. The following research highlights three policy-driven advantages for Chinese companies: influence in technical standard development organizations, robust subsidies for 5G research and development, and low-cost financing and credit lines for Chinese 5G vendors and their customers.

Four policy alternatives for ITA and the broader United States Government are analyzed:

- 1) Establish standard development organization workshops and training resources.
- 2) Provide grants or tax credits to cover the costs of participating in standard development organizations.
- 3) Establish digital economy agreements with MENA states.
- 4) Provide R&D grants and low-cost financing to US 5G vendors and their customers.

Each alternative is evaluated using four criteria: (1) estimated cost, (2) administrative and political feasibility, (3) sustainability, and (4) effectiveness. Effectiveness is measured by an alternative's anticipated impacts on 5G-related export revenue to US firms.

Key Findings and Recommendation: The final recommendation is for alternative four: provide R&D grants and low-cost financing to US 5G vendors and their customers. A large body of literature provides strong evidence that “national and state-level R&D financial support through direct subsidies or tax support positively effects firms’ R&D spending and exports” (Rao, 2016). A meta-analysis of research on R&D by the Information Technology Information Foundation found that “every dollar of federal R&D spurs an additional 30 cents in business R&D” (Wu, 2018). The same study found that “when firms increase R&D investment by 1 percent, their productivity increases by 0.05 to 0.25 percent, translating to a 20 to 30 percent return on investment” (Wu, 2018). A company's return on assets at the firm level is positively affected by developing standard essential patents (Blind et al., 2015). Strong patent positions also “increase the strategic complementarity between a firm’s R&D investment and its participation in standards development” (Baron et al., 2019). Disclosing patents to standard development organizations has positively affects companies' market value (Hussinger & Schwiebacher, 2015). Although this option is the costliest, it has the strongest direct impact on export revenue and investment in future technology, essential for remaining competitive in the coming decades.

Establishing a Digital Economy Agreement (alternative three) would also be effective long-term. Digital Economy Agreements, on average, increase export growth by 3.8 percentage points. In addition, they increase the output of the ICT sector by an average of 6.8 percent. Furthermore, agreements that “aim to improve the interoperability of digital systems between countries also increase inter-regional trade by an average of 7.27 percent” (Yang & Zheng, 2022). However, given its low political feasibility, this option becomes less achievable in three to five years and therefore is not the priority recommendation.

Introduction

The international political system is gradually entering a phase of power transition. The United States seeks to remain the global hegemon, and China seeks to establish an alternative international system to strengthen its structural power. Internet connectivity is fast becoming the field for non-violent competition, making the study of the global governance of digitalization critical to understanding the new global bipolarity (Degterev et al., 2021).

The Digital Silk Road (DSR) is the technological arm of China's broader Belt and Road Initiative (BRI) - the ambitious plan to "develop an expanded, interdependent market for China, grow China's economic and political power, and build a highly technological society" (Jie & Wallace, 2021). American strategic experts generally agree that the DSR "poses a major challenge to the economic, diplomatic, and security interests of the United States" (Minghao, 2020). Chinese enterprises are strengthening their commercial and technological advantages and threatening American economic interests and technological leadership. With China positioning itself at the heart of the international information technology ecosystem, it will be able to promote its ideas and the design of the digital economy and cyberspace governance, further challenge the United States in terms of international rules and norms, and serve as a vector for Beijing's global economic and political influence (Degterev et al., 2021).

The race to dominate the global 5G wireless communication field is among the top priorities for both the US and China. The telecommunications firms that win the race to deploy 5G will reap immense economic benefits from equipment sales, patent royalties, and service revenue. Capturing a significant 5G market share also provides the dominant firms with increased economic and political influence both within the region they operate and within international governing bodies. This is especially pertinent for the Middle East and North Africa (MENA), where China has focused much of its economic diplomacy. This technical report addresses the following problem statement: **US telecommunications companies are failing to adequately compete with Chinese firms for 5G exports in the Middle East and North Africa.**

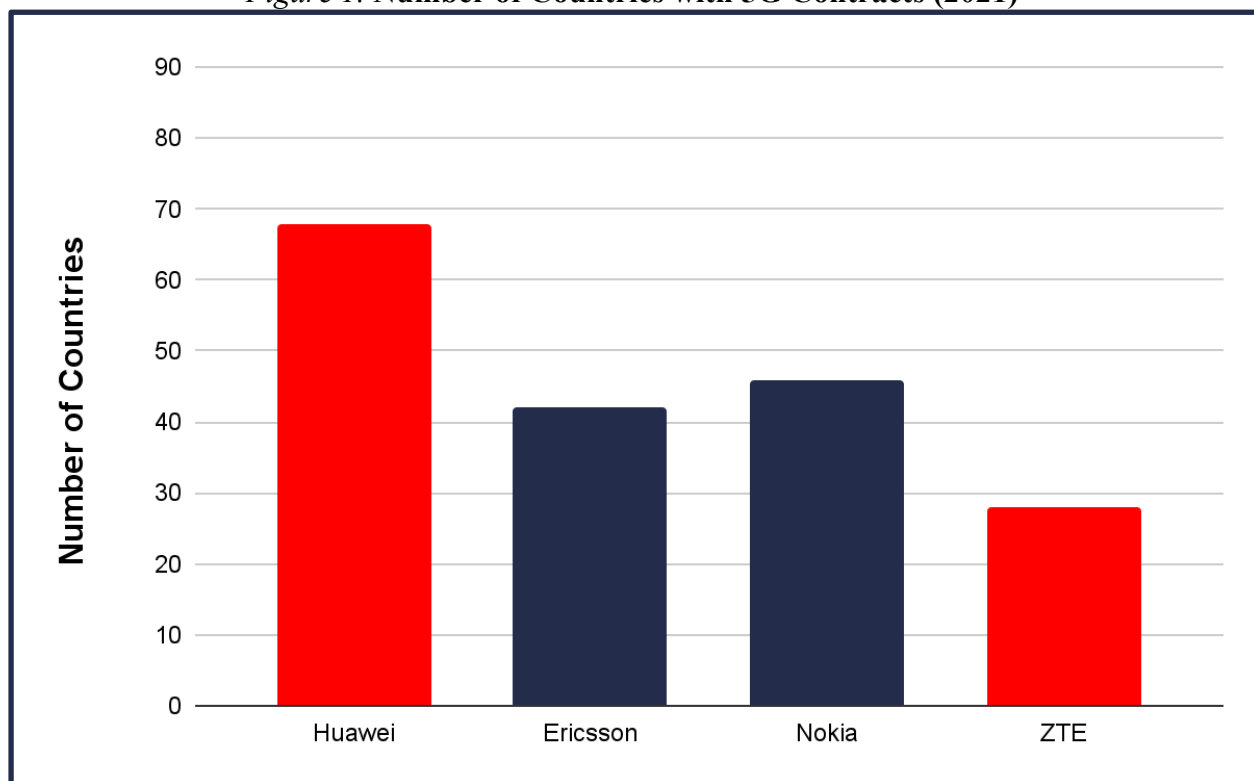
Background

5G is "ultra-fast, has low latency, uses less power, and is up to 20 times faster than 4G. It can handle vast volumes of data, which allows cloud and edge computing applications to process more data faster" (Butcher, 2022). As a result, the 5G network will positively impact industries such as cloud services, mobile payments, social media applications, and energy use optimization.

Over the past decade, heavy state-backed financing under the DSR label has turned China into a global competitor in vital digital industries such as e-commerce, fintech, online payments, and cloud computing (Chaziza, 2022). The DSR aims to ensure that leading Chinese platforms Alibaba, Tencent, and Baidu, along with the telecom carriers Huawei, ZTE, China Mobile, and China Telecom, utilize DSR-labeled projects to out-compete with Western firms in emerging markets such as MENA. The current global leaders in deploying 5G equipment are China's Huawei and ZTE, followed by Europe's Ericsson and Nokia. Huawei leads the world in 5G network equipment sales with about 26 percent of global sales, about equal to its two biggest competitors combined, Ericsson and Nokia. Despite limited sales in the US market from 2009 to

2018, Huawei grew global revenues from approximately \$28 billion to \$107 billion. In the same period, Ericsson's global revenue fell from \$27.9 billion to \$23.9 billion, while Nokia's revenue fell from \$57.6B to \$26.6 billion. In 2009, the top ten internet companies by revenue were American; by 2018, four of the top ten were Chinese (Medin & Gilman, 2019). Figures 1 and 2 illustrate Huawei's dominance globally. Its 5G operates in 68 countries, while ZTE is in 28. Ericsson and Nokia serve 42 and 46 countries, respectively (Congressional Research Service, 2021).

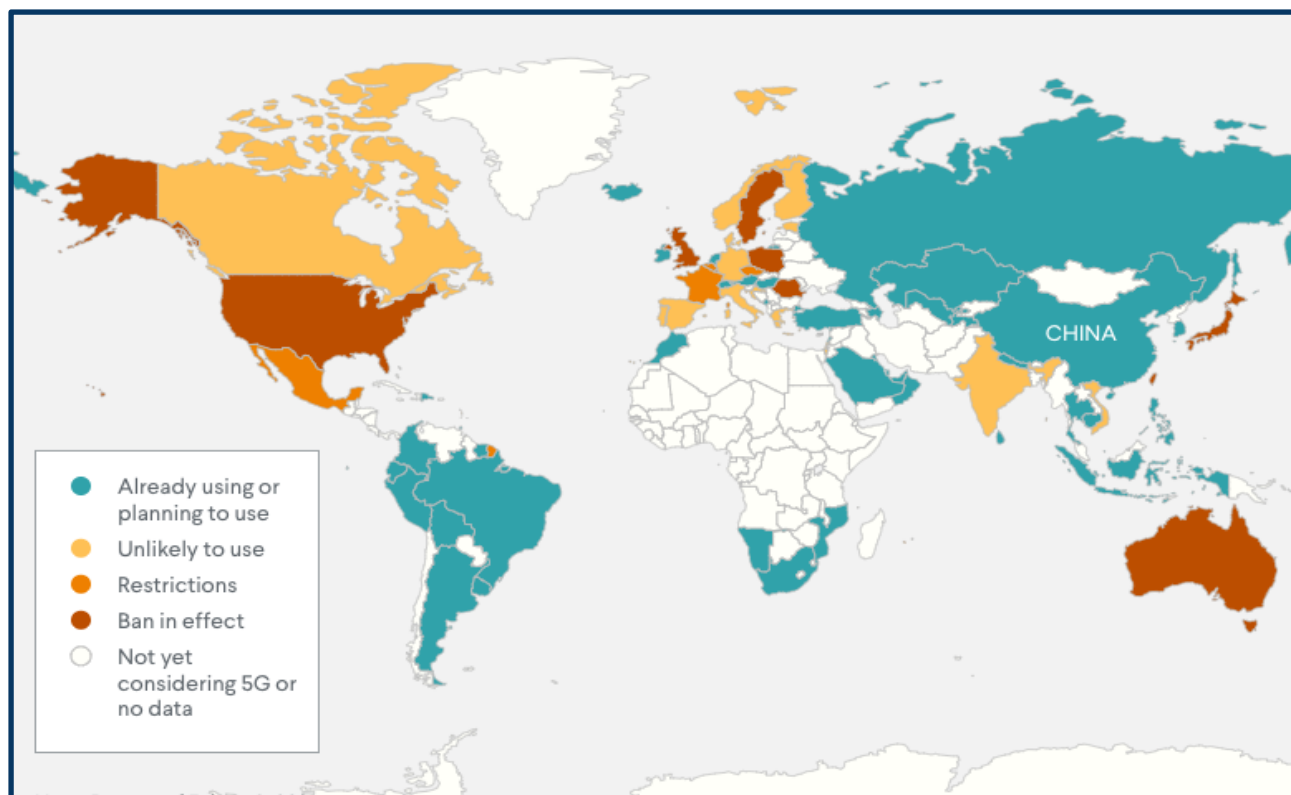
Figure 1. Number of Countries with 5G Contracts (2021)



(Congressional Research Service, 2021)

China has been particularly successful in offering low-cost telecommunications capabilities to developing countries that are eager to modernize their economies to serve a growing middle class. For instance, Huawei built “over 70 percent of Africa’s 4G infrastructure and is currently leading 5G distribution” on the continent (Hart & Link, 2020). Huawei is the “world's largest producer of telecommunications equipment and the second-largest producer of smartphones” (Inkster, 2019).

Figure 2. Who is Using Huawei Equipment in 5G Networks (2021)



Source: Council on Foreign Relations (Sacks, 2021)

US companies are not yet substantially involved in the race to deploy “end-to-end” 5G networks globally. However, US firms such as Qualcomm, Cisco, and Intel are heavily involved in 5G chipset development which goes into smartphones and other wireless devices. These firms participate in standards development and collect royalties from patents in other vendors' smartphones internationally. Tech companies such as Apple, Google, Amazon, and others have a substantial global presence and are heavily affected by Chinese influence over technology infrastructure and standards. Government permission is mandatory for the establishment of the 5G network. The announcement of bids results in fierce competition among vendors. Established vendors enjoy the advantage of economies of scale, making it difficult for new players to enter the market (Technavio, 2022).

5G in the Middle East and North Africa

MENA is responsible for most of the global oil exports and houses two of the world's most critical shipping chokepoints. About 12 percent of all global trade passes through the Suez Canal annually. About 20 million barrels, or one-sixth of all oil trade, pass through the Strait of Hormuz daily. Additionally, the region is home to nearly 40 US military bases, which are critical for power projection and in securing shipping lanes. After a 20-year military campaign in the region, recent tensions over oil production, human rights violations, and the assassination of US journalist Jamal Khashoggi by Saudi Arabia, relations between the US and many MENA states are near a historical low point. Meanwhile, China has been actively courting MENA states such as Saudi Arabia through foreign direct investment and increased physical and digital goods trade.

MENA is a diverse region regarding mobile market maturity, internet adoption, and 5G timelines. The wealthier Gulf Cooperation Council (GCC) States hope to be global leaders in 5G deployments and began leading the region in 5G commercialization in 2019.

Following suite, another fifteen MENA countries plan to launch 5G mobile services by 2025. Several MENA operators have announced collaboration on developing industry standards in the 3GPP SDO and agreements with vendors such as Huawei, ZTE, Ericsson, Nokia, and Samsung develop 5G capabilities. In the 2022 GSMA Mobile Economy report, GSMA estimates 5G technology will account for 17 percent of the total technology mix by 2025 in the Middle East and North Africa (GSMA, 2022). MENA has 24 million 5G subscriptions and is expected to reach 270 million by 2027. Samsung and Apple, using Qualcomm's patented 5G technology in their smartphones, have 36 percent and 7 percent market shares in MENA, respectively. Chinese smartphone producers Huawei, OPPO, and Xiaomi combined account for 28 percent of the MENA market share. For non-phone related 5G, Huawei owns about 70 percent of the data center and 5G fixed wireless access equipment in MENA (GSMA, 2022).

Huawei continues to deepen ties within the region. In 2022, Huawei announced that it had signed an agreement with Zain KSA to accelerate the rollout of 5G in Saudi Arabia. The Saudi telecoms firm will deploy Huawei products in its national network to increase 5G capacity and coverage. Huawei will also open its second Middle Eastern data center in Saudi Arabia. Huawei has secured key 5G contracts in the United Arab Emirates (UAE) and Qatar as well. The UAE airline Emirates and Huawei established a strategic partnership in early 2020 and recently signed an agreement to expand collaboration. In addition, Flat6Labs, a MENA-focused venture capital firm, recently signed a deal with Huawei to launch a 5G program in Egypt geared to provide low-cost 5G to Egyptian startups.

"Faced with the choice between having vulnerable systems or expensive systems, most developing countries will choose the former."

- Jonathan Hillman, CSIS

Economic Impacts

Firms that develop 5G technology that meet the globally adopted standards will reap enormous economic value. The more Chinese firms control the global market, the more they are able to set standards and develop the next generation of technologies to match (Hillman, 2019). Huawei, and by extension, the CCP, can push standards that encourage the adoption of China-made technologies, further locking US firms out of new markets.

As Qualcomm did for 2G-4G technology, companies owning the 5G standard essential patents will have substantial economic gains from royalties charged for smartphones and wireless infrastructure (Voo, 2021). It is estimated that global 5G wireless infrastructure revenue in 2021 was \$36.5 billion and will reach \$81.1 billion by 2027. Royalties from standard essential patents in 2020 was estimated to be about \$20 billion, much of which benefitted US firms as it was still 3G and 4G related (Pohlman, 2021). Market researchers anticipate a "substantial increase in the annual growth rate of royalty income over the next decade due to the broad implementation of 5G-

enabled services such as big data, the Internet of Things (IoT), fiber-optic cable, cloud computing, e-commerce, digital finance, and autonomous vehicles” (Voo, 2021). The MENA market will be one of the fastest-growing opportunities for 5G revenue. The wealthier Gulf States are heavily investing in 5G-enabled services such as AI and smart cities as they digitize their economies.

As the world shifts away from legacy systems to 5G and given the number of 5G patents owned and standards contributed, revenue from patent royalties will continue to shift in Huawei’s favor. Reliance on Chinese technology to access and scale these additional services will hinder American business interests beyond just the telecom industry (Bruer & Brake, 2021). Exports from American companies support well-paying jobs, growth, and investments in research and development. The US does not have a domestic market of China’s size to fall back on. US workers and companies can benefit by succeeding in foreign markets, or China and other countries will (Hillman, 2019).

Political Impacts

Beyond just the negative economic impact for US firms, Washington fears that Huawei’s growth poses national security threats. A 2022 FBI investigation found that “Huawei’s 5G infrastructure could contain backdoors that allow Beijing access to attack communications networks and public utilities, and disrupt US military communications, including those used for US nuclear arsenals” (Berman et al., 2023). The US intelligence community has stated that Beijing could use intentionally vague Chinese intelligence laws to pull user data from Huawei, thereby using the company as a tool for espionage (Berman et al., 2023).

More broadly, the US fears Beijing could advance its geopolitical and geoeconomic interests by leveraging its dominant position in global 5G infrastructure and standards to construct a China-centered tech ecosystem. In addition to weakening US influence globally, this “could lead to further fragmentation of the internet, allowing state operators to erect firewalls and hurting the prospects for future technological innovations while undermining the civil rights of citizens” (Voo, 2021). The competition of between the US and China for digital dominance could ultimately alter the balance of power by dividing the world between two rival geo-tech camps (Voo, 2021). Moreover, given the importance the Middle East states have in the global power competition and that MENA states house nearly 40 US military bases, which are critical for power projection and securing shipping lanes, Huawei’s domination in the region poses acute security concerns for military communications and economic influence.

US Reactions

In 2018, the Trump administration added Huawei, ZTE, and other Chinese high-tech enterprises that have participated in the Digital Silk Road to the Entity List, tightened export controls over China, and restricted business contacts of American companies with China (Inkster, 2019). The Pentagon also banned all Huawei and ZTE phones on US military bases in the same year (Woo & Lubold, 2018). These actions justified on the grounds that these telecommunications companies pose security threats by collecting vast amounts of user information and imposing censorship on political content posted by users (Hosain, 2019). In the Biden administration, the United States is lobbying its allies to restrict market access by major Chinese telecommunications enterprises. In August 2020, then Secretary of State Mike Pompeo announced the implementation of the Clean Network Initiative to “limit the activities of Chinese companies in ICT services, installation of

Chinese software applications, storage and processing of cloud data, and building fiber optic cable systems” (Degterev et al., 2021). Joining the initiative means a country “commits to reducing the presence of Chinese telecommunications companies in their markets and rejects Chinese 5G technologies” (Degterev et al., 2021). As of 2021, 53 primarily Western European states have joined the program, and no MENA region states have joined (Department of State, 2021).

Responses to these actions have been mixed. In 2019, Huawei was developing 5G networks in Greece. However, after joining the program in September 2020, Greece opted for Ericsson instead (Department of State, 2021). Similar outcomes took place with many Western European states that have joined the program, which helps Ericsson and Nokia in the European 5G market but does little to impact their competitiveness in MENA. Results in developing countries have been less favorable. Some feel that evidence does not support the "security threat" warning raised by the United States (Minghao, 2020). They also believe Chinese enterprises have advantages in technology and pricing, and the US has failed to provide a good alternative. Even if security threats are validated, China expert Jonathan Hillman of the Center for Strategic & International Studies notes: "Faced with the choice between having vulnerable systems or expensive systems, most developing countries will choose the former" (Hillman, 2019).

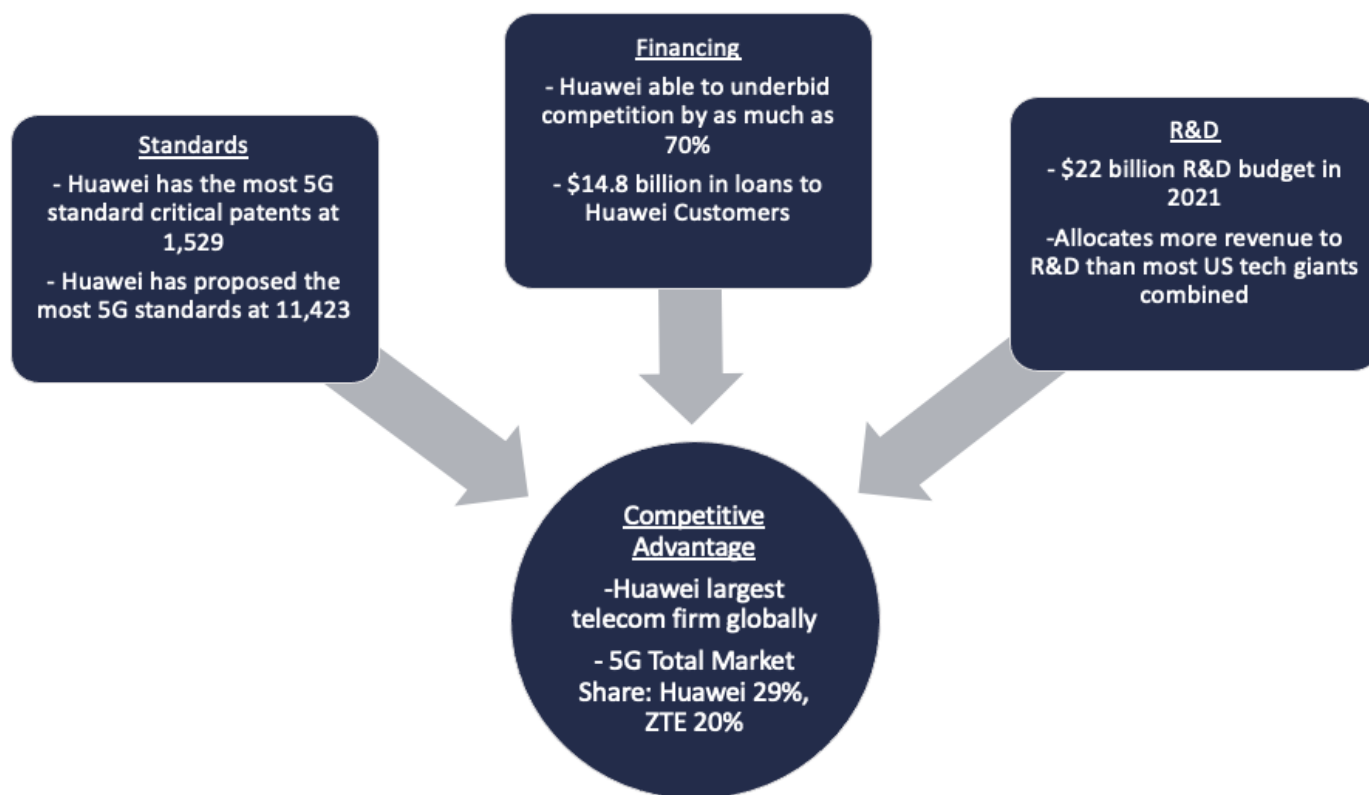
The US recently passed legislation to boost competitiveness in conjunction with these protectionist policies. Creating Helpful Incentives to Produce Semiconductors Act (CHIPS) was signed into law on August 9, 2022, and is aims to “boost US competitiveness, innovation, and national security. The law aims to encourage investments in domestic semiconductor manufacturing capacity. It also seeks to boost R&D and commercialization of cutting-edge technologies, such as 5G, O-RAN, quantum computing, AI, clean energy, and nanotechnology” (McKinsey & Company, 2022).

In 2018, the Department of State and USAID formed the Digital Connectivity and Cybersecurity Partnership (DCCP). The DCCP is “a global, multi-year, whole-of-government effort to promote access to an open, integrated, interoperable, reliable, and secure internet, including 5G and other emerging digital technologies. DCCP is the umbrella initiative under which most of the programming on 5G is funded and coordinated” (NIST, 2021).

Huawei's Advantages

Affordability is the primary advantage behind the spread of Chinese technology. Under the DSR umbrella, Beijing has leveraged technical standards influence, low-cost financing, and state-backed investments in research and development to keep costs to customers low to gain a competitive advantage over US 5G developers (Eurasia Group, 2020). Without additional support from the United States government, US telecom companies, such as Qualcomm, Cisco, and others, likely cannot offer competitive prices by 2030.

Figure 3. Root Cause Analysis of Huawei's Growth



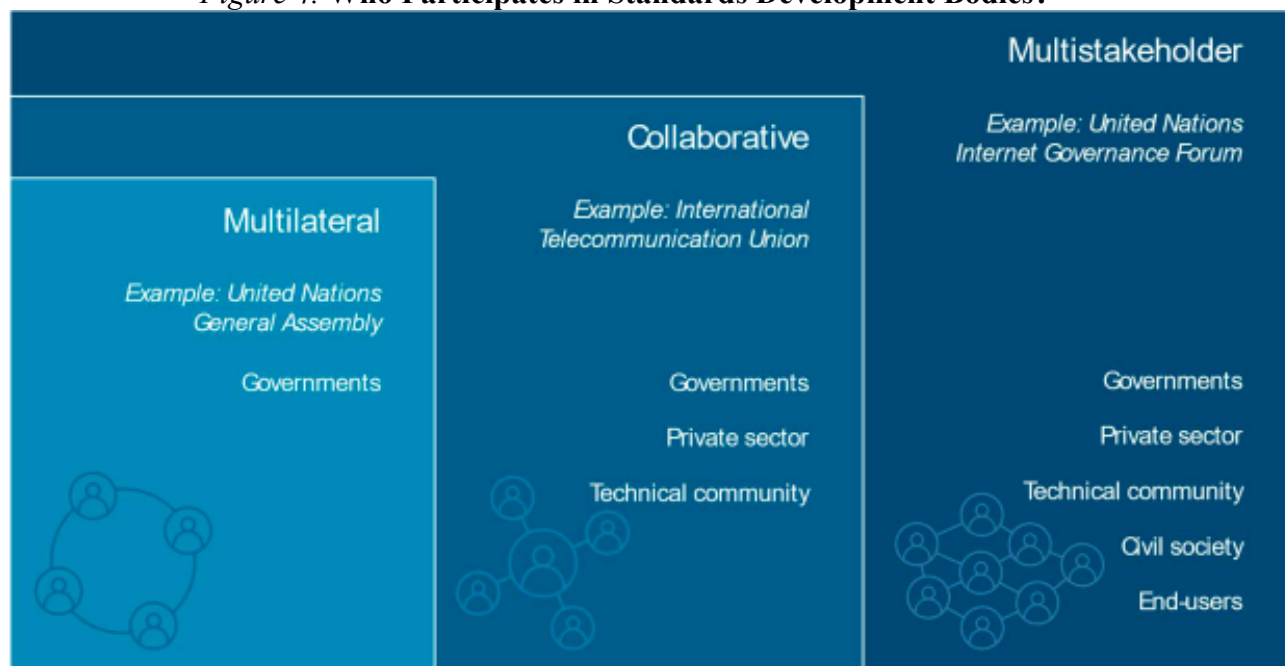
Standards

ICT standards refer to the development and application of shared principles, norms, rules, and decision-making procedures that coordinate and shape global cyberspace and its related infrastructure by the public and the private sector. Standards increase the quality of domestically manufactured products and enable more cost-effective production (Swann et al., 1996). A

“Standards are the commanding heights, the right to speak, and the right to control. Therefore, the one who obtains the standards gains the world.”
- President Xi Jinping

standards development organization (SDO) is an organization that develops, publishes, or disseminates technical standards to meet the needs of an industry or field. Although many SDOs focus on telecommunications, this analysis focuses on two: the International Telecommunications Union (ITU), which is a collaborative UN agency that develops broad information and communication standards, and the 3rd Generation Partnership Project (3GPP), which is a multi-stakeholder organization which focuses exclusively on standards for mobile communications and is the most important SDO for the future of 5G. Figure 4 shows the three types of SDOs and what actors participate.

Figure 4. Who Participates in Standards Development Bodies?



Source: (Férdeline, 2022)

Government: “includes accredited representatives of nation-states, such as civil servants, political actors, and law enforcement officers.”

Private sector: “includes industry representatives directly impacted by standards development. The most represented sectors are telecommunication companies, Internet Service Providers, domain name registries and registrars, software developers, online content providers, social media platforms, search engines, and business associations.”

Technical community: “includes academic researchers, staff, network operators, and engineers from the private sector who have technical knowledge of specialized technologies.”

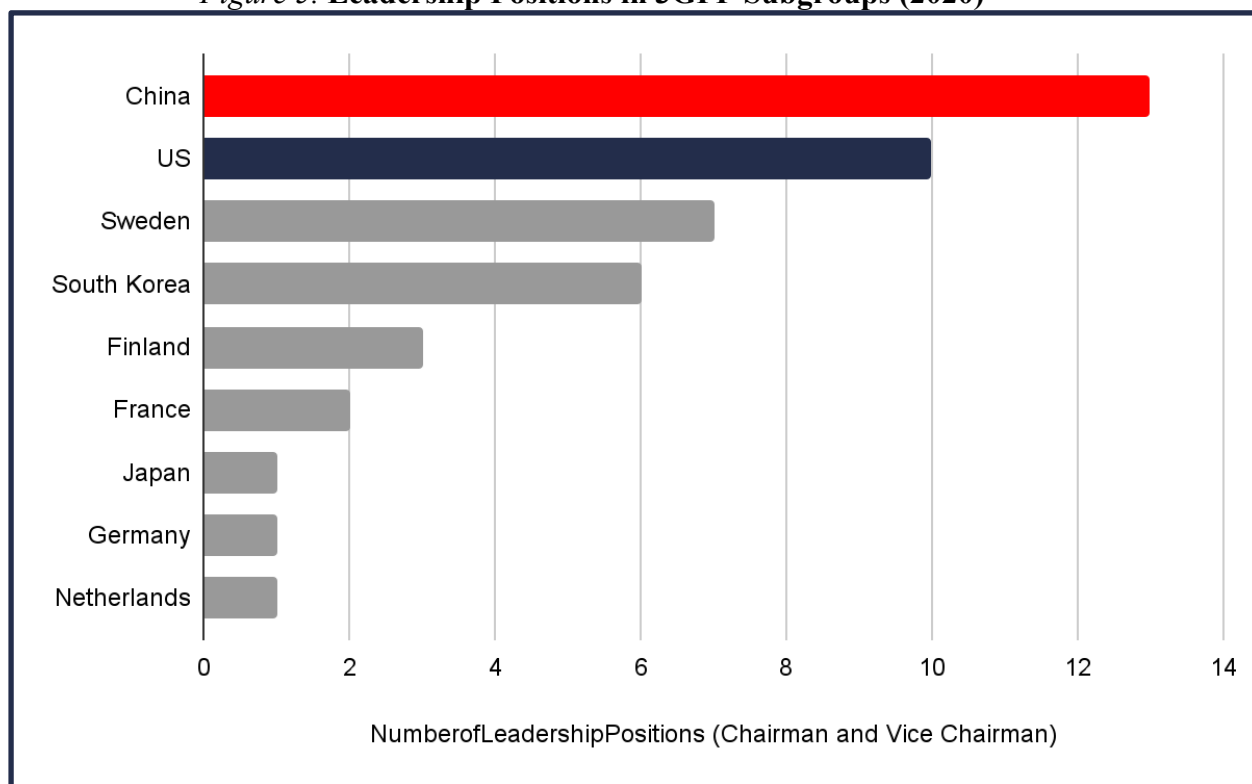
Civil society: “includes large and small nonprofit organizations, community groups, grassroots movements, trade unions, independent media, philanthropic institutions, students, and activists.”

End users: “all individuals and institutions impacted by the internet, including commercial and noncommercial actors. Not all institutions recognize this stakeholder group because effectively engaging such a large and divergent community is complex.”

Source: (Férdeline, 2022)

By participating in SDOs, companies can influence standards and ensure that the final requirements for equipment align with preferred specifications. A report by Bruer & Brake (2021) of the Information Technology and Innovation Foundation notes that because international technical standards directly impact global interoperability, they determine the degree to which companies can market their products worldwide. Favorable standards “yield greater economies of scale, lower development and production costs, reduced customer pricing, and increased innovation” (Bruer & Brake, 2021). Conversely, operating under standards that do not align with a company's technology and practices can limit a firm's ability to serve a market by requiring firms to retrofit products for the approved standard, which is often capital intensive. Hence, wielding influence over these standards is a crucial touchpoint within the broader power competition between the United States and China (Bruer & Brake, 2021).

In 2015, China's President Xi Jinping noted, “Standards are the commanding heights, the right to speak, and the right to control. Therefore, the one who obtains the standards gains the world” (Shivakumar, 2022). Since the launch of the DSR in 2013, Chinese firms, with the PRC's assistance, have sought to advance guidelines and standards over governments' rights to regulate and control the internet. The PRC believes participation across the communications sector will mean more significant roles for its firms in standards-setting bodies, thereby generating reliance on Chinese technological ecosystems and increasing its political and economic influence (Eurasia Group, 2020). China treats the standardization system with a top-down, centralized approach, where government dictates most negotiations.

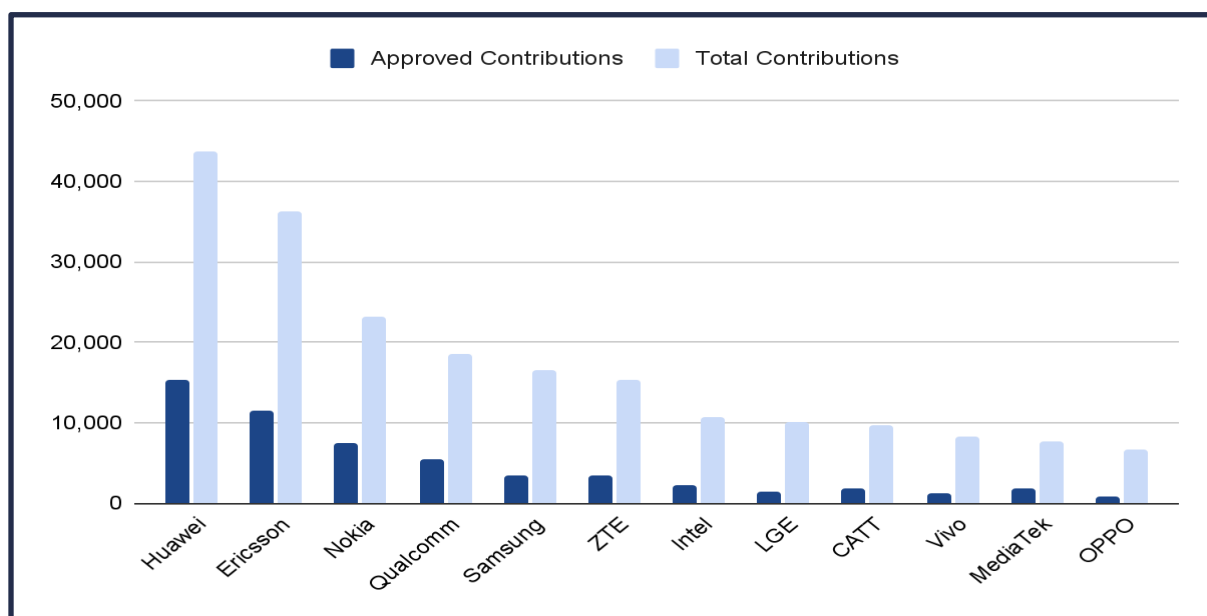
Figure 5. Leadership Positions in 3GPP Subgroups (2020)

Source: (Voo, 2021)

Conversely, the US supports decentralized, open, and responsible cyberspace governance where private organizations set standards in a multi-stakeholder decision-making process (The White House, 2011). This model has historically promoted US influence in terms of technological dependence because most of the major players globally were US companies. Recently, the United States government has been increasingly focused on rules-making and standard-setting as concern grows that the state power of China, combined with its industrial advantage, will lead to global acceptance of Chinese standards, and further challenge the United States in terms of international rules. Tech companies such as Google, Apple, Facebook, Amazon, and Microsoft, along with 5G vendors such as Qualcomm, Cisco, and Intel, play a vital role in competing with Chinese firms such as Huawei, China Telecom, Alibaba, and others, for international leadership status in internet governance (Degterev et al., 2021).

Figures 5 and 6 illustrate how delegations from Huawei, ZTE, and China Mobile have gained leadership roles in SDO working groups and subcommittees and used written contributions to influence the standards-setting agenda. By 2020, Chinese companies contributed 32 percent of the approved 5G technical standards in the 3GPP compared to just 14 percent by US companies. (Hart & Link, 2020). As of 2023, Huawei has made the most 5G contributions in the 3GPP and ITU, followed by Ericsson, Nokia, Qualcomm, and ZTE (Voo, 2021). Wielding this influence, Beijing is paving the way for a new form of multilateral instead of multi-stakeholder Internet governance. China opposes the multi-stakeholder model because it gives voice to civil society. While China sees participation by market actors as valuable, mainly as the state heavily influences its private sector, it still does not view them on a level playing field with the government (Férdeline, 2022).

Figure 6. 3GPP 5G Standard Contributions by Company



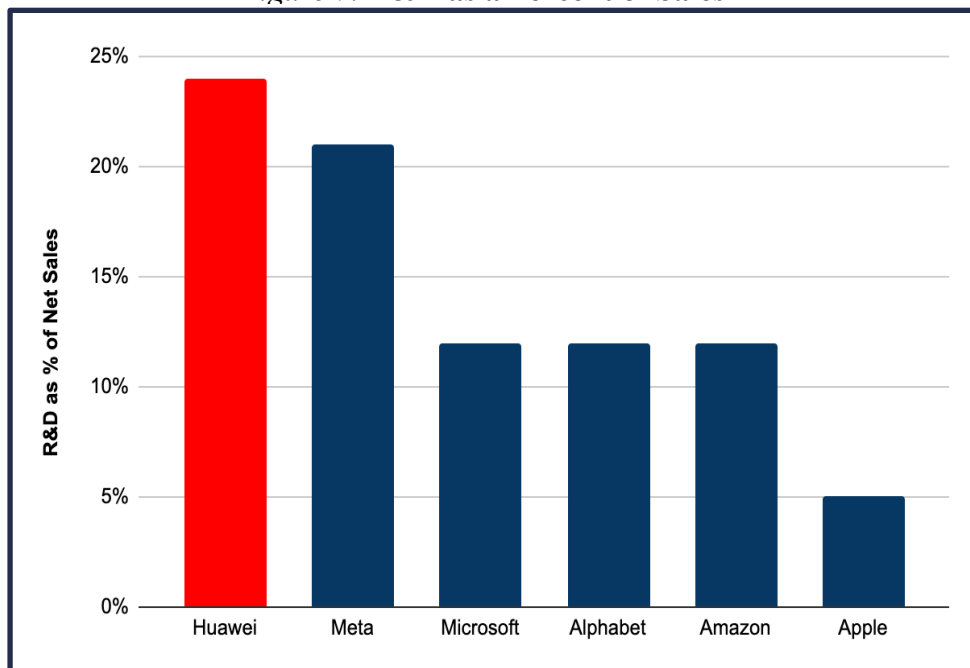
Source: (Zhang, 2023)

Research & Development

R&D subsidies and tax support have effectively enabled Chinese firms to quickly catch up to Western firms' technical ability and increase influence in SDOs through developing standard essential patents (SEP). From 2015 to 2020, Huawei received around \$1.2 billion in government grants for 5G R&D (Hart & Link, 2020). In addition, Huawei, already the most prominent foreign technology entity operating in MENA, recently announced its plan to increase its 5G R&D budget to \$20 billion. No American competitor currently comes close to that level of 5G investment (Chaziza, 2022). Figure 7 compares R&D as a percent of Huawei's sales and the US's largest technology firms.

R&D is critical to increasing competitiveness, especially as it leads to SEPs accepted by SDOs. Patents are used as an output measure for R&D activities and therefore viewed as an indicator of innovativeness (Verhoeven et al., 2016). A large body of literature concludes that “national and state-level R&D financial support through direct subsidies or tax support positively affects firms’ R&D spending and on a firm’s exports” (Bloom et al., 2002; Hall & Van Reenen, 2000; Rao, 2016). A meta-analysis of research

Figure 7. R&D as a Percent of Sales



Source: (Bloomberg News, 2022)

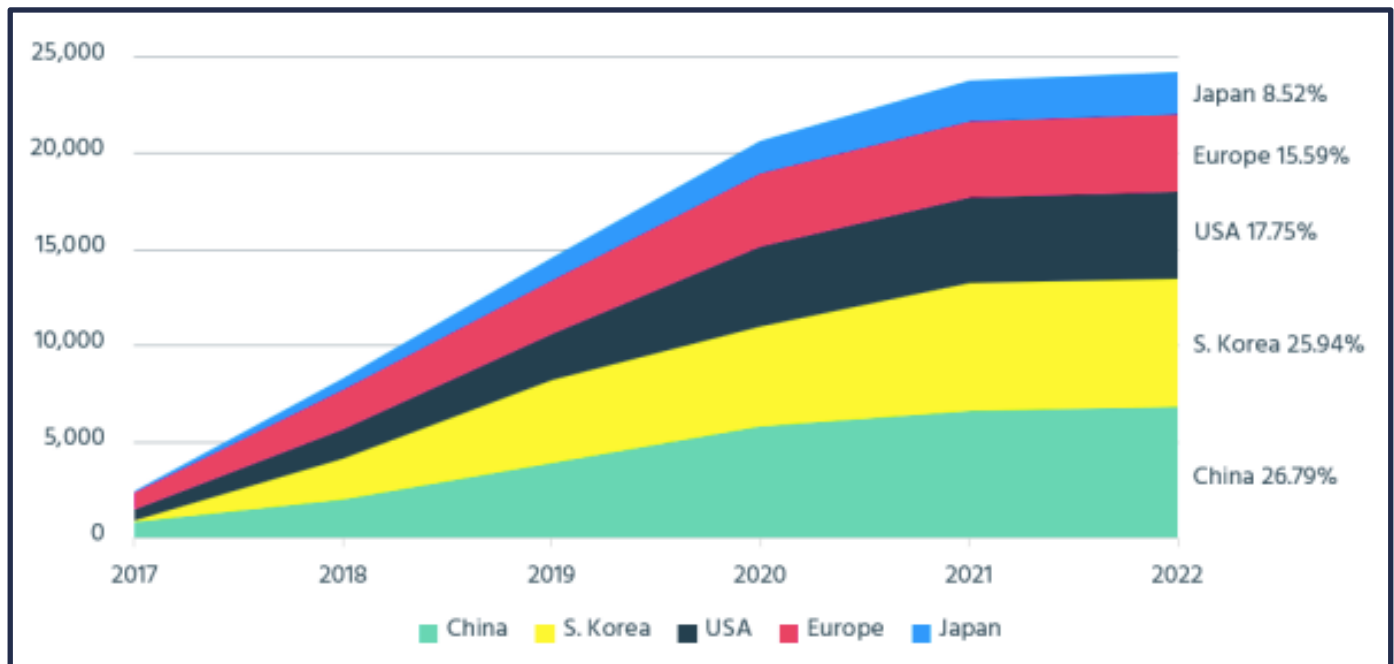
(2019) found a positive and statistically significant association between a firm’s R&D expenditure and its membership in standards organizations. It also concluded that a strong patent position increases the strategic complementarity between a firm’s R&D investment and its participation in standards development (Baron et al., 2019). Pohlmann, Neuhäusler, & Blind (2015) show that SEPs have a positive effect on a company’s return on assets at the firm level (Blind et al., 2015). Hussinger & Schwiebacher (2015) find that disclosing patents to SDOs has a positive effect on companies’ market value (Hussinger & Schwiebacher, 2015). As shown in Figure 8, China collectively owns the most 5G-related patents.

The most promising US answer to Huawei is the recently announced O-RAN Alliance. This industry coalition that aims to develop an open-source software platform for mobile Open Radio Access Networks (O-RAN). The project aims to move away from the proprietary network equipment challenges of the past by transforming the backbone of 5G networking into an open ecosystem with many vendors (Tews, 2020). If successful, it would provide a new competitive edge for US firms in the global struggle for 5G development. However, the technology is still being prepared for scalable commercial use, and further spending on research and development is required.

on R&D by the Information Technology Information Foundation found that “every dollar of federal R&D spurs an additional 30 cents in business R&D” (Wu, 2018). The report also concludes that “when firms increase R&D investment by 1 percent, their productivity increases by 0.05 to 0.25 percent, translating to a 20 to 30 percent return on investment” (Wu, 2018).

Many ICT SDOs, including the ITU, use the number of relevant patents to determine firms’ number of seats, leadership positions, and influence. A recent study by Baron et al.

Figure 8. Cumulative Number of Declared 5G Patents (2022)



Source: (Pohlmann & Buggenhagen, 2022)

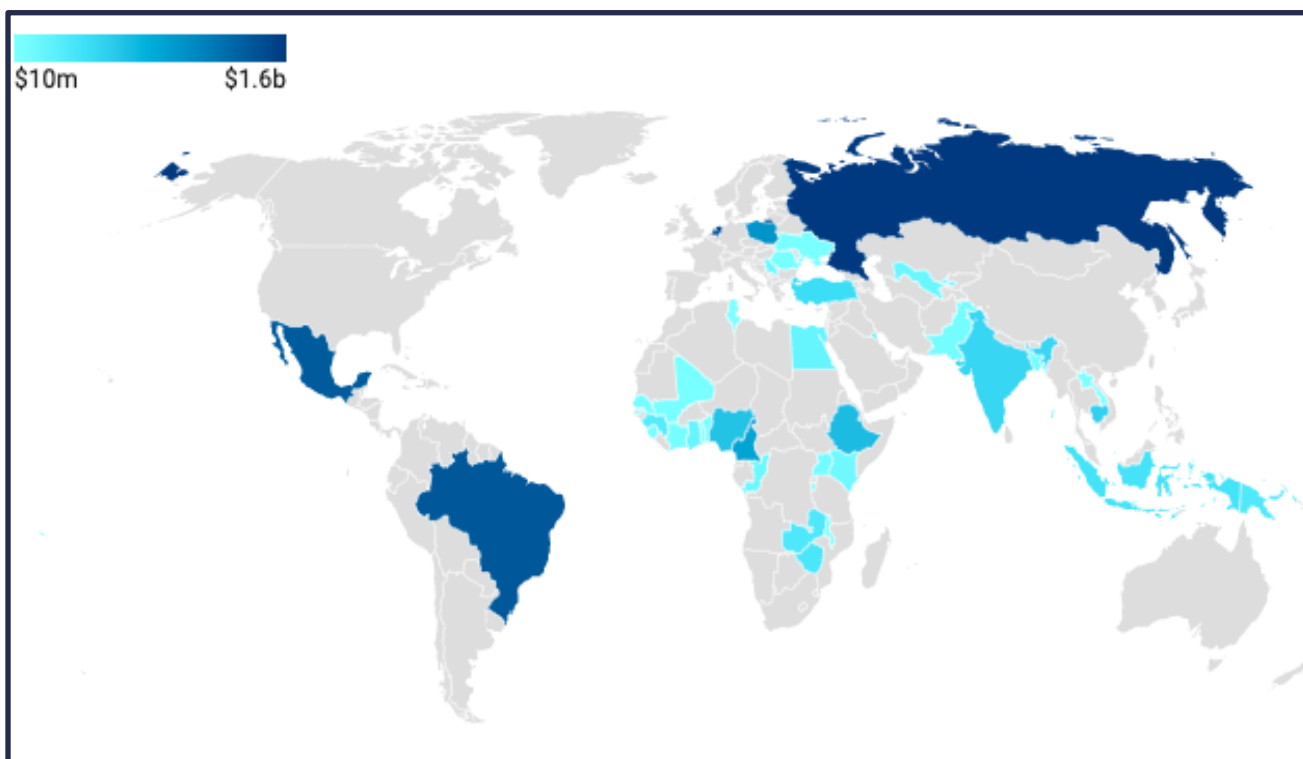
Financing

As shown in Figure 8, the China Development Bank and the Export-Import Bank of China have provided billions of dollars to mobile network operators in other nations earmarked to purchase Huawei equipment (Hart & Link, 2020). Chinese state banks provide advanced low-interest loans for customers who contract with Huawei, enabling customers to launch projects without drawing from cash reserves. In reaction to the United States' recent pressure on nations to reject Huawei and ZTE contracts, Chinese banks began extending grace periods and zero-cost financing for loans up to three years to make them more attractive. Even if US and European competitors could match Huawei's state-backed low prices, these loan packages make Huawei difficult to beat because commercial banks generally unwilling to match the low-cost financing rates or float credit lines for three years, especially given the higher risk nature of loaning in developing markets. For instance, in 2008, Reliance Communications Ltd., India's second-largest mobile operator, secured a \$750 million loan from the China Development Bank to contract with Huawei to build India's second mobile network. When the former chairman of the US EXIM Bank, Frank Hochburg, was asked about Huawei's surge in India, he noted, "That kind of growth takes more than just good sales and marketing" (Clark, 2020). Figure 9 shows an analysis by the Center for American Progress which found that the total estimated value of the 99 4G and 5G-related loans made to Huawei customers is about \$14.8 billion. Africa was the largest borrower, with 57 loans totaling \$4.66 billion, while the Middle East has secured three loans totaling \$375.4 million (Hart & Link, 2020).

Digital infrastructure is relatively cheap to finance when compared to traditional infrastructure. The average size of DSR-related loans from Chinese banks is \$155.57 million. Traditional

infrastructure projects such as ports often cost over \$1 billion (Hart & Link, 2020). Analysis by Hart and Link (2020) states that “these loans are a lifeline to the mobile operators buying Huawei network equipment who often have relatively thin profit margins. For China’s state banks, these loans deliver a massive impact at a relatively small cost” (Hart & Link, 2020). However, the loans are not without significant risk, as smaller operators in developing countries are typically higher-risk borrowers. Some contend that China’s banks are content with the higher risk profile because defaults can create opportunities for political leverage in what is known as “debt trap diplomacy.” A philosophy that US banks are unwilling to practice.

Figure 9. Chinese Loan-Backed Projects Involving Huawei



China’s state banks have lent about \$1.3 billion to Huawei customers in the MENA region.

Source: CSIS (Hart & Link, 2020).

Criteria

Each policy alternative is assessed on four criteria: cost, effectiveness, feasibility, and sustainability.

Cost

Costs are a paramount criterion for assessing policy outcomes because ITA's Global Markets Business Unit relies on limited congressional funding for its operations. This analysis estimates the administrative costs to the ITA and the broader costs to the United States Government for each proposal. All costs are calculated assuming each alternative is executed from 2024 to 2030. Annual costs are then adjusted for inflation using the Congressional Budget Office's inflation estimates for the same period (CBO, 2023). The total estimated costs are then discounted to present value using a 7 percent discount rate as recommended by the Council of Economic Advisors (Council of Economic Advisors, 2017). All costs are estimates and aimed to be a starting point for future consideration of each alternative. Further details on cost calculations are found in the Appendix A and B.

Effectiveness

Effectiveness is defined by the relative likelihood that a policy option directly results in increased 5G-related export revenue in the MENA region. The degree to which a policy can be reasonably attributed directly to potential revenue by US firms will determine an effectiveness rating of high, medium, or low. If sufficient and credible research shows a strong direct correlation between a policy and increased digital export-related revenue, the alternative received a high rating. Medium and weak correlations receive a medium and low rating, respectively.

Feasibility

Feasibility evaluates an alternative's likelihood of successful near-term execution administratively and politically. The alternatives will start with a baseline ranking of low (score of 1). Alternatives then receive an increase in score (+.5) for each sub-criterion it meets. The total score will determine an alternative's rating.

- (+.5) ITA: The proposal meets current ITA practices, expertise, and FY2023 budgetary constraints.
- (+.5) Admin: ITA likely to form partnerships when appropriate and/or executing agency likely to support proposal.
- (+.5) Political: Projected outcomes align with executive and congressional priorities therefore likely to be supported and funded by Congress and/or the Executive branch.
- (+.5) MENA: Proposal likely to be supported by sufficient public and private actors in the MENA region.

Sustainability

Sustainability will evaluate an alternative's likelihood of remaining effectively administered through 2030. Each alternative will be scored based on four sub-criteria and totaled. The alternatives will start with a baseline ranking of low (score of 1). Alternatives will then receive an increase in score (+ .5) for each sub-criterion it meets. The total score will determine an alternative's rating.

- (+.5) Life: Upon execution, the life of the proposal is established at least through 2030.
- (+.5) Funding: Annual funding likely to be secured through 2030 upon execution.
- (+.5) Maintenance: Administrative maintenance is established to last at least through 2030.
- (+.5) Relevance: Executed proposal remains equally or increasingly effective annually through 2030.

Feasibility and Sustainability scores are totaled and rated based on the following scale:

| Rating | High | Medium-High | Low-Medium | Low |
|-------------|------|-------------|------------|-----|
| Total Score | 3 | 2.5 | 1.5 | 1 |

Policy Alternatives

Alternative 1: *Workshops to train the private sector, civil society, and public officials to increase effectiveness in SDO governing processes.*

Stakeholders: NIST, CTIA, FCC, ITA

The immense complexity of the 3GPP, ITU, and other SDO processes are barriers to effective participation, especially from small and medium-sized firms, civil society actors, and public officials in developing states. Former ITU official Richard Hill said “some representatives who come into the ITU haven’t read the ITU Constitution and don’t understand treaty level provisions, so their interventions are embarrassing and ineffectual” (Férdeline, 2022). Chair of UNESCO’s Information for All Program, Dorothy Gordon said, “There is an understanding that digital issues are important, but some representatives don’t participate as they don’t have the skills or knowledge to shape the debates in a way that is useful. We don’t have good communication between civil society and government. We need training for people to understand how different players are motivated and how they can work together” (Férdeline, 2022).

Leveraging existing standards expertise within the National Institute for Standards and Technology (NIST), and the Cellular Telecommunications and Internet Association CTIA, ITA should identify SDO work streams that are most likely to result in proposals for new standards development activities in priority areas. Using these resources, ITA and relevant agencies should develop standards training workshops for the appropriate technical private sector, civil society, and public officials who would benefit from training in participating in standards development. This training should include specific processes and norms in each SDO. Research shows that an individual’s affiliation with a leading SDO stakeholder increases their chances of appointment to chair positions (Baron & Kanevskaia Whitaker, 2021). Therefore, soft skills training should accompany

the technical resources to enhance relationship building within governing bodies and facilitate long-term influence. ITA should regularly brief senior executives with authority over standards resourcing to align training needs.

Present Cost: -\$3,899,768

Using a corporate event calculator to estimate the cost of the workshop in the Middle East with two hundred attendees, the average cost was 319,000 per workshop (Brightspot Events, n.d.). If executed twice a year from 2024-2030, the inflation-adjusted present value totals -\$3,899,768. The cost per workshop could be considerably less if they have fewer attendees or host a webinar series instead of in-person events. Compared to the other alternatives, this is the least expensive and fits feasibly within ITA budgetary projections.

Feasibility: High (3)

This alternative is highly feasible, with a total score of three. This policy achieves all sub-criteria because working closely with other agencies to organize international workshops is already a common practice for ITA. It will likely have political and funding support because it falls within routine practices.

Sustainability: Medium (2)

Alternative one has a total sustainability score of two because it meets the requirements of execution and relevance. Execution of this alternative is likely to happen within one to three years, given that workshops and webinars are already in ITA's wheelhouse, and it is relatively inexpensive. Developing SDO expertise will likely remain relevant and practical in 2030 as the role of telecommunications standards will continue to increase in importance and competitiveness. However, as workshops are not typically set up to repeat regularly, and the effectiveness of the alternative is difficult to predict, it receives a score of (2).

Effectiveness: Low

By increasing the effectiveness of small to medium size firms, civil society, and foreign public officials in US participants in the SDO process, Western favored standards are more likely to gain approval. When favorable standards are accepted, it reduces barriers to entry and increases the royalty revenue for the firms who own the relevant patents. However, this alternative is ranked as low because it is difficult to predict if the workshop training will lead to more favorable standards or how exactly that will impact US revenues long term.

Alternative 2: USG provides grants or tax support to cover costs of SDO participation and incentivize increased US private sector and civil society engagement in the standards development process.

Stakeholders: Congress, NIST, ITA

High costs are a substantial barrier to participating in SDOs. A report by the Center for American Progress, which interviewed firms about the standards development process, found that many US firms report that 3GPP participation is too costly to participate regularly, especially for smaller to medium-sized firms (Hart & Link, 2020). While each SDO has different fee structures, Hart & Link (2020) estimates a yearly average cost of \$300,000 per engineer across the SDO fora (Hart

& Link, 2020). The PRC currently covers all costs for Chinese representatives to participate in SDOs.

To reduce barriers to US participation in SDOs, Congress should provide grants to companies that cannot pay SDO participation fees. The Center for American Progress advocates for “funding support that covers the membership fee of the Alliance for Telecommunications Industry Solutions; travel expenses to participate in ITU and 3GPP meetings; and personnel funding to support developing, writing, and submitting technical contributions” (Hart & Link, 2020). The Information Technology and Innovation Foundation recommends “Congress explore changing the research and experimentation tax credit to allow companies to include their spending on global standards setting activities when they calculate their total expenditures on R&D” (Bruer & Brake, 2021).

Present Cost: -\$122,450,419

Of the 683 3GPP members, 54 are from the United States, 111 are from China, and 435 are from the EU (3GPP, 2020). To achieve parity in just the 3GPP, the US would need to send 57 representatives with an average cost of 300,000 USD per engineer for a total of 17,100,000 USD a year. After adjusting for inflation, the present value of the total costs through 2030 is - \$122,450,419. Participation costs for all 5G-related SDOs would add to the total considerably; however, the 3GPP should be the top priority. A change to the R&D tax credit would not require direct funding but would reduce IRS revenue by roughly the same amount annually.

Feasibility: Medium (2)

Alternative two gains a medium feasibility rating. Given the recent slew of bipartisan legislation aimed at increasing US economic competitiveness with China, such as the CHIPS Act and the relatively low cost, it is reasonable to assume further political support from Congress for such an initiative in the next three to five years. If executed, this falls outside of normal ITA functions and scope, however the agency most likely to spearhead the initiative is NIST, which will likely support and execute SDO participation grants.

Sustainability: Medium-High (2.5)

This alternative has a sustainability rating of medium-high as it meets three out of four sub-criteria. Actions taken by congress are difficult to undo once passed. Funding could likely be secured through 2030, and a change to the R&D tax credit would likely remain secure well into the future. As costs for SDO participation continue to rise, this option will likely remain relevant and effective through 2030. However, because this option requires action by congress and SDO participation costs are not at the forefront of China-related discussions, it is unlikely to be passed within one to three years.

Effectiveness: Low

This option is highly effective in increasing US participation in SDOs. However, this alternative face similar difficulties as alternative one, whereas concluding that this alternative will directly lead to increased US revenue with confidence is difficult and therefore is ranked as low effectiveness.

***Alternative 3:** Digital Economic Agreements with MENA states that specify 5G standards and cross-border data flow regulations.*

Stakeholders: Congress, USTR, TANC

In the long term, new or updated Free Trade Agreements (FTAs) are likely the best way to reduce the abovementioned barriers. However, FTAs are often huge political lifts and are time intensive. According to Peterson Institute for International Economics, the average time it takes the US to negotiate a new free trade agreement is a year and a half, and implementation of the new terms takes an average of three and a half years (Freund & Weinhold, 2002). A budding and more feasible option is a digital economy agreement (DEA). DEAs are comprehensive “digital-only” agreements that establish trade rules and facilitate interoperability between two or more states. Traditional trade agreements sometimes include chapters on digital trade and typically focus on market access, whereas DEAs encourage domestic regulatory reforms and “soft” cross-border collaboration on issues such as digital standards, data innovation, digital identities, cybersecurity, consumer protection, and inclusion (Warren & Fan, 2022). Through consistent, interoperable digital regulations, DEAs are particularly beneficial for small to medium-sized firms who stand to gain the most from overcoming the barriers of entering global markets usually only accessible to larger businesses. (Hufbauer & Hogan, 2021).

According to the Ministry of Trade and Industry of Singapore, DEAs should:

“(1) Align digital rules and standards and facilitate interoperability between digital systems; (2) support cross-border data flows and safeguard personal data and consumer rights, and (3) encourage cooperation between economic partners in nascent areas such as digital identities, Artificial Intelligence (AI), and data innovation.” (MTI Singapore, n.d.).

Present Cost: -\$4,418,700

When the US-Korea free trade agreement was passed in 2011, Congress appropriated a yearly budget of \$750,000 to the Department of Commerce to establish and operate the office managing the agreement (112th Congress, 2011). Assuming a similar cost for forming and managing a new DEA, the present value of these costs through 2030 is -\$4,418,700.

Feasibility: Medium-Low (1.5)

Although DEAs are a lighter lift than a comprehensive Free Trade Agreements, establishing one would still require significant support from Congress and the executive branch. Despite increased Congressional attention to China, including the newly minted House Select Committee on the Strategic Competition Between the United States and the Chinese Communist Party, it is still unlikely that a DEA will be considered and passed in the next three years. DEAs also take multi-year negotiations, which means it is unlikely to be executed within three years. Also, ITA is not typically involved in FTA negotiations. However, the US currently has FTAs with Israel, Jordan, Morocco, Bahrain, and TIFA’s with many other MENA states, meaning that buy-in from MENA states would be feasible.

Sustainability: High (3)

Once established, formal trade agreements such as DEAs are long-lasting, often indefinite, and difficult to remove. If executed, it would require funding and administrative maintenance for the life of the agreement.

Effectiveness: High

The effectiveness of DEAs on US 5G export revenue is high. The positive impacts on exports stemming from free trade agreements have been widely studied. According to the Department of Commerce, in 2014, FTA partner countries purchased 13 times more goods per capita from the US than non-FTA countries. While DEAs are relatively new, 2022 research found that Digital Trade Agreements among economies significantly impact the export of related digital products. Research found that the DEAs increased average export growth by 3.8 percentage points. They also increase the ICT sector's output by an average of 6.78 percent and have downstream benefits for the business services & financial sector. When DEAs aim to “improve the interoperability of digital systems between countries, they increase inter-regional trade by an average of 7.27 percent” (Yang & Zheng, 2022).

***Alternative 4:** The United States should invest in the domestic 5G industry through R&D incentive and low-cost financing to US and foreign firms for 5G related projects.*

Stakeholders: Congress, EXIM, DCF, ITA, NSF

Targeted public investments are necessary for US firms to overcome the market barriers formed by China's policies. This alternative considers the recent initiatives by the federal government to increase US competitiveness in the 5G and semiconductor space while also recommending additional programs and funds be allocated.

Low-Cost Financing

The US Export-Import Bank (EXIM) and the US Development Finance Corporation (DFC) have recently changed their mandates to counter Chinese lending in developing nations for critical tech sectors, such as 5G equipment. To accomplish this, EXIM and DFC should provide fast-tracked financing for US vendors deploying disruptive technologies. The program should target developing markets of particular concern such as MENA states where the US requires secure mobile networks for military operations or democracies seeking to push back against China. New US market entrants, smaller firms, firms deploying new technologies, and operators from developing states report difficulties securing EXIM and DCF financing for overseas deals. These actors typically do not have the resources to invest in the time required or legal counsel to assist in the byzantine application process.

R&D Incentives

In a recent survey by the Center for American Progress, “a third of technology buyers said that government investment in infrastructure or subsidies to drive down costs would encourage them to invest more in 5G” (Hart & Link, 2020). Emphasis should be placed on the development and deployment of virtualized O-RAN systems which currently has the most potential to eliminate many of Huawei's current advantages.

Present Cost: -\$6,697,661,921

The recently enacted CHIPS Act earmarked \$1.5 billion for 5G and ORAN research and development. However, if the US were to match the 5G-related R&D subsidies provided to Huawei to just the top five 5G firms in the US, it would total about \$4.7 billion over five years.

Smaller, more researched based firms and academia will increase the total; however smaller firms would likely not be approved for the \$235 million given annually to Huawei. A total estimate for all 5G research in the US is about \$6 billion over seven years. The inflation-adjusted present value of the funds spread evenly each year through 2030 comes to -\$5,049,943,764. This figure is still considerably less than the PRC 's expected \$50 billion on 5G research over the next five years. To make these funds competitive, the US must focus its R&D funding on ventures where the US is likely to maintain a competitive advantage, such as O-RAN.

China has provided around \$14.8 billion in 4G and 5G related lending to customers of Huawei. About \$1.3 billion went to four MENA countries. Initially, the low-cost financing efforts should aim to at least match the MENA loan totals. However, given the stricter lending practices of EXIM bank relative to Chinese banks, it is likely that less than the entire 1.3 billion would be lent through 2030. Assuming a three-year grace period was given to incentivize uptake, EXIM Bank would start collecting payments on the loans in 2027. Considering this, the present value of the total cost through 2030 is -\$954,692,369.

ITA should increase partnerships with administering agencies to connect and assist stakeholders in accessing these resources. ITA's FY2023 budget included funding for 67 new hires; if 25 percent were trade specialists hired to assist in the above alternative, the total additional cost would be -\$2,588,664 annually (FederalPay.org, 2021). After adjusting for inflation through 2030, the present value of total costs is -\$13,652,647.

Feasibility: Medium-High (2.5)

This alternative is medium-high in feasibility. Congress has recently passed legislation that accomplishes much of what this alternative recommends and calls for further funding are expected. It is feasible that congressional action makes additional resources available in the next one to three years as technological competition with China continues to ramp up. The Department of Commerce is already leading the way in implementing the CHIPS Act, so the administrative capability to participate in additional projects is highly feasible. This alternative, however, does fall outside of ITA expertise, and further steps are required for ITA to triangulate its role during implementation. MENA is highly likely to support the additional resources, especially low-cost financing to US 5G vendor's customers.

Sustainability: Medium

Recent legislation earmarked funds for R&D and financing for five years. Given the short time horizons the recent bills were funded, this alternative has a medium sustainability rating. However, the changes to EXIM Bank and DFC mandates were given no specific end date, therefore securing administrative sustainability. This alternative will likely remain highly relevant and effective well past 2030 as telecommunications innovation continues, and 6G is expected to reach the market in ten to fifteen years.

Effectiveness: High

As discussed earlier in the root cause analysis section, R&D is critical to increasing competitiveness, especially as it leads to SEPs that are accepted by SDOs. Research has found that R&D increases participation in standards development positively effects a company's return on assets, has a positive effect on a firm's market value, and most notably that federal support for

R&D has positive effects on a firm's exports (Baron et al., 2019; Blind et al., 2015; Wu, 2018). In terms of measuring effectiveness by how likely each alternative will positively affect US companies' export related revenue, this policy option is the strongest as there is a clear relationship to export competitiveness and R&D expenditure. Low-cost financing also effectively increases US competitiveness by lowering the financial barriers that MENA actors face in securing 5G from US vendors and making US contract bids more attractive. However, there are increased risks in lending to developing countries and the direct relationship between low-cost financing from EXIM and a US firm's revenue is not as strong as R&D incentives.

Outcomes Matrix

| Alternatives | Cost (PV) | Feasibility | Sustainability | Effectiveness |
|--|-----------------|-------------|----------------|---------------|
| 1: Workshops to train private sector, civil society, and public officials to increase effectiveness in SDO governing processes | \$3,899,768 | High | Medium | Low |
| 2. Grants for US private sector and civil society to cover costs of engagement in SDO's | \$122,450,419 | Medium | Medium-High | Low |
| 3. Digital Economy Agreements that specify 5G standards and cross-border data flow regulations | \$4,418,700 | Medium-Low | High | High |
| 4: Invest in domestic R&D incentives and low-cost financing to both US and foreign firms | \$6,697,661,921 | Medium-High | Medium | High |

Recommendation

The above alternatives are not mutually exclusive. Ideally, the ITA could implement option one while other alternatives progress. However, the most impactful option, especially in terms of the likelihood of future export revenue for US firms, is alternative four: *The United States should invest in the 5G industry through R&D incentives and additional financing to US and foreign firms for 5G-related projects.* ITA should increase efforts to assist domestic and foreign firms to access existing resources. Although alternative four is by far the most expensive, it is the most likely to close the gap on China's competitive advantages, positively impact SDO participation through the development of SEPs, create long term value for US firms as they develop O-RAN and eventually 6G technology, and given recent legislation is politically and administratively feasible. Alternative three likely would also have substantial long-term effectiveness in reducing barriers to US firms but is far less politically feasible over the next three to five years and fails to address the need for increased innovation to remain competitive. Alternative one and two would likely be highly effective in improving US participation in SDO processes which help curb China's influence over the global technical governance system, but their effect on export revenue is subject to myriad other variables and therefore difficult to predict.

Implementation

The FY2023 ITA budget includes an additional \$26.1 million designated to “boost the United States’ ability to counter unfair trade practices and economic coercion by the People’s Republic of China.” The funding proposal includes “hiring 28 new Foreign Commercial Service Officers and 28 Locally Employed Staff in overseas offices, and an increase of 11 international trade staff in Global Market’s domestic offices” (Congressional Research Service, 2022). All the above initiatives are new, and implementation is still being worked out, which provides an excellent opportunity for the ITA to leverage these additional resources to establish partnerships early on to enhance the rollout of each to meet the agency's goals. While each of the above initiatives varies in size, complexity, and stakeholders, Figure 10 shows generalizable next steps that the ITA can take to get involved.

Support for ICT exports and related R&D has been a major priority of the past two administrations, specifically as it relates to competition with China. Therefore, a recent slew of legislative efforts and whole-of-government initiatives have recently developed. Given their recency, the specifics of the implementation of each are still being refined. This creates an opportunity for the ITA to find ways to add value through partnerships with various stakeholders. Additional legislation for public 5G investments will likely closely resemble the frameworks used in the CHIPS Act and DCCP.

Figure 10. ITA Next steps



Stakeholder Analysis

The following lists the most relevant departments, agencies, and funds that, through the CHIPS Act, DCCP, or otherwise directed to execute new funds or initiatives in boosting US 5G and semiconductor capabilities. The ITA should use this list to assess where current partnerships exist and with whom new partnerships should be established in its effort to boost US 5G competitiveness.

Department of Commerce

CHIPS Program Office: Oversees the implementation of the CHIPS Act within the Department of Commerce (DOC) (Senate Commerce Committee, 2022).

National Semiconductor Technology Center (NSTC): “A public-private partnership to conduct advanced semiconductor manufacturing R&D and prototyping; invest in new technologies; and expand workforce training and development opportunities” (Senate Commerce Committee, 2022).

National Telecommunications and Information Administration (NTIA): “\$1.5 billion in coordination with NIST, the Department of Homeland Security, and the Director of National Intelligence to spur movement towards O-RAN, software-based wireless technologies, and funding innovative technologies in the US mobile broadband market” (Senate Commerce Committee, 2022).

Commercial Law Development Program (CLDP): “Creates a reference guide of successful actions taken by countries around the world to secure their 5G networks and engage with partner countries on a bilateral and regional basis” (NIST, 2021).

National Institute of Standards and Technology (NIST): “\$10 billion for NIST to invest in STEM, workforce development, and R&D related to semiconductors and related technologies, including the Microelectronics Metrology research program to advance measurement science, standards, material characterization, instrumentation, testing, and manufacturing capabilities.” (McKinsey & Company, 2022).

Manufacturing USA Semiconductor Institute: “A partnership between government, industry, and academia to research the virtualization of semiconductor machinery and the development and deployment of training” (Senate Commerce Committee, 2022).

Other Stakeholders

Export-Import Bank

“Supports United States exports of 5G technologies by providing (1) loan guarantees, (2) trade credit insurance, (3) working capital guarantees, and (4) direct loans. When there is evidence of a competing offer with State-backed financing terms that are more generous than those allowed under OECD export credit rules, EXIM is permitted to consider matching a Chinese competitor’s financial terms to help level the playing field for US exports” (NIST, 2021).

US Trade and Development Agency

“Deploys technical advisory services to evaluate and develop recommendations for project preparation related to enabling, developing, deploying, or upgrading secure and sustainable 5G networks. For international project preparation, the USTDA: (1) performs feasibility studies; (2) provides technical assistance and comprehensive analyses of technology options and requirements; and (3) supports pilot projects that test commercially viable US technologies” (NIST, 2021).

Development Finance Corporation

“Partners with the US and foreign private sectors to provide financing solutions to private companies in countries seeking to build out 5G networks. DFC’s products include (1) equity financing for developmentally and strategically significant companies and projects; (2) debt financing through direct loans and guarantees; (3) political risk insurance to protect investments against losses due to currency inconvertibility, governmental interference, and political violence; and (4) technical assistance to accelerate project identification and preparation to attract and support private investment” (NIST, 2021).

US Agency for International Development (USAID) ProICT Taskforce: “Develops strategies to help countries adopt ICT and digital economy policies that advance open, interoperable, reliable and secure cyberspace; engages secure network supply alternatives using private sector investment and innovation models; and works with implementing partners to ensure safe access to the Internet and related technologies” (NIST, 2021).

National Science Foundation (NSF) Workforce and Education Fund: “\$200 million to kick start development of the domestic semiconductor workforce, which faces near-term labor shortages, by leveraging activities of the NSF” (Senate Commerce Committee, 2022).

Department of Defense (DoD) America Defense Fund: “\$2 billion for the DoD to implement the Microelectronics Commons, a national network for onshore, university-based prototyping, lab-to-fab transition of semiconductor technologies, and semiconductor workforce training” (Senate Commerce Committee, 2022).

Department of State (DoS) Cybersecurity and Infrastructure Security Agency: “Provides legal and regulatory advisory services to assist countries in developing and implementing laws, regulations, and other measures on 5G security. State will also support capacity building training and workshops for developing country government officials on 5G security with participation from experts from the private sector, like-minded foreign governments, and academia.” (NIST, 2021).

“The International Technology Security and Innovation Fund provides \$500 million to the DoS, in coordination with the USAID, the Export-Import Bank, and the DFC, to support international information and communications technology security and semiconductor supply chain activities, including supporting the development and adoption of secure and trusted telecommunications technologies, semiconductors, and other emerging technologies” (Senate Commerce Committee, 2022).

Risks

It is also possible that since Congress recently passed legislation earmarking federal funds for 5G and O-RAN research, the legislative window of opportunity is closed. It may take further security threats from Chinese telecommunications companies or more evident negative economic impact to move Congress to action again. There is also a risk that the funds earmarked for these initiatives simply will not be enough to effectively challenge China in the MENA market and elsewhere. While the funds listed above are impressive, they still do not meet the quantities that the PRC has provided to Chinese firms like Huawei. It is imperative that we try not to match China dollar for dollar in state subsidies and support but focus the dollars we spend on gaining a competitive advantage through viable alternatives to Chinese 5G, such as O-RAN technology. For ITA, there is a risk that after assessing their formal partnerships with other agencies, ITA does not find itself in a position to add value to the implementation of the policy in a significant way.

Conclusion

The International Trade Administration's goal is to "strengthen the international competitiveness of U.S. industry, promote trade and investment, and ensure fair trade and compliance with trade laws and agreements." The Office of the Middle East within the ITA is particularly concerned with keeping US 5G exports competitive with China in the MENA region. The United States is currently losing the race to deploy 5G technology within the region, and if swift action is not taken to remove barriers and boost competitiveness, there will likely be significant negative impacts on US 5G export revenue. In terms of the great power competition between the US and China, this issue is at the crux of the struggle for economic and political influence in the Middle East and North Africa, as well as broader international governance systems that oversee the future of telecommunications. The US should prioritize boosting US competitiveness by investing in 5G and O-RAN R&D and increasing access to low-cost financing for 5G vendors and their customers. ITA should work with partners within the Department of Commerce and other relevant agencies to establish valuable relationships where ITA's expertise in bringing in diverse stakeholders both domestically and abroad to access new resources can be utilized.

Appendix

Appendix A: Inflation Adjusted Present Cost Estimates

| Alternatives | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | PV |
|-------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Alternative 1 | -\$681,777 | -\$696,776 | -\$711,409 | -\$726,348 | -\$743,054 | -\$760,144 | -\$775,347 | -\$3,899,768 |
| Alternative 2 | -\$17,613,000 | -\$18,540,500 | -\$19,926,697 | -\$21,866,280 | -\$24,546,533 | -\$28,189,088 | -\$33,019,620 | -\$122,450,419 |
| Alternative 3 | -\$772,500 | -\$789,495 | -\$806,074 | -\$823,001 | -\$841,931 | -\$861,295 | -\$878,521 | -\$4,418,700 |
| Alternative 4 | | | | | | | | |
| Subsidies | -\$882,857,142 | -\$902,279,999 | -\$921,227,879 | -\$940,573,665 | -\$962,206,859 | -\$984,337,617 | -\$1,004,024,369 | -\$5,049,943,764 |
| Staffing | -\$2,666,323 | -\$2,724,983 | -\$2,782,207 | -\$2,840,634 | -\$2,905,968 | -\$2,972,805 | -\$3,032,262 | -\$13,652,647 |
| Lending | -\$191,285,714 | -\$193,975,600 | -\$197,661,705 | -\$201,812,601 | -\$208,076,714 | -\$212,862,478 | -\$217,538,613 | -\$954,692,369 |
| Loan Repayment (4.82% APY) | \$0.00 | \$0.00 | \$0.00 | \$2,678,223 | \$5,394,108 | \$8,161,602 | \$10,987,215 | |
| Lending Totals | | | | -\$199,134,378 | -\$202,682,605 | -\$204,700,875 | -\$206,551,398 | |
| Total | -\$1,076,809,180 | -\$1,098,980,582 | -\$1,121,671,793 | -\$1,341,683,055 | -\$1,370,478,039 | -\$1,396,712,174 | -\$1,420,159,428 | -\$6,697,661,921 |
| Expected Inflation Rate | 1.03 | 1.022 | 1.021 | 1.021 | 1.023 | 1.023 | 1.02 | |

Appendix B: Cost sources

| Alternative | Annual Cost (2023 Dollars) | Source |
|---------------------------------|----------------------------|---------------------------|
| Alternative 1 | | |
| Hotels | \$209,300 | (Brightspot Events, n.d.) |
| Meals | \$89,700 | (Brightspot Events, n.d.) |
| Audio visuals | \$16,000 | (Brightspot Events, n.d.) |
| Event Registration | \$4,000 | (Brightspot Events, n.d.) |
| Total (per two events) | \$638,000 | |
| Alternative 2 | | |
| Average Cost of Participation | \$300,000 | (Hart & Link, 2020) |
| Number of 3GPP seats for parity | \$57 | (3GPP, 2020) |
| Total | -\$17,100,000 | |
| Alternative 3 | | |
| Oversight Office Annual Budget | -\$750,000 | (112th Congress, 2011) |
| Total | -\$750,000 | |
| Alternative 4 | | |
| Average ITA Salary | -\$123,738 | (FederalPay.org, 2021) |
| Fringe Rate (30% of salary) | -\$37,121 | (Tanski-Phillips, 2020) |
| Total Staffing (17 Hires) | -\$2,588,664 | Author Estimate |
| Subsidies | -\$857,142,857 | Author Estimate |
| Lending | -\$185,714,286 | (EXIM Bank, 2023) |
| Total | -\$1,045,606,666 | |

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