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CAN YOU HEAR ME NOW? INTERNATIONAL WIRELESS SOLUTIONS FOR THE DOD

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By: **Aaron J. Shinoff**
Richard J. Wilson

Co-Advisor: **Nicholas Dew**
Co-Advisor: **E. Cory Yoder**

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This topic has been directly requested for research by Naval Supply Systems Command (NAVSUP) Fleet Logistics Center (FLC) San Diego. The Navy and other Department of Defense (DOD) entities use a contracting vehicle called the Spiral 3 Multiple Award Contract (MAC) that provides cellular and other handheld wireless services to Navy commands within all 50 states. Broadly, the Spiral 3 contract is set up with three participating vendors: AT&T, Verizon, and T-Mobile. For any given Navy command, they each submit to their local NAVSUP FLC contracting officer a list of their cellular and wireless requirements. These requirements are then solicited to the Spiral 3 vendors. A task order against the Spiral 3 contract is then awarded to the vendor that came in with the lowest-priced, technically acceptable offer. This contract model has consistently been able to keep domestic cellular costs down from older contract vehicles. However, costs have remained high for international services, with frequent cost overruns occurring due to overages in international service by various Navy commands. Our research found that high international costs were due to a combination of suboptimal contract language and not fully utilizing vendor competition. Better defined contractual language and better utilizing existing vendor competition should lower international wireless costs.

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CAN YOU HEAR ME NOW? INTERNATIONAL WIRELESS SOLUTIONS FOR THE DOD

Aaron J. Shinoff, Lieutenant Commander, United States Navy
Richard J. Wilson, Lieutenant Commander, United States Navy

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Approved by: Nicholas Dew
Co-Advisor

E. Cory Yoder
Co-Advisor

Rene G. Rendon
Academic Associate, Graduate School of Defense Management

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ABSTRACT

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LIST OF ACRONYMS AND ABBREVIATIONS

2G	Second Generation
3G	Third Generation
4G	Fourth Generation
5G	Fifth Generation
AOR	Area of Responsibility
BCA	Business Case Analysis
BPA	Blanket Purchase Agreement
CAA	Civilian Agency Acquisition
CENTCOM	Central Command
CICA	Competition in Contracting Act
CLIN	Contract Line Item Number
CONUS	Continental United States
COTS	Commercial-Off-The-Shelf
CRS	Congressional Research Service
DAR	Defense Acquisition Regulations
DASN(P)	Deputy Assistant Secretary of the Navy (Procurement)
DFARS	Defense Federal Acquisition Regulation Supplement
DOD	Department of Defense
DON	Department of the Navy
ELIN	Exhibit Line Item
EU	European Union
FAR	Federal Acquisition Regulation
FASA	Federal Acquisition Streamlining Act
FCC	Federal Communications Commission
FFP	Firm Fixed Price
FLC	Fleet Logistics Center
FLC SD	Fleet Logistics Center San Diego
FSSI	Federal Strategic Sourcing Initiative
GAO	Government Accountability Office
GB	Gigabyte

GCC	Gulf Cooperation Council
GSA	General Services Administration
GSM	Global System for Mobile Communications
GSMA	Global System for Mobile Communications Association
IGE	Independent Government Estimate
IOT	Internet of Things
KO	Contracting Officer
MAC	Multiple Award Contract
MB	Megabyte
MNO	Mobile Network Operator
MVNA	Mobile Virtual Network Aggregator
MVNE	Mobile Virtual Network Enabler
MVNO	Mobile Virtual Network Operator
NAVSUP	Naval Supply Systems Command
NMCARS	Navy–Marine Corps Acquisition Regulation Supplement
NTE	Not to Exceed
OCONUS	Outside Continental United States
OECD	Organisation for Economic Co-Operation and Development
OMB	Office of Management and Budget
OSS	Operational Support System
TO/DO	Task Order/Delivery Order
VPN	Virtual Private Network

EXECUTIVE SUMMARY

Like the U.S. commercial market itself, the federal government relies on the four major U.S. wireless vendors to fulfill wireless requirements: Verizon, AT&T, Sprint, and T-Mobile. Historically, the federal government has used myriad different government contracting vehicles to procure wireless services, with agencies often procuring these services either on their behalf with their contracting authority or through an intermediary, such as the General Services Administration. The Department of the Navy (DON) is on the third iteration of their wireless contract, the Spiral 3 contract. This contract has used competition among all the major U.S. wireless vendors and prepriced exhibit line items (ELIN) to provide competitive wireless pricing to DON customers on domestic services.

However, according to the Spiral 3 contract manager at Naval Supply Systems Command Fleet Logistics Center San Diego (NAVSUP FLC SD), the cost savings seen in the domestic sphere have not been seen in the international services provided under the Spiral 3 contract. Consequently, the NAVSUP FLC SD requested that we look into how NAVSUP might be able to obtain cost savings on the international requirements for DON customers. By determining the current gaps in acquiring international services and exploring why it is currently costly to acquire them, we show how the DON can acquire international services at a lower cost than it does currently.

Unlike the structure for domestic services, which has all Exhibit Line Items (ELIN) with set prices during the time of solicitation, all international services for DON customers are solicited for competitive pricing from all Spiral 3 vendors during the solicitation of that customer's requirements. To come up with a quote for international services, all Spiral 3 vendors were given anticipated usage for minutes and texts within each country that a DON customer was expected to travel within that year. Additionally, the structure allowed for unlimited international email usage, with a price ceiling in the contract at $16/month per line. This aligns with the standard commercial framework in which the largest U.S. wireless service providers have provided service to their customers when traveling abroad. Due to their agreements with wireless providers overseas, U.S. wireless providers tend to

charge their customers rates that are dependent on where they are traveling, with some countries having much cheaper rates than others.

Even though the structure of the Spiral 3 contract is that international service quotes are based on competition at the time of solicitation, the actual market for international rates under the Spiral 3 umbrella is extremely noncompetitive. Notably, the two vendors with the largest number of task orders under the Spiral 3 contract, Verizon and AT&T, have the most costly rate structures for their clients. In the course of examining market research provided by NAVSUP FLC SD with the main Spiral 3 vendors, we discovered that both AT&T's and Verizon's rate structures consisted of higher costs per minute and more texts taken on average across all countries than Sprint or T-Mobile, in addition to charging their customers $16/month per line for unlimited international data. Conversely, T-Mobile and Sprint both offered lower international rates than their competitors. Both offered unlimited international texts, flat voice rates of $0.20/min (T-Mobile) or $0.25/min (Sprint) for calls made in most countries, and unlimited international services included in the domestic ELINs under the Spiral 3 contract, which essentially made international data a free service provided by both vendors if services were acquired under one of their domestic ELINs.

Furthermore, our analysis looked at the surrounding market for wireless services to see whether there were any potential competitors outside the current Spiral 3 vendors. Even though the U.S. wireless market is dominated by these four vendors, mobile virtual network operators (MVNO) that use existing infrastructure from other wireless vendors to sell services to customers have been entering the market and providing customers with more competitive options. Notably, we examine the MVNO Google Fi and found that Google Fi's commercial rates for international services are more competitive than Verizon's and AT&T's government rates for international services under the Spiral 3 contract. Google Fi's model is similar to T-Mobile's and Sprint's with $0.20/voice minute and unlimited texting and data.

To do an accurate business comparison, we attempted to get bills and invoices from the vendors in order to analyze their charges and determine how much an actual DON command would have been charged by each vendor. However, given the COVID-19 pandemic, the data were not obtainable. Instead, the authors constructed a variety of

hypothetical usage scenarios for DON commands operating overseas based on the aggregate data that was available, with these scenarios varying in degree of command size, international phone usage, and so on. Based on these scenarios, we concluded that if all Verizon and AT&T accounts that used international service switched to Sprint, T-Mobile, or Google Fi, the government would experience the following cost savings:

- **Total Savings Verizon to Google: $1,019,397.76**
- **Total Savings Verizon to T-Mobile: $1,016, 878.72**
- **Total Savings Verizon to Sprint: $983,501.44**

- **Total Savings AT&T to Google: $4,129,034.40**
- **Total Savings AT&T to T-Mobile: $4,124,656.80**
- **Total Savings AT&T to Sprint: $4,066.653.60**

While these cost savings were based on improvised scenarios rather than actual data usage, our analysis highlights how much more costly the top two Spiral 3 providers are compared to their counterparts for international services.

Consequently, our recommendations to NAVSUP FLC SD are as follows. First, standardize all international rates into the next iteration of the Spiral contract rather than soliciting pricing from vendors at the time of solicitation. Second, bring more competition into the next Spiral contract. As can be seen from our analysis, a competitive MVNO such as Google Fi already offers better pricing for international services than the current providers on the Spiral contract. With the purchasing power available to the DON, these rates could get even lower if new vendors were added. Finally, the DON should ensure that end users better define their international requirements so that vendors with a more competitive international services rate structure have a better chance of winning those contracts. This would also ensure that end users do not become anti-deficient when they understate their international requirements and then go over their allotted dollar thresholds of services within their task orders.

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I. INTRODUCTION

As the technology for wireless cellular devices has made the use of smartphones ubiquitous in daily life for most U.S. citizens, it has also become a necessity for the daily operational needs of the U.S. military. Wireless cellular devices are often provided to a command's most essential personnel for official work functions, such as business calls and emails. Increasingly, personnel deploying or traveling need their command wireless devices as a "tether" back to their home unit or command for support, questions, and so on. To meet this increased demand for wireless cellular devices, many federal agencies—including the General Services Administration (GSA), Army, Air Force, and Navy—have all offered their own contract models for wireless services and their corresponding devices (Thompson, 2018). These contract models have been put in place within the last decade. At the same time, the contract models have been administered under a background of continual reform within federal contracting. Such reforms have included consolidating identical requirements to reduce the number of contracts written, bundling requirements to more effectively take advantage of the government's massive purchasing power, and leveraging commercial industry to maximize competition and lower prices among participating vendors.

The Department of the Navy's (DON) first modern wireless contract was the Spiral contract, with its first iteration, Spiral 1, being awarded in 2011. It is now on its third iteration, Spiral 3, and continues to be streamlined through each successive iteration to provide maximum operational support to the warfighter at the lowest possible costs. With Sprint joining the Spiral 3 contract near the end of 2019, all major U.S. cellular providers (i.e., AT&T, Verizon, Sprint, and T-Mobile) are now participating vendors. While unlimited data, voice, and texting plans are available under the Spiral 3 contract for domestic service, this is currently not an option for some of the international services provided by major vendors. Competition in the U.S. wireless telecommunication industry has been artificially limited by corporate lobbying and has declined largely due to policy influenced strongly by lobbyists' efforts and campaign finance contributions. Where pro-competition policies should have led to increased cost savings for the American consumer

without a decrease in service quality, this has not been the case in the wireless telecommunication industry (Philippon, 2019). Additionally, the contract managers still believe that even though competition and contract reforms have helped lower prices on domestic plans, international services under the Spiral 3 should have lower prices than they do currently (Ott, 2019). Consequently, we research the current international data services offered under the Spiral 3 contract and why the prices for international services are perceived to be much higher than they should be by the DON personnel who oversee the Spiral 3 contract.

A. RESEARCH QUESTIONS

The primary research question we intend to answer is

1. How can the Navy better acquire international cellular and wireless services than it does currently?

Secondary and related research questions that help answer our primary research question include

2. What are the gaps in international service currently, and how can the Navy fill them?
3. Why is it so costly for the Navy to acquire international cellular and wireless service?

B. CHAPTER OVERVIEW AND METHODOLOGY

To answer these research questions, we provide a thorough background in the U.S. telecommunication industry both domestically and internationally. This includes concepts such as the regulatory environment both in the United States and abroad. By analyzing international data rates under the Spiral 3 contract, we attempt to leverage innovation in both technology and the commercial world to determine a solution for the DON that might result in lower prices for international services than what are provided currently. The following list describes the contents of the ensuing chapters:

- **Chapter II:** A background on DON wireless contracts and a review of the commercial mobile telecommunication industry as a basis for comparing the level of competition in the mobile telecommunication industry and how the different players operate in the United States and globally.
- **Chapter III:** A literature review on federal contracting and the economics of the mobile telecommunication industry and the role of government regulations and market competition.
- **Chapter IV:** A presentation of the data collected, of the trends identified from the Spiral 3 contract, and of the international roaming fee structures of the providers within the contract.
- **Chapter V:** An analysis of the data collected and of the usage patterns that were identified to build a model using the international data rates identified. The model used identifies a clear heuristic view on which providers offer the best value to the Navy for international wireless services.
- **Chapter VI:** A summary of findings from our analysis and findings on international service gaps and the high cost of international wireless services. Additionally, a recommendation to improve future DOD contracts for wireless services is included, as well as recommendations for areas that may be beneficial for future studies.

Additionally, appendices are included to elaborate on our data for our basis of modeling and the detailed tables on modeling results.

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II. BACKGROUND

Chapter II provides relevant background covering the history of DON wireless contracts. It also includes an overview of the mobile telecommunication ecosystem and a description of the role of mobile network operators (MNO) and mobile virtual networks operators (MVNO), the process of international roaming, and the future of mobile telecommunication with the fifth-generation (5G) network.

A. DEPARTMENT OF THE NAVY WIRELESS CONTRACTS

Since 2009, the DON has been looking for avenues to "improve the acquisition and management of wireless services" (Thompson, 2015, p. 1), so they established a wireless commodity team to look into exploring improvement avenues (Thompson, 2015). The big deficiencies in the DON's acquisition of wireless orders included (a) no competition per issuance of each task order on a contract, (b) the large number of contract line item numbers (CLINs) associated with each task order, (c) plans not aligned with current commercial offerings, (d) lack of additional features available for many of the plans, and (e) no visibility across the DON on wireless usage rates (Thompson, 2015). These all led to detrimental effects for the DON's wireless acquisition structure. First, with no competition on task orders, the DON could not take advantage of the competition between U.S. wireless providers. Once a contract was written, those prices would be locked in against all subsequent task orders against that contract. Second, the sheer number of CLINs on each task order needlessly increased the administrative time it took to write each task order. Third, given that the Navy locked in plans when they wrote contracts, they were often unable to later take advantage of new commercial plans that might offer either new technology or similar services being provided but at lower costs. Fourth, lack of feature availability only hindered the customer—the warfighter—by not giving them the opportunity to outfit themselves with the most innovative commercial wireless technology available, especially when they were operating outside the continental United States (OCONUS). Finally, without usage rate data, the DON was unable to get a good grasp on their spend rate and usage rate on commercial wireless services.

In order to correct these deficiencies, the DON developed a plan that would maximize competition, simplify the contract structure of a task order to have one CLIN per task order, only put on contracts for orders that were being used by DON commands, look to optimize rate plan pools, improve wireless packaging with newer features, and define wireless metrics that would allow the DON to gain transparency on wireless spend and usage rates (Thompson, 2015). As a result of this corrective action plan, the DON developed a multiple award contract (MAC) vehicle for wireless services called the Spiral 1 contract in early 2011. This contract was spearheaded by a naval regional contracting office, Naval Supply Systems Command Fleet Logistics Center San Diego (NAVSUP FLC SD), and included potential contract awards to all four major wireless providers, which are AT&T, Verizon, Sprint, and T-Mobile (Thompson, 2011). This contract met corrective actions by

- offering only plans that had historical DON usage;
- ensuring that all plans were competitively priced;
- standardizing rates among all eligible competitors to maximize competition between them, leading to lower pricing;
- taking advantage of innovation and changes within the marketplace;
- providing the DON with real-time wireless usage rates and spending; and
- allowing for the ability to optimize rate plans by sharing and pooling data and minutes. (Thompson, 2015, p 3)

In 2012, NAVSUP FLC SD introduced a successor to their Spiral 1 contract, the Spiral 2 contract, which further capitalized on the features that originated in the Spiral 1 contract. As a result of the implementation of the Spiral 1 and 2 contracts, between Fiscal Year (FY) 2012 and FY2014, the DOD eliminated 14,414 excess phone lines, reduced average cost per wireless device by $5.45, reduced OCONUS roaming costs by 55%, and increased the minute utilization rate by 150% (Thompson, 2015). Additionally, since the start of FY2011 through FY2014, NAVSUP FLC SD estimates that they have saved the government $51.9 million through the utilization of these contract vehicles (Thompson, 2015).

Around the time that NAVSUP FLC SD rolled out the Spiral 1 contract, the Government Accountability Office (GAO) voiced criticism, government-wide, of the

inefficiencies in MAC award trends that would have large ramifications on the Spiral contract going forward. In their report to Congress titled *Opportunities to Reduce Potential Duplication in Government Programs, Save Tax Dollars, and Enhance Competition,* the GAO highlighted two major issues with MAC contracts as used at the time in government (Dalton & St. Laurent, 2011). The first issue was that there was no government-wide, comprehensive view of outstanding contracts that government agencies could use to determine whether there were open contracts that could meet their needs, which itself posed two problems. First, if agencies recompeted similar requirements that could have been covered under one contract but instead covered different contracts and possibly different vendors, the government loses an opportunity to leverage its large buying power to lower prices (Dalton & St. Laurent, 2011). When the government can consolidate its requirements, businesses might be more apt to lower their prices to get a large sale. Second, when a redundant contract is written, that is just an unnecessary burden on an agency's contracting department, essentially resulting in duplicate work for a requirement that could have been fulfilled elsewhere.

Besides the government being unable to leverage its buying power, the use of excess or redundant contracts actually leads overall contract cost to come in higher than it would have had contracts been efficiently utilized across agencies. Many of these costs could end up being very significant. Vendors accrue administrative costs in preparing bids for government contracts, which are then passed to the government if the vendor wins the award. Based on feedback from vendors, the GAO estimated that additional costs in redundant contracts ranged from $10,000 to $1 million (Dalton & St. Laurent, 2011). Had agencies utilized existing contracts, these excess vendor costs would have disappeared.

Even though the GAO recommendations are nonbinding, federal agencies typically take them very seriously and do what they can to comply with them. In September 2011, Daniel Gordon, administrator of federal procurement policy in the Office of Management and Budget (OMB), released a memorandum highlighting the corrective action that federal agencies would need to take as a result of the GAO's recommendations. Moving forward, all federal agencies were required to do a business case analysis on all new or renewal of existing "GWACs [Government-Wide Acquisition Contracts], MACs, Blanket Purchase

Agreements (BPAs), and agency specific contracts" (Gordon, 2011, p. 1). The intent with this requirement was to force agencies during their procurement research to determine whether existing contracts could cover their new requirement. If contracts do exist, and if it is financially feasible to do so, federal agencies need to use those contract vehicles or justify why they are not using them. The requirement to determine adequate use of existing contracts might also be seen as an explicit extension of Federal Acquisition Regulation (FAR) Part 10 on market research, which mandates that a federal agency must determine whether sources exist to satisfy their requirement. In the course of market research, other agency contracts could be found, which would show that a vendor could satisfy this requirement as they already had a contract with another agency for it. However, since there was no explicit requirement to explore using these existing contracts, agencies were free to execute their own contracts.

In 2015, when NAVSUP FLC SD started to get ready to transition to the next iteration of their wireless contract, Spiral 3, they were required to do a business case analysis (BCA) as a result of the aforementioned OMB mandate (Gordon, 2011). When they completed their BCA, NAVSUP FLC SD found that two other wireless contracts could be utilized. There were the Federal Strategic Sourcing Initiative (FSSI) wireless Basic Purchase Agreements administered by the General Services Administration (GSA) and the Army/Air Force next-generation wireless contracts, administered by those service branches. After conducting research into their respective contract structures, NAVSUP FLC SD determined that these contracts were not as cost-efficient as the Navy's current Spiral contract, as the features that made the contracts so cost-efficient were not present in either the GSA's or the Army/Air Force's existing wireless contracts (Thompson, 2015). Consequently, the DON determined that based on this BCA, the most financially prudent decision to make would be to continue on with their next iteration in the series, Spiral 3.

In 2017, the Navy awarded its follow-on Spiral 3 contract to three vendors: T-Mobile, Verizon, and AT&T (Hill, 2017). In doing so, the Navy continued to capitalize on the efficiencies that were initiated by Spiral 1 and Spiral 2 contract vehicles and used the previous contracts efficiencies to provide great value for DON customers.

As seen in Figure 1, the Navy's Spiral 3 contract offered better prices to customers than almost every other federal wireless vehicle for participating vendors. Additionally, the Navy's contract was the only one of all the contracts compared that offered completely unlimited data and minutes. While all the other government contracts advertised unlimited data, none of them advertised unlimited minutes. Even in those few cases where another government contract, such as GSA Schedule 70, could provide a cheaper price with a vendor, they did not offer as robust a service as the Navy's contract. So even where it might be more expensive, a customer choosing between the two might determine they were better off paying more when the trade-off was better operational capability.

Figure 1. Federal Wireless Contract Price Comparison. Adapted from Thompson (2018).

As the DON showed with each iteration of their Spiral contract model, they continued to achieve efficiencies and cost savings on wireless services agency-wide while still ensuring they could support the warfighter's requirements. Meanwhile, the OMB focused their earlier efforts on reducing federal contract duplication onto federal wireless contracts, which would ultimately lead to the Spiral 3 contract being adopted DOD-wide for all wireless CONUS services. In 2016, Anne Rung, the OMB's chief acquisition officer, and Tony Scott, the OMB's chief information officer, released a joint memorandum further addressing the need for remedies of excessive duplication of wireless contracts across the government. They noted that there are over 1,200 separate contracts for awards, and almost all went to the four main U.S. wireless providers (Rung & Scott, 2016). The OMB's guidance to government agencies in this memorandum was to reduce the number of existing contracts for wireless service and, if possible, transition to a government-wide contract (Rung & Scott, 2016).

Consequently, the DOD attempted to enact this OMB guidance within its own agency. In 2018, DOD Chief Management Officer John Gibson released an official memorandum stating that, in accordance with Secretary of Defense Jim Mattis's guidance to streamline requirements and acquisition processes, all DOD agencies would be directed to procure all unclassified, wireless services in the continental United States (CONUS) through the DON Spiral 3 contract, which—between its base year and 4 additional option years—is expected to run from 2017 through 2022 (Gibson, 2018). In order to potentially cover this increased demand, the entire contract ceiling of the Spiral 3 contract was $993.5 million (Thompson, 2018). The DOD made this decision after a stringent review of all DOD wireless contracts, finding that, overall, the DON Spiral 3 contract provides the "best value" to the customer across the spectrum of DOD wireless contracts (Gibson, 2018).

B. COMMERCIAL MOBILE TELECOMMUNICATION INDUSTRY

Since 1837, when Samuel Morse invented the telegraph, the way people communicate with one another across great distances has been rapidly advancing and changing. In just under 40 years, Alexander Graham Bell would invent the telephone, and in fewer than 100 years after that, Motorola would invent the very first mobile phone.

Mobile telecommunication services are a necessary aspect of daily life. The mobile telecommunication ecosystem is made up of a global industry including several layers and markets that work together to provide services to the consumer. The layers in this industry can be broken down into hardware and service providers on the highest level and can be further segmented into the types of service providers. However, the forces at work within industries across different areas are quite different for many reasons, including federal regulations and customer preferences (O'Neal & Dixon, 2011).

1. The Mobile Telecommunication Industry

The mobile market has many different parts, including end users, services providers, and hardware/software distributors. In the arena of telecommunication, there are many types of operators. Some of these could be considered fixed operators and some mobile. For this study, we focus on the mobile sector. Businesses have started to increasingly offer fixed and mobile services simultaneously, leveraging agreements with other businesses. Even though the market is dominated by a small number of providers, it also includes smaller regional service providers (Wakefield et al., 2007).

A divided but synergistic industry provides voice and data to meet growing demand. The major entities consist of those who operate the telecommunication infrastructure, those who deliver hardware to customers, and those who create content that customers get with their mobile devices (O'Neal & Dixon, 2011). MNOs are companies or organizations that are licensed to operate and have the necessary hardware to provide radio coverage and telephone services. MNOs own, run, and sustain all the telecommunication equipment themselves or hire contractors to run and sustain the equipment on their behalf. The MNO must have a license to operate a specific part of the radio spectrum and must set up the infrastructure required (e.g., acquiring sites, building radio stations, etc.) to provide capacity on those parts of the radio spectrum on which it has a license to operate (Balon & Liau, 2012). Governments typically keep a close hold on the number of MNOs through regulation and control of the mobile spectrum, mostly to ensure that monopolies are not created.

The end user is not strictly limited to MNOs in their pursuit of mobile services. There is a whole market of service providers that do not own or operate a mobile infrastructure—such as Google Fi, MetTel, and Boost Mobile—which are labeled as mobile virtual network operators (MVNO). An MVNO will brand all hardware and services provided as its own, but in reality they have set up an agreement with an MNO that sells the MVNO both the hardware and wireless capacity necessary to provide to their customers (Wakefield et al., 2007). There are several definitions of an MVNO and explanations of how they differ from other mobile service providers, which are explored further in other sections of this study. Depending on the size and customer base of an MVNO, they may utilize the services of a mobile virtual network enabler (MVNE).

The third leg of the mobile telecommunication industry triumvirate is an MVNE, which provides network infrastructure and other ancillary services to an MVNO. The services that MVNEs provide allow MVNOs to offer mobile telecommunication service to their customers with their brands without having the administrative overhead that a typical MNO requires. Different from an MNO or MVNO, an MVNE does not provide services directly to the consumers but is a provider to the providers, giving the MVNO the capability required for them to provide services to the customer (Wakefield et al., 2007). Related to an MVNE is a mobile virtual network aggregator (MVNA). While an MVNE provides required hardware/software capability to an MVNO, an MVNA is better understood as a business model (O'Neal & Dixon, 2011).

Figure 2 highlights how all three legs of the of the triumvirate interact with each other.

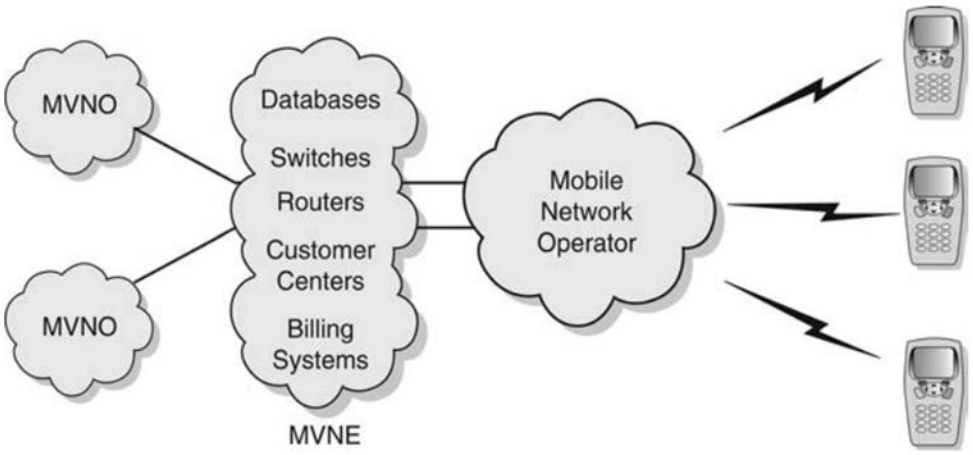

Figure 2. Mobile Virtual Network Enabler. Source: Wakefield et al. (2007).

Over the past two decades, the mobile telecommunication infrastructure has been growing globally, allowing access to mobile services across the majority of the populated areas in the world. In 2019, over five billion people had some type of mobile service (GSMA, 2019). The mobile telecommunication industry accounted for 4.7% of gross domestic product worldwide, a value of approximately $4.1 trillion (GSMA, 2019). Additionally, the industry employs 30 million people and provides tax revenue of $490 billion (Hatt & Robinson, 2020). According to Bogdan-Martin (2020), 97% of the global population lives in proximity of a cellular signal, and 82% have access to a fourth-generation (4G) or higher broadband. Figure 3 highlights the increasing growth of mobile subscriptions globally, while Figure 4 shows the ever-increasing availability for the global population to obtain higher mobile-broadband services.

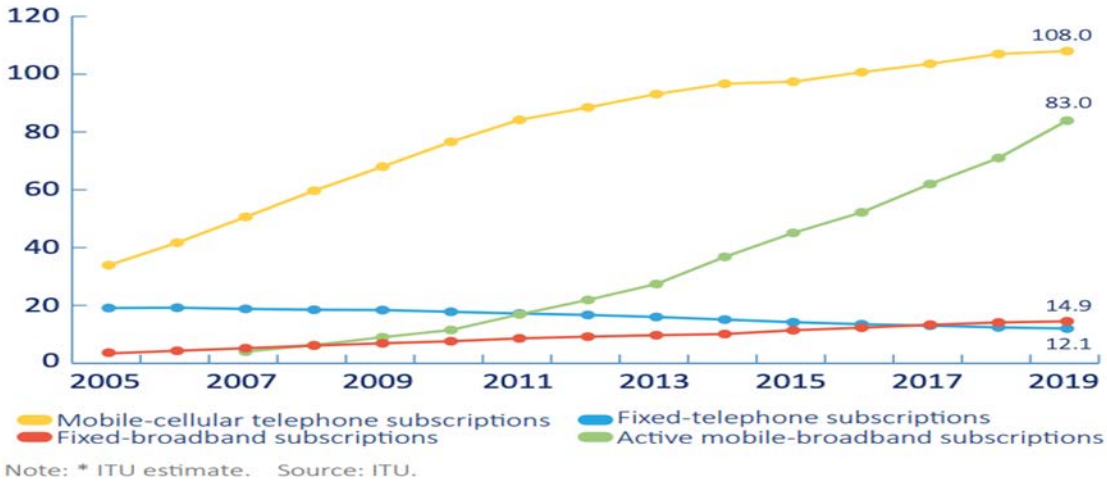

Figure 3. Evolution of Mobile and Fixed Trends, 2005–2019. Source: Bogdan-Martin (2020).

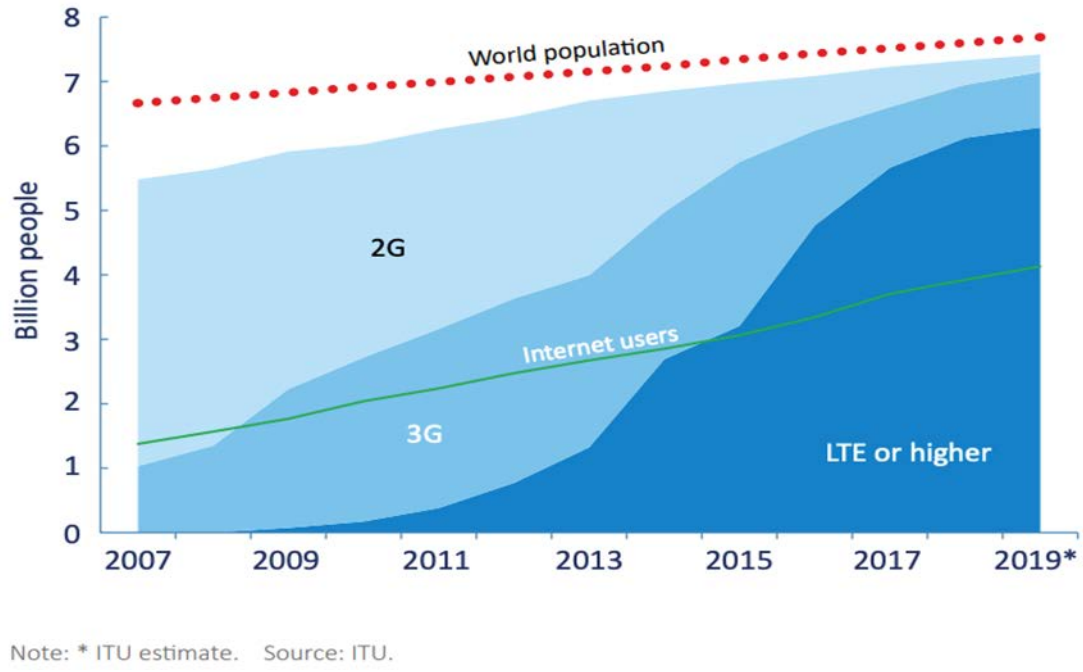

Figure 4. Mobile Population Coverage. Source: Bogdan-Martin (2020).

2. Mobile Network Operators

A mobile network operator (MNO) provides wireless voice and data services for the end user. An MNO owns the complete telecommunication infrastructure that it operates

(Wakefield et al., 2007). MNOs also own and operate the infrastructure required to enable the services they provide. The basic infrastructure includes many base stations that provide network access to mobile subscribers (Cricelli et al., 2011). Besides providing voice capabilities, MNOs also provide data services in the forms of texting and internet. In the traditional business model for mobile telecommunication, the MNO provides all of these capabilities, but a growing player in the mobile telecommunication space is the MVNO provider.

An MNO receives a license from the U.S. government to utilize a specific frequency band in a specific area, commonly referred to as *spectrum*. The regulating body for these licenses is the Federal Communications Commission (FCC), which is responsible for selling off spectrum for a given area (typically through an auction system), ensuring that no single MNO holds a monopoly over any given area (Federal Communications Commission [FCC], 2017). The MNO acquires network infrastructure and operates and manages it. The mobile telecommunication industry refers to these areas as the operational support system (OSS; Wakefield et al., 2007). The MNO supports a large swath of business, which creates the opening for specialized companies that focus around a single core competency, hence the existence of MVNOs.

3. Mobile Virtual Network Operators

A mobile virtual network operator (MVNO) is a mobile service provider that do not own spectrum rights or (typically) network infrastructure. Rather, MVNOs purchase, rent, or—through some other agreement with MNOs—buy spectrum use to sell to their customers. The services MVNOs offer are similar to those of MNOs, but they offer additional benefits such as brand appeal (Michael & Salter, 2006). MVNOs that have had success are the ones whose operations are indistinguishable from those of an MNO. Independent MVNOs have the potential to offer product bundling that MNOs cannot match, such as a hypermarket MVNO offering a package of MVNO services along with other shopping rewards within the hypermarket. MVNOs have complete control over all facets of their operations, with customer service operations being just one example (Lehikoinen et al., 2014).

Typically, MVNOs target specific markets related to their business customer base through diversification of the mobile telecommunication market. An MVNO's objective is to create a consumer of their mobile service. Within the MVNO market, there exist many different niche markets: low-cost MVNOs with no contracts (pay-as-you-go) leverage the MVNOs' existing commercial service, marketing, and distribution and offer more aggressive prices, and cultural or age-related MVNOs (such as Boost or Jitterbug) target customers with specific backgrounds (Balon & Liau, 2012).

In 2016, the largest MVNO was the American company TracFone Wireless (TracFone). However, other big tech companies have entered into the market. Google launched Project Fi, which capitalizes on the existing networks of T-Mobile and Sprint (FCC, 2017). Google Fi is innovative in the MVNO game because it automatically transitions between networks based on better coverage while also automatically connecting to Wi-Fi hotspots. Additionally, it is widely available globally, as it currently services over 170 countries (Raphael, 2019).

We have thus far talked about the role of the MNO and the role in a competitive market that the MVNO plays and how they provide service to their subscribers within their coverage area. Things get a little more complicated when users are outside their network coverage area, which the mobile telecommunication industry refers to as roaming.

4. International Roaming

Mobile service providers can offer coverage outside of the areas covered by their infrastructure through roaming arrangements, which give their end users the ability to automatically receive coverage from other mobile service providers' networks. Where an MVNO purchases capacity wholesale to provide to its customer, a provider uses roaming services to market extended coverage for users living in its own coverage area but not to acquire new users living outside of it (FCC, 2017). Roaming enables a mobile subscriber to automatically perform all cellular functions that it would have access to under their own network.

Roaming is reliant on agreements between network providers, with national roaming being based on agreements between providers within the same country and international

roaming being based on agreements between providers in different countries (Mauro & Arancibia, 2012). Figure 5 provides a visual representation of international roaming.

Figure 5. International Roaming Overview. Source: Mauro & Arancibia (2012).

Global System for Mobile Communications (GSM) roaming allows a subscriber to roam in over 200 countries using one continuous phone and number (Faylor et al., 2012). The way this works is depicted in Figure 5. When the user is in a different country, their phone automatically attempts to connect with a local network. The visited network picks up the connection and automatically determines whether it is allowed within its own network, which is based on whether that customer's network provider and this local provider have a preset roaming agreement. If so, the phone connects automatically to the local network (Mauro & Arancibia, 2012). All this is done seamlessly and instantaneously, so the user does not recognize any appreciable difference in service between their home network and that provided through the international partner. This ease of use does come at a high cost to the customer based on a number of factors.

Across the board, prices remain very high for international roaming rates compared to those rates available through local national providers. Even though wholesale pricing on roaming has gone down, the prices for retail roaming rates have not (Organisation for Economic Co-operation and Development [OECD], 2013). International roaming is different from most telecommunication markets in that the wholesale and retail aspects are within separate countries. Numerous factors contribute to the unequally high prices that consumers pay for international roaming, including tariffs and fees related to the

agreements the mobile service providers have with their international partners (Faylor et al., 2012). While the number of mobile users has been increasing at a steady rate globally, the number of those users using international roaming has not increased at the same rate, which is yet another contributing factor to an unequal reduction in prices. Another factor that needs to be explored is how prices across the market may be affected in the future with technological advancements in mobile communications. The future lies in the 5G network.

5. 5G and the Future of Mobile Telecommunication

Previous generations of mobile networks have grown from allowing voice communication to providing internet access on our mobile devices. Fifth-generation (5G) technology is anticipated to fundamentally change the telecommunication industry (Marsch et al., 2018). 5G is also expected to enable the connection of many devices virtually, which the tech industry has come to describe as the *Internet of Things* (IoT), creating a single connected network (Calabuig et al., 2015). 5G is poised to be the center of the next telecommunication transformation, building on the previous successes of second-generation (2G), third-generation (3G), and 4G networks (Oughton et al., 2018).

In theory, 5G networks can provide data rates 10 to 100 times faster with latencies of up to 10 times smaller than currently available with 4G networks. With better performance come better and more efficient technology, using more spectrum bandwidth and more network densification (Rost et al., 2015). 5G will move data faster, creating a significantly better customer experience—even providing an alternative to broadband services and opportunities for a new customer base. While much focus is on potential 5G speed, faster speeds do not necessarily equate to better customer experience (Pujol et al., 2016). Besides offering a *faster* internet, a 5G experience is expected to offer possibilities heretofore unimagined.

With its promise for increased performance, 5G also requires increased resources. America's wireless companies have spent $275 billion on 5G research and infrastructure. Current estimates are that 5G technology will create three million jobs and infuse the economy with $500 billion (Global System for Mobile Communications Association [GSMA], 2019). The speed of transmission and low latency that 5G will offer will make wire lines as obsolete

as the telegraph, but to be successful in its development it will require investment from much more than just the mobile telecommunication industry in the infrastructure that will need to be built to support the new network. There not only needs to be infrastructure investment but also an expansion on the available spectrum, which has historically been reserved for military use, for radars and other such equipment, to allow the vast deployment of 5G (Vergun, 2019).

While previous broadband technology could not meet military requirements, the military expects 5G to have massive potential for them (Kenyon, 2020). 5G provides reliability and security capabilities that previous broadband networks did not (Freedberg, 2020). These capabilities mean that 5G will be key technology for the DOD. One example is Smart Base, which would use the IoT to send data between base installations (Temin & D'Itri, 2020). As more technology is used by the DOD, there is a burgeoning requirement to manage the data flow used by this technology, and the DOD's investment in the future of 5G is integral to its successful implementation. This massive undertaking will not only require nontraditional players' input but will also require cooperation among traditional service providers to build up the required infrastructure. Results will not just be an improved use and customer experience but may present new opportunities for how the end user chooses their service provider outside the traditional MNO and MVNO options. As the implementation of 5G networks becomes more global, the cost of using the infrastructure should be expected to decrease as competition and availability increase. As such, the agreements that the MNOs have with international partners should translate to lower costs for the customers using international roaming while abroad. Another potential area for savings is the potential for open network access that does not require users to have contracts with particular providers but to pay for use similar to the design of some MVNOs.

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III. LITERATURE REVIEW

Chapter III provides a relevant literature review covering federal contracting and the economics of the mobile telecommunication industry including the role of government regulations and the mobile market's role in competition.

A. FEDERAL CONTRACTING

Besides the surrounding literature review on the telecommunication industry, a literature review on the Spiral 3 contract must also focus on the regulations that bind the contract, and all government contracts are governed by the Federal Acquisition Regulation (FAR). The FAR itself incorporates both federal acquisition law as well as any other additional guidance that is incorporated as a result of meetings from two separate councils, which are the Defense Acquisition Regulations (DAR) Council and the Civilian Agency Acquisition (CAA) Council. Between the two councils, which hold representation from all major federal agencies, they determine the revisions to make through periodic updates of the FAR (FAR 1.2, 2019). Furthermore, DON contracts must adhere to two additional supplemental regulations. The first is the Defense Federal Acquisition Regulation Supplement (DFARS), which is a supplemental regulation to the FAR that all DOD agencies must follow in addition to the FAR. This instruction itself is overseen by the DAR Council (DFARS 201.2, 2020). Additionally, Navy contracting officers (KO) must also follow the Navy–Marine Corps Acquisition Regulation Supplement (NMCARS), which is itself a supplement to both the FAR and the DFARS. The NMCARS is administered and maintained by the Office of the Deputy Assistant Secretary of the Navy for Procurement (DASN[P]; NMCARS 5201.1, 2018).

As a contract for commercial services, the Spiral 3 ensures compliance with the competition requirements of FAR Part 6 by maximizing full and open competition (FAR 6.1, 2020). Full and open competition, "when used with respect to a contract action, means that all responsible sources are permitted to compete" (FAR 2.101, 2020). Competition in federal procurement goes as far back as 1781, when the federal government solicited multiple proposals from food suppliers for federal employees working in Philadelphia

(Manuel, 2011). Competition has often been seen as having many positive impacts by (a) promoting accountability by contracts getting picked on their own merits, (b) allowing the government to be good stewards of taxpayer money by buying the best goods at the cheapest prices, and (c) providing transparency to the taxpayer who can see that contracts are being awarded on a justified playing field via competition versus some type of favoritism by the government (Manuel, 2011). Although competition was recognized as favorable both as a policy goal and an avenue to achieve cost savings, the legislators who wrote the Competition in Contracting Act (CICA, 1984) did identify that maximum competition would eventually have diminishing returns and that there were reasonable exceptions to not having competition in some cases, so the verbiage "full and open" was used instead (Manuel, 2011).[1] While there are certainly many potential exceptions to CICA and FAR Part 6, those exceptions cannot be unilaterally waived by the KO at their discretion, especially as the monetary thresholds of these contracts increase. Given that the price ceiling of the Spiral 3 contract is almost $1 billion, the only authority to waive CICA requirements at this threshold would be the undersecretary of defense for acquisition and sustainment (CICA, 1984).[2]

The competition requirements for the Spiral 3 contract outlined in FAR Part 6 result directly not just from CICA but also from the Federal Acquisition Streamlining Act (FASA, 1994). FASA was signed into law in 1994 and had a lot of influence on the MACs, of which Spiral 3 is one type. Under this contract model, multiple vendors are eligible to be awarded task orders for services. This is different from single award task order/delivery order (TO/DO) contracts, where multiple vendors all bid for a specific TO/DO contract, but once awarded to a single vendor, all TO/DOs written against that contract are provided by the specific vendor that originally won the award. Due to this, these single award contracts are sometimes called *monopoly contracts* (Manuel, 2011). MACs, on the other

[1] FAR 6.2 (2020) and FAR 6.3 (2020) both highlight the exceptions to full and open competition as is typically mandated. FAR 6.2 highlights exceptions to full and open competition when a procurement can be set aside to specific sources rather than being open to full competition. FAR 6.3 highlights those occasions (e.g., when only one responsible source is available) where full and open competition is not required.

[2] Within the DON, this authority can be delegated down either to (a) any assistant secretary of defense or (b) an O-7 or higher or their GS equivalent (CICA, 1984).

hand, still provide another level of competition, by allowing multiple vendors within a specific MAC structure to all bid on each TO/DO that is up for an award. Language in the FASA also maintains a preference for MAC over single award TO/DO contracts due to this increased competition level (Manuel, 2011).

As a service contract for commercially available wireless services, the Spiral 3 contract falls under FAR Part 12 (2020), "Acquisition of Commercial Items." Even if these commercial companies did have noncommercial services that were potentially available, the contracts themselves specifically cite that the services being acquired are for commercial products (SAM, 2017c). FAR Part 12 (2020) streamlines many acquisition requirements if the item is commercial-off-the-shelf (COTS), which makes the item easier and quicker to procure than non-COTS material and services. Additionally, the contract type mandated for COTS material is firm-fixed-price (FFP; FAR 12.2, 2020). This contract type provides the least risk to the government, as the contractor must deliver a product or service specified in the contract at an agreed-upon price, which is irrelevant to the actual costs that the contractor might end up accruing to execute the contract. Additionally, the contractor does not get paid at all if they do not deliver the product to the government.[3]

The Spiral 3 contract, as currently set up, adheres to many of the central tenets of the FAR. It is important to highlight a few of these, as many potential contract solutions to the current issues with the Spiral 3 contract will need to share many of these same features. First, for costs to be allowable within a contract, they must be considered reasonable (FAR 31.201, 2020). *Reasonable* is defined as a cost that "does not exceed that which would be incurred by a prudent person in the conduct of competitive business" (FAR 31.201, 2020). While not itself an automatic qualifier for a reasonable cost, competition goes a long way towards a cost being reasonable (i.e., one could imagine a scenario where a paper clip is quoted as being hundreds of dollars by multiple vendors, and while this paper clip has competition, none of these prices would be considered reasonable by a prudent person). In the case of the Spiral 3 contract, the costs provided by all vendors could then be compared

[3] Under the other major type of contract model, cost reimbursement, the government takes on more risk as it shares costs with the contractor in the performance of the contract, regardless of whether a final product is ever actually delivered.

with not just each other but also with the rates provided by other vendors in the commercial marketplace for wireless services, providing more than enough justification to determine whether the costs within the Spiral 3 contract could be construed as reasonable.

Besides the fact that competition is typically the best way to lower prices for government and that it is a great indicator that a cost is reasonable, competition also allows the government to avoid forcing contractors to provide costly certified cost and pricing data to the KO to show that the costs in their contract are current, accurate, and reliable. Two exceptions to this include if the items or services being procured are either (a) commercially available or (b) have adequate price competition (FAR 15.4, 2020). Adequate price competition requires that (a) there are at least two responsible offers, where *responsible* means that a vendor can perform the contract requirements as set in the solicitation; (b) the award is made based on best overall value but where price retains significant weight in the award decision; and (c) the price of the successful offeror is not otherwise unreasonable (FAR 15.4, 2020). Since the Spiral 3 contract meets both of these criteria, it does not force vendors to provide certified data, which would otherwise increase their upfront administrative costs in both time and money. Based on many of the central tenets of the FAR, the Spiral 3 contract provides a highly competitive, commercial solution to provide the best capability to the warfighter than it would already have while also taking advantage to attract more vendors and keep costs low.

B. ECONOMICS OF THE MOBILE TELECOMMUNICATION INDUSTRY

Competition is the cornerstone of any market, which is especially true for the mobile telecommunication industry. When multiple providers compete for customers, there is incentive to offer superior products and competitive pricing. In September 2017, the FCC released its *20th Annual Report and Analysis of Competitive Market Conditions with Respect to Mobile Wireless, Including Commercial Mobile Services,* which stated that "there is effective competition in the marketplace for mobile wireless services" (FCC, 2017, p. 70). While there are differing opinions among those at the FCC, the industry, and the consumers on how they define *effective,* it is clear that competition is integral to the quality of service and innovation from mobile service providers. The economy in the

industry is shaped by government regulation, domestically and internationally, of mobile telecommunication and market forces.

1. Government Regulation and Competition

The Communications Act of 1934 established the FCC to control the radio and telephone industry monopolies, such as Bell Telephones and AT&T. In the following years, the FCC often appeared as a special interest for the major telecommunication firms. Key elements of the Telecommunication Act of 1996 were meant to stop FCC protectionist behavior and deregulate the industry (FCC, 2013). Unfortunately, the act did not provide the FCC with the tools or legal authority to deregulate the industry. Following the passage of the Telecommunication Act (1996), the FCC created piles of new regulations but did not have much effect on creating a competitive market.

In *The Great Reversal: How America Gave Up on Free Markets*, Thomas Philippon (2019) discusses how competition in the U.S. cellular market is artificially limited by corporate lobbying. He states that "competition has declined in most sectors of the U.S. economy [and] … the lack of competition is explained largely by policy choice influencing by lobbying and campaign finance contributions" (Philippon, 2019, p. 9). He argues that pro-competition policies could lead to increased cost savings for the American consumer without a decrease in service quality. This is arguably the purpose of the FCC, but regulations have failed to shape a truly competitive market in the United States.

The interaction between technological advancement and regulation have had drastic effects on the industry as a whole. Essentially, protectionist regulations in favor of the big telecommunication companies have precipitated changes to the structure of the industry itself among the big companies, which has drastic implications on telecommunication technology advances. With such a highly regulated market, it is hard for newcomers to enter (Trubnikov, 2017).

Entering the mobile telecommunication industry depends on the ability to obtain radio resources such as spectrum. Only very limited parts of the radio spectrum worldwide are freely available, with the most commercially viable radio resources being under government control, thereby making it impossible for newcomers to enter the industry and

provide disruption and competition. Even in the capitalist market society of the United States, it has always been social utility desired by the government that has allowed the big telecommunication companies to maintain a stranglehold on the industry (Trubnikov, 2017). While competition promotion is often a goal in the U.S. market economy, the telecommunication industry's market share is increasingly owned by only a few companies. Trubnikov has put forward the idea that

> regulation of telecommunication has evolved since the appearance of the industry, addressing its efforts to new issues that have been arising with the development of the technology. … The ideas that radio spectrum, or, at least, some of its parts, represents a common resource that should be returned to the realm of commons have become popular among many scholars. (Trubnikov, 2017, p. 414)

This plays on some of the ideas of net neutrality, in that access to broadband should now be considered a human right, and the government regulation of who has access to spectrum is not just a question of economic policies but also social policies.

The paper *Political Determinants of Competition in the Mobile Telecommunication Industry* presents how political factors shape competition in the mobile telecommunication sector (Faccio & Zingales, 2017). Limited competition in the mobile telecommunication sector, particularly in the United States, drives mobile communication prices well above the price for the same quality service in similarly developed countries (Faccio & Zingales, 2017). Faccio and Zingales (2017) establish connections between mobile service operators and politicians who create or support rules that limit competition in the mobile telecommunication sector through the process used by the FCC when selling available radio (spectrum) allocations:

> In designing regulation governments want to restrict competition to raise more revenues in the spectrum's auctions. A necessary condition for this motive to be a relevant factor in regulation is that indeed less competition among mobile operators leads to higher revenues in spectrum auctions. Theoretically, it could go both ways. On the one hand, less competition means a higher value of the spectrum to the few winners. On the other hand, less competition also means fewer potential bidders to the auction. (Faccio & Zingales, 2017, p. 19)

Faccio and Zingales (2017) argue that the presence of rules that limit competition is associated with higher concentration, profit margins, and prices. Most importantly, globally they find that the presence and magnitude of the connections between mobile operators and the political system, either through lobbyists or even the regulators themselves, correlate negatively with the presence of pro-competition regulation (Faccio & Zingales, 2017). The lobbyists and politicians argue that limited competition results in better quality for the consumer:

> Yet, we do not find any evidence that rules that are more pro-competition lead to lower quality of service or decrease investments in the mobile telecommunications sector. If any, the evidence is mildly supportive of the opposite claim. Thus, pro-competition rules clearly benefit consumers, while hurting producers. (Faccio & Zingales, 2017, p. 4)

Faccio and Zingales conclude that political connections create limited competition, with no clear efficiency or benefits. While these rules lead to higher profits for the industry and higher prices for consumers, there is no evidence that they lead to better quality, more investments, or higher wages (Faccio & Zingales, 2017). It is important to understand the political effects on limiting competition in the mobile telecommunication industry because more competition results in lower prices for the consumer and improved service. While global regulation strongly affects the level of competition in each country, it is further complicated when it comes to international roaming agreements.

The Organisation for Economic Co-operation and Development (OECD, 2013) has recommended several measures that should be adopted globally to provide a more competitive market and better prices to the consumer. While international roaming rates have gone down in recent years, the international rates have not experienced the same downward trend as have national rates. Since the wholesale and retail markets for international roaming are in different countries, it is hard for individual country policy-makers to affect forceful action to lower international roaming rates (OECD, 2013).

Occasionally, national and international roaming rates can be comparable, such as in the United States, where there is no single nationwide provider of wireless services.

> The United States provides one example where an operator with access to lower wholesale rates coincided with a commercial desire to build retail

> market share. AT&T Wireless had bought a mobile operator (McCaw Communications) and established a significant network footprint across the United States market which was larger than that of any of its competitors. (OECD, 2013, p. 10)

For the most part, international roaming agreements are dependent on companies coming to usage agreements with other international mobile providers.

Exceptions exist where strong trade agreements exist, such as within the European Union (EU) and the Gulf Cooperation Council (GCC): "Some regions have effectively eliminated roaming on certain bilateral routes. However, such developments are normally the result of a combination of deep regional economic integration and a significant degree of operator integration across borders" (OECD, 2013, p. 23). The OECD has recommended that if countries are to attempt to artificially control prices, they will require immense cooperation with other countries given the current market structure.

2. Market Competition

The commercial mobile telecommunication ecosystem is a worldwide industry that contains subindustries and markets that operate in conjunction to provide a product to the customer. These subindustries, or regional industries, "are generally separated by geographic boundaries…the dynamics within industries in different regions can vary significantly due to a multitude of factors such as government regulations and consumer tastes" (O'Neal & Dixon, 2011, p. 11). Integral to understanding the space for market competition in the industry is the interplay of MNOs and MVNOs in creating competition and more opportunities for the customer as an interchangeable product.

MVNOs are valuable to the industry as a whole, providing affordable rates to customers and profits to MNOs by utilizing their excess and unused bandwidth. An MVNO signs an agreement with an MNO to utilize all the same services that the MNO offers to its own customers. Hypothetically, this means that any company could act as an MVNO as long as they have the funding available to rent or buy what they need from the MNO (Ekanoye et al., 2018). The MVNO business model has historically been driven by three strategies: segmentation-driven strategy, network utilization–driven strategy, and product-driven strategy. In segmentation-driven strategy, the MVNOs do not generate revenue for

MNOs but allow them to access market segments that they had not previously. In network utilization–driven strategy, an MVNO helps an MNO use excess capacity through targeted marketing. The product-driven strategy involves marketing to customers who have specialized service requirements (O'Neal & Dixon, 2011).

The relationships between MNOs and MVNOs are easily created because of the net positive benefits for both entities. MNOs make money off excess bandwidth, and MVNOs sustain their business model (Ekanoye et al., 2018). One example of a successful MVNO was Virgin Mobile, utilizing Sprint Nextel as its MNO. Virgin Mobile ultimately had over four million subscribers (Le Cadre & Bouhtou, 2011).

However, notwithstanding their initial success, MVNOs are not powerful in the retail market and have not lived up to their potential. This is mostly because MNOs sign restrictive contracts with MVNOs that limit their market share, most notably in foreign markets. More recently, voluntary partnerships between MVOs and MVNOs have formed, with MNOs focusing on those with good brand reputations or other high-value services (Le Cadre & Bouhtou, 2011).

The economist Cricelli (2011) and his colleagues, in the paper "The Competition Among Mobile Network Operators in the Telecommunication Supply Chain," explore the relationship of an MNO and MVNO and the impact they have on one another and the customer base as well. The supply of customers being unchanged, the MVNO finds an opportunity for increased revenue by using rented radio spectrum that would otherwise be a deadweight loss to the MNO. The study concludes,

> The results of the competition model have shown that when the MVNO is hosted by the incumbent, their collaborative strategy is advantageous for both of them, as their profits and market shares assume the maximum value for the other two possible relationships. Instead, when the MVNO is hosted by the follower, their network externality is lower than that in the previous situation; in fact, neither of them prefers to collaborate as they find evident advantages in a different relationship: the MVNO will prefer the "competitive" relationship, while it's hosting (the follower) will prefer the "aggressive" relationship. (Cricelli et al., 2011, p. 29)

The collaboration of the MNO and the MVNO is not just a win–win but also presents more opportunity to the customer base with more providers to choose from by creating more

competition. In the last decade, the mobile industry has experienced drastic changes in providers as more MVNOs have entered the market (Lescop & Isckia, 2010). There is an opportunity for the end user to leverage their buying power as the market grows and more players enter the industry.

MNOs gain profits and value through their MVNOs' brand reputations, due to their highest subscription bases. It can be argued that under certain demand and sales conditions, consumers can induce cost savings by leveraging excess MNO capacity. "As more operators adopt increasingly more capable radio access and core network technologies, they will gain the capacity to provide better services to users, but they will lose the ability to differentiate on that facet" (O'Neal & Dixon, 2011, p. 40). These circumstances give way to the possibility of increased rivalry among service providers in that MNOs may begin to seek increased revenues on their unused capacity when selling to MVNOs, creating a price competition among MNOs and MVNOs to maintain customers—creating savings for the end user. These concepts are explored in our analysis by comparing the data we examined from Spiral 3 contract user data and modeling for potential cost savings between the providers on the MAC and an MVNO alternative, Google Fi.

IV. DATA

The necessary data for our analysis were provided to us by the Spiral 3 program director, Tine Thompson. Much of the analysis that we did was compiled from each vendor's monthly J-018 reports, whereby vendors break out all their accounts by command and identified relevant metrics to track that included but were not limited to the following:

- Total amount of spend per month
- Recurring monthly plan costs
- Taxes and fees
- International roaming costs
- Number of smartphones (IOS/Android/Blackberry)
- Number of tablets
- Number of air cards (T. Thompson, personal communication, August 10, 2020)

These J-018 reports were provided to us over a 14-month period, from May 2019 through June 2020, with a couple of exceptions that we will explain as they arise for each vendor. Much of our focus on these reports were both on total spend and international roaming costs per each month under each vendor. We break this data out by each vendor in this chapter.

The other main source of data we had was based on market research conducted by Tine Thompson with questions provided by us to each vendor. We have compiled these questions and their answers from each vendor. These data were integral to helping us make comparisons among the vendors on the differences in their international plans. In the following sections, we analyze the data of the four vendors, Verizon, AT&T, T-Mobile, and Sprint, that have contracts awarded under the Spiral 3 contract. We do not have any data on MetTel, the only MVNO on the Spiral 3 contract, as they have had no task orders awarded to them, and they did not provide any feedback to the market research questionnaire provided by Tine Thompson and NAVSUP FLC SD.

One final source of data that we refer to in this chapter is the Spiral 3 Independent Government Estimate tool that NAVSUP FLC provides on their website to Spiral 3 customers, which can be seen in Figure 6. This is one of the documents in the contracting

package that is required to be turned into a NAVSUP contracting shop before the contracting office can solicit bids from the Spiral 3 vendors for a command's wireless and cellular services. A command inputs their estimated travel requirements for the base year of the contract and their expected wireless usage in each country for minutes and texts, and this price calculator uses proprietary formulas based on countries visited to generate a total estimated cost. There are also options for unlimited data/emails as can be seen in Figure 6.

(Select a Country) --->	Afghanistan	Bahrain	Select	Select	Select
Type in the Country for "All other countries"					
Number of Voice Minutes Per Month					
Number of Months Per Year					
Number of Incoming Text Per Month					
Number of Months Per Year					
Number of Outgoing Text Per Month					
Number of Months Per Year					
Number of Smartphone(s) Requiring Unlimited Data/Emails					
Number of Months Per Year					
Number of Data Cards					
Monthly GB Per Device					
Number of Months Per Year					
Grand Total International	$0.00				

Figure 6. Spiral 3 International Independent Government Estimate Price Calculator. Source: NAVSUP FLC SD (2020).

Throughout this chapter, we identify sources of unavailable data that we attempted to get but that were not provided. Much of this inability was a direct impact of COVID-19. Many quarantine and shelter-in-place orders went into effect as we began our data collection efforts. While we were still able to collect some data, we did not have the same access to the data that we might have had under normal working conditions given that many of our sources were teleworking and did not have full access to the data that we needed as we were preparing this thesis.

It should also be noted here that our inability to examine some potential cost drivers does not just have ramifications on our ability to do in-depth analysis in Chapter V but can

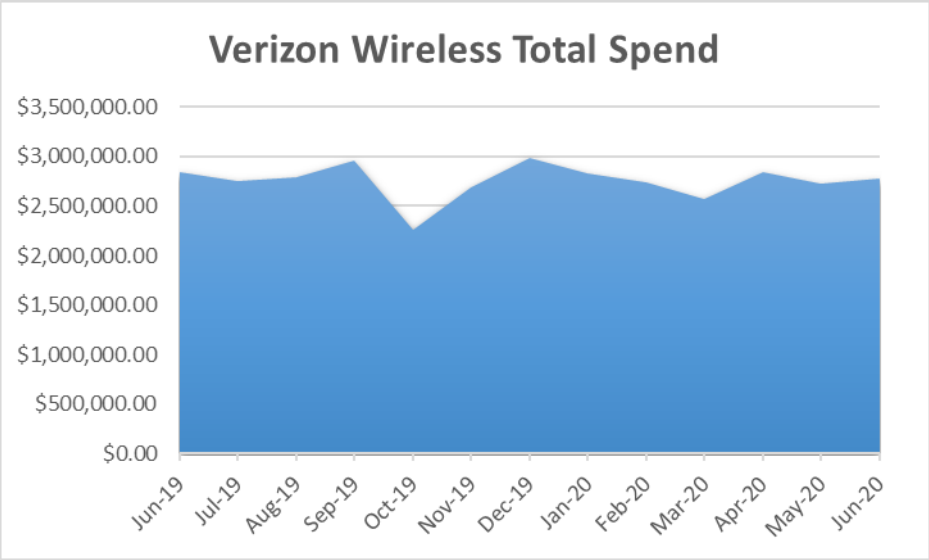
also have legal ramifications. Since all the task orders written under the Spiral 3 contract are for commercial items and services, they are necessarily firm-fixed-price contracts (FAR 12.2, 2020). Not only do unknown or unforeseen costs drive up costs, they also potentially cause the government to violate the Antideficiency Act (1982). Since the international costs in the task order are a fixed price based on the government's estimated usage for the life of that contract, if the government uses services above that contract, they must stop international usage on the contract. To pay for services that exceed the original amount in the contract prior to the contract being modified would be in violation of the Antideficiency Act, since these cost overages were never appropriated in the original contract. While the contractor technically is supposed to shut off service before the government accrues international overages, they are understandably reluctant to do so given the importance of the work that is being done by their end users within the DOD and the issues that may arise if service is disconnected, which puts the contractor in a very unfavorable predicament.

A. VERIZON DATA

Verizon currently holds the largest number of task orders under the Spiral 3 contract. From the beginning of our data period in June 2019, they had 455 accounts, while by the end of our data period in June 2020, they had 480 accounts (T. Thompson, personal communication, August 10, 2020). The average total spend across all these accounts during this time period was $2,749,200.43 a month. Figure 7 graphically shows the spend level across all accounts for each month from June 2019 through June 2020. While we had partial data for May 2019 for Verizon, we did not have any international wireless cellular data for this period that we were able to analyze, so we omitted the partial data so as not to skew our analysis.

1. Spiral 3 Trends

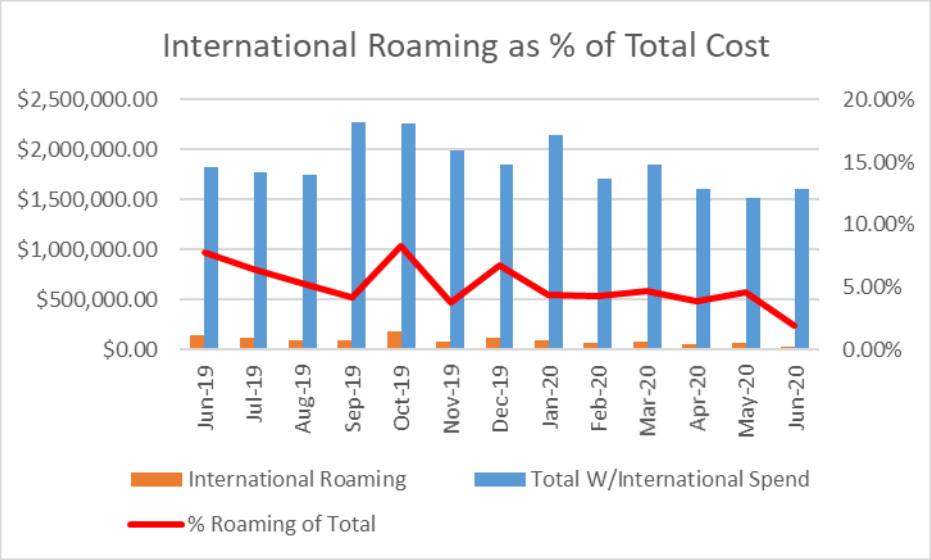
Figure 7 graphically shows the spend level across all accounts for each month from June 2019 through June 2020. While we had partial data for May 2019 for Verizon, we did not have any international wireless cellular data for this period that we were able to analyze, so we omitted the partial data so as not to skew our analysis.



Adapted from T. Thompson, personal communication, August 10, 2020.

Figure 7. Verizon Total Spend (May 2019–June 2020).

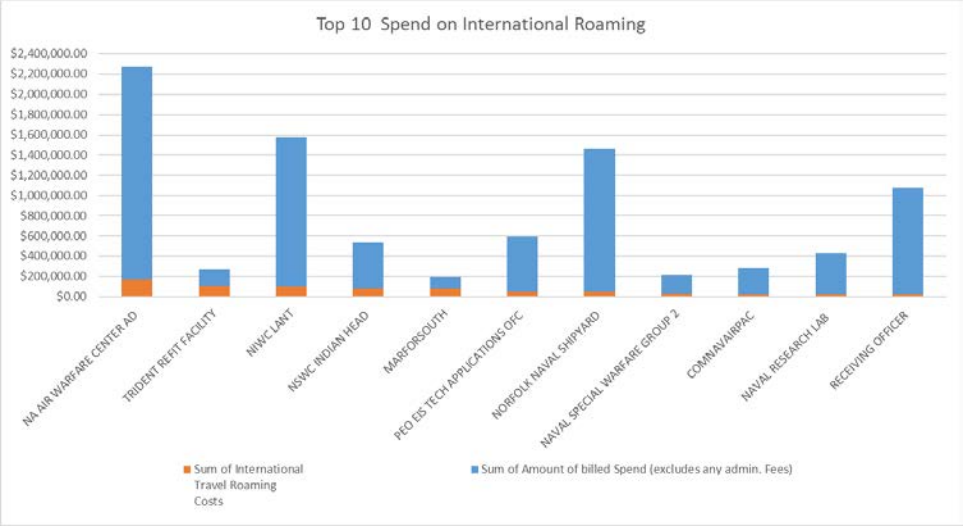
In both accounts and total spend, Verizon currently is the leading vendor among all its competitors under the Spiral 3 contract. In order to determine how their international rates affected their total expense levels, we next took the total spend levels while overlaying international spend data to determine the percentage of international costs against total spend across all accounts. Figure 8 identifies absolute dollar totals for both international spend and total spend for all accounts that had international charges combined for each month while also denoting overall percentage of international spend compared to total spend. The total dollar figures identified in Figure 8 differ slightly from Figure 7 since not every Verizon account used international services.



Adapted from T. Thompson, personal communication, August 10, 2020.

Figure 8. Verizon International Costs from June 2019–June 2020.

On average throughout this data period, international roaming costs for Verizon amounted to an average of 5.15% ($95,654.43) of their total spend per month, with the highest percentage being 8.28% in October 2019 and a low of 1.89% in June 2020. Additionally, based on the data we had on international charges, we also broke out the top 10 commands who had the largest spend total with Verizon across our data range, which is shown in Figure 9 below. Table 1 identifies the data from which Figure 9 was built.



Adapted from T. Thompson, personal communication, August 10, 2020.

Figure 9. Verizon Top 10 Commands' International Spend. Adapted from T. Thompson (personal communication, August 10, 2020).

Table 1. Verizon Top 10 International Spend Accounts. Adapted from T. Thompson (personal communication, August 10, 2020).

Command	Sum of Inter. Spend	Sum of Total Spend	% of Inter. Spend
NA AIR WARFARE CENTER AD	$174,046.75	$2,102,764.58	8.28%
TRIDENT REFIT FACILITY	$111,944.75	$154,522.56	72.45%
NIWC LANT	$104,520.42	$1,471,933.30	7.10%
NSWC INDIAN HEAD	$82,095.90	$459,103.73	17.88%
MARFORSOUTH	$78,988.58	$113,629.20	69.51%
PEO EIS TECH APPLICATIONS OFC	$48,034.46	$547,265.11	8.78%
NORFOLK NAVAL SHIPYARD	$44,118.42	$1,419,562.89	3.11%
NAVAL SPECIAL WARFARE GROUP 2	$30,752.35	$181,847.83	16.91%
COMNAVAIRPAC	$25,834.90	$257,439.10	10.04%
NAVAL RESEARCH LAB	$24,486.20	$403,784.21	6.06%
RECEIVING OFFICER	$23,725.95	$1,054,980.75	2.25%

Adapted from T. Thompson, personal communication, August 10, 2020.

For these commands, international spending was, on average, 9.2% of their monthly total spend. We also saw a high degree of variance in international roaming costs as a percentage of total spend for these commands. Notably, Marine Corps Forces South (MARFORSOUTH), the Marine combatant commander for U.S. Southern Command, had international roaming charges that were 69.5% of their total spend ($78,988.58 in international charges with total spend of $113,629.00), while the Trident Refit Facility, a

Navy maintenance command in King's Bay, GA, had international roaming charges that were 72.5% of their total spend ($111,944.75 in international charges with total spend of $154,522.56).

To help put this data into context, we also need to analyze it against Verizon's current rate offerings under the Spiral 3 account. Verizon currently offers the Navy models that appear to be tailored from two of their different commercially available plans, which are highlighted in Figures 10 through 12.

CD01 International & Global Mobile Broadband Data Feature			
ELIN	Description	Unit of Measure	Unit Charge
	CD01 - International		
CD01.511	GSM International Travel Voice Zone 1 (a – g) (*)	Per Minute	(1a) $0.00/minute (1b) $0.03/minute (1c) $0.05/minute (1d) $0.10/minute (1e) $0.14/minute (1f) $0.24/minute (1g) $0.49/minute
CD01.511	GSM International Travel Voice Zone 2 (*)	Per Minute	$1.99/minute
CD01.515	International Text Messaging **(Originating Outside of U.S.)**	Per Message	$0.50 per Sent / $0.05 per Received
CD01.515	International Text Messaging **(Originating Inside of U.S.)**	Per Message	$0.25 per Sent / $0.20 per Received
CD01.516	International Long Distance (CONUS (US) to OCONUS)	Per Minute	Rates vary depending on country called
CD01.528	Global Email Feature	Per Month	16.00
CD01.531	Global Data Package Feature – 100MB ***Requires domestic mobile broadband plan. Can only be used in conjunction with global capable MiFi, USB, tablets, and embedded laptop devices (not for use with Smartphones). Not available in all countries.*****	Per Month	$18.75
CD01.532	Global Data Package Feature – 150MB ***Requires domestic mobile broadband plan. Can only be used in conjunction with global capable MiFi, USB, tablets, and embedded laptop devices (not for use with Smartphones). Not available in all countries.*****	Per Month	$22.50
CD01.534	Global Data Package Feature – 1GB ***Requires domestic mobile broadband plan. Can only be used in conjunction with global capable MiFi, USB, tablets, and embedded laptop***	Per Month	$90.00

Adapted from T. Thompson, personal communication, July 20, 2020.

Figure 10. Verizon Spiral 3 International Wireless Rates.

Custom 4G International Travel Data Feature Navy Subscribers Only This feature is NOT eligible for monthly access fee discounts.								
Monthly Access Fee†	$16.00							
International Travel Data Allowance††	Unlimited							
GSM International Travel Voice Roaming	**Zone 1a**	**Zone 1b**	**Zone 1c**	**Zone 1d**	**Zone 1e**	**Zone 1f**	**Zone 1g**	**Zone 2**
See custom groupings below	$0.00/min	$0.03/min	$0.05/min	$0.10/min	$0.14/min	$0.24/min	$0.49/min	$1.99/min

Notes: †This feature requires a 4G LTE GSM/UMTS may only be added onto a spiral 3 smartphone voice/data plan. ††The international travel data allowance applies in Canada, Mexico, and the rest of the world where coverage is available; aircraft and cruise ship data usage is not included. To see supported countries and rates for services such as voice, messaging, and non-terrestrial (aircraft and cruise ship) voice rates, go to www.verizonwireless.com/international. Verizon Wireless will terminate a line of service if more than half of the usage over three consecutive billing cycles is outside of the United States, following 30 days' notice to Customer.

Zone 1a Countries are as follows: Canada, Mexico

Zone 1b Countries are as follows: Albania, Aruba, Austria, Belgium, Bolivia, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Estonia, Falkland Islands, Finland, France, Germany, Greece, Guernsey, Haiti, Honduras, Hungary, Ireland, Isle of Man, Israel, Italy, Kosovo, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, Malta, Mayotte, Montenegro, Netherlands, Poland, Portugal, Romania, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Taiwan, Vatican City.

Zone 1c Countries are as follows: Anguilla, Antigua & Barbuda, Argentina, Australia, Bahamas, Barbados, Belize, Bermuda, Brazil, British Virgin Islands, Cape Verde, Cayman Island, Central African Republic, Chile, Christmas IS, Colombia, Costa Rica, Dominica, Ecuador, El Salvador, French Guiana, Greenland, Grenada, Guadeloupe, Guatemala, Hong Kong, Indonesia, Iceland, India, Jamaica, Japan, Madagascar, Martinique, Moldova, Montserrat, Netherlands Antilles: (Bonaire, Sint Eustatius, Saba), New Zealand, Niger Republic, Norfolk Islands, Norway, Panama, Palestinian Territories, Paraguay, Peru, Senegal, St. Barthelemy, St. Kits and Nevis, St. Lucia, St. Martin, St. Vincent & Grenadines, South Korea (Republic of), Sri Lanka, Saint Maarten, Tonga, Turks and Caicos Islands, United Kingdom, US Virgin Islands, Vanuatu.

Zone 1d Countries are as follows: Algeria, Benin, Botswana, Brunei Darussalam, Cambodia, Chad, China, Congo, Congo Dem Republic of, Cote d'Ivoire, Curacao, Egypt, Faroe Island, Fiji, Ghana, Gibraltar, Guinea, Guinea-Bissau, Guyana, Guam, Iraq, Jersey, Jordan, Kenya, Kuwait, Liberia, Lesotho, Macao, Myanmar, Malaysia, Morocco, Nauru, Nigeria, Nicaragua, Papua New Guinea, Philippines, Qatar, Reunion, Russian Federation, Rwanda, Samoa, Saudi Arabia, Singapore, South Africa, Suriname, Swaziland, Thailand, Trinidad & Tobago, Tunisia, Ukraine, United Arab Emirates, Uruguay, Venezuela, Zambia.

Zone 1e Countries are as follows: Armenia, Bangladesh, Bosnia & Herzegovina, East Timor (Timor-Leste), French Polynesia, Gabon, Gambia, Georgia, Kazakhstan, Malawi, Oman, St Helena, Seychelles, Sierra Leone, Tanzania, Uganda, Vietnam.

Zone 1f Countries are as follows: Afghanistan, Azerbaijan, Bahrain, Belarus, Bhutan, Burundi, Cameroon, Kyrgyzstan, Laos, Mozambique, Pakistan, Solomon Island, Tajikistan.

Zone 1g Countries are as follows: American Samoa, Andorra, Burkina Faso, Cook Islands, Lebanon, Libya, Mali, Mauritius, Monaco, Mongolia, Namibia, Nepal, New Caledonia, South Sudan, Togo, Uzbekistan, Yemen, Zimbabwe.

Zone 2 Countries are as follows: Angola, Comoros, Cuba, Djibouti, Equatorial Guinea, Ethiopia, Maldives, Mauritania, Micronesia, Northern Mariana Islands, Sao Tome and Principe, St. Pierre & Miquelon and Turkmenistan.

Other available countries will be billed at the Zone 2 rates.

The lists of countries are subject to change.

Adapted from T. Thompson, personal communication, July 20, 2020.

Figure 11. Verizon Spiral 3 International Country Breakdown.

Global Data Package Features			
A discount has been applied and this plan is not eligible for any further discounts.			
Monthly Line Access	**Data Allowance (non-share)**	**Data Overage for Included Countries**	**Data Overage for Rest of World**
$18.75 per device	100 Megabytes	$0.25 per MB	$2.05 per MB
$22.50 per device	150 Megabytes	$0.25 per MB	$2.05 per MB
$45.00 per device	350 Megabytes	$0.25 per MB	$2.05 per MB
$90.00 per device	1 Gigabyte	$0.25 per MB	$2.05 per MB
Notes: †This feature requires a 3G or 4G LTE GSM/UMTS global-capable MiFi, USB, and embedded laptop devices and may only be added to Mobile Broadband Plans with a monthly access of $29.99 or greater. Prevailing rates apply to text, picture, and video messages.			

Global Data Package Features Country List (for Data Allowance)			
Aland Islands	Albania	Andorra	Anguilla
Antigua	Argentina	Armenia	Aruba
Australia	Austria	Azerbaijan	Bahamas
Barbados	Barbuda	Belarus	Belgium
Bermuda	Bolivia	Bonaire	Bosnia and Herzegovina
Brazil	Bulgaria	Canada	Cayman Islands
Chatham Island	Chile	China	Christmas Island
Colombia	Croatia	Curacao	Cyprus
Czech Republic	Denmark	Dominica	Dominican Republic
Ecuador	Egypt	England	Estonia
Faroe Islands	Finland	France	French Guiana
Georgia	Germany	Gibraltar	Grand Bahamas
Greece	Greenland	Grenada	Guadeloupe
Guam	Guernsey	Guyana	Haiti
Hong Kong	Hungary	Iceland	India
Ireland	Ireland, Northern	Isle of Man	Israel
Italy	Jamaica	Japan	Jersey
Kazakhstan	Korea, South	Latvia	Liechtenstein
Lithuania	Luxembourg	Macao	Macedonia
Malta	Martinique	Mayotte Island	Mexico
Moldova	Monaco	Montenegro	Montserrat
Netherlands	Netherlands Antilles	New Providence (Nassau)	New Zealand
Northern Mariano Islands	Norway	Palestinian Authority	Paradise Island
Paraguay	Peru	Philippines	Poland
Portugal	Reunion	Romania	Russia
Saba	Saipan	Samoa	San Marino
Scotland	Serbia	Singapore	Slovakia
Slovenia	South Africa	Spain	St. Barthelemy
St. Eustatius	St. Kitts and Nevis	St. Lucia	St. Maarten
St. Martin	St. Vincent & Grenadines	Svalbard	Sweden
Switzerland	Taiwan	Thailand	Tortola
Trinidad & Tobago	Turkey	Turks and Caicos Islands	Ukraine
United Kingdom	Uruguay	Uzbekistan	Vatican City
Venezuela	Vietnam	Virgin Gorda	Virgin Islands, British
Wales			

Adapted from T. Thompson, personal communication, July 20, 2020.

Figure 12. Verizon Spiral 3 Data-Only Device Country Rates.

2. International Roaming Fee Structure

Based on the figures provided as market research by Verizon, one of the biggest cost savers that the Navy gains access to, which is not available in Verizon's commercial

accounts, is an unlimited wireless data allowance for smartphones, after paying a $16 monthly access fee, as can be seen in Figure 10. This mirrors Verizon's two monthly international plans in terms of format, where a flat buy-in cost gives the customer access to an international package. However, Verizon's commercial accounts for their monthly plans have access fees that are either $70 or $130, and neither of these plans offers unlimited data (Verizon, 2020).

Verizon's voice plan under the Spiral 3 contract is also similar to another one of their commercial international plans, which is their Pay as You Go plan. In their commercial model, countries are split into two zones, with Zone 1 holding approximately 130 countries, where each minute costs $1.79, and Zone 2 with all other countries, where each minute costs $2.99. These zones roughly correspond with the eight zones under the Spiral 3 contract seen in Figure 11, with Zones 1a–1e corresponding with Zone 1 of the commercial plan and Zones 1f–2 corresponding with Zone 2 of the commercial plan. Again, here as with smartphone data usage, Spiral 3 DOD customers with Verizon can experience significant cost savings relative to their commercial counterparts. Only the most expensive zone in the Spiral 3 plan, Zone 2, which consists of only 14 countries in the Spiral 3 plan, has more expensive rates for voice minutes than any of the rates Verizon offers to its commercial customers under its Pay as You Go plan.

The other main offering by Verizon for Spiral 3 customers is its data-only plan, which really has no commercial equivalent, as seen in Figure 11. This data plan is specifically offered for all data-only devices, with all smartphones being excluded. The plan is offered under four different price points with larger price breaks per megabyte (MB) of data as larger blocks of data are pre-bought. The overage rate of $2.05 per MB is identical to the data overage rate charged by Verizon on its other international plans that it offers commercially (Verizon, 2020).

While these data are essential in the next chapter during the data analysis, there were some data that would have been fruitful that we were unable to get. Notably, we were unable to get any bills from Verizon that would have helped us analyze the charges for commands each month. This was especially critical for some of the top 10 commands mentioned earlier that had high international spending charges and/or a high percentage of

international charges relative to total spend levels. By having access to bills from these commands, we would have been able to pinpoint how these wireless charges originated (e.g., voice minutes, data overages on data-only devices, etc.).

Another cost driver that is unknown to us is Verizon's process for international data charges. The Spiral Independent Government Estimate (IGE) in Figure 6 does have a column where the customer can give their estimated number of phones that require unlimited international data/email, and the rate given by NAVSUP FLC SD for this is one phone at $16/month, which corresponds to the international access fee offered by Verizon that can be seen in Figure 11. If we had access to specific accounts, we would have been able to analyze this as a potential cost driver. For example, if a command wanted 40 phones with 12 months each of unlimited email and data, according to the IGE price calculator, that would be approximately $480 in access charges alone. However, if a command then needed another 40 phones to have international services for 12 months and turned their international services on, that would presumably be another $480.[4] Without access to this information, we are unable to determine if this could have been a cost driver, and it is a cost driver that would have real-world applicability. A shore-based operational command not expecting to deploy in the next 12-month period might have estimated their usage at 20 cell phones needing international service.

Finally, one other unknown cost driver is Verizon's data-only plans. We were unsure which data plan was chosen, and we were not able to determine if this was picked by the government KO writing the contract or if this was arbitrarily provided to the customer at Verizon's discretion. Either way, both cases could lead to multiple cost overages. For example, if the government underestimated its international usage on data-only devices, it might have picked cheaper data plans with less data provided in order to keep the overall contract price down. If the end user went over this data limit, the cost to

[4] This also assumes that any additional international services charged that were not originally estimated in the IGE would still be charged under the same pricing plan. Verizon's Spiral 3 contract does not lock in international pricing but only specifies that any price given to a customer under a Spiral 3 contract could not be more than what they charge other federal, state, or local government agencies (SAM, 2017c). If a command wanted to lock in a specific international pricing scheme, this would have to be done at the task order level, if it could be done under Spiral 3.

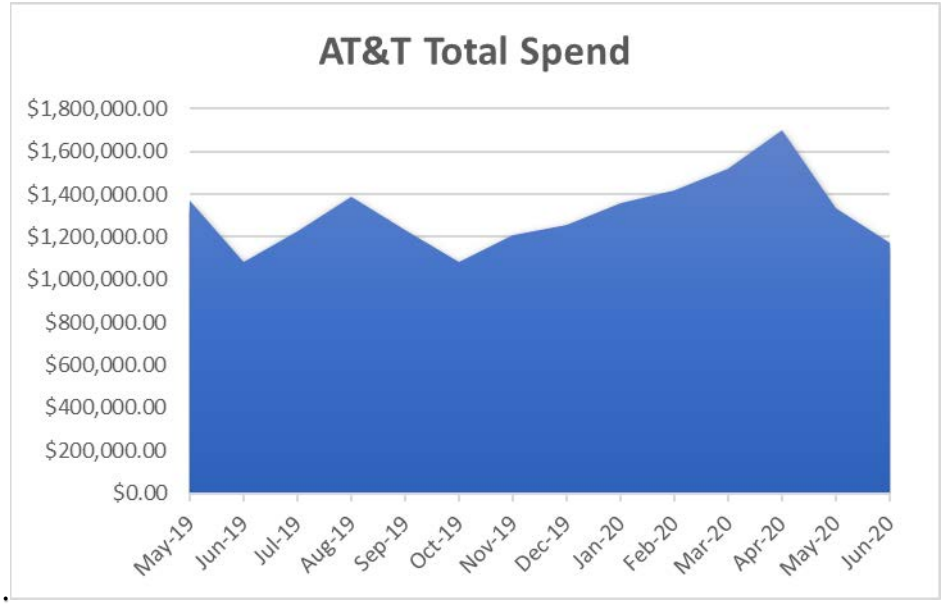
the government would most likely have been much higher than it would have been under another more expensive data plan due to the high cost in overage fees a command would now have to pay. Conversely, if Verizon chose which data plan to provide, they could provide a lower cost to the government to (a) make their bid appear more competitive compared to other Spiral 3 vendors and (b) potentially increase their profit ratio if the government did go over their allotted data plan.

B. AT&T DATA

After Verizon, AT&T holds the largest number of task orders under the Spiral 3 contract. Their trends will be examined next.

1. Spiral 3 Trends

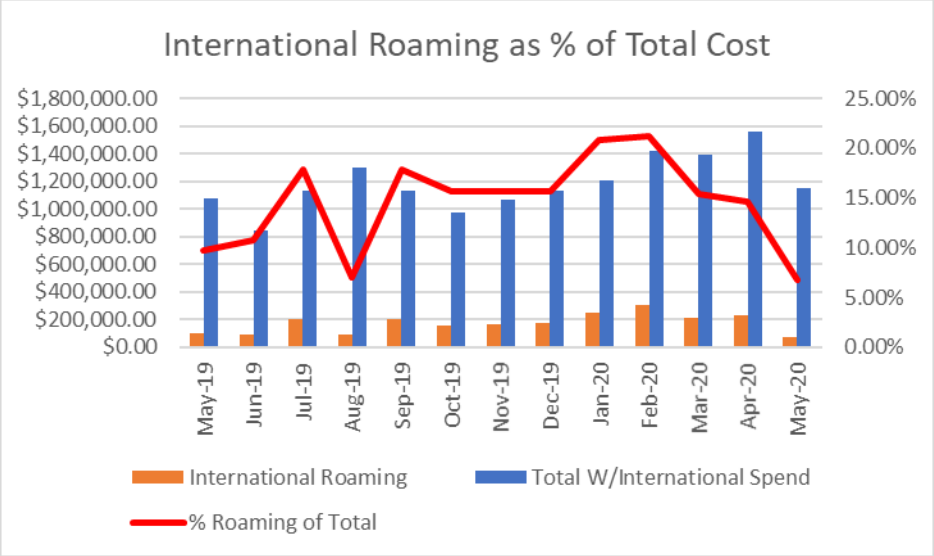
At the beginning of the period our data encompasses, May 2019, AT&T had 360 accounts. By the end of this period, June 2020, they maintained 372 accounts (T. Thompson, personal communication, August 10, 2020). The average total spend across all accounts during this time period was $1,310,341.78 a month. Figure 13 graphically shows the spend level for all accounts for each month from May 2019 through June 2020.



Adapted from T. Thompson, personal communication, August 10, 2020.

Figure 13. AT&T Total Spend (May 2019–June 2020).

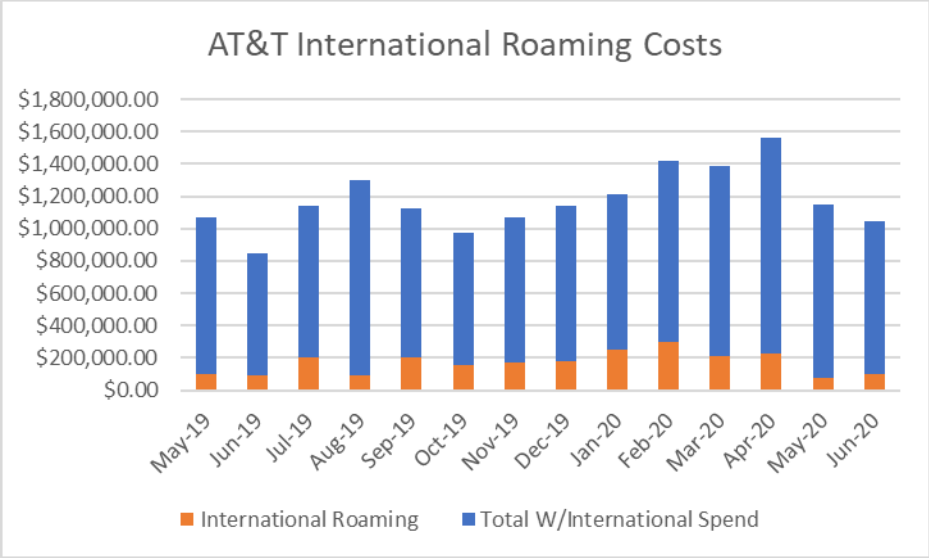
Just like with the other vendors, we also compared international spend totals for AT&T Spiral 3 accounts. Figure 14 shows the percentage of international roaming costs per month for the AT&T data period, May 2019 through June 2020, while also showing the international spend percentage compared to total spend of accounts that had international usage for all AT&T accounts each month.



Adapted from T. Thompson, personal communication, August 10, 2020

Figure 14. AT&T International Costs from May 2019–June 2020.

Of the four Spiral 3 vendors that have been awarded task orders, AT&T shows the highest variance in international spend as a percentage of total spend in the data period that we examined. While international spend totals accounted for a monthly average of 14.39% of total spend throughout the data period, this percentage was as low as 6.73% in May 2020 and as high as 21.25% in February 2020 (T. Thompson, personal communication, August 10, 2020). As with all the other Spiral 3 vendors, we also broke out the top 10 accounts with the most international spend to identify and analyze any potential trends of the accounts with the most international wireless use. This is highlighted in Figure 15. Table 2 is the data table on which Figure 15 was built.



Adapted from T. Thompson, personal communication, August 10, 2020

Figure 15. AT&T Top 10 Commands' International Spend from May 2019–June 2020.

Table 2. AT&T Top 10 International Spend Accounts.

Command	Sum of Inter. Spend	Sum of Total Spend	% of Inter. Spend
26TH MEU M20181 US GOV	$227,447.59	$272,187.89	83.56%
NAVFAC	$189,870.05	$2,328,046.82	8.16%
NCIS	$185,038.83	$814,751.52	22.71%
3RD MARINE AIRCRAFT WING	$147,962.19	$336,397.24	43.98%
NSWC PORT HUENEME	$138,419.50	$506,727.01	27.32%
SPAWAR SYSTEMS CENTER, PACIFIC	$122,725.73	$778,980.58	15.75%
MARCORSECFORBN	$120,356.44	$149,841.06	80.32%
NAVSEA HQ	$118,966.40	$1,672,154.23	7.11%
NAVAIR WARCENWD CHINA LAKE	$60,832.08	$803,326.71	7.57%
NAVAL SURFACE WARFARE CARDEROCK	$59,600.60	$335,567.23	17.76%

Adapted from T. Thompson, personal communication, August 10, 2020

As can be seen in Table 2, some commands had international spend totals that made up the majority of their total sum spent on wireless services. Notably, the 26th Marine Expeditionary Unit (26TH MEU M20181 U.S. GOV) and the Marine Corps Security Force Battalion (MARCORSECFORBN) had over 80% of their total spend for the year be consumed by their international wireless fees. At least in the case of the 26th MEU, their international spend coincides with a U.S. Central Command (CENTCOM) deployment from December 2019 to July 2020 (Heisterberg, 2020). In comparing the data to this

deployment, the first three full months of this deployment, January through March 2020, the 26th MEU had monthly international charges of $51,770,56; $91,339.73; and $67,731.89, respectively (T. Thompson, personal communication, August 10, 2020).

2. International Roaming Fee Structure

In their market research response to NAVSUP FLC SD, AT&T gave the following as the available plans they offered for international services under the Spiral 3 contract:

- Day Pass, Unlimited Voice/Data/Text in 200+ Countries ($10 per day of use) - FFP
- Passport Pro Data Only ($200/month for 10 GB data, no overages) - FFP
- Unlimited International Data for Smartphones ($16/month)
- Data Only, 1.5 GB for MiFi Devices ($123.50/month)
- International Texting Plans (50 messages/$9.50, 200 Messages/$28.50, 500 messages/$47.50)
- World Traveler (price per minute varies by country of use)
- World Connect Voice Plan ($3.50/month/line; T. Thompson, personal communication, August 10, 2020)

Similar to Verizon, much of AT&T's offerings under the current Spiral 3 contract are modeled after their current existing plans, with some of them being identical, such as the Day Pass offering, which is also offered as an unlimited international commercial option at $10 per day (AT&T, 2020a). Their Passport Pro Data Only plan is a variant of their commercial Passport Pro plan, which is offered at 2 gigabytes (GB) for $70/month or 6GB for $130/month but also includes unlimited international texting and a flat rate of $0.35 per minute on international calls (AT&T, 2020a). While the government gets more GB per dollar under the Passport Pro Data Only, they do not get price breaks for voice minutes or texts under this plan. Similarly, the World Connect Voice Plan is a similar model to a commercial voice plan that is offered commercially at $15 a month (AT&T, 2020). However, the countries under the World Connect Voice Plan were not provided to us, so it is unknown if these are identical plans that are offered to the government at a discount. Additionally, these plans have somewhat of a limited utility for DON personnel operating overseas, as they are tailored towards international calls originating from CONUS to another country.

One interesting divergence in plans offered is the World Traveler plan. The only commercial equivalent we could find was a World Traveler plan that was retired by AT&T in 2012, although it is still carried as a legacy plan for those accounts that held it at the time of its retirement. This plan offered discounted per-minute rates, with the cost and rate varying by country (AT&T, 2016). Given that AT&T provided NAVSUP FLC SD no other data, it is impossible to discern what pricing structure is offered under the Spiral 3 plan, and if it was similar or identical to the plan that was originally offered commercially. AT&T provides links for its international rates on its customer support page for Spiral 3 customers, but currently none of these links are operable. From a contracting perspective, not having the data available on what the international rates are from AT&T presents significant issues in understanding what they are billing the customer and in ensuring that they are being charged appropriately. While not getting the particulars of their proprietary agreements with their international partners is understandable and to be expected, not getting the rates that the customers are actually being charged needs to be addressed.

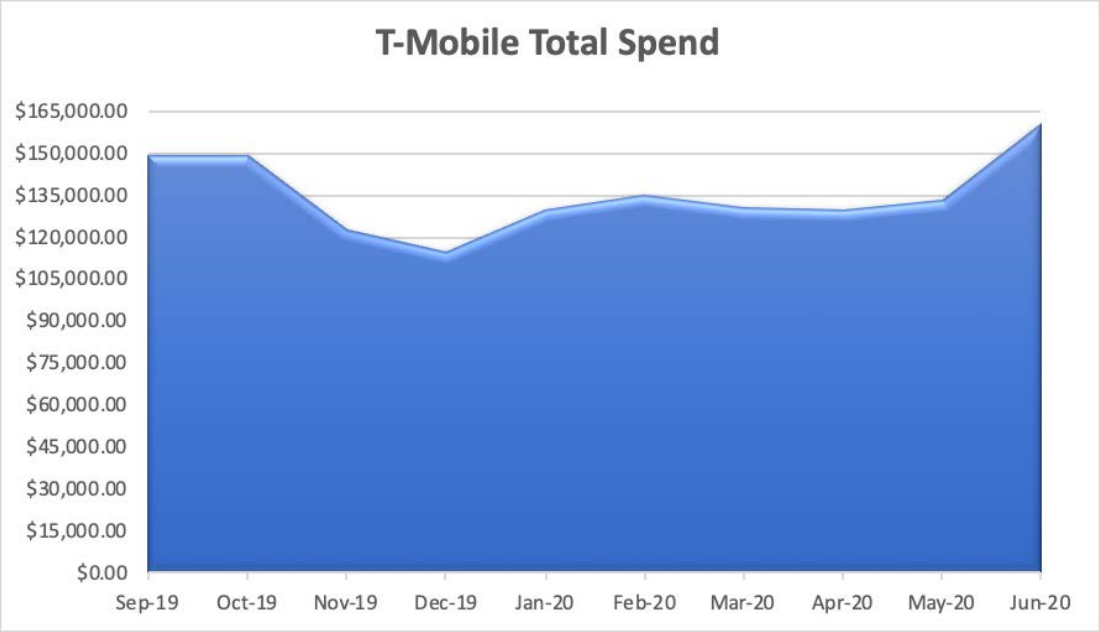
AT&T also offers a monthly unlimited international data for smartphones at $16/month that is not offered commercially, which does not include texts or voice minutes, both of which are offered under the separate fee structures mentioned above. This $16/month flat fee for international services under the Spiral 3 contract is identical to the plan that is offered by Verizon. AT&T, like Verizon, also offers a data-only plan for data-only devices.

Just like with Verizon, we were unable to get any bills for AT&T that would have helped us analyze the charges for commands each month. This causes many of the same problems in analyzing AT&T data that it does for Verizon. Since AT&T has multiple different pricing plans for international voice minutes, texts, and data, and without bills, we have no way of knowing how these have been charged to their customers. Additionally, AT&T states on their Spiral 3 page that customers can change their pricing structure for international plans on their Spiral 3 support page (AT&T, 2020b). Since only the final estimate for international services is incorporated into a Spiral 3 task order as a firm fixed total, it does appear that customers currently have the leeway and flexibility to change their rate plans as they deem fit.

However, like with Verizon, this leads to other underlying questions. Notably, since AT&T offers multiple pricing plans for international services that the customer does not pick by default, how does AT&T charge for these international services? Of their available plans, do they pick the one that provides the most cost savings to the government or the one that gives them the most value for their money that they have obligated under their Spiral 3 task order? Do they standardize all Spiral 3 task orders with a default international plan, which the customer can then change to suit their specific needs? Or does AT&T pick the plans that, based on the estimates, will maximize their profits? Like with Verizon, it is impossible to determine without being able to analyze detailed bills.

C. T-MOBILE DATA

After AT&T, T-Mobile holds the next largest number of task orders under the Spiral 3 contract, but they hold significantly fewer than both Verizon and AT&T. At the beginning of the period our data encompasses, September 2019, T-Mobile had 44 accounts. By the end of this period, June 2020, they maintained 53 accounts (T. Thompson, personal communication, August 10, 2020). The average total spend across all accounts during this time period was $135,623.57 a month. Figure 16 graphically shows the spend level for all accounts for each month from September 2019 through June 2020.

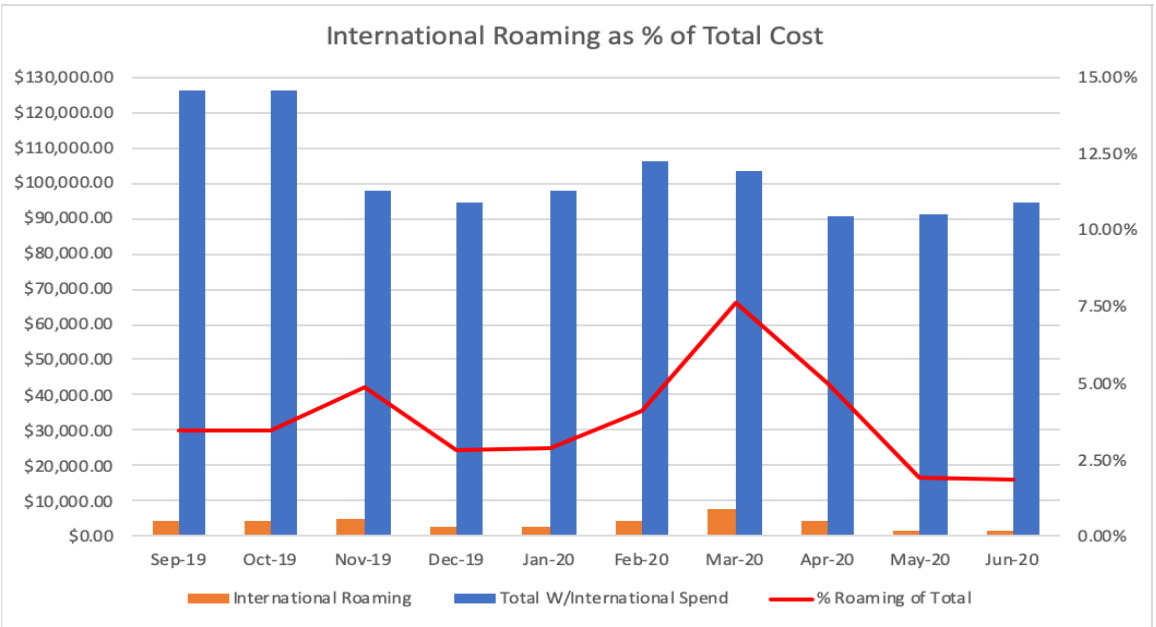


Adapted from T. Thompson, personal communication, August 10, 2020.

Figure 16. T-Mobile Total Spend (September 2019–June 2020).

1. Spiral 3 Trends

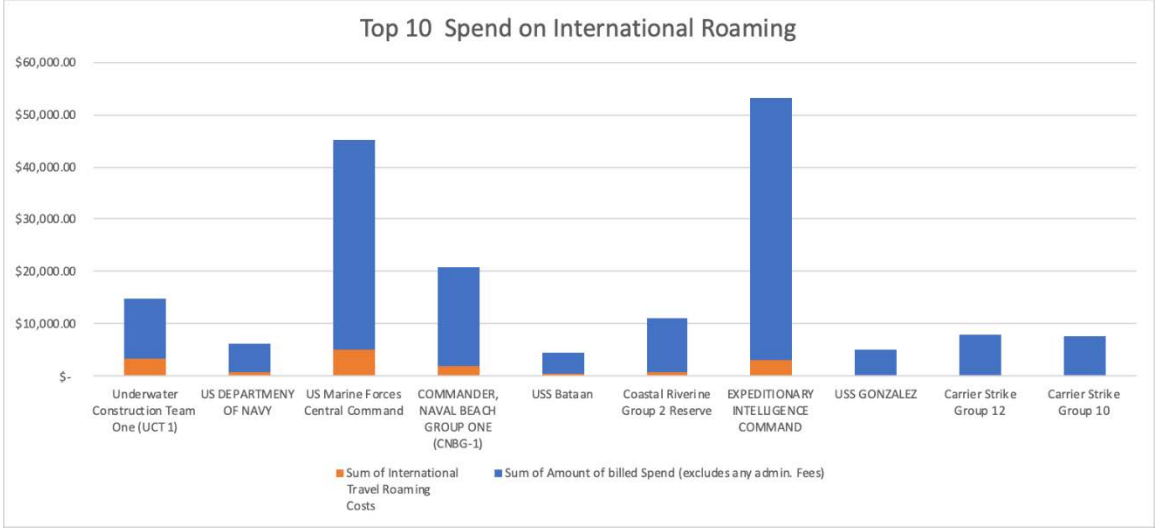
In both accounts and total spend, T-Mobile's numbers pale in comparison to Verizon and AT&T, who hold the lion's share of accounts under the Spiral 3 contract. Nonetheless, to have an objective comparison of providers, and in order to determine how their international rates affected their total expense levels, we took the total spend levels while overlaying international spend data to determine the percentage of international costs against total spend across all accounts that had international usage. Figure 17 identifies absolute dollar totals for both international spend and total spend for each month while also denoting overall percentage of international spend compared to total spend.



Adapted from T. Thompson, personal communication, August 10, 2020.

Figure 17. T-Mobile International Costs from September 2019–June 2020. Adapted from T. Thompson (personal communication, August 10, 2020).

On average throughout this data period, international roaming prices for T-Mobile amounted to an average of 3.80% ($3,923.92) of their total spend per month, with the highest percentage being 7.60% in March 2020 and a low of 1.87% in June 2020. Additionally, based on the data we had on international charges, we also broke out the top 10 commands who had the largest spend total with T-Mobile across our data range, which is shown in Figure 18 and Table 3.



Adapted from T. Thompson, personal communication, August 10, 2020.

Figure 18. T-Mobile Top 10 Commands' International Spend.

Table 3. T-Mobile Top 10 Commands' International Spend

Command	Sum of Intern. Spend	Sum of Intern. Roaming	% of Inern. Spend
Underwater Construction Team One (UCT 1)	$ 11,592.91	$ 3,291.80	28.39%
US DEPARTMENY OF NAVY	$ 5,336.08	$ 740.20	13.87%
US Marine Forces Central Command	$ 40,125.69	$ 4,917.80	12.26%
COMMANDER, NAVAL BEACH GROUP ONE (CNBG-1)	$ 18,824.69	$ 1,883.60	10.01%
USS Bataan	$ 4,190.46	$ 373.20	8.91%
Coastal Riverine Group 2 Reserve	$ 10,397.34	$ 672.13	6.46%
EXPEDITIONARY INTELLIGENCE COMMAND	$ 49,989.09	$ 3,156.51	6.31%
USS GONZALEZ	$ 4,846.45	$ 238.40	4.92%
Carrier Strike Group 12	$ 7,729.30	$ 305.00	3.95%
Carrier Strike Group 10	$ 7,366.88	$ 279.80	3.80%

Adapted from T. Thompson, personal communication, August 10, 2020.

For these commands, international spending was, on average, 9.89% of their monthly total spend. We also saw a large degree of variance in international roaming costs as a percentage of total spend for these commands. Notably, the Underwater Construction Team One (UCT 1) is based out of Virginia Beach, VA, but has three Construction Dive Detachments that deploy worldwide to conduct underwater construction, inspection, repair, and demolition. UCT 1 had international roaming charges that were 28.39% of their total spend ($3,291.80 in international charges with total spend of $11,592.91). U.S. Marine Forces Central Command, the Marine Corps component of the CENTCOM combatant command based out of Tampa, FL, sends forward deployed personnel to the Middle East

and had international roaming charges that were 13.87% of their total spend ($740.20 in international charges with total spend of $5,336.08).

2. International Roaming Fee Structure

Unlike Verizon and AT&T, T-Mobile uses a much more straightforward fee structure. T-Mobile uses their Simple Global feature that is included in the ELIN structure. Simple Global provides unlimited texts and data in more than 210 countries and territories. Voice minutes are just $0.20 per minute in these same locations. This allows the end user to travel to any of these 210 plus countries without having to make any modifications to existing task orders in order to add or delete an international feature. The end user just deploys, and the services work accordingly. The Simple Global rates are $42.30 per line per month. (T. Thompson, personal communication, August 10, 2020).

There are only a handful of countries that do not fall within the Simple Global plan that have resulted in higher international roaming charges for DON users, including Libya ($5.99/day), Djibouti ($4.19/day), Ethiopia ($4.19/day), and Lebanon ($3.59/day), which have potential to create significant charges, especially for those commands that regularly operate in those areas (T. Thompson, personal communication, August 10, 2020).

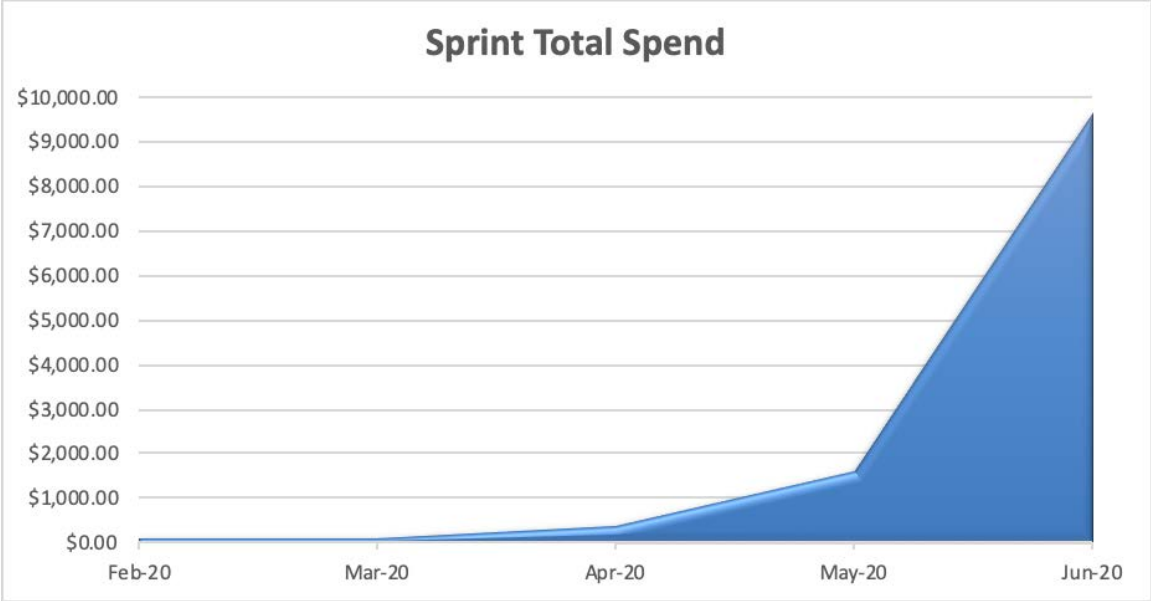
The international rates provided by T-Mobile under the Spiral 3 are consistent over the life of the Spiral 3 master contract and do not change from task order to task order. Additionally, T-Mobile's international unlimited text and data service in the previously mentioned Simple Global feature is included at no additional charge, so there are no overages on these services as experienced with other providers under Spiral 3. The International high-speed data features include 1.5GB, 5GB, or 10GB of data respectively; once this threshold is reached then the line reverts to standard speeds until the end of the bill cycle and then resets (T. Thompson, personal communication, August 10, 2020). No overages are incurred as part of the high-speed data options either, because using more than the allotted high-speed data amount is not an option, which is an ancillary benefit as there is no risk of incurring large overage charges and becoming anti-deficient.

While these data will be essential in the next chapter during the data analysis, there were some data that would have been fruitful that we were unable to get. Similar to the

data we were unable to receive from other service providers, we were not able to receive bills from T-Mobile to provide a more granular review. The detail behind the specific cost drivers, similar to those previously mentioned, would have provided for a more thorough analysis and a better understanding of what is producing the inordinate international roaming charges, particularly for the commands who are seeing their international roaming costs as a much higher percentage of their total spend than that of the average user.

D. SPRINT DATA

Besides MetTel, who has yet to be awarded any task orders since joining the Spiral 3 contract, Sprint has had the fewest contracts since joining Spiral 3 in October 2019, receiving their first DON task order in January 2020. At the beginning of the period our data encompasses, February 2020, Sprint had only 2 accounts. By the end of this period, June 2020, they had been awarded an additional 10 task orders, for a total of 12 accounts (T. Thompson, personal communication, August 10, 2020). The average total spend across all accounts during this time period was $2,363.25 a month. Figure 19 graphically shows the spend level for all accounts for each month from February 2020 through June 2020.



Adapted from T. Thompson, personal communication, August 10, 2020.

Figure 19. Sprint Total Spend (February 2020–June 2020)

1. Spiral 3 Trends

In both accounts and total spend, Sprint holds only a miniscule number of DON accounts under the Spiral 3 contract due to Sprint's relative newness as a Spiral 3 vendor. Additionally, unlike Verizon, AT&T, and T-Mobile, Sprint has not had any of their account holders have any requirements for international roaming services, so a similar comparison is not possible at this point with the current data available for DON users. This is most likely due to COVID-19 travel restrictions and commands being unable to utilize international roaming when they typically would have.

Notably, Navy Trident Refit Facility opened a new account with Sprint in June 2020 and had previously used Verizon as their service provider under the Spiral 3 contract. Under their Verizon account, Trident Refit Facility had been one of the top 10 in total spend for international roaming and as a percentage of their total spend during the period we had reviewed. It will be interesting to see their usage and costs going forward with Sprint in comparison to what they had been spending with Verizon.

2. International Roaming Fee Structure

Market research questions were sent out to Sprint government contract representatives from the Spiral 3 manager at NAVSUP FLC SD to better understand the international roaming fee structure that Sprint uses to bill the government. Similar to T-Mobile, Sprint uses a much more straightforward fee structure. Sprint offers the Sprint Global Roaming plan, included at no additional cost, as part of the domestic plans offered. Sprint Global Roaming allows for international roaming coverage in more than 200 countries, and texts and data are included freely with their domestic ELINs, with calls priced at only $0.25 per minute (T. Thompson, personal communication, August 10, 2020). In addition to the Sprint Global Roaming plan, Sprint has developed custom international price plans, which are shown in Figure 20. The smartphone plan for unlimited international roaming voice and data, priced at only $29.99 per line, is the most reasonably priced of all the service providers' plans available under the Spiral 3 master contract.

Sprint Unlimited International Voice Plan for Phones	$15.99
Sprint Unlimited International Data Plan for Phones	$15.99
Custom Smartphone Plan for Unlimited International Roaming Voice and Data	$29.99
Sprint Unlimited International Data Plan for Tablets & Connection Cards	$99.99

Adapted from T. Thompson, personal communication, August 10, 2020.

Figure 20. Sprint Spiral 3 Global Roaming Plan.

While the list of countries covered by Sprint international roaming services is extensive, there are a limited number of countries where service is unavailable—in particular, countries around the Horn of Africa. DON commands that operate in these countries may require service that cannot be received through Sprint. Some of these countries have service available at much higher rates through other providers, but it is service nonetheless.

Sprint negotiates international roaming rates with partner carriers across the globe to provide their customers the most economical rates. Under the Spiral 3 master contract, Sprint rates remain the same for the duration of the task order period of performance and for the life of the overall Spiral 3 master contract, even if the rate Sprint is charged by the third party changes. Additionally, Sprint's prices charged to the DON are consistent with those offered to other federal, state, and local government entities for similar services with comparable terms and conditions. Civilian business accounts are not a reasonable comparison due to unique government customer requirements and regulations, including termination for non-appropriation and termination for convenience without penalty (T. Thompson, personal communication, August 10, 2020).

V. ANALYSIS

As we stated in the previous chapter, we were unable to get bills and invoices from commands that had accounts with any of the major wireless providers under the Spiral 3 account. Our original intention to compare data rates among all the providers was to use actual bills from a command and then see how much the command was charged under its actual provider and how much it potentially could have been charged under the other wireless service providers. From there, we would have determined which plans might have provided the most cost savings to the customer. However, what we did have from most vendors, besides AT&T, were the rates that they charged under the Spiral 3 contract, which we received as a result of the market research that had been conducted by the Spiral 3 program manager at NAVSUP FLC SD. AT&T did not provide those rates during the market research. However, AT&T does provide Not to Exceed (NTE) rates that they are not allowed to go over (T. Thompson, personal communication, September 9, 2020). Additionally, in our modeling, we did add an MVNO, Google Fi, into our price comparison to see how adding additional competition would compare against the current Spiral 3 providers. To do this, we used Google Fi's commercial plans as a starting rate (Google Fi, 2020).

A. ASSUMPTIONS

Before going into the hypothetical model, we provide here all the planning assumptions for usage patterns of a hypothetical command and data rates for each provider that we used to build a price comparison on identical usage patterns across all plans.

1. Proposed Usage Patterns

Our usage patterns for hypothetical commands were based on two main factors. The first factor was the size of the command, which we broke out based on analysis of the number of phones commands had in their custody that we could analyze from their collective J-018 parts. The trends we noticed were that commands either had a very small number of phones (e.g., a command on a U.S. ship), or they were typically a shore command or shore-based operational command, with a larger requirement for cellular

phones. Based on these data, we came up with three different command sizes to analyze, which were as follows:

- Small Commands: 10 phones
- Medium Commands: 100 phones
- Large Commands: 300 phones

Next, we had to determine international usage for commands to analyze. This is where we had no data to base our assumptions on, because the J-018 reports did not break out which phones had international services and which did not; the reports only gave the total international monthly spend that a command had. This meant that we needed a workable assumption that would adequately highlight cost drivers among the existing Spiral 3 plans. One definite cost driver in two of the Spiral 3 plans, AT&T and Verizon, was a flat "buy-in" monthly fee to use unlimited international data, so given this, we decided to break out three different percentages for each command size to highlight this access fee charge as a cost driver as more phones are added. Again, given that we had no granular, historical data to pull from, but wanting to explore this cost driver, we settled on three percentages that we felt were distinct enough to examine this cost driver. For each command size, we would identify costs when 30% of a command's phone inventory had international services, when 50% of a command's phone inventory had international services, and when 70% of a command's phone inventory had international services.

Finally, we had to come up with modeling assumptions for usage rates for both texts and voice minutes, the other two cost drivers for international services provided by Spiral 3 vendors. Again, we had no granular, historical data to pull from for these either, but—like with international data—what was more important was not so much examining historical data but highlighting the difference between cost drivers among all Spiral 3 vendors and Google Fi. We did align voice/text usage with international data usage, in that we assumed that for any given command the more phones they had with international data, the more minutes and texts those commands would use. Since some commands had different rates for incoming and outgoing texts, we also assumed that there was a reciprocal relationship between texting so that for every text sent, one was received and vice versa. Given these assumptions, we were able to create nine distinct models to use in order to

examine international pricing among the current Spiral 3 vendors and Google Fi. All minutes and texts are pooled among all phones with international data. The models are as follows:

- Small Commands: **10** phones
- **30% [3]** phones with data, **100** voice minutes, **10** texts
- **50% [5]** phones with data, **200** voice minutes, **20** texts
- **70% [7]** phones with data, **300** voice minutes, **30** texts

- Medium Commands: **100** phones
- **30% [30]** phones with data, **200** voice minutes, **40** texts
- **50% [50]** phones with data, **400** voice minutes, **80** texts
- **70% [70]** phones with data, **600** voice minutes, **120** texts

- Large Commands: **300** phones
- **30% [90]** phones with data, **400** voice minutes, **200** texts
- **50% [150]** phones with data, **800** voice minutes, **400** texts
- **70% [210]** phones with data, **1200** voice minutes, **600** texts

For all vendors, we ran their data rates through each model just described to get both an estimated international spend total for each model for each vendor as well as total spend based on the actual figures for domestic services that would have to be procured along with the international services in each model (i.e., if a small command had 10 phones, we would identify how much an international plan cost under a specific model in addition to the cost to procure those 10 phones and associated lines).

2. Data Rates

Before going into the modeling, we must go over the data rates that would be proscribed to each vendor. The rates themselves were already laid out in Chapter IV, but for some, such as voice minutes, the prices can vary based on location. Due to this, we first had to come up with a suitable international location that has a continuous DON presence. Given this criterion, we deemed the most suitable location to be Bahrain. Bahrain is the location of Commander, U.S. Naval Forces Central Command (COMUSNAVCENT), which is the naval component for CENTCOM. Due to this, Bahrain sees a major influx of deployed and temporarily assigned personnel, with these personnel using their command-

provided cellular phones procured under the Spiral 3 contract to conduct official business. This planning assumption should not have a drastic effect on pricing, however, since—with the exception of Verizon—all the other vendors had standardized rates for voice minutes and texts.[5] For Bahrain, Verizon charges $0.24 per voice minute. However, as seen in Figure 11, in some countries Verizon charges much lower rates for voice minutes. In order to better control for this cost driver, we also ran an additional data analysis on the large model with 70% usage, except with the country being Japan instead of Bahrain. Japan is another location with a large DON presence, and Verizon charges $0.05 minute to Spiral 3 customers for voice minutes in Japan, lower than any other vendor.

Based on these planning assumptions, these are the rates that we use for each vendor as we conduct our models for data, texts, and voice minutes. Unless otherwise stated for each service provided by a vendor, all rates are standardized:

- T-Mobile
    - Monthly Access Fee for Unlimited Data: **$0.00**
    - Voice Minute: **$0.20**
    - Outgoing Text: **$0.00** / Incoming Text: **$0.00**

- Verizon
    - Monthly Access Fee for Unlimited Data: **$16.00**
    - Voice Minute: **$0.24** (Bahrain) / **$0.05** (Japan)
    - Outgoing Text: **$0.50** / Incoming Text: **$0.05**

- AT&T (Based on NTE Prices Under the Spiral 3 Contract)
    - Monthly Access Fee for Unlimited Data: **$16.00**
    - Voice Minute: **$2.00**
    - Outgoing Text: **$0.50** / Incoming Text: **$0.05**

- Sprint
    - Monthly Access Fee for Unlimited Data: **$0.00**
    - Voice Minute: **$0.25**
    - Outgoing Text: **$0.00** / Incoming Text: **$0.00**

[5] This might not be technically true for AT&T, but since they would not provide their Spiral 3 rates, they are based on the NTE pricing under the Spiral 3 contract, which is standardized.

- Google Fi
    - Monthly Access Fee for Unlimited Data: **$0.00**
    - Voice Minute: **$0.20**
    - Outgoing Text: **$0.00** / Incoming Text: **$0.00**

For Sprint, we assumed people would pay for voice minutes separately vice buying an unlimited talk and data plan, as seen in Figure 20, given how relatively cheap their voice minutes were.

B. MODELING ANALYSIS

The completed results of our modeling analysis can be found in Appendices A and B. Appendix A contains all the raw totals of our modeling analysis that were already provided in Section A of this chapter. However, these raw data numbers as they are would not actually give an accurate picture on their own. Commands were broken out in the modeling analysis based on size, and—unsurprisingly—the bigger commands ended up paying more for services. Additionally, the price differences between the vendors only increased during this analysis as the model moved from small commands to large commands.

Taken on its own, it might then look like there was a bigger disparity between the vendors than there is in actuality, as most commands are not as large as our largest model. Given this, the totals among all the different models then had to be weighted to give a weighted average of total costs across all nine models. These are outlined in Appendix B. We weighted the average among each group size (e.g., Small Commands 1–3) and provided a weighted average among all nine models, both with individualized cost breakouts for each component as well as a weighted average of cost totals among each vendor. The weighted average, to have some predicative use, needs to reflect the actual sizes of the commands currently under the Spiral 3 contracts across all vendors. Based on our analysis of current task orders under this contract, 60% of the commands meet the description of a small command, 30% meet the description of a medium command, and 10% meet the description of a large command. So even though the large command models have the biggest price differences between the vendors, when they are weighted appropriately, the cost savings are not as much as they would appear to be when

unweighted, since such a small percentage of commands meet the criteria for a large command as given in Section A of this chapter. Figure 21 highlights the weighted averages for each vendor—both in individual cost components, where they charge for services, and in total international services and overall services, including domestic charges.

	Weighted Average
Data Costs (Verizon)	**$6,336.00**
Data Costs (AT&T)	$6,336.00
Minutes $ (T-Mobile)	$768.00
Minutes $ (Verizon)	**$1,017.60**
Minutes $ (AT&T)	$7,680.00
Minutes $ (Sprint)	**$960.00**
Minutes $ (Google)	$768.00
Outgoing Texts $ (Verizon)	**$456.00**
Outgoing Texts $ (AT&T)	$456.00
Incoming Texts $ (Verizon)	**$45.60**
Incoming Texts $ (AT&T)	$1,860.00
International Subtotal (T-Mobile)	**$814.08**
Domestic Subtotal (T-Mobile)	**$35,511.71**
Grand Total (T-Mobile)	**$36,325.79**
International Subtotal (Verizon)	$7,014.56
Domestic Subtotal (Verizon)	$43,864.00
Grand Total (Verizon)	$50,878.56
International Subtotal (AT&T)	**$15,286.56**
Domestic Subtotal (AT&T)	**$44,496.17**
Grand Total (AT&T)	**$59,782.73**
International Subtotal (Sprint)	$1,017.60
Domestic Subtotal (Sprint)	$25,177.21
Grand Total (Sprint)	$26,194.81
International Subtotal (Google)	**$798.72**
Domestic Subtotal (Google)	**$33,512.46**
Grand Total (Google)	**$34,311.18**

Figure 21. Modeling Analysis Weighted Averages

The main takeaway here is that the two vendors with the most task orders assigned to them, Verizon and AT&T, have the highest costs associated with their plans when international services are used. Figures 22 and 23 highlight the cost savings per account for both Verizon and AT&T if these accounts with international charges switched to one of the other three other vendors.

Savings Verizon to Google Per Account	$6,215.84
Savings Verizon to T-Mobile Per Account	$6,200.48
Savings Verizon to Sprint Per Account	$5,996.96
Number of Verizon Accounts w/ Int.	164
Total Savings Verizon to Google	**$1,019,397.76**
Total Savings Verizon to T-Mobile	**$1,016,878.72**
Total Savings Verizon to Sprint	**$ 983,501.44**

Figure 22. International Cost Comparison for Verizon

Savings AT&T to Google Per Account	$14,487.84
Savings AT&T to T-Mobile Per Account	$14,472.48
Savings AT&T to Sprint Per Account	$14,268.96
Number of AT&T Accounts w/Int.	285
Total Savings AT&T to Google	**$4,129,034.40**
Total Savings AT&T to T-Mobile	**$4,124,656.80**
Total Savings AT&T to Sprint	**$4,066,653.60**

Figure 23. International Cost Comparison for AT&T

In our modeling analysis, if all accounts under Verizon switched to Google, Verizon, or Sprint, they would save approximately $6,000 per account. With AT&T, this would be more than twice that, with cost savings of over $14,000 per account if they switched to a service provider with more competitive rates, such as Google, T-Mobile, or Sprint.

A few caveats need to be made here. First, given that we did not actually obtain granular data, these are not *actual* cost savings but hypothetical cost savings derived from the assumptions made in our modeling. The variance in reality is always going to be different than the steady state that we take as given when the modeling assumptions are

presented. What this means is that the actual charges would vary by individual commands across months when they did not need to utilize international services as much. However, what our modeling analysis does show is that under the current pricing structure of the Spiral 3 contract, there likely are *major* cost differences that can drive prices up for those commands that utilize international services.

Second, the AT&T prices were based on the NTE prices defined in the Spiral 3 contract. It is quite likely that the prices AT&T charges are lower than these prices in some instances, although in the one instance of AT&T pricing that we have, international data, the price they charge matches the NTE rate in the Spiral 3 contract. As can be seen in Chapter IV, AT&T has eight accounts that reached international charges of over $100,000 in our data period. AT&T is the vendor with the largest number of accounts that reached six figures; the next closest, Verizon, only had three. While it is impossible to determine what AT&T's rates are—given their refusal to provide them to NAVSUP FLC SD as market research—it appears very likely based on actual prices that they currently charge the highest for international services between data, voice, and texting.

Given that we had to use NTE rates for AT&T, this allowed for another observation on the current iteration of the Spiral 3 contract. Essentially, the AT&T rates in this modeling analysis are equal to the highest rates that a company could charge under the Spiral 3 contract. As mentioned in Figure 23, the cost savings that would be gained by moving to one of the more competitive accounts such as T-Mobile are over $14,000 per account. Even under the constraint of an artificial price ceiling imposed by the government onto commercial vendors, there is a great amount of price volatility under this ceiling that can have very costly ramifications for those commands that have a lot of international usage.

Given our analysis, it is easy to look at the cost breakdowns and determine the biggest cost driver for international services. First, for AT&T, their highest cost breakdown would be voice minutes, but these rates are also based on a flat rate of NTE $2/minute, which led to a weighted average of $7,680.00. While this seems high, it is in line with and slightly cheaper than their current commercial model, which charges $1/minute for Canada and Mexico, $2/minute for Europe, and $3/minute for everywhere else (AT&T, 2020).

Second, AT&T data charges were another big factor at $6,336.00. Given that each phone that uses international data charges accrues a $16 monthly access fee, the more phones that are used overseas at large commands, the more costs will rise for those commands. Indeed, this was also the main cost driver for Verizon. Since Verizon also charge $16 for unlimited service, their weighted average for international data was also $6,336.00.

Since the above analysis was based on assumptions, in order to calculate total savings by switching from more expensive to less expensive vendors, assumptions on number of accounts had to be made. For Verizon, 165 accounts were used as a working assumption since, in our data period, this was the number of accounts that had international charges during that time. Likewise, for AT&T, 285 accounts were used as this was the number of accounts that had international charges for AT&T within our data period. For Verizon, granular total cost savings can be seen in Figure 22. On average, the government could save a total of $1,006,592.64 if all Verizon accounts with international plans switched from Verizon to either Sprint, Google Fi, or T-Mobile. For AT&T, granular total cost savings can be seen in Figure 23. On average, the government could save a total of $4,106,781.60 if all AT&T accounts with international plans switched from Verizon to either Sprint, Google Fi, or T-Mobile. These savings might seem large, and they are, but it must be remembered that these are based on hypothetical usage models tailored with actual rates, with the additional assumption of maximum usage of international services provided. In actuality, international rate usage—and what is charged against a command's international plan on a monthly basis—will vary from our modeling assumption, which assumed a static and constant usage rate. Based on our analysis, there is a clear and substantial cost difference when choosing Verizon or AT&T over the other service providers, and there should be a compelling reason beyond brand preference to justify using them over their competitors.

Based on our modeling analysis, the top vendors that had the most international charges, AT&T and Verizon, also had the highest total of international charges among their respective accounts. Conversely, T-Mobile, one of the cheapest options for international service in our modeling, had the lowest total of international charges, where the command with the international spend was around $20,000, which was approximately five to 10 times

less for the highest accounts at Verizon and AT&T, respectively. While not conclusive, our modeling does suggest at the very least that the reason T-Mobile international charges are so much cheaper in reality is not because of usage or lack thereof (i.e., the commands who had task orders with T-Mobile just did not use much international services), but because T-Mobile pricing structure—where only voice minutes were charged at a competitive rate—deflated all costs for international services for T-Mobile DON accounts in comparison to its competitors AT&T and Verizon.

Interestingly, Google Fi, even at its commercial prices, was much more competitive than both AT&T and Verizon for international services and was in line with the government pricing provided by T-Mobile and Sprint. While the Spiral series of contracts have typically been the domain solely of the "Big Four" U.S. wireless companies, companies entering into the market as MVNOs are showing that there is much potential to use them as competitive resources on future iterations of the Spiral 3 contract. Even though there is one MVNO already on the contract, it is hard to say how much of a serious bidder they are because (a) we do not have any of their pricing, and (b) we do not know if they have even made any bids. If an MVNO such as Google Fi were added to a future Spiral contract and maintained a competitive presence, the potential for cost savings for the DON may be significant.

In sum, what we could not do in this chapter, due to lack of data, was to identify actual cost savings, since the data we had was not the data we needed to parse this out. However, what we have shown in this chapter is that, based on the actual cost structures provided by the Spiral 3 vendors themselves and some reasonable assumptions about a command's international wireless service requirements, commands have the opportunity to make significant cost savings by picking a different wireless vendor that has a more competitive pricing scheme for international services.

VI. CONCLUSION AND RECOMMENDATIONS

In the beginning of Chapter I, the following primary research question was presented:

1. How can the Navy better acquire international cellular and wireless services than it does currently?

Secondary and related research questions that help answer our primary research question include

2. What are the gaps in international service currently, and how can the Navy fill them?
3. Why is it so costly for the Navy to acquire international cellular and wireless service?

Based on the analysis and background provided in the preceding chapters, we can now answer these research questions. By answering the second and third questions first, we can then easily answer the primary research question.

A. INTERNATIONAL SERVICE GAPS

The main gaps in international service are a direct consequence of how international services are acquired in the Spiral 3 contract. Under the ELIN structure, all domestic wireless and cellular services have set prices that are negotiated and incorporated into the contract at the time of the contract's award, and all future task orders must comply with the prices written into the contract; however, requirements for international services are not formulated with set prices. The impetus behind this was most likely due to the nature of international roaming agreements, whereby wireless vendors would come to agreements with overseas vendors on roaming prices so that their customers traveling overseas could utilize those foreign wireless networks when abroad. AT&T responded on this process in their market research to NAVSUP FLC SD as follows:

> AT&T's international roaming rates are based upon a negotiation between the host nation Carriers and the Country of origin. Inbound and outbound

> local calling ratios are analyzed by each carrier, and a surplus/deficit in usage may compel either carrier to raise or lower rates. The agreed upon rate is the basis for AT&T's international roaming packages available to all customers at any given time. AT&T analyzes historical roaming and customer usage patterns to derive compelling international roaming packages. (T. Thompson, personal communication, August 10, 2020)

Likewise, Verizon responded similarly, illuminating the process as they stated the following to NAVSUP FLC SD:

> Verizon and other carriers negotiate commercial agreements with OCONUS (Outside the Continental United States) carriers to provide commercial wireless service outside the U.S. Verizon maintains hundreds of such agreements to make wireless service available to all customers including government, enterprise, and consumer in over 200+ countries worldwide. Pricing is negotiated with each individual OCONUS carrier. Details on these negotiations are proprietary and confidential. These commercial vendor agreements are negotiated on behalf of all of Verizon customers. They are not subcontracts entered to serve just the Federal Government or the Navy/USMC. As a result, the Federal Government benefits from these commercially negotiated rates as a component of the entire Verizon pricing platform. (T. Thompson, personal communication, 2020)

Some main points provided by both AT&T and Verizon here might go a long way toward showing why the current international structure under the Spiral 3 was originally implemented. First, U.S. wireless vendors maintain a plethora of international agreements with OCONUS wireless vendors to provide roaming services to their customers. Presumably, these agreements are based on local competition, capability of a provider's range, and so on. Additionally, the rates in the agreement appear to constantly change based on usage. Given this, a U.S. wireless vendor would argue that these factors would then make it impossible for them to provide the government standardized international pricing. Due to the constantly changing landscape of international roaming agreements, companies could not forecast that far in advance on a multiple-year contract vehicle such as Spiral 3.

There are two sides to this argument. The vendors could obviously say that they cannot offer a standardized price because if international roaming agreements increased, they might fail to make a profit and could potentially lose money if the rates they charge their Spiral 3 customers are less than what they would end up paying under an international

roaming agreement. Conversely, the vendors could argue that by allowing for a contract structure to match the unknown qualities that make up the landscape of international roaming agreements (i.e., having constant competition for international wireless services) this would allow wireless vendors to potentially be in a position to offer lower prices than if they had to standardize them over a multiple-year period, where these prices would most certainly be higher to cover against any potential increase in prices that they are charged in international roaming agreements.

However, this idea that because the market for international roaming agreements is so volatile that prices cannot be predetermined in a multiyear contract is based on a flawed premise and uses the guise of proprietary data as justification for not being up front with their prices. In a report on international roaming agreements, the OECD discussed the trend of wholesale prices steadily decreasing between vendors while the retail prices to the customers remained stagnant, concluding that "experience has shown that large operators … do not seek to put rates into the retail market at levels that would be expected in a competitive market, even though balancing gives them the wherewithal to do so" (OECD, 2013, p. 8). The veracity of this idea can be seen even within the Spiral 3 contract, where both Sprint and T-Mobile offer much more competitive international wireless services than either AT&T and Verizon, even though they operate within the same business environment. T-Mobile stated that they currently have over 700 international roaming agreements in place (T. Thompson, personal communication, August 10, 2020), yet this has not stopped them from being able to offer an extremely competitive model for wireless services, including free data and texts when ordering domestic lines and voice minutes that are only $0.20 globally, regardless of country. It is therefore abundantly clear that Verizon and AT&T believe that their lack of transparency on international rates favors them due to their dominance in the market and their brand popularity, which allows them to take advantage of the lower rates they are paying to exploit their customers. Our modeling has shown that they are not a strong competitor when it comes to choosing an international service provider.

Even within the constraints of the Spiral 3 contract, the vendors themselves are willing to comply with standardized, long-term pricing. As mentioned in the previous

chapter, since Spiral 3 rates for AT&T could not be obtained, the NTE price ceilings for the Spiral 3 contract had to be used in lieu of that, which included $2 per voice minute in any country, $0.50 per incoming and outgoing text, and a $16 per month flat fee per phone for unlimited international data. If a wireless vendor did not have *some* idea of what their costs would be for international services, even these price ceilings would not be amenable to them from a business standpoint.

The main gap in how international services are procured currently becomes more pronounced based on the NTE price ceilings as the Spiral 3 contract essentially allows the vendors to set the pricing on a case-by-case basis on any given task order rather than working to negotiate with the vendors before the Spiral 3 contracts were even awarded to lock in pricing throughout the contract. Additionally, there are very minimal controls on international service procurement other than price ceilings, but as can be seen in the previous chapter, these NTE price ceilings can lead to significantly higher costs than usage with vendors that had substantially more competitive rates. A lot of negotiation and analysis went into the domestic portion of the Spiral 3 contract, which undoubtedly makes up the bulk of the services procured, but it is worth highlighting the main aspects of this part of the contract to see how NAVSUP FLC SD was able to maximize cost savings:

- Offering only those wireless plans that aligned with DON usage,
- Delivering competitively priced wireless packages (inclusive of devices, unlimited texting, Push to Talk [PTT], and other features used by the DON),
- Standardizing rate plans among all wireless providers to maximize competition and obtain even lower pricing,
- Capitalizing on changes in the marketplace,
- Incorporating improved industry standards and technological advances (technology leveling),
- Providing the DON real-time (as invoiced) visibility of its wireless usage, and
- Aggregating and optimizing rate plans by sharing and pooling. (Thompson, 2015, p. 3)

All of these processes that were used to cut down on prices on the domestic portion of the Spiral 3 contract are noticeably absent on the international portion of the contract. Just based on the analysis within this thesis itself, many of these initiatives would seem to

be very promising in lowering pricing on international services rather than the current laissez-faire model that allows the wireless vendors a lot of latitude when providing pricing on Spiral 3 task orders. This gap in the international service procurement portion of the Spiral 3 contract leads into the other secondary research question of this thesis: Why is procuring international services so costly?

B. HIGH COSTS OF INTERNATIONAL WIRELESS SERVICES

The fundamental reason that international wireless services are so costly has to do with the fact that the U.S. cellular industry is not purely competitive. The U.S. wireless industry is split among, up until recently, four vendors, T-Mobile, Sprint, AT&T, and Verizon, which made up 98% of the market share in the United States for wireless and cellular services (Wallis, 2019). With the recent T-Mobile/Sprint merger, this means that 98% of the market share is now controlled by three vendors. This classifies the market as an oligopoly, where a small number of sellers have a lot of purchasing power due to their large share of the market. In an environment such as this, the sellers typically act as price setters rather than price takers, as there is not much competition that could drastically stop one of these sellers from acting in such a manner. This does not mean that the threat of competition will not have any effect on a competitor's pricing. For example, in 2017, Verizon abruptly brought back its unlimited domestic plans, which promptly led AT&T, T-Mobile, and Sprint to quickly follow suit and offer unlimited plans of their own (Gartenberg, 2017). However, given the amount of infrastructure that is owned by the various U.S. wireless companies to provide services to consumers, the barriers for entry are not just high for new entrants, they can also give these specific companies an advantage since they already have infrastructure in place when their competitors do not. For example, let's say that in one city only Verizon has a cellular tower that provides coverage. Even if a competitor can offer lower prices to a consumer in that area, it will not do much good if their lower prices also provide lesser coverage. From an economics standpoint, the actualities of physical infrastructure cause the U.S. telecommunication industry to be more inelastic than it would be otherwise if all companies could provide equal service coverage to all consumers equally. This allows cellular companies to keep their prices higher given that (a) for some consumers, a cellular company might be their only option in a specific

area, and (b) each company has such a giant share of the market that losing a few customers to a competitor will not have much effect on their bottom line.

Yet, the DON has one advantage that the average consumer does not, and that is its own purchasing power. The Spiral 3 contract, including its base value and four option years, has a potential value of $993.5 million (Lieberman, 2019). This is a significant amount of business to *any* company, whether they be in a monopoly, an oligopoly, or an environment of pure competition. Notably, this purchasing power is the underlying reason that the Navy was able to compel the Spiral 3 vendors into providing such competitive government rates when compared to the commercial market. Given that the vendors with the most task orders under the Spiral 3 account, Verizon and AT&T, also have the costliest international service plans, it is clear that the DON has not yet utilized their purchasing power to achieve the same levels of cost savings on international services that they have on domestic plans.

The answer to why international services are so costly then becomes twofold. First, the major vendors of the cellular industry that all compete for task orders under the Spiral 3 contract operate in an environment of oligopoly. Consequently, the traditional benefits of competition for the buyer to help lower prices among qualified vendors do not work to the extent that would be seen in an environment of pure competition. This allows AT&T and Verizon to offer less competitive prices under the Spiral 3 contract than its other competitors, Sprint and T-Mobile.[6] Second, NAVSUP FLC SD has not utilized the purchasing power of the DON to its full advantage in the way that it did when it was negotiating prices for domestic services. The rationale behind this might be due to what was mentioned in the previous section, that the complexity of vendors using international roaming agreements to offer roaming services to its consumers has enabled this idea of constant competition for international services at the time of pre-award on a task order as opposed to being codified within the contract. However, NAVSUP FLC SD could look to the service plans of Sprint or T-Mobile, or vendors not under the plan, like Google Fi, to

[6] What is unknown is if the vendors under the Spiral 3 contract know each other's international service plans that are offered under the Spiral 3 contract. If they are known, the cheaper plans available under the Spiral 3 contract have not compelled prices to go down on those plans that are more expensive.

see that even though the prices that vendors negotiate for international roaming services might fluctuate, this does not mean that the vendors cannot forecast relatively accurate estimates that both enable the vendor to continue to make a profit and ensure that the government pays a fair and reasonable price for these services.

C. RECOMMENDATIONS FOR PROCESS CHANGES AND FUTURE STUDY

Based on the findings of our research, we identified several recommendations and opportunities for process changes to the business and contracting practices for DOD wireless solutions and future studies for stakeholders to consider.

1. Recommendation #1: Standardize International Rates in Contract

One of the problems that we recognized during our background review of the existing contracts under the Spiral 3 MAC and data collection for our research was the lack of clarity on pricing for international service ELINs. The prices listed in the contracts were "TBD based on competition" (SAM, 2017c). This essentially turned over all cost control for international service to the service providers and has contributed to the government's lack of insight into the disproportionally large costs the government is paying for these services as identified in our data and analysis chapters.

In doing our market research for these chapters to better understand the rates that actually go into what the government is spending on international services, it became clear that these prices need to be requested up front in the next iteration of the Spiral contract. The service providers, for the most part, were reluctant to share how they develop their pricing schemes for international services, citing their being proprietary in nature due to their use agreements with their global partners, but they did share their international rates without specifics on how the government has been charged.

Therefore, we recommend that in the solicitation for the next Spiral contract that all service providers provide the specifics on international service fees and rate structures to better inform the government's decision on which providers to include in the MAC and which providers offer the best and most competitive pricing for the commands that require international services. By holding them to agree upon pricing structure up front, the

government will at least know the charges to expect and will be able to avoid the regular instances of anti-deficiency from the commands that require international services.

Additionally, we recommend that the data on international usage be included as a reporting requirement from the service providers. This data was one of the largest roadblocks we came across in attempting to do our analysis. By having the international usage data available, the government can be better informed on actual usage and can develop better requirements definitions in future follow-on contracts. While the data will surely come at a cost to the government, we believe it will be essential to improving competition and driving prices down in the long run.

2. Recommendation #2: Increase Competition

Throughout the course of our research, we determined that increased competition in the Spiral 3 MAC has decreased prices across the board except when it comes to the cost of international services. We noted that this is due to the nature of the wireless industry in the United States. The U.S. wireless industry is split among, up until recently, four vendors, T-Mobile, Sprint, AT&T, and Verizon, which made up 98% of the market share in the United States for wireless and cellular services (Wallis, 2019), and with the recent T-Mobile/Sprint merger, this means that 98% of the market share is now controlled by only three vendors, operating in an oligopoly. From our analysis, there was clear cost savings to be had from T-Mobile and Sprint in their generous pricing for international services. Only time will tell if they will maintain these competitive pricing schemes as a singular company, being closer in size to Verizon and AT&T, or if they will increase their pricing to be more in line with their larger competitors as they approach equality in the market place through their merger.

We recommend bringing in smaller, boutique-type service providers for the next version of the Spiral contract. In our research, we discussed the potential benefits that MVNO providers may offer. In our analysis, we included one of the more popular MVNO providers, Google Fi, as commercially they have proven to be a strong provider, especially for international service requirements. Additionally, Google has made it clear that they are interested in expanding the business that they do with the government through cloud

computing and artificial intelligence programs (Tucker, 2019), so it would be safe to assume that they would be interested in being included in the next version of the Spiral contract. Our analysis showed that they would be a strong competitor based solely on their commercial prices, so bringing them in as a competitor against traditional MNO providers has the potential for further cost savings to the government and is likely to improve Google's place as a competitor in the U.S. wireless industry.

3. Recommendation #3: Better Define End User Requirements

From our research and analysis, it became clear that the end users do not adequately define their requirements, particularly when it comes to international service requirements. This has the secondary effect of framing the quotes the service providers submit under Spiral 3 when a new task order is competed. If the requirements submitted by commands requesting new service were more accurate and in line with what is seen through the usage, we would expect that T-Mobile and Sprint would be winning a more significant number of awards, especially from those commands that require any marginal amount of international services, due to their significantly lower costs.

A better end user requirements definition will not only result in more savings but will also result in more commands not becoming anti-deficient when they exceed their service agreements. This will also relieve the administrative burden of the contracting office and the service providers in doing frequent and unnecessary modifications to the task orders. Additionally, a better requirements definition will assist NAVSUP in creating requests for proposal for the next version of the Spiral MAC through accurate and detailed requirements. This further supports our first recommendation to standardize rates for international services. It will also better inform how NAVSUP defines its business rules for commands when submitting requests for new task orders under the Spiral 3 contract. Based on our analysis, we recommend that NAVSUP create business rules for commands that have any moderate level of international service requirements, stating that the commands must request service from the preferred service provider T-Mobile/Sprint due to the significant cost savings potential.

4. Recommendations for Future Study

In the process of conducting our research, and due to extenuating circumstances involved in obtaining data during the COVID-19 pandemic, we have identified a few areas that we recommend for future studies and research that may have the potential to identify further savings for the DOD through the way the government acquires wireless services.

The first recommendation we have for future study would be to conduct a business case analysis based on actual command usage for international services. As previously discussed in our data and analysis chapters, we were unable to get the granular data we had originally hoped to obtain. Therefore, we had to build a model based on some reasonable assumptions about phone usage. By using actual usage data, a future study may be able to calculate cost-saving potential with more confidence than our model does.

Another area that we recommend for future studies would be to do an analysis of global rates for international services. This should be done by obtaining the cost of data, text messaging, and voice minutes in areas where the DOD currently uses international services and compare those prices to what our current service providers charge to determine if there are actual cost savings obtained by using them for international service or if there are other avenues available for further saving potential. Our attempts to obtain this data ended early on due to extremely high costs to access the readily available databases where this information is available through GSMA. There is potential to partner on further research with organizations who already have access to GSMA data or to access the data through sponsors who have the funding available to access to the GSMA database.

That research may help inform a larger study into a cost–benefit analysis of the DOD establishing its own MVNO and forgoing contracts with commercial service providers to internalize the cost and ability to provide wireless services through their existing communication infrastructure. We envision such a study involving market research that explores potential MVNEs' ability to maintain a DOD mobile network, examines costs to obtain the devices currently included in the Spiral 3 contract through service providers, and analyzes existing communication infrastructure capability to support a DOD MVNO. This can be used as a basis to conduct a business case analysis on the

establishment of a program office for a DOD mobile network to determine if the government is truly better off acquiring mobile services commercially or if an MVNO would be more cost effective.

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APPENDIX A. RAW TOTAL RESULTING FROM MODELING

	Small Company 1	Small Company 2	Small Company 3
Number of Phones	10	10	10
Phones with International Data	**3**	**5**	**7**
Data Costs (T-Mobile)	$0.00	$0.00	$0.00
Data Costs (Verizon)	**$576.00**	**$960.00**	**$1,344.00**
Data Costs (AT&T)	$576.00	$960.00	$1,344.00
Data Costs (Sprint)	**$0.00**	**$0.00**	**$0.00**
Data Costs (Google)	$0.00	$0.00	$0.00
Pooled Minutes	**100**	**200**	**300**
Minutes $ (T-Mobile)	$240.00	$480.00	$720.00
Minutes $ (Verizon)	**$288.00**	**$576.00**	**$1,344.00**
Minutes $ (AT&T)	$2,400.00	$4,800.00	$7,200.00
Minutes $ (Sprint)	**$300.00**	**$600.00**	**$900.00**
Minutes $ (Google)	$240.00	$480.00	$720.00
Pooled Out. Texts	**10**	**20**	**30**
Outgoing Texts $ (T-Mobile)	$0.00	$0.00	$0.00
Outgoing Texts $ (Verizon)	**$60.00**	**$120.00**	**$180.00**
Outgoing Texts $ (AT&T)	$60.00	$120.00	$180.00
Outgoing Texts $ (Sprint)	**$0.00**	**$0.00**	**$0.00**
Outgoing Texts $ (Google)	$0.00	$0.00	$0.00
Pooled In. Texts	**10**	**20**	**30**
Incoming Texts $ (T-Mobile)	$0.00	$0.00	$0.00
Incoming Texts $ (Verizon)	**$6.00**	**$12.00**	**$18.00**
Incoming Texts $ (AT&T)	$60.00	$120.00	$7,200.00
Incoming Texts $ (Sprint)	**$0.00**	**$0.00**	**$0.00**
Incoming Texts $ (Google)	$0.00	$0.00	$0.00
International Subtotal (T-Mobile)	**$254.40**	**$508.80**	**$763.20**
Domestic Subtotal (T-Mobile)	**$5,380.56**	**$5,380.56**	**$5,380.56**
Grand Total (T-Mobile)	**$5,634.96**	**$5,889.36**	**$6,143.76**
International Subtotal (Verizon)	$964.56	$1,725.60	$2,486.64
Domestic Subtotal (Verizon)	$7,632.00	$7,632.00	$7,632.00
Grand Total (Verizon)	$8,596.56	$9,357.60	$10,118.64
International Subtotal (AT&T)	**$3,130.56**	**$6,057.60**	**$8,876.64**
Domestic Subtotal (AT&T)	**$6,740.33**	**$6,740.33**	**$6,740.33**
Grand Total (AT&T)	**$9,870.89**	**$12,797.93**	**$15,616.97**
International Subtotal (Sprint)	$318.00	$636.00	$954.00
Domestic Subtotal (Sprint)	$3,814.73	$3,814.73	$3,814.73
Grand Total (Sprint)	$4,132.73	$4,450.73	$4,768.73
International Subtotal (Google)	**$254.40**	**$508.80**	**$720.00**
Domestic Subtotal (Google)	**$5,724.00**	**$5,724.00**	**$5,767.20**
Grand Total (Google)	**$5,978.40**	**$6,232.80**	**$6,487.20**

	Medium Company 1	Medium Company 2	Medium Company 3
Number of Phones	100	100	100
Phones with Int. Data	**30**	**50**	**70**
Data Costs (T-Mobile)	$0.00	$0.00	$0.00
Data Costs (Verizon)	**$5,760.00**	**$9,600.00**	**$13,440.00**
Data Costs (AT&T)	$5,760.00	$9,600.00	$13,440.00
Data Costs (Sprint)	**$0.00**	**$0.00**	**$0.00**
Data Costs (Google)	$0.00	$0.00	$0.00
Pooled Minutes	**200**	**400**	**600**
Minutes $ (T-Mobile)	$480.00	$960.00	$1,440.00
Minutes $ (Verizon)	**$576.00**	**$1,152.00**	**$1,728.00**
Minutes $ (AT&T)	$4,800.00	$9,600.00	$14,400.00
Minutes $ (Sprint)	**$600.00**	**$1,200.00**	**$1,800.00**
Minutes $ (Google)	$480.00	$960.00	$1,440.00
Pooled Out. Texts	**40**	**80**	**120**
Outgoing Texts $ (T-Mobile)	$0.00	$0.00	$0.00
Outgoing Texts $ (Verizon)	**$240.00**	**$480.00**	**$720.00**
Outgoing Texts $ (AT&T)	$240.00	$480.00	$720.00
Outgoing Texts $ (Sprint)	**$0.00**	**$0.00**	**$0.00**
Outgoing Texts $ (Google)	$0.00	$0.00	$0.00
Pooled In. Texts	**40**	**80**	**120**
Incoming Texts $ (T-Mobile)	$0.00	$0.00	$0.00
Incoming Texts $ (Verizon)	**$24.00**	**$48.00**	**$72.00**
Incoming Texts $ (AT&T)	$240.00	$480.00	$720.00
Incoming Texts $ (Sprint)	**$0.00**	**$0.00**	**$0.00**
Incoming Texts $ (Google)	$0.00	$0.00	$0.00
International Subtotal (T-Mobile)	**$508.80**	**$1,017.60**	**$1,526.40**
Domestic Subtotal (T-Mobile)	**$53,805.60**	**$53,805.70**	**$53,805.60**
Grand Total (T-Mobile)	**$54,314.40**	**$54,823.30**	**$55,332.00**
International Subtotal (Verizon)	$6,945.60	$11,856.00	$16,766.40
Domestic Subtotal (Verizon)	$76,320.00	$76,320.00	$76,320.00
Grand Total (Verizon)	$83,265.60	$88,176.00	$93,086.40
International Subtotal (AT&T)	**$11,385.60**	**$20,736.00**	**$30,086.40**
Domestic Subtotal (AT&T)	**$67,503.28**	**$67,403.28**	**$67,403.28**
Grand Total (AT&T)	**$78,888.88**	**$88,139.28**	**$97,489.68**
International Subtotal (Sprint)	$636.00	$1,272.00	$1,908.00
Domestic Subtotal (Sprint)	$38,147.28	$38,147.28	$38,147.28
Grand Total (Sprint)	$38,783.28	$39,419.28	$40,055.28
International Subtotal (Google)	**$480.00**	**$1,017.60**	**$1,526.40**
Domestic Subtotal (Google)	**$28.80**	**$57,240.00**	**$67,035.41**
Grand Total (Google)	**$508.80**	**$58,257.60**	**$68,561.81**

	Large Company 1	Large Company 2	Large Company 3
Number of Phones	300	300	300
Phones with International Data	**90**	**150**	**210**
Data Costs (T-Mobile)	$0.00	$0.00	$0.00
Data Costs (Verizon)	**$17,280.00**	**$28,800.00**	**$40,320.00**
Data Costs (AT&T)	$17,280.00	$28,800.00	$40,320.00
Data Costs (Sprint)	**$0.00**	**$0.00**	**$0.00**
Data Costs (Google)	$0.00	$0.00	$0.00
Pooled Minutes	**400**	**800**	**1200**
Minutes $ (T-Mobile)	$960.00	$1,920.00	$2,880.00
Minutes $ (Verizon)	**$1,152.00**	**$2,304.00**	**$3,456.00**
Minutes $ (AT&T)	$9,600.00	$19,200.00	$28,800.00
Minutes $ (Sprint)	**$1,200.00**	**$2,400.00**	**$3,600.00**
Minutes $ (Google)	$960.00	$1,920.00	$2,880.00
Pooled Out. Texts	**200**	**400**	**600**
Outgoing Texts $ (T-Mobile)	$0.00	$0.00	$0.00
Outgoing Texts $ (Verizon)	**$1,200.00**	**$2,400.00**	**$3,600.00**
Outgoing Texts $ (AT&T)	$1,200.00	$2,400.00	$3,600.00
Outgoing Texts $ (Sprint)	**$0.00**	**$0.00**	**$0.00**
Outgoing Texts $ (Google)	$0.00	$0.00	$0.00
Pooled In. Texts	**200**	**400**	**600**
Incoming Texts $ (T-Mobile)	$0.00	$0.00	$0.00
Incoming Texts $ (Verizon)	**$120.00**	**$240.00**	**$360.00**
Incoming Texts $ (AT&T)	$1,200.00	$2,400.00	$3,600.00
Incoming Texts $ (Sprint)	**$0.00**	**$0.00**	**$0.00**
Incoming Texts $ (Google)	$0.00	$0.00	$0.00
International Subtotal (T-Mobile)	**$1,017.60**	**$2,035.20**	**$3,052.80**
Domestic Subtotal (T-Mobile)	**$161,416.80**	**$161,416.80**	**$161,416.80**
Grand Total (T-Mobile)	**$162,434.40**	**$163,452.00**	**$164,469.60**
International Subtotal (Verizon)	$20,788.80	$1,728.00	$50,155.20
Domestic Subtotal (Verizon)	$228,960.00	$33,744.00	$228,960.00
Grand Total (Verizon)	$249,748.80	$35,472.00	$279,115.20
International Subtotal (AT&T)	**$30,316.80**	**$54,528.00**	**$78,739.20**
Domestic Subtotal (AT&T)	**$202,209.84**	**$202,209.84**	**$202,209.84**
Grand Total (AT&T)	**$232,526.64**	**$256,737.84**	**$280,949.04**
International Subtotal (Sprint)	$1,272.00	$2,544.00	$3,816.00
Domestic Subtotal (Sprint)	$114,441.84	$114,441.84	$114,441.84
Grand Total (Sprint)	$115,713.84	$116,985.84	$118,257.84
International Subtotal (Google)	**$1,017.60**	**$1,920.00**	**$3,052.80**
Domestic Subtotal (Google)	**$185,614.66**	**$171,835.20**	**$171,720.00**
Grand Total (Google)	**$186,632.26**	**$173,755.20**	**$174,772.80**

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APPENDIX B. WEIGHTED AVERAGE OF TOTAL INTERNATIONAL ROAMING COSTS ACROSS MODELS

	Small Company 1	Medium Company 1	Large Company 1	Weighted Company 1
Data Costs (Verizon)	$345.60	$1,728.00	$1,728.00	**$3,801.60**
Data Costs (AT&T)	$345.60	$1,728.00	$1,728.00	$3,801.60
Minutes $ (T-Mobile)	$144.00	$144.00	$96.00	$384.00
Minutes $ (Verizon)	$172.80	$172.80	$115.20	**$460.80**
Minutes $ (AT&T)	$1,440.00	$1,440.00	$960.00	$3,840.00
Minutes $ (Sprint)	$180.00	$180.00	$120.00	**$480.00**
Minutes $ (Google)	$144.00	$144.00	$96.00	$384.00
Outgoing Texts $ (Verizon)	$36.00	$72.00	$120.00	**$228.00**
Outgoing Texts $ (AT&T)	$36.00	$72.00	$120.00	$228.00
Incoming Texts $ (Verizon)	$3.60	$7.20	$12.00	**$22.80**
Incoming Texts $ (AT&T)	$36.00	$72.00	$120.00	$228.00
International Subtotal (T-Mobile)	$152.64	$152.64	$101.76	**$407.04**
Domestic Subtotal (T-Mobile)	$3,228.34	$16,141.68	$16,141.68	**$35,511.70**
Grand Total (T-Mobile)	$3,380.98	$16,294.32	$16,243.44	**$35,918.74**
International Subtotal (Verizon)	$578.74	$2,083.68	$2,078.88	$4,741.30
Domestic Subtotal (Verizon)	$4,579.20	$22,896.00	$22,896.00	$50,371.20
Grand Total (Verizon)	$5,157.94	$24,979.68	$24,974.88	$55,112.50
International Subtotal (AT&T)	$1,878.34	$3,415.68	$3,031.68	**$8,325.70**
Domestic Subtotal (AT&T)	$4,044.20	$20,250.98	$20,220.98	**$44,516.17**
Grand Total (AT&T)	$5,922.53	$23,666.66	$23,252.66	**$52,841.86**
International Subtotal (Sprint)	$190.80	$190.80	$127.20	$508.80
Domestic Subtotal (Sprint)	$2,288.84	$11,444.18	$11,444.18	$25,177.21
Grand Total (Sprint)	$2,479.64	$11,634.98	$11,571.38	$25,686.01
International Subtotal (Google)	$152.64	$144.00	$101.76	**$398.40**
Domestic Subtotal (Google)	$3,434.40	$8.64	$18,561.47	**$22,004.51**
Grand Total (Google)	$3,587.04	$152.64	$18,663.23	**$22,402.91**

	Small Company 2	Medium Company 2	Large Company 2	Weighted Company 2
Data Costs (Verizon)	$576.00	$2,880.00	$2,880.00	**$6,336.00**
Data Costs (AT&T)	$576.00	$2,880.00	$2,880.00	**$6,336.00**
Minutes $ (T-Mobile)	$288.00	$288.00	$192.00	**$768.00**
Minutes $ (Verizon)	$345.60	$345.60	$230.40	**$921.60**
Minutes $ (AT&T)	$2,880.00	$2,880.00	$1,920.00	**$7,680.00**
Minutes $ (Sprint)	$360.00	$360.00	$240.00	**$960.00**
Minutes $ (Google)	$288.00	$288.00	$192.00	**$768.00**
Outgoing Texts $ (Verizon)	$72.00	$144.00	$240.00	**$456.00**
Outgoing Texts $ (AT&T)	$72.00	$144.00	$240.00	**$456.00**
Incoming Texts $ (Verizon)	$7.20	$14.40	$24.00	**$45.60**
Incoming Texts $ (AT&T)	$72.00	$144.00	$240.00	**$456.00**
International Subtotal (T-Mobile)	$305.28	$305.28	$203.52	**$814.08**
Domestic Subtotal (T-Mobile)	$3,228.34	$16,141.71	$16,141.68	**$35,511.73**
Grand Total (T-Mobile)	$3,533.62	$16,446.99	$16,345.20	**$36,325.81**
International Subtotal (Verizon)	$1,035.36	$3,556.80	$172.80	**$4,764.96**
Domestic Subtotal (Verizon)	$4,579.20	$22,896.00	$3,374.40	**$30,849.60**
Grand Total (Verizon)	$5,614.56	$26,452.80	$3,547.20	**$35,614.56**
International Subtotal (AT&T)	$3,634.56	$6,220.80	$5,452.80	**$15,308.16**
Domestic Subtotal (AT&T)	$4,044.20	$20,220.98	$20,220.98	**$44,486.17**
Grand Total (AT&T)	$7,678.76	$26,441.78	$25,673.78	**$59,794.33**
International Subtotal (Sprint)	$381.60	$381.60	$254.40	**$1,017.60**
Domestic Subtotal (Sprint)	$2,288.84	$11,444.18	$11,444.18	**$25,177.21**
Grand Total (Sprint)	$2,670.44	$11,825.78	$11,698.58	**$26,194.81**
International Subtotal (Google)	$305.28	$305.28	$192.00	**$802.56**
Domestic Subtotal (Google)	$3,434.40	$17,172.00	$17,183.52	**$37,789.92**
Grand Total (Google)	$3,739.68	$17,477.28	$17,375.52	**$38,592.48**
	Small Company 3	**Medium Company 3**	**Large Company 3**	**Weighted Company 3**
Data Costs (Verizon)	$806.40	$4,032.00	$4,032.00	**$8,870.40**
Data Costs (AT&T)	$806.40	$4,032.00	$4,032.00	$8,870.40
Minutes $ (T-Mobile)	$432.00	$432.00	$288.00	$1,152.00
Minutes $ (Verizon)	$806.40	$518.40	$345.60	**$1,670.40**
Minutes $ (AT&T)	$4,320.00	$4,320.00	$2,880.00	$11,520.00
Minutes $ (Sprint)	$540.00	$540.00	$360.00	**$1,440.00**
Minutes $ (Google)	$432.00	$432.00	$288.00	$1,152.00
Outgoing Texts $ (Verizon)	$108.00	$216.00	$360.00	**$684.00**
Outgoing Texts $ (AT&T)	$108.00	$216.00	$360.00	$684.00
Incoming Texts $ (Verizon)	$10.80	$21.60	$36.00	**$68.40**
Incoming Texts $ (AT&T)	$4,320.00	$216.00	$360.00	$4,896.00
International Subtotal (T-Mobile)	$457.92	$457.92	$305.28	**$1,221.12**
Domestic Subtotal (T-Mobile)	$3,228.34	$16,141.68	$16,141.68	**$35,511.70**
Grand Total (T-Mobile)	$3,686.26	$16,599.60	$16,446.96	**$36,732.82**
International Subtotal (Verizon)	$1,491.98	$5,029.92	$5,015.52	$11,537.42
Domestic Subtotal (Verizon)	$4,579.20	$22,896.00	$22,896.00	$50,371.20
Grand Total (Verizon)	$6,071.18	$27,925.92	$27,911.52	$61,908.62

International Subtotal (AT&T)	$5,325.98	$9,025.92	$7,873.92	**$22,225.82**
Domestic Subtotal (AT&T)	$4,044.20	$20,220.98	$20,220.98	**$44,486.17**
Grand Total (AT&T)	$9,370.18	$29,246.90	$28,094.90	**$66,711.99**
International Subtotal (Sprint)	$572.40	$572.40	$381.60	$1,526.40
Domestic Subtotal (Sprint)	$2,288.84	$11,444.18	$11,444.18	$25,177.21
Grand Total (Sprint)	$2,861.24	$12,016.58	$11,825.78	$26,703.61
International Subtotal (Google)	$432.00	$457.92	$305.28	**$1,195.20**
Domestic Subtotal (Google)	$3,460.32	$20,110.62	$17,172.00	**$40,742.94**
Grand Total (Google)	$3,892.32	$20,568.54	$17,477.28	**$41,938.14**

	Weighted Average
Data Costs (Verizon)	**$6,336.00**
Data Costs (AT&T)	$6,336.00
Minutes $ (T-Mobile)	$768.00
Minutes $ (Verizon)	**$1,017.60**
Minutes $ (AT&T)	$7,680.00
Minutes $ (Sprint)	**$960.00**
Minutes $ (Google)	$768.00
Out. Texts $ (Verizon)	**$456.00**
Out. Texts $ (AT&T)	$456.00
In. Texts $ (Verizon)	**$45.60**
In. Texts $ (AT&T)	$1,860.00
Int. Subtotal (T-Mobile)	**$814.08**
Dom. Subtotal (T-Mobile)	**$35,511.71**
Grand Total (T-Mobile)	**$36,325.79**
Int. Subtotal (Verizon)	$7,014.56
Dom. Subtotal (Verizon)	$43,864.00
Grand Total (Verizon)	$50,878.56
Int. Subtotal (AT&T)	**$15,286.56**
Dom. Subtotal (AT&T)	**$44,496.17**
Grand Total (AT&T)	**$59,782.73**
Int. Subtotal (Sprint)	$1,017.60
Dom. Subtotal (Sprint)	$25,177.21
Grand Total (Sprint)	$26,194.81
Int. Subtotal (Google)	**$798.72**
Dom. Subtotal (Google)	**$33,512.46**
Grand Total (Google)	**$34,311.18**

60% Commands = Small
30% Commands = Medium
10% Commands = Large

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