

Space, Security, and Trust: Federal Contracting in the Commercial Space Industry

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Abstract

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The space industry is intrinsically tied to national security, nonetheless the U.S. government has entrusted commercial entities with the provision of critical space-based data systems and land sensing technologies. By examining the language that the government uses within the legal documents surrounding bid deliberation and award selection, this paper provides an historical analysis of the relationship between the U.S. government and the commercial space industry in an attempt to understand the degree of control and discretion that commercial entities possess over matters of national security. The analysis shows that a competitive commercial industry once prevented any one entity from manipulating the price or quality of deliverables, but a series of mergers and acquisitions allowed a few large entities to dominate the industry. Recently, enterprises have spawned as potential industry disruptors; however, the U.S. government lacks suitable oversight capacity to effectively manage a diverse array of values and interests.

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Introduction: A State of Insecurity

In the 1960s, the United States was embroiled in a fierce competition with the Union of Soviet Socialist Republics to see who could go farther and faster into outer space. Security concerns were the primary motivations fueling the Space Race, as neither the U.S. nor the U.S.S.R. wanted to cede supremacy to the other in any theater; terrestrial or otherwise. As the Cold War progressed, each country's desire to demonstrate global primacy through space exploration would dominate the directive space agencies for decades. By the turn of the millennium, however, the United States and the National Aeronautics and Space Administration (NASA) had begun to rely on Russia to launch its equipment and astronauts into space; an idea utterly inconceivable in the decades before. In an attempt to alleviate this contradiction of national security priorities, the U.S. has recently begun to rely upon private companies for the placement of equipment in space in the hope of simultaneously being able to capitalize on the private industry's ability to develop innovative, cost-saving designs as well as lessen the United States' reliance on Russia for future space programs.

Given this brief retrospective of the space industry, is it interesting to observe its evolution with respect to national security. What was once a government-controlled, security-driven industry has since come to rely upon foreign nations and private industries to complete missions. Furthermore, the United States' reliance on private entities will likely increase considerably in the near future. Indeed, the 2010 National Space Policy of the United States of America explicitly stated that a robust and competitive commercial space sector is vital to continued progress in space.¹ Simultaneously, the commercial space industry has undergone an

¹ "National Space Policy of the United States of America," June 28, 2010, https://history.nasa.gov/national_space_policy_6-28-10.pdf.

explosive growth in the number of private entities in operation or have received start-up investments.² In 2009, there were fewer than 100 commercial space entities which had received investment globally.³ By 2018, that number had increased to more than 400 companies.⁴ Increased investment indicates an increased likelihood of competition in the commercial industry in the future. To date, many of the entities that have been the most innovative or the furthest along in terms of maturity were based in the United States.⁵ As the private market for space services has grown, Congress has expressed interest in transitioning away from reliance on Russian-made rockets and seeks to increase its cooperation with private companies.⁶ In the past, these private industries have been permitted considerable leeway in how they fulfill government contracts. When combined with the current lack of an effective oversight framework in the United States for commercial space actors, these trends mean that these entities have operated with limited accountability to the public and have the potential to create security vulnerabilities that would carry significant global implications. Of greatest concern would be a potential manipulation of the Global Positioning System (GPS), which would disrupt navigation and time keeping on a global scale, disrupting everything which relies on the GPS's highly accurate timekeeping and record-keeping.⁷ This would impact services such as weather monitoring,

² Caleb Henry, "Space Startup Investments Continued to Rise in 2018," SpaceNews.com, February 4, 2019, <https://spacenews.com/space-startup-investments-continued-to-rise-in-2018/>.

³ Ibid.

⁴ Ibid.

⁵ Monica Grady, "Private Companies Are Launching a New Space Race – Here's What to Expect," Global Policy, August 8, 2018, <https://www.globalpolicyjournal.com/blog/08/08/2018/private-companies-are-launching-new-space-race-heres-what-expect>.

⁶ "Investigation Regarding Assertions Made by Former United Launch Alliance Executive" (U.S. Department of Defense Inspector General, December 5, 2016), https://www.defensedaily.com/wp-content/uploads/post_attachment/150808.pdf. P5-6

⁷ Dan Glass, "What Happens If GPS Fails?," The Atlantic, June 13, 2016, <https://www.theatlantic.com/technology/archive/2016/06/what-happens-if-gps-fails/486824/>.

telecommunications, sea navigation, military deployment, energy infrastructure, and even financial markets.⁸

Recognizing this threat, the U.S. government and the Department of Defense are in the midst of upgrading the GPS with new capabilities.⁹ Many of the key components for this new system are being developed by private companies.¹⁰ While the collaboration with private entities to complete such projects is not inherently problematic, the United States government's increased reliance on private actors and the ever-increasing number of private entities entering the space industry necessitates that the United States carefully manage its relationships with private partners who may have competing interests. Some scholars have noted that governments around the world have already taken responsive measures by liberalizing technology export controls and relaxing regulations so as to allow private actors the ability to provide services which were previously restricted to government provision.¹¹ Others argue that the absence of bolstered regulation creates security vulnerabilities which threaten global telecommunication and navigation technologies, both of which are especially vulnerable to cyber interference.¹² Further compounding this risk is the fact that the number of attacks and the sophistication of attacks on satellite and data systems have increased substantially.¹³

Understanding the need for increased cybersecurity preparedness, the National Space Policy of 2010 mentions the need to address requirements for "radiofrequency spectrum and

⁸ Ibid.

⁹ "GPS Satellites," Lockheed Martin, accessed June 3, 2019, <https://www.lockheedmartin.com/en-us/products/gps.html>.

¹⁰ Ibid.

¹¹ Bhavya Lal, "Reshaping Space Policies to Meet Global Trends," *Issues in Science and Technology* XXXII, no. 4 (Summer 2016): 13. P63

¹² David P. Fidler, "Cybersecurity and the New Era of Space Activities," Council on Foreign Relations, April 3, 2018, <https://www.cfr.org/report/cybersecurity-and-new-era-space-activities>.

¹³ Caleb Henry, "Cyber Experts Say Threats to Satellites Are Legion - SpaceNews.Com," November 7, 2017, <https://spacenews.com/cyber-experts-say-threats-to-satellites-are-legion/>.

orbital assignments” prior to approving acquisitions of space capabilities.¹⁵ However, the policy does not mention how these considerations would be enforced and verified, nor does it assign an entity to handle oversight.¹⁶ As such, this statement appears largely hollow. This has caused continued outcry from scholars nationwide.¹⁷ For reasons that become more evident in later sections of the report, specific radiofrequency security requirements are not explicitly outlined in the contracts for space assets. Instead, the contracts refer to dozens of supplemental figures, reports, guidelines, requirements, and criteria which all have varying degrees of specificity and include clauses which allow for exemptions. In total, the flexibility that the U.S. government affords private actors in terms of how best to satisfy a contract’s requirements extends to security considerations, particularly in the realm of cybersecurity. This lies at the heart of scholars’ expressed concerns. The authors appear to voice a desire to avoid catastrophe, and to proactively plan for and defend against would-be catastrophe. Instead, the current system seemingly would only be able to retroactively identify where security protocols could be bolstered or be more explicit. Regardless, proactively assessing a threat landscape remains an inherently difficult task especially with regard to cybersecurity concerns because identifying and adequately defending against all potential vulnerabilities and threat actors is nigh impossible.

Ultimately, by contracting with commercial actors, the government could potentially benefit from the private sector’s expertise and innovative approaches to completing projects, safeguarding assets, and defending data information systems. However, blindly relying upon the expertise and efficacy of the private sector can prove disastrous. This is a lesson that the United States’ Coast Guard learned all too recently in the wake of the now defunct Deepwater Program.

¹⁵ “National Space Policy of the United States of America.”

¹⁶ Ibid.

¹⁷ Ibid.

The Deepwater Program saw its funding terminated in 2012 due to the program's deliverables consistently costing more than originally estimated.¹⁸ Furthermore, the deliverables were unable to meet even the most basic, core duties of the Coast Guard, let alone any of the newly expanded responsibilities.¹⁹ In short, the program was a total failure. Thinking back to the program, Stan Soloway, Former Deputy Undersecretary of Defense & Director for Defense Reform, states that in the advent of failure the federal government tends to scrap entire programs and systems, rather than use program failures as learning sources for future activities.²⁰

Truthfully, the similarities between the Deepwater Program and joint ventures in the space industry are eerily similar. Both the Coast Guard and NASA are involved in long-term, incredibly complex, and highly expensive contracts. Each agency was born out of national defense considerations and are integral to the provision of essential navigational and security services. In both industries, some of the primary private-sector partners included Northrup Grumman, Lockheed Martin, or one of these corporation's joint ventures. This is not to say that the space industry is doomed to suffer the same fate as the Coast Guard's Deepwater program, nor that the partnerships currently in place are inadequate and inherently flawed. Instead, it highlights the need for a closer examination of the partnerships involved. The reliability of an actor should not be taken as an unflinching certainty. Given the United States government's fervent focus on national security, why has it entrusted so much discretion to a private sector over which it has limited oversight? To identify an answer to this question, it is first necessary to understand the nature of relationships between the public and private sectors and how public-private partnerships operate. With a more developed understanding of public-private partnerships and

¹⁸ Trevor L. Brown, Matthew Potoski, and David M. Van Slyke, *Complex Contracting: Government Purchasing in the Wake of the US Coast Guard's Deepwater Program* (Cambridge University Press, 2013).

¹⁹ Ibid.

²⁰ Ibid.

contracting, it becomes possible to analyze these practices within various space programs, namely the Challenger Space Shuttle, the Landsat Program, and the GPS-III Program. By analyzing the contracting practices associated with these programs, we can begin to understand why discretion has been given to the commercial sector, where additional regulation may be needed, and what shape such regulation could take. This paper does not aim to make any specific policy prescriptions, but instead establishes a groundwork of knowledge that would facilitate future policymaking in the commercial space industry.

Literature Review: The Complexity of Public-Private Partnerships

Before it is possible to create a cogent and comprehensive contracting policy or security policy, it is important to understand the political and business environment in which the space industry operates. As the sophistication of private companies has expanded and allowed for them to provide new products and services in space, the risks and impacts associated with their partnerships with governments have expanded as well. Recently, there has been a rise in literature regarding public-private partnerships (PPPs) that has called into question their efficacy, affordability, and accountability. This section will set out to define what public-private partnerships are, how they operate, and offers a summary of their potential risks and benefits. With an understanding of how PPPs operate, it will be possible to examine the history of the space industry to see whether the involvement of private actors is a cause for concern, if new regulations are necessary, or if the government's trust in its partners is well placed.

To begin, it is worth distinguishing public-private partnerships from privatization. While privatization can encompass a wide range of activities and meanings, it generally involves the reduction of a government's provision of services and the increase in the role that other institutions or entities have in the production of goods or provision services.²¹ More specifically, privatization refers to a shift of the production of goods and services from the public sector to the private sector.²² This more specific definition creates the possibility that privatization may not

²¹ Emanuel C. Savas, *Privatization and Public-Private Partnerships*, second (Chatham House, 2000), <http://offcampus.lib.washington.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=35251&site=ehost-live>.

²² Paul Starr, "The Meaning of Privatization," *Yale Law and Policy Review* 6 (1988): 6–41.

result in less government spending and regulation, but can instead unexpectedly increase spending and decrease regulation as the government attempts to make the transfer of responsibility as easily or as quickly as possible.²³

Just as there are many considerations as to what constitutes privatization, there is no single definition of a PPP. Public-private partnerships commonly refer to an arrangement in which the government and private entities join together to produce and deliver goods and to provide services.²⁴ Commonly, these arrangements involve a contractual agreement between a public agency and a private sector entity, during which the public and private actors share in the risks and the rewards in the delivery of a service.²⁵ It is this shared liability that is particularly worthy of note and can simultaneously make PPPs very attractive and very concerning. The respective share of risk assumed by the public or the private sector is not uniform across all PPPs. In many agreements, the risk associated with the project is transferred to the party best positioned to manage it.²⁶

Despite the potential to create increased costs, decreased regulation, and the sharing of risks with the private sector, PPPs can provide several considerable benefits that make them attractive to governments worldwide. First, many forms of PPPs call for the private entities to bare much of the upfront cost associated with a large project, thusly allowing the government to spread the tax burden across the life of the project's delivery timeline.²⁷ Some also argue that

²³ Ibid.

²⁴ Savas, *Privatization and Public-Private Partnerships*.

²⁵ "Public-Private Partnership (P3) Basics | Associated General Contractors," accessed March 25, 2019, <https://www.agc.org/public-private-partnership-p3-basics>.

²⁶ Deloitte Research Group, "Closing the Infrastructure Gap: The Role of Public-Private Partnerships," 2006, https://www2.deloitte.com/content/dam/Deloitte/ie/Documents/Finance/Corporate%20Finance/2006_closing_in_frastructure_gap_deloitte_ireland.pdf.

²⁷ Ibid.

PPPs are more likely to complete projects on-time and on-budget.²⁸ Similarly, the cost savings associated with PPPs can be realized in construction savings and reduced life-cycle costs.²⁹ Indeed, in the United States, the benefits and attractiveness of PPPs has reached a fever pitch in recent decades. However, this fervent support may neglect a set of considerable, and very real drawbacks that warrant further examination.

A considerable body of research indicating potential drawbacks of PPPs has stemmed from the European Union. The United Kingdom had pioneered PPPs, or what they labelled as “Private Finance Initiatives”, as innovative methods to provide financing for large infrastructure projects that may otherwise fail to gain adequate support.³⁰ These types of financing agreements would not establish a foothold in the United States until the early 1990s and did not gain substantial support until the mid-2000s.³¹ In recent years, however, European countries have become some of the most vocal critics of PPPs. A report published by the European Court of Auditors argues the public-private partnerships in the E.U. experience widespread shortcomings and provide limited benefits.³² The report specifically notes that although PPPs can provide authorities the ability to procure large-scale infrastructure through a single procedure, it also increases the risk of insufficient competition and puts contracting authorities in a weaker negotiating position.³³ Furthermore, the report noted that the majority of audited PPPs were

²⁸ Ibid.

²⁹ Ibid.

³⁰ Ibid.

³¹ Ryan Holeywell, “Public-Private Partnerships Are Popular, But Are They Practical?,” *Governing Magazine*, November 2013, <https://www.governing.com/topics/transportation-infrastructure/gov-public-private-popular.html>.

³² Iliana Ivanova et al., “Public Private Partnerships in the EU: Widespread Shortcomings and Limited Benefits,” Audit Report (European Court of Auditors, 2018), https://www.eca.europa.eu/Lists/ECADocuments/SR18_09/SR_PPP_EN.pdf.

³³ Irfan Bora, “EU Public Private Partnerships Not Economically Viable, Say Auditors,” *Public Finance International*, March 20, 2018, <https://www.publicfinanceinternational.org/news/2018/03/eu-public-private-partnerships-not-economically-viable-say-auditors>.

subject to considerable inefficiencies in the form of delays and major cost increases.³⁴ In many cases, the PPP option was chosen without any prior comparative analysis of alternative options, such as a Public Sector Comparator, and had, thus, failed to demonstrate that the PPP option would maximize value for money.³⁵ In total, the European perspective on PPPs has dictated a systemic re-evaluation of PPPs writ large, including how they are negotiated and what should be considered a reasonable expectation from PPPs.

This perspective of public-private partnerships contrasts starkly with the perspective of the United States. Public-private partnerships in the United States appear to have garnered a momentum that has made them difficult to curtail. Much of the discussion surrounding PPPs focuses on how best to facilitate contracts, and are less likely to fully explore whether it is wise for the government to enter in such deals in the first place.³⁶ However, in the period since public-private partnerships have become popular in the United States, there have been concerns over the accountability and answerability of the privately-contracted entities. For instance, in PPPs, managers often do not have direct hierarchical control of their partners.³⁷ Simultaneously, in projects involving multiple private partners, the partners involved have varying levels and different types of power, as well as difference stakes in the collaboration.³⁸ The partners may also have widely varying normative and operational practices.³⁹ Each of these considerations adds complexity to the fact that many of the partners are voluntary participants, and yet their

³⁴ Ivanova et al., "Public Private Partnerships in the EU: Widespread Shortcomings and Limited Benefits."

³⁵ Ibid.

³⁶ Holeywell, "Public-Private Partnerships Are Popular, But Are They Practical?"

³⁷ Muhittin Acar, Chao Guo, and Kaifeng Yang, "Accountability When Hierarchical Authority Is Absent: Views From Public-Private Partnership Practitioners," *The American Review of Public Administration* 38, no. 1 (March 2008): 3–23, <https://doi.org/10.1177/0275074007299481>.

³⁸ Ibid.

³⁹ Ibid.

performance or ability to complete a project may rely upon the performance and reliability of other partners.⁴⁰ Overcoming these deficiencies in accountability and direct operational administration would traditionally require considerable oversight capabilities, however, such oversight is often underfunded.⁴¹ All in all, this creates a situation wherein there are no clear principal nor agents, but instead each partner involved is simultaneously a principal and an agent.⁴² In each case, there is serious concern and doubts regarding the extent to which the principals (e.g., public actors or purchasers) truthfully influence and regulate the agents (e.g., the providers of the public service or product) in a manner that is efficient.⁴³ There are also considerations to be made regarding whether the interactions are socially sufficient, regardless of whether they are economically efficient. That is, there is little consideration as to the true social costs that would be incurred in the advent of a failure adequately. In total, each partner is accountable to one another, yet none have any true control or direct influence in the operations of the other. There is little to no true method for oversight or enforcement responsibilities to be executed. Instead, each actor simply must trust that their partners will fulfill their obligations to the best of their ability.

Furthermore, in the context of particularly complex contracts and contracting processes such as those in the space industry, the transaction costs associated with designing, testing, monitoring, and enforcing contracts could very well mean that government agencies are better off undertaking many activities in-house, even when the agency may be particularly bad at

⁴⁰ Ibid.

⁴¹ Ibid.

⁴² Ibid.

⁴³ Tony Bovaird, "Public-Private Partnerships: From Contested Concepts to Prevalent Practice," *International Review of Administrative Sciences* 70, no. 2 (June 2004): 199-215, <https://doi.org/10.1177/0020852304044250>.

completing these activities.⁴⁴ This argument contains one caveat however. If the agency or government can adequately establish “relational contracts” with the commercial sector, then engaging in PPPs may remain attractive.⁴⁵ Relational contracts rely on trust rather than the purely economic incentives on which traditional “transactional” contracts rely.⁴⁶ Such relational contracts may be beneficial for long-term relationships.⁴⁷ This level of collaboration engenders with it a sense of shared liability and risk, and, therefore, can produce a sense necessary relationality and mutual trust needed to combine each actor’s respective expertise in a way that ensures that the project is completed optimally.

In this context, trust refers to the actors’ understanding and at least partial adoption of the other’s values, as well as their participation in behavior that is consistent with cooperation for mutually beneficial and satisfactory outcomes.⁴⁸ It is the willingness of the actor to take on the risk of being vulnerable to the possibility that another actor may pursue its own self-interest at the expense of collectively agreed-upon contract goals.⁴⁹ This trust can be built over time, by explicitly aligning the missions of the actors involved, or by agreeing to periodic performance measures and milestone monitoring.⁵⁰ In all cases, successful relationships can create a virtuous cycle wherein trust begets more trust, and successful contracts lead to continued or increased contracting between the actors.⁵¹ This is not to say that once trust has been established in PPPs, that it is unbreakable. It is a distinct possibility that as the relationship matures, one actor may

⁴⁴ Ibid.

⁴⁵ Ibid.

⁴⁶ Ibid.

⁴⁷ Ibid.

⁴⁸ Trevor L. Brown, Matthew Potoski, and David M. Van Slyke, “Trust and Contract Completeness in the Public Sector,” *Local Government Studies* 33, no. 4 (August 2007): 607–23, <https://doi.org/10.1080/03003930701417650>.

⁴⁹ Ibid.

⁵⁰ Ibid.

⁵¹ Ibid.

develop into a dominant, if not monopolistic position in the market, and the temptation to exploit power asymmetries could result in detrimental actions or sub-optimal contract completion.⁵² Indeed, Brown et al. found that the effectiveness of a contract, or the ability of a contract to result in a product that satisfies both parties goals, is in part contingent on the degree of trust between the contracting parties.⁵³

Identifying these trust-based, relational contracts requires some experience and is more art than science. According to Brown et al., more detailed and complete contracts are indicative of a more transactional relationship as they demonstrate an attempt of the contracting government to clearly and explicitly define the terms and interactions between itself and the vendor.⁵⁴ Contrastingly, less specific contracts establish broader parameters to guide the relationships and often establish terms for future renegotiation over areas of uncertainty.⁵⁵ The authors note, however, that all contracts remain inherently imperfect instruments which rely upon imperfect information and uncertainty about the future, thereby causing all contracts to remain incomplete to some degree.⁵⁶ There remain several core components that help to gauge the degree to which a contract is “complete” and more transactional. In general, a contract establishes 1) the compensation to be received by the vendor, 2) a period of service, 3) specificity regarding the tasks or actions the vendor must undertake to ensure that the service is delivered according to the contracting government’s desires, and 4) what outputs/outcomes are expected as a result of the vendor’s actions.⁵⁷ In addition to these core elements, a more

⁵² Ibid.

⁵³ Ibid.

⁵⁴ Ibid.

⁵⁵ Ibid.

⁵⁶ Ibid.

⁵⁷ Ibid.

transactional contract may also specify additional “governance features” such as vendor requirements, arbitration procedures, certification and insurance requirements, performance reviews, and/or monitoring and enforcement procedures.⁵⁸ As a final consideration, terms and conditions for extension and re-negotiation may indicate a desire for a more relation-based contract.⁵⁹

In light of the tenuous relationship that PPPs have with scrutiny and accountability measures and their relational nature, the concerns raised by researchers nationwide regarding the security of space-based assets become much more understandable. Trust is inherently a difficult concept to measure, and an even more difficult concept to serve as the foundation buttressing against what would be substantial losses associated with the compromise of a space asset. Many academics have flagged the seemingly exponential increase in the number of private actors and, by association, the increase in number of these partnerships as a large, potentially dangerous shift in the space industry. An increase in the number of actors present in an industry makes it increasingly difficult to ensure consistent, high-quality work is being completed by all actors involved.

Cumulatively, with this understanding of PPPs and the ability to identify trust-based relational contracts, it is possible to examine the contracting process in the space industry to see if it exhibits features of trust-based contracting and relationship building. If evidence for relational contracting is found, it may be a first step in identifying the possibility of security risks in the space industry, as a relational contract leaves much to the discretion to the contractors. This becomes problematic if there are no effective regulatory entities to ensure compliance to established policies and procedures. Additionally, as the number of contractors increases, it

⁵⁸ Ibid.

⁵⁹ Ibid.

becomes more difficult to ensure that each actor is meeting quality and security standards. While this paper cannot feasibly analyze the adequacy of the current contracting system's security considerations, this paper will argue that our present moment in time may not actually represent a pivotal moment in the space industry wherein private entities have any larger of a presence than they have had in years past. Instead, it could be argued that the space industry is currently subject to an oligopolistic market which has exerted substantial pressure on would-be entrants to the commercial space industry. In the presence of a few, dominant actors, the U.S. government has retained considerable power and discretion in the contracting process, yet it does not exercise such power often, likely for fear of being viewed as untrustworthy, thereby quashing the private sector's desire to engage in future PPPs. However, the United States government has also failed to otherwise create a trust-based contracting environment which would ensure voluntary alignment of values and interests amongst both the public and private actors. Instead, the contracting process has long been mired in scrutiny and suspicion from all actors involved. Interestingly, however, this scrutiny has at times helped to create an industry that, to a certain degree, exhibits signs of self-regulation and oversight. To demonstrate each of these points, it is necessary to examine how prevalent PPPs have historically been in this industry, what their roles and responsibilities are, and how these roles have changed over time. This will also serve to create a foundational understanding of the environment in which such contracting is completed. Understanding this history will allow for future research to state conclusively whether any further change in the number of active commercial space actors truly constitutes a security concern, and whether it dictates a need for a change to the regulatory framework surrounding the space industry.

Methodology: Case Selection

To investigate the evolution of the commercial space industry and its relationship with the United States government, this paper will conduct a historical analysis. By examining several key projects and programs in the space sector that occurred in different decades, this analysis will track changes in the processes, actors, and stipulations surrounding the contracting environment in the commercial space industry. Analyzing these changes can highlight the evolution of institutional values, threat landscapes, and the relationship between the public and private sectors and can signpost areas that may have potential security implications or warrant further examination.

Testing the security of a process or a system is difficult, however. It is even more difficult when the systems themselves are digital and cannot be observed and are intangible. In cases such as this, assessing the security would usually involve analyzing the specific security protocols themselves to determine their suitability. However, due to the national security implications involved, such information is highly restricted and inaccessible. Alternatively, security could be tested by attempting to infiltrate or exploit the system. For obvious legal reasons, this too is not feasible. Therefore our ability to accurately gauge the security of these systems is extremely constrained. Despite this, or potentially because of this, many scholars and experts still feel that our current state of security is insufficient.

Since it is not possible to directly obtain the specific security protocols in place, nor to individually “test” the security of the system, this paper suggests turning to the legal documents and policy frameworks surrounding the systems themselves. That is, to better understand the current state of (in)security, it may be beneficial to first examine the commercial and political

environment in which they exist. To do so, the previously established understanding of public-private partnerships, the ideologies motivating their increased prevalence, and the interactions that determine their execution and effectiveness will offer guidance as to what aspects of the documents provide insights into the adequacy and implications of the current contracting environment. By critically analyzing the contracting processes over the span of several historical, high-profile partnerships in the space industry, it will be possible to gain an understanding of how the contracting process has changed over time and the implications such changes may have with regard to security.

The main articles for examination for this analysis will be documents involved in the contracting process. This includes Requests for Proposals (RFP), various Award Protests submitted by unsuccessful bidders, various reports investigating contracting processes, news articles detailing the process and progress of the projects, Selected Acquisition Reports which monitor the progress of a contract's fulfillment, and the various handbooks detailing evaluation or selection criteria for contracts which serve as an indication as to the government's goals, priorities, and considerations which engaging with would-be contractors.

The availability of each of these documents varies from project to project meaning that the same document types may not be available across each of the examined programs. By analyzing the contents of these documents in combination, however, it will be possible to create a more complete picture detailing the way in which the government interacts with commercial space entities, as well as how the private actors interact with one another. By examining the terms of the available contracting documents, the outcomes of the programs, and any resultant/related policies, it becomes possible to trace the evolution of public-private partnerships in the space industry. This will provide an intimate understanding of how the two sectors have

collaborated in the past, the sorts of information and autonomy or trust afforded to various entities, the limits of this collaboration, and what types of policy are born out of the successful and unsuccessful interactions. This baseline will then allow us to make a more accurate assessment as to whether the current space industry truly represents a pivotal moment in time wherein security is of greater concern than ever, or whether regulation is needed to ensure more adequate security provisions.

In conducting this historical analysis, the most beneficial cases will, therefore, be those that contain multiple forms of the aforementioned documents. These cases will also have ample, widely available communications regarding timelines, budgeted costs, and indications as to competition within the industry. These documents will provide a snapshot of the structure, provisions, and expectation of PPPs in the industry at the time of the project in question. The commonalities or differences between these cases can then be compared to determine whether there has been an evolution in the structure, responsibilities, and number of actors involved in PPPs in the space industry. However, given the nature and size of NASA and Department of Defense projects and their national security considerations, much of the information surrounding the particulars of the PPPs are redacted, classified, or otherwise difficult to obtain. As such, the number of available cases wherein this information is readily available and from which meaningful insights can be gleaned are relatively few in number.

To navigate around this limitation, this paper will examine three cases that could largely be considered negative or failed agreements. The benefit of selecting these “limited” successes or outright failures is multi-faceted. Firstly, projects that do not progress as intended tend to attract a certain level of media, congressional, and public attention, which in turn causes key details surrounding the project to become more publicly available. Secondly, by studying these failures

or limited success, it is possible to examine what potentially precluded success and whether the resulting failure was a result of the PPPs themselves or due to outside factors. Lastly, these types of agreements tend to inspire regulatory conversations or administrative adjustments in how future agreements will be pursued. As such, by understanding these cases, it becomes easier to track and predict the evolution of PPPs at-large.

This paper examines several distinct cases where the U.S. government contracted outer space services to the private sector. Each of these cases are substantially different, involving different missions, occurring in different decades, and delivering distinct products and services. Despite these considerable differences, the cases examined offer insight into how the U.S. government engages with private contractors. Furthermore, each of these cases garnered international attention, involved the considerations of multiple state actors, and could influence the livelihoods of individuals across the world. Each of the cases are similar in that they involve high-profile, highly valuable contracts that highlight the salient security concerns of the time, the government's willingness/hesitancy to engage the private sector in highly public and highly expensive endeavors, and have considerable impact on the regulatory systems surrounding the space industry. In some regards, the services provided are the only ones of their kind offered globally, and, therefore, serve as a template for future space endeavors. Additionally, the cases selected offer rare moments of transparency in an industry that otherwise is surrounded by secrecy and classified information.

The first case to be examined is the development and eventual disaster of the Space Shuttle Challenger in 1986. This case is an exemplary starting point as it has high public salience, and due to the disastrous nature of the mission's failure, information surrounding the incident is plentiful. As such, contract information, congressional hearings, news articles, and

countless other public reports provide ample data with which to examine the interplay between the public sector and the commercial sector. While the private sector may not be to blame for the mission's failure, the plethora of data still offers valuable information as to how the industry operates. Furthermore, the resultant regulations show how legislators approach regulating in the industry when it is needed.

The second case examined is the Landsat Program. Specifically, the analysis will focus on the Landsat Program as it entered the 1990s, as there was notable upheaval which occurred in the wake of the 1986 Challenger Disaster. Additionally, this case allows for an examination into how PPPs operate within the context of satellite and surveillance services which are used globally for scientific, civilian, and military functions. Lastly, this case offers a rare glimpse in which a more European approach to services was adopted. The United States would ultimately reverse course and decide to re-assume control of a function previously dedicated for commercial operation. Consequently, the case is invaluable as an example of when the United States determines public ownership and operation as preferable, and indicates how the United States engages with satellite systems that highly valuable for national security.

The final case examined is the ongoing development and launch of the next generation GPS-III system. The new system is designed to improve the GPS's software resiliency to emerging cyber threats and to increase the overall effectiveness of the globally relied-upon GPS constellation.⁶⁰ The ongoing nature of the project offers insight into the current state of the contracting processes for satellite and information systems. Furthermore, the GPS has specifically been identified by several publications as the worse-case scenario in terms of the potential damages and disruption to civilian and military capabilities should an information

⁶⁰ "Next Generation Operational Control System (GPS OCX)," 2014, 35.

system be exploited. As a result of its recency and importance to global navigation and record keeping, the media has closely followed the project. Furthermore, its recency means that some of the contracting documents, such as RFPs and Award Protests, remain accessible on federal databases, and updates relating to progress are continually reported by the media, the Department of Defense, and the commercial entities themselves. Cumulatively, these facts mean the GPS-III is a particularly salient case with which to examine the current nature of PPPs and the impact they have on national security.

In reviewing these cases, the analysis will examine relevant contracting documents with particular attention given to any stipulations or requirements that would indicate the values driving the collaborations, the potential existence of relational contracting, the degree of adequate competition, as well as several other considerations highlighted by PPP literature. Specifically, this analysis will examine the documents with the following questions in mind:

- What was the impetus driving engagement with the commercial sector?
- Were considerable cost-savings or efficacy increases realized?
- What policies or regulations were altered because of the partnership?
- Who bears the risk or liability for the project?
- What was the degree of competition in the market?
- To what degree are the same entities awarded contracts across cases?
- Are performance evaluation or milestone monitoring processes in place?
- How detailed were the solicitations to the commercial actors?

Each of the following chapters will follow a similar structure. The chapters will begin with a brief historical context of the project to be examined, before highlighting key background developments that are important to understanding the subsequent contracting processes. The

chapters will then spend considerable time examining the specific contracting environment and the interactions between actors as they unfolded over the course of the project and will analyze what these interactions mean for the relationship between the actors involved. The chapter will then summarize how the sequence of events affected the commercial industry at large and will end with concluding remarks before moving to the next chapter.

After reviewing these cases, it will become more apparent that the current relationship between the U.S. government and the private space industry is defined by the unstructured nature of the public-private partnerships involved. While the government may have pursued some PPPs to capitalize on the comparative expertise or cost-effectiveness that the private sector possesses, it has done so without any guiding frameworks, reliable measures of effectiveness, or oversight capabilities that are publicly apparent or accessible. Furthermore, neither the commercial industry nor the government has demonstrated the willingness or ability to create the forms of trust required to make long-term, complex, relational contracting optimal. As a result, several values that are of paramount to the government, such as transparency and security, have been neglected.

Chapter 1: The Challenger Space Shuttle

No disaster in the space industry looms as large, nor has had more information publicly released than the 1986 Space Shuttle Challenger Disaster. Faulty seals, referred to as O-rings, located on the rocket's boosters caused the shuttle to explode approximately 75 seconds after launch.⁶¹ Tragically, all those aboard lost their lives. To fully understand the impact of the disaster on the space industry at large, it is necessary to first examine the founding objectives which gave rise to the shuttle program, how the shuttle was designed and its construction completed, and what regulatory changes occurred in the wake of the fatal accident in 1986. This will provide a firmer understanding as to the role that private actors play in the space industry and will serve as base for comparison for subsequent cases.

Background

At the height of the Space Race, the United States was perpetually searching for ways to establish a presence in low-earth orbit using a more cost-effective, reusable transportation system.⁶² This dream became a reality in 1972 when NASA formally announced the Space Shuttle Program, formally known as the Space Transportation System (STS).⁶³ Shortly thereafter, work began in designing a concept that would meet NASA's programmatic needs.⁶⁴ The program was first conceptualized in the 1950s by German-American rocket engineer Werner von Braun,

⁶¹ NASA Content Administrator, "Remembering Space Shuttle Challenger," Text, NASA, March 9, 2015, http://www.nasa.gov/multimedia/imagegallery/image_gallery_2437.html.

⁶² Mike Wall, "How the Space Shuttle Was Born," Space.com, June 28, 2011, <https://www.space.com/12085-nasa-space-shuttle-history-born.html>.

⁶³ Mike Wall, "NASA's Shuttle Program Cost \$209 Billion — Was It Worth It?," Space.com, July 5, 2011, <https://www.space.com/12166-space-shuttle-program-cost-promises-209-billion.html>.

⁶⁴ *Ibid.*

who had been enlisted by NASA to help propel the United States' space program ahead of the Soviet Union.⁶⁵ In what later became known as the "von Braun Paradigm", Werner von Braun laid out a multiphase, long-term strategy for spaceflight.⁶⁶ The paradigm aimed to develop a multi-stage rocket with the ability to place satellites and people into orbit, create a large, reusable spacecraft to make space access routine, install a permanently occupied space station, complete human flights around the moon, and assemble spaceships in Earth orbit to one day send humans to Mars.⁶⁷ To meet these many goals, NASA announced that it would adopt a phased development approach for the Shuttle as it would allow NASA to spread the considerable costs of the program across multiple years.⁶⁸ This phased-based approach is reflected in the multitude of various contractors selected to complete the various stages of the Shuttle, the Shuttle booster, and the many other constituent parts of the rocket.⁶⁹

During the initial phase of the program, NASA sponsored North American Aviation, Boeing, and Lockheed Missiles & Space Company to conduct research into the feasibility and design requirements for creating a reusable spacecraft.⁷¹ These studies began as early as 1962, with several other studies beginning and ending throughout the mid to late 1960s.⁷² At the conclusion of these various contracted "definition" studies in the first half of the 1970s, NASA would issue request for proposals (RFP) for Shuttle definition studies, design alternatives, and

⁶⁵ Michael J Neufeld, "The 'Von Braun Paradigm' and NASA's Long-Term Planning for Human Spaceflight," *Acta Astronautica* 63 (2008): 23.

⁶⁶ Wall, "How the Space Shuttle Was Born."

⁶⁷ Neufeld, "The 'Von Braun Paradigm' and NASA's Long-Term Planning for Human Spaceflight."

⁶⁸ Linda Neuman Ezell, "Table 2.57: Chronology of Shuttle Orbiter Development and Operations," in *SP-4012 NASA Historical Data Book: Volume III Programs and Projects 1969 - 1978*, 1988, <https://history.nasa.gov/SP-4012/vol3/table2.57.htm>.

⁶⁹ *Ibid.*, 2.

⁷¹ Ezell, "Table 2.57: Chronology of Shuttle Orbiter Development and Operations."

⁷² *Ibid.*

concept testing for the Shuttle.⁷³ Contracts were awarded to Grumman, Boeing, Lockheed, and Chrysler.⁷⁴ After nearly two decades of researching, designing, redesigning, and delays due to the Apollo mission and the Moon landing in 1969, the Shuttle program was finally formally announced in 1972.⁷⁵ The von Braun Paradigm had finally been given form.

Contracting Environment

Once the definition and preliminary analyses of the Shuttle's prospects had been concluded, NASA moved into the final phases of the program: design and development. In 1971, NASA issued its first construction RFPs.⁷⁶ The RFPs were issued directly to Aerojet Liquid Rocket Company, Pratt & Whitney, and Rocketdyne and were for the development of the Shuttle's main engine.⁷⁷ On July 12, 1971 NASA selected its first contractor for design and construction: Rocketdyne would be tasked with the design and fabrication of Shuttle's 35 main engines.⁷⁸ Later that same month, McDonnell Douglas, General Electric, and Lockheed would be awarded contracts for the development and testing of a ceramic insulator for the Shuttle's thermal protection.⁷⁹

Evidence that sentiments of distrust pervaded the commercial space industry can be found in the immediate aftermath of NASA's first engagements with the private sector for Shuttle contract fulfillment. Shortly after these contract awards had been announced, Pratt & Whitney voiced their suspicion that NASA had unfairly selected Rocketdyne's proposal for

⁷³ Wall, "How the Space Shuttle Was Born."

⁷⁴ Ibid.

⁷⁵ Ibid.

⁷⁶ Ibid.

⁷⁷ Ezell, "Table 2.57: Chronology of Shuttle Orbiter Development and Operations," 2.

⁷⁸ Ibid., 57.

⁷⁹ Ibid.

engine development, and submitted a formal protest of the award.⁸⁰ Pratt & Whitney requested that the General Accounting Office (GAO), the predecessor to the Government Accountability Office, launch an investigation into NASA's selection of Rocketdyne as the builder of the Shuttle's main engine.⁸¹ This caused NASA's contract with Rocketdyne to be supplanted by an interim, short-term contract that could be renewed every 4 months, pending the report's findings.⁸² After a year-long investigation, in March of 1972, GAO determined that NASA had fairly chosen Rocketdyne as contractor for the Shuttle main engine.⁸³

The debacle surrounding the first set of request for proposals issued by NASA provides several notable insights into the workings of government contracting within the space industry. First, it is immediately apparent that even nearly 50 years ago, there was a notable number of private entities that were actively engaged in the space industry. No fewer than five companies were awarded definition or design contracts, and another four received actual development and fabrication contracts for the heat shielding and main engines alone. When the fact that a great number of other companies were unsuccessful in their bids for NASA contracts, and that there were a practically uncountable number of other development projects associated with the Shuttle Program, each with their own RFPs, it becomes apparent that private entities played an incredibly significant role in the US's space history of project development. Indeed, even at the outset of the space race, a competitive commercial market existed.

Furthermore, the Shuttle Program was only one of the multiple concurrent programs operated by NASA that utilized private contractors. In fact, between 1960 and 1968 alone,

⁸⁰ Ibid.

⁸¹ Ibid.

⁸² Ibid.

⁸³ Ibid.

NASA had engaged in over 1,531,400 procurement actions with small and large businesses.⁸⁴

NASA defines a procurement action as a transaction which obligates or deobligates funds through the use of either letter contracts or other preliminary notices of negotiated awards, definitive contracts, purchase orders, orders against indefinite deliver contracts, or modifications.⁸⁵ For each of these years, NASA had contracted with over 100 contractors.⁸⁶ This trend continued throughout the Shuttle Program's development and operation phase, which lasted through the end of the 1970s.⁸⁷ As a result, any contentions that the growth in the number of private entities entering space industry as being indicative of a pivotal shift in industry, or as potentially contributing to a new security concern, are likely overstated. The presence of many commercial space entities is not a new development. However, simply because this trend may not be new, it does not make the challenge of aligning the multitude of competing interests any easier. Furthermore, this does not preclude the possibility that the new entrants into today's space industry are engaging in services and projects that are new and carry new considerations. Instead, this first set of Shuttle RFPs demonstrate the presence of a large commercial industry as early as the 1970s and indicates that NASA and the U.S. government have had a long history of interacting with a multitude of private actors and considerable experience engaging in PPPs.

Secondly, this set of RFPs offer a glimpse into the complex relationships between the private actors themselves. Pratt & Whitney's decision to protest Rocketdyne's selection indicates that the actors are not inherently trusting of NASA and its decision-making processes. Naturally, it is understandable for a private actor to use any strategy at their disposal in an attempt to secure

⁸⁴ Jane Van Nimmen, Leonard C. Bruno, and Robert L. Rosholt, "NASA Historical Data Book 1958-1968 Volume I - NASA Resources," The NASA Historical Series, 1976, 532.

⁸⁵ Ibid.

⁸⁶ Ibid.

⁸⁷ Linda Neuman Ezell, "NASA Historical Data Book: Volume IV - NASA Resources 1969 - 1978," 1985, <https://history.nasa.gov/SP-4012/vol4/ch5.htm>.

a contract and ensure that the contract selection process is conducted in a fair manner. The size and value of these contracts, coupled with the fact that securing a contract has the possibility of allowing for continued contracting in the future means that these contracting practices have a large influence on the creation of relationships between the government and the private sector. As such, these grievances are more than just about the money involved. They offer a glimpse into the beginning of what could eventually become a potentially ongoing relationship, and, therefore, their impact and meaning should not be dismissed lightly.

Many of the grievances which Pratt & Whitney submitted to the GAO were largely targeted at NASA's contractor selection practices and final decisions.⁸⁸ In their formal submission to the GAO, Pratt & Whitney contended that the negotiations surrounding the contract for the main rocket booster did not comport with U.S. federal regulations which require that government agencies engage in meaningful discussion with would-be contractors so as to afford competitors an opportunity to improve their proposals, address any weaknesses or deficiencies, and ensure that the competitor adequately understood the request.⁸⁹ Pratt & Whitney argued that NASA's Procurement Directive 70-15, which prohibits NASA personnel from pointing out deficiencies in cost-reimbursement-type contracts and all contracts for research and development, violates the aforementioned U.S. federal procurement regulations.⁹⁰ Pratt & Whitney contends that in the absence of full or meaningful negotiations, the government will not receive the most advantageous contract.⁹¹ It could be argued that Pratt & Whitney is not entirely concerned with the government's ability to secure the most advantageous proposal and simply

⁸⁸ U. S. Government Accountability Office, "Upheld the Negotiations Under 10 U.S.C. 2304(G) Leading to the Award of a Contract for the Space Shuttle Main Engine B-173677, MAR 31, 1972, 51 COMP GEN 621," no. B-173677 (March 31, 1972), <https://www.gao.gov/products/462300>.

⁸⁹ Ibid.

⁹⁰ Ibid.

⁹¹ Ibid.

was concerned that their proposal was not the one selected. However, the fact that they framed their grievance in this wording indicates their understanding that the overarching purpose of pursuing such public-private partnerships is to find agreements that are mutually advantageous. At the very least, it is an indication of understanding as to the role of private entities within these collaborations.

Ultimately, GAO reported in NASA's favor and upheld NASA's decision-making processes for the Shuttle Main Engine. GAO stated that the federal regulations do not list strict specification as to the scope or extent that discussions, oral or otherwise, must be to adhere to federal regulations.⁹² NASA's procurement directive which prohibits the discussion of deficiencies was put in place to prevent "transfusions", or the sharing of one competitor's innovative or ingenious solution to a problem with other competitors.⁹³ GAO admits that any discussion with competition offerors raises the question as to how to avoid unfairness or unequal treatment, or how to help one offeror through discussions regarding any potential lack of diligence, competence, or inventiveness without given said competitor an unfair advantage.⁹⁴ Over the course of a year, GAO examined the history of interactions between NASA and Pratt & Whitney and found that there had been extensive written and oral discussions, some of which were related to areas of the proposal judged to be weak, but were framed by NASA in the context of "clarifications".⁹⁵ This indicates that NASA was committed to consistent and meaningful conversations with contractors and weakens Pratt & Whitney's protest argument.

Furthermore, the vagueness of GAO's language and their admission that it difficult, yet possible to conduct such conversations in a fair manner indicates that there is no strict

⁹² Ibid.

⁹³ Ibid.

⁹⁴ Ibid.

⁹⁵ Ibid.

framework governing contract selection process across all government agencies. Contract selection processes largely depend upon the particular contract and the competitors involved. Had there been strict criteria on how such procurement needed to occur, GAO would have stated so and their determination would have indicated as such. Instead, their acknowledgement as to the difficulty in finding an adequate balance between assistance and fairness indicates how flexible this process is and the amount of discretion the agencies have. This is not inherently problematic, and such discretion may be necessary given the large variance between programs within an agency, let alone given the variance of programs across agencies. However, this does present issues for ensuring an agency's ability to consistently measure what is considered sufficient satisfaction of a contract's requirements, and makes it even harder to make determinations regarding the adequacy of specific aspects of the submissions, such as security safeguards. The ability to accurately, fairly, and consistently measure these considerations is particularly important given substantial public funding and attention involved.

In light of what Pratt & Whitney felt was inadequate communication from NASA, Pratt & Whitney also contended that the determination of their proposal's deficiencies was arbitrary and capricious.⁹⁶ Pratt & Whitney specifically argued that NASA's Source Evaluation Board (SEB), the board responsible for evaluating proposals and selecting the winning contract, did not fully read and understand Pratt & Whitney's proposal.⁹⁷ They also felt that the SEB had judged Pratt & Whitney more harshly than they had Rocketdyne, despite similar or comparatively worse performance estimations.⁹⁸ Pratt & Whitney also contended that such a determination would effectively scrap eleven years of progress, knowledge, and government investment in prior Pratt

⁹⁶ Ibid.

⁹⁷ Ibid.

⁹⁸ Ibid.

& Whitney designs that NASA had used in previous programs.⁹⁹ Once again, GAO would argue in NASA's favor, stating that the extensive history of communication and lengthy volumes detailing the evaluations indicate that the determination was not capricious nor arbitrary.¹⁰⁰

Despite their failure to change NASA's award determination, the grievances listed are notable for two reasons. Firstly, the determination to select Rocketdyne's proposal over Pratt & Whitney indicates that NASA is willing to select what they view as a superior proposal even when they have an established relationship with one of the competing offerors. This indicates that even though NASA awards long-term project contracts and may contract with similar sets of contractors across programs, NASA does not exclusively rely upon the relational nature of their previous contracts to determine future awards. Therefore, NASA's contracting processes may have been relational to a certain degree, but it may be inaccurate to say that NASA utterly and unflinchingly trusted the same set of contractors to complete all of their programs.

Secondly, the pointed language of this grievance indicates the extent of Pratt & Whitney's distrust in the NASA selection process. Specifically, Pratt & Whitney's deep distrust appears to lie most heavily with the SEB, as indicated by the insinuation that the SEB may not have fully read the proposal. Pratt & Whitney's protests demonstrate that contractors are inherently suspicious of the selection committees' ability to adequately and objectively evaluate proposals from competitors. Such a grievance is particularly notable because any perceived bias on part of the SEB could threaten to disrupt the relationality of the contracting process for NASA and could hamper the agency's ability to receive truly competitive proposals in the future. As such, the SEB plays an incredibly influential role in establishing the foundations of what could be long-term relationship between the government and private entities, and offers a poignant insight as to

⁹⁹ Ibid.

¹⁰⁰ Ibid.

the extent of the connectedness between the public and private sectors. This becomes increasing apparently over the course of the Shuttle Program.

As the discussion regarding the fairness of the Rocketdyne determination was concluding, NASA awarded North American Rockwell a contract for a feasibility study to examine a low-cost, reusable chemical stage for the Shuttle Booster.¹⁰¹ In March 1972, the year that the Shuttle Program was formally announced, NASA issued an RFP for the development of a Shuttle, with the final designs due in May of that year.¹⁰² NASA received responses from North American Rockwell, McDonnell Douglas, Grumman Corporation, and Lockheed Corporation.¹⁰³ After examining the proposals, NASA selected North American Rockwell as the prime contractor for the Shuttle, and North American Rockwell in turn subcontracted with both Grumman and McDonnell Douglas for engineering support services.¹⁰⁴ The fact that Rockwell decided to subcontract portions of the engineering support services is noteworthy as it indicates a specific instance within the space industry where private-sector competitors share connections and collaboration for the delivery of products and services to the public sector. Such collaboration harkens back to literature discussing the need for adequate frameworks to ensure oversight and a convergence of goals and objectives between all actors involved so that the PPPs operate optimally in terms of effectiveness and cost-savings. While the willingness of one actor to subcontract out to other private entities indicates a certain degree of trust and understanding amongst the private actors involved, the ever-looming threat of GAO audits and grievances indicates that this trust has its limits. As such, the complexities of familial or relational nature of contracting not only applies to interactions between public and private entities, but also between

¹⁰¹ Ezell, "Table 2.57: Chronology of Shuttle Orbiter Development and Operations," 57.

¹⁰² *Ibid.*

¹⁰³ *Ibid.*

¹⁰⁴ *Ibid.*

multiple private entities as well. NASA's willingness to allow prime contractors to subcontract out also indicates that NASA trusts the private entities to determine the most effective manner with which to fulfill the contract, even it involves further contracting.

Lastly, one of the later requests for proposal offered by NASA was for solid rocket motor development. This particular RFP and subsequent contract fulfillment are worthy of further examination for a multitude of reasons. Firstly, it is this particular contract that would contribute to the eventual failure and destruction of the Challenger Space Shuttle in 1986. Additionally, the award of this contract was yet another instance of contention between the private entities involved. Examining the sources of this contention and the result helps to highlight how the entities interact with one another and the nature of their relationships.

On July 16, 1973, NASA issued RFPs for the Shuttle's Solid Rocket Motor (SRM) to Aerojet-General Solid Propulsion Company, Lockheed Corporation, Thiokol, and United Technology Center and final proposals were due by August 27, 1973.¹⁰⁵ On November, 20, 1973, having reviewed all of the submissions, NASA selected Thiokol to design, develop and test the Shuttle's SRM.¹⁰⁶ A short two months later, in January of 1974, Lockheed protested NASA's selection of Thiokol to the GAO, thereby forcing NASA to issue Thiokol a short-term contract to last during the investigation, pending renewal on GAO's final findings.¹⁰⁷ Once again, the private offerors had voiced their distrust of NASA's award determination process.

¹⁰⁵ Linda Neuman Ezell, "Table 1-39: Chronology of Shuttle Solid Rocket Booster Development.," in *SP-4012 NASA Historical Data Book: Volume III Programs and Projects 1969 - 1978, 1988*, <https://history.nasa.gov/SP-4012/vol3/table1.39.htm>.

¹⁰⁶ *Ibid.*, 1.

¹⁰⁷ Ezell, "Table 1-39: Chronology of Shuttle Solid Rocket Booster Development."

Similar to previous investigations, GAO found that NASA had not violated the applicable bid protest regulation or procures.¹⁰⁸ This investigation is distinct from the previous grievance submitted by Pratt & Whitney in that they analyzed the specific cost-difference calculations used to differentiate between the proposals as well as investigated allegations of conflicts of interest on behalf of NASA's Source Evaluation Board.¹⁰⁹ During their investigation, GAO did find that the cost difference between the Thiokol proposal and the Lockheed proposal was likely significantly less than had been previously calculated.¹¹⁰ As a result, on June 24, 1974, GAO recommended that NASA reconsider its selection of Thiokol.¹¹¹ By June 26, a mere two days later, NASA had made the decision to retain Thiokol as the SRM developer.¹¹²

NASA's ability to re-evaluate and confirm their selection of Thiokol as the SRM development in a mere two days caused concern amongst the other prospective contractors involved. NASA responded to these concerns in their response to GAO's reports, stating that the initial rationale for selecting Thiokol remained valid.¹¹³ NASA stated that both Lockheed's and Thiokol's proposals were essentially equal in mission suitability, and that determination was a result of cost differences.¹¹⁴ GAO reported that the two proposals were likely closer in cost than NASA had determined, and the discrepancies were largely due to the use of different fuel price projections. As such, NASA's determination was feasible and was not deemed as an unreasonable use of discretion.¹¹⁵ Nevertheless, it remains unclear as to why GAO decided to

¹⁰⁸ "NASA Procurement: The 1973 Space Shuttle Solid Rocket Motor Contractor Selection" (Government Accountability Office, September 1987), <https://www.gao.gov/assets/210/209720.pdf>.

¹⁰⁹ *Ibid.*

¹¹⁰ *Ibid.*

¹¹¹ *Ibid.*

¹¹² *Ibid.*

¹¹³ *Ibid.*

¹¹⁴ *Ibid.*

¹¹⁵ *Ibid.*

scrutinize minute details, such as fuel costs, during their evaluation procedures. Perhaps this level of scrutiny was solicited due to the previous investigation. Alternatively, such scrutiny may have been due in part to the fact that Senator Al Gore had requested additional information post GAO's receipt of protests from Lockheed. In either case, by this time, it had become apparent that NASA's ability to objectively award contracts for the Shuttle Program had garnered greater scrutiny, thereby signifying a gradual degradation of trust in NASA to behave in a fair manner when selecting contract recipients.

While the previous reports by the GAO would seemingly indicate that perhaps this degradation of trust was unwarranted, the concurrent investigation into allegations of conflict of interest presented reasonable basis to question the inherent fairness and trustworthiness of the selection process. To evaluate proposals and make determinations as to the acquisition of goods and services, NASA created a Source Evaluation Board (SEB) to ensure the selection of the source was most advantageous to the government in terms of cost, mission suitability, and other factors.¹¹⁶ SEB members are selected and approved with consultation of NASA line management and administration.¹¹⁷ Along with a multitude of other factors, such as cost, company resources, understanding of the requirement, and excellence of proposed design, the SEB Manual lists "past performance" as an especially important criterion because "how well the offeror did on earlier work for the Government can be a very significant indicator of how well he can be expected to perform the job at hand."¹¹⁸ The manual goes on state that it is a specific responsibility of the board to collect information on the past performance of offerors considered to be within the

¹¹⁶ "NASA Source Evaluation Board Manual" August 1973, <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19740072598.pdf>.

¹¹⁷ Ibid.

¹¹⁸ Ibid.

competitive range.¹¹⁹ While past performance may very well be a valid criterion with which to judge an offerors suitability, this selection process nonetheless benefits corporations with a history of contracting with the government and contributes to the creation of a repeat, or relational contract environment wherein established corporations are in a favorable position to win a contract over newcomers to the field.

While the evaluation of offerors based on their previous history of contracting with the government may not be of substantial concern in of itself, it requires that the Source Evaluation Board remain impartial otherwise it could create inequitable advantages for established corporations in the industry. This concern was at the heart of the report published by GAO and the protests submitted by Lockheed, itself an established name in the field.¹²⁰ Two of the 13 voting members of the SEB were former Thiokol employees.¹²¹ These two members were vetted by NASA officials and deemed to be suitable for board membership, a finding which GAO corroborated, citing the fact they did not have investments nor any pension holdings involving profit-sharing or stock-bonus entitlements in any entities involved, and, therefore, were not disqualified from participating in the selection process.¹²² As a result, GAO had determined that NASA had not violated any conflict of interest regulations or rulings.¹²³ The fact that former employees of a contracting company were members of the Source Evaluation Board tasked with selected contract awards serves as a potent demonstration as to how deeply rooted the relationships between NASA and the private sector were as early as the 1970s.

¹¹⁹ Ibid.

¹²⁰ "Space Shuttle Procurement."

¹²¹ Ibid.

¹²² Ibid.

¹²³ Ibid.

Corporations not only benefit from their history of government contracting through favorable evaluation in future contracts, but they also can benefit from having former employees in place throughout NASA operations, including the contract awarding board. Naturally, the presence of former employees within government agencies does not necessary indicate foul play. Indeed, previous private sector experience can greatly benefit government operations. However, the specifics of the evaluation in question remain unknown. Since the Source Evaluation Board was comprised solely of NASA, Air Force, and federal employees, the SEB's meeting minutes were not subject to public disclosure.¹²⁴ As a result, it is not possible to truly evaluate the extent to which former ties to a potential contractor may have influenced how the individual SEB members evaluated the various proposals. This lack of transparency presents a barrier to the creation of a truly trustworthy process for all actors involved and can hamper the creation of a healthy, effective contracting environment.

Implications of the Shuttle Program on the Commercial Industry

The Shuttle Program was a massive endeavor involving a multitude of private actors collaborating to usher in a new era of space flight. This new era came at a substantial cost, however. During the program, the United States Congress was eager to find ways to gain additional benefit from the developments of the Shuttle Program, and more importantly, to find more cost-effective methods to complete space missions. Having witnessed the shuttle launch in 1981 and realizing the commercial prospects accompanying the continued growth of the

¹²⁴ Ibid.

industry, Congress proposed and passed the Commercial Space Launch Act in 1984.¹²⁵ The act created a framework in which private companies could now become licensed to launch vehicles or operate a launch site within the United States.¹²⁶ The Act was passed with the intent to promote economic growth and entrepreneurial activity in space in a way that would encourage innovation and allow for regulation by the Department of Transportation.¹²⁷ This act represents a monumental shift in the space industry. While private actors had long been involved in NASA operations through product design, testing, and development, this act allowed for private entities to essentially operate with full autonomy so long as they received a license from the Department of Transportation. This would set the stage for private enterprises focused on space operations such as SpaceX and Blue Origin to form.

The shift would only accelerate in the wake of the disaster that befell the Challenger Space Shuttle in 1986. The Challenger accident would cause NASA to reassess the Shuttle program, its design, and associated costs.¹²⁸ The government would also decide to largely remove itself from the commercial launch market, thusly paving the way for private ventures to fill the void.¹²⁹ The disaster indirectly contributed to the 1988 amendment to the Commercial Space Launch Act, which required NASA to collaborate with representatives in satellite and commercial launch industries to develop a program to encourage research and development of advanced launch technologies.¹³⁰

¹²⁵ “[USC02] 51 USC Ch. 509: COMMERCIAL SPACE LAUNCH ACTIVITIES,” accessed April 14, 2019, <http://uscode.house.gov/view.xhtml?path=/prelim@title51/subtitle5/chapter509&edition=prelim>.

¹²⁶ Daniel K. Akaka, “H.R.3942 - 98th Congress (1983-1984): Commercial Space Launch Act,” webpage, October 30, 1984, <https://www.congress.gov/bill/98th-congress/house-bill/3942>.

¹²⁷ “[USC02] 51 USC Ch. 509: COMMERCIAL SPACE LAUNCH ACTIVITIES.”

¹²⁸ Timothy A Brooks, “Regulating International Trade in Launch Services,” *Berkeley Technology Law Journal* 6, no. 1 (n.d.): 51.

¹²⁹ *Ibid.*

¹³⁰ *Ibid.*

NASA was not the first entity in the world to make this shift to a markedly more privatized space launch industry. Indeed, Europe had long been dissatisfied with NASA's treatment and handling of cooperative space ventures. Europe had enlisted Arianespace, a private multinational corporation, for its space launches since 1980.¹³¹ The European Space Agency had viewed NASA's approach to public-private partnership in the space industry akin to a "lord accepting peasants onto his land."¹³² Interestingly, this is a shift in perspective when compared to previous literature which suggested that European perspectives on PPPs are more skeptical. In the space industry, however, it seems that Europe had long been a pioneer in enlisting the help of private actors. However, the dominance of Arianespace has since been seen as a potential hindrance to the growth of a comparatively competitive commercial space sector as compared to that of the United States.¹³³

Overall, the United States government's passage of the Commercial Space Act in 1984, and its further amendments in 1988, indicate that the government largely trusted the private sector to lead the development of next age space-faring technologies. Far from losing its trust in the private sector in the wake of the Challenger disaster, the U.S. government seemingly positioned itself to more extensively rely upon the services provided, and perhaps one day cede all operations to the private sector at large. The U.S. government had double-downed on its trust in the private sector's ability to lead the industry.

¹³¹ *Ibid.*

¹³² *Ibid.*

¹³³ *Ibid.*

Chapter Conclusion

Overall, the Shuttle Program demonstrates that commercial entities have long been integrated in nearly every aspect of NASA's operation and have been permitted considerable flexibility in how best to address a contract's requirements. Interestingly, through the use of testing contracts and award protests to the GAO, these private entities were also responsible for holding one another accountable. The fact that NASA by this point had already created relationships with private actors that had spanned decades and had former contractor employees imbedded in its essential contracting processes also indicates the extent to which the government and the private sector had become integrated. The impact of these long ties, and, therefore, the potentiality of a purely trust-based, relational contract environment is damaged by the fact that NASA did select against Pratt & Whitney, a long-time partner, for booster development. This indicate that NASA was to a certain degree committed to fair evaluation at the expense of the development of a relationship. Furthermore, these companies are also not so naïve as to not press the GAO when they feel slighted, or that something foul is afoot. Naturally, these checks on fairness and accountability requires there to be multiple contractors vying for the same specific contract. Tragically, amidst this flurry of public-private interaction, the Challenger Program experienced a tragic failure resulting in the loss of seven lives. What would result is a regulatory framework that would indicate the U.S. government's desire to create a fully commercial space launce industry, thereby placing further trust and responsibility in the hands of private actors.

Chapter 2: The Landsat Program

The successes of the Space Shuttle Program in the 1980s reinvigorated the American imagination and demonstrated to policy makers the value that space programs could offer. The Commercial Space Launch Act of 1984, as well as its 1988 Amendment, were but two of resultant policy priorities and administrative shifts to occur in the wake of the Shuttle's many successes. These policies and the underlying contracting processes offer considerable insight into the nature of the relationship between the U.S. government and commercial space entities. The Challenger Space Shuttle Disaster in 1986 opened the possibility for commercial entities to play an even greater role in the launch of space-based assets. This expansion of the commercial sector's role in providing space assets continued to experience growth and further reaffirmation through the 1990s. The Landsat Program represents one such example of a program highlighting how the commercial sector experienced a reemphasis, this time within the context of the development and operations of satellite-based systems. This chapter will overview the Landsat Program, the policies which defined and determined its relative value to the public, the political and technical challenges it faced in the early 1990s, and the evolution of its procurement process as the program entered the new millennium. Through this overview, we will be able to expand our understanding of how the U.S. government perceives the role of commercial entities in the space industry, how they fit within national security concerns, and what degree of budgetary priority these programs warrant in the wake of the Challenger disaster.

Background

The Landsat Program is the longest running space-based survey of Earth's surface and was originally designed to help land managers and policy makers make informed decisions about the Earth's resources and the environment.¹³⁴ Through continuous collection and archiving of detailed land images provided by satellites in orbit, the program can monitor ecological and topographical changes on the Earth's surface which have occurred as a result of climate change or human development.¹³⁵ The Landsat Program began in the early 1970s and is currently jointly operated by NASA and the United States Geological Survey.¹³⁶ Through nearly 50 years of operation, the images provided by the program have proven incredibly valuable for both public and private research as well as for national security.¹³⁷ Landsat's value was not always a given, however. It took several years and the effort of private entities and researchers to determine the fate of the program in the 1980s and the 1990s.

Much like the Shuttle Program, 1984 proved an impactful year for the commercial satellite industry. Along with the Commercial Space Launch Act which allowed for the Department of Transportation to award licenses to private entities to launch objects into space, Congress passed the Land Remote-Sensing Commercialization Act of 1984.¹³⁸ Riding the wave of space successes, the United States Congress felt that the time was appropriate to further provide nondiscriminatory access to Landsat data through the promotion of competitive and

¹³⁴ "Landsat Science," accessed April 21, 2019, <https://landsat.gsfc.nasa.gov/>.

¹³⁵ "About « Landsat Science," accessed April 21, 2019, <https://landsat.gsfc.nasa.gov/about/>.

¹³⁶ *Ibid.*

¹³⁷ "Landsat Science."

¹³⁸ "Land Remote-Sensing Commercialization Act of 1984," Pub. L. No. 98-365, 15 USC 4201, accessed April 21, 2019, <https://www.govinfo.gov/content/pkg/STATUTE-98/pdf/STATUTE-98-Pg451.pdf>.

market-driven private sector involvement in land remote sensing.¹³⁹ Congress had felt that the use of remote-sensing data had been stifled by slow market development and by vocalized concerns regarding the continued availability of data.¹⁴⁰ As a result, Congress expressed a desire to initiate a transition to a fully commercial system for land-sensing technologies.¹⁴¹ However, Congress recognized that the high risk of the failure and the substantial capital investment required for such ventures necessitated cooperation between the federal government and the private industry.¹⁴² Congress particularly wanted to ensure that data continuity was maintained and that the United States government remained the global leader in land-sensing information as it was deemed essential to national security.¹⁴³

During this planned period of PPP collaboration, Congress stated that such cooperation should be structured so as to involve the minimal practicable amount of support or regulation by the Federal Government and the maximum practicable amount of competition by the private sector, while assuring continuous availability to the federal government of land remote-sensing data.¹⁴⁴ In total, the stated intent of the Act and the priorities listed within demonstrated the U.S. government's determination to allow the commercial sector to play a greater role in all aspects of remote land-sensing technologies, and also shows the government's recognition of its role in assisting commercial entities to attain the capabilities and resources necessary to provide such services.

¹³⁹ *Ibid.*

¹⁴⁰ *Ibid.*

¹⁴¹ *Ibid.*

¹⁴² *Ibid.*

¹⁴³ *Ibid.*

¹⁴⁴ *Ibid.*

The 1984 Act would permit the Secretary of Commerce to contract out the orbiting, operation, and disposition of the Landsat 1, 2, 3, 4, and 5, as well as the associated ground control stations so long as the United States Government retained ownership of the system, the unenhanced data, and the authority to make decisions concerning the operation of the system.¹⁴⁵ The Act also permitted the Secretary to competitively contract out the marketing of the unenhanced data collected by the Landsat System.¹⁴⁶ Lastly, the Act also provided the Secretary of Commerce the authority to license the development and operation of independent, private remote-sensing systems and operations to any interested private sector parties.¹⁴⁷ As such, the groundwork was set for the creation of a commercial land remote-sensing industry.

Contracting Environment

The way in which the United States government would carry out its contracting process in the wake of the Land Remote-Sensing Commercialization Act of 1984 Act helps to further indicate how the government viewed its relationship with the private sector. The 1984 Act charged the Secretary of Commerce with monitoring special provisions and considerations when awarding a contract. Among the topics to be considered, conditions regarding the marketing of unenhanced data, competition of the contracting process, the methodology of awarding the contract, and the archival of the system's data were the most explicit.¹⁴⁸

Regarding the marketing Landsat data by private entities, the Act stated that the Secretary can only solicit contracts for the marketing of the data by private actors if the Secretary can

¹⁴⁵ Ibid.

¹⁴⁶ Ibid.

¹⁴⁷ Ibid.

¹⁴⁸ Ibid.

adequately determine that such sale by the private sector will likely result in a net cost savings for the United States government.¹⁴⁹ Furthermore, any private contractor must offer to sell and deliver the data to all potential buyers on a non-discriminatory basis.¹⁵⁰ Consequently, it becomes immediately apparent that the primary goal and consideration for the commercialization of the project was indeed to cut costs. Additionally, through the non-discriminatory sale requirement, Congress also indicated its belief in competition as a driver of growth, benefit, and savings and the necessity that the data remain available to all those interested. Lastly, the Secretary is advised to take into consideration the citizenship of key personnel, location of assets, foreign ownership, control, influence and other factors when screening eligible contractors.¹⁵¹ In contrast to the previous stipulations which are seemingly aimed at civilian and public implications of data access, this final consideration shows the government's understanding as to the military value of the data obtained by the Landsat Program. Security considerations had effectively, albeit loosely, been included in the language of the Act.

The 1984 Act also stipulates the conditions of competition for the contracts. The Act requires any would-be contractor to meet all required international obligations, national security concerns, sensitive information protections, and domestic legal considerations in agreeing to accept a contract for such services.¹⁵² Furthermore, the would-be contractor must include within their proposal a description of their ability to aggressively market data, offer the best overall financial return to the government, their technical competence including the ability to provide timely and continuous delivery of data, and to ensure a smooth transition of services from the

¹⁴⁹ Ibid.

¹⁵⁰ Ibid.

¹⁵¹ Ibid.

¹⁵² Ibid.

government.¹⁵³ When evaluating the proposals offered by the would-be contractors, the Secretary is directed to consider each of the above requirements of the proposals, as well as the net cost to the federal government to develop the contractors suggested system that would replace the Landsat system, the financial condition of the contractor, the availability of the data upon the termination of the Landsat system, the contractor's ability to supplement the requirement for the data continuity by adding remote-sensing capabilities which maintain the United States' leadership in remote sensing, the potential to expand the market for data, the commercial viability of the proposal, and proposed procedures for satisfying the national security concerns and international obligations of the United States.¹⁵⁴ In combination, while this long list of requirements does guide the considerations that the private entities must make, they stop short of stipulating the precise metrics they must meet, therefore showing that private entities are afforded a considerable degree of freedom in how the current system and future systems would operate. Interestingly, the fact that marketing and fair pricing considerations were listed before stipulations for competition or operational specifications indicates that the government gave priority to fair access to data and cost savings as objectives driving the privatization of this industry.

Lastly, the Act explicitly indicates that it is within the public interest to ensure that the data obtained by any such operator remains public available. Any operator must ensure the archive of Landsat data is of sufficient scope, content, quality, integrity, continuity, and accessibility as determined by the Secretary of Commerce.¹⁵⁵ Additionally, the Act states that the operator retains exclusive rights to sell Landsat-sensed data for a period of ten years following

¹⁵³ *Ibid.*

¹⁵⁴ *Ibid.*

¹⁵⁵ *Ibid.*

the date of the original sensing.¹⁵⁶ Once again, the importance of the data is placed at the forefront of the language of the Act. Congress's desire to place explicit quality control stipulations within the Act as well as ownership rights shows that there were limits to the degree of discretion the government was willing to provide commercial entities. The Act was more concerned with the data and its value than it was with realizing a fully commercial land sensing industry. Conditions as to the operations of the system, however, remain comparatively scant.¹⁵⁷ The Act only specifies that the Secretary is permitted to contract out any part of the Landsat system's operations. It makes no recommendations or requirements as to how a would-be contractor must operate the Landsat system or how any proposed successor to the Landsat system must be operated.¹⁵⁸ The government was less interested in making managerial or operational prescriptions for the Landsat system so long as the data remained accessible and of consistently high quality.

Then in 1989, citing a lack of funding, the U.S. government stated an intention to end the Landsat program altogether, including its role as owner of the system and ability to make further operation decisions on a discretionary basis.¹⁵⁹ Ownership and management of the program was transferred to the Earth Observation Satellite Company (EOSAT).¹⁶⁰ Following this transfer, the price for using Landsat data rapidly increased, causing all but the largest purchasers of data to drop out of the market.¹⁶¹ This caused data availability to drop to a "per request basis" as

¹⁵⁶ *Ibid.*

¹⁵⁷ *Ibid.*

¹⁵⁸ *Ibid.*

¹⁵⁹ "Ellensburg Daily Record - Google News Archive Search," accessed April 21, 2019, <https://news.google.com/newspapers?id=EjkQAAAAIIBAJ&sjid=G48DAAAAIIBAJ&dq=satellite%20congress%20landsat&pg=3918%2C6412636>.

¹⁶⁰ "Landsat Looks and Sees," Text.Article, July 23, 2012, <https://earthobservatory.nasa.gov/features/LandsatLooks/page2.php>.

¹⁶¹ *Ibid.*

opposed to consistently generating data, and global coverage dropped significantly.¹⁶² The resultant public outcry and accompanying testimony by Vice President Dan Quayle in his role as chairman of the National Space Council called for sustained funding.¹⁶³ After being made aware of planned budgetary cut, several members of Congress, led by a particularly incensed Senator Al Gore, voiced fierce protest to the ending of the program, citing the many jobs that would be lost domestically, and the even larger impact it would have internationally.¹⁶⁴ Landsat received support from both political parties, leading to the decision by Congress to reaffirm the United States' commitment to funding the Landsat Program.¹⁶⁵ Congress would outline its renewed investment with the passage of the Land Remote Sensing Policy Act of 1992.¹⁶⁶

In so doing, however, many of the 1984 Act's provisions and considerations would ultimately prove to be unwarranted. The 1992 Act would transfer administration of the program back to NASA and the Department of Defense but would still allow for the Secretary of Commerce to issue licenses to private companies who wished to orbit privately owned and operated land-sensing satellites.¹⁶⁷ The shift was the result of several concerns. Firstly, the resultant price of Landsat data had impeded the use of such Landsat data for scientific purposes and other public sector applications, such as the monitoring of environmental changes resulting from human development.¹⁶⁸ Secondly, the United States government had determined that it was of paramount importance to receive expedited and continuous procurement of data because data

¹⁶² Ibid.

¹⁶³ John Noble Wilford, "U.S. Halts Plan to Turn Off the Landsat Satellites," *The New York Times*, March 17, 1989, sec. U.S., <https://www.nytimes.com/1989/03/17/us/us-halts-plan-to-turn-off-the-landsat-satellites.html>.

¹⁶⁴ "Ellensburg Daily Record - Google News Archive Search."

¹⁶⁵ "Land Remote Sensing Policy Act of 1992," Pub. L. No. 105-555, 15 USC 5601, accessed April 21, 2019, <https://www.govinfo.gov/content/pkg/STATUTE-106/pdf/STATUTE-106-Pg4163.pdf>.

¹⁶⁶ Ibid.

¹⁶⁷ Ibid.

¹⁶⁸ Ibid.

continuity was a matter of national security.¹⁶⁹ As a result, the U.S. government determined that full commercialization of the Landsat Program could not be completed within the short term, nor within a timeframe that was acceptable for their international and national security obligations.¹⁷⁰ All management responsibilities were subsequently given to the Department of Defense and NASA. Furthermore, the program was extended to include two more satellites, Landsat 6 and 7, which were to be launched within the decade.¹⁷¹ The construction and launch of these new satellites into orbit was to be contracted out to private entities.

In combination, the progression of events has substantial implication for the commercial space industry. The decision to reassume ownership and operation of the Landsat in the 1992 Act demonstrates that sort of considerations that would cause the government to avoid privatization or commercialization of a system. In short, this Act offers insight into the limits of government's trust of the commercial industry. The fact that the government chose to reassume control of the entire program instead of passing further regulation that would dictate the required pricing and provision of data shows that it was either assumed that oversight of such regulation would either be infeasible, or that it would not be feasible for the private sector to operate under the prices required to meet the simultaneous data continuity and accessibility requirements.

Following the passage of the 1992 Act which called for the construction of two new satellites, the Department of Defense issued RFPs for their development and subsequent launches. The Landsat 6 satellite was to be developed by Martin Marietta.¹⁷² The satellite was launched in 1993 by Martin Marietta's own Titan-series rockets, however, Landsat 6 failed to

¹⁶⁹ *Ibid.*

¹⁷⁰ *Ibid.*

¹⁷¹ *Ibid.*

¹⁷² "Landsat-6 - EoPortal Directory - Satellite Missions," accessed April 24, 2019, <https://directory.eoportal.org/web/eoportal/satellite-missions/l/landsat-6>.

reach orbit due to a manifold rupture.¹⁷³ Subsequent investigations by Martin Marietta and by NOAA verified the cause of the orbit failure, and led to the creation of a taskforce to research strategies to prevent similar failures from occurring in the future.¹⁷⁴ The failure of the Landsat 6's launch caused the United States' government to reassess its strategy for providing land sensing data yet again. Still recognizing the value of the Landsat program, the government expressed its intent to continue the program with the launch of the successor satellite, the Landsat 7.¹⁷⁵ However, administration of the program would be transferred away from the Department of Defense due to cited budgetary constraints.¹⁷⁶ In its stead, administration would be given jointly to NASA, the Department of Commerce/NOAA, and the Department of the Interior.¹⁷⁷ The new strategy would once again reaffirm the importance of data continuity, affordability, accessibility, and international cooperation.¹⁷⁸ Landsat 7 would eventually be manufactured by the newly formed merger of the Lockheed Corporation and Martin Marietta, Lockheed Martin, and would be launched in 1999 by a Boeing Delta-series rocket.¹⁷⁹

Cumulatively, the Landsat program underwent many changes during this 15-year period, changing administrative across multiple governmental agencies. Additionally, throughout this period of governmental flux, the commercial space industry itself was in flux as well. This is demonstrated by consistent, yet evolving list of commercial contractors involved in the Landsat

¹⁷³ *Ibid.*

¹⁷⁴ Laura Rocchio, "Landsat 6 Failure Attributed To Ruptured Manifold," n.d., 1.

¹⁷⁵ "1994 Whitehouse Landsat Remote Sensing Strategy" (1994), <https://eros.usgs.gov/sites/all/files/external/eros/history/1990s/1994%20Whitehouse%20Landsat%20Remote%20Sensing%20Strategy.pdf.pdf>.

¹⁷⁶ *Ibid.*

¹⁷⁷ *Ibid.*

¹⁷⁸ *Ibid.*

¹⁷⁹ "Landsat 7 Media Kit," May 8, 1999,

<https://web.archive.org/web/19990508193945/http://www.boeing.com/defense-space/space/delta/delta2/Landsat/index.html>.

program's history. General Electric was signed as the prime contractor for the original Earth Resources Technology Satellites A and B (ERTS), or Landsat 1 and Landsat 2.¹⁸⁰ The Department of Defense would return to General Electric's space division for construction of each of the various iterations of Landsat's spacecrafts.¹⁸¹ However, it would be fallacious to assume that DoD's consistent contracting with GE's space division would indicate a relatively stable contracting environment. In fact, GE's space division underwent several transformations during this period. GE Aero Space was purchased by Martin Marietta in 1993 to become Martin Marietta Aero Space.¹⁸² Martin Marietta Aero Space would in turn merge with the Lockheed Corporation in 1995 to form Lockheed Martin.¹⁸³ This convergence and dominance of a few, select contractors is also evident in the companies selected to provide the launch services for the Landsat program. Landsat 1 – 5 were all launched aboard a Boeing Delta-series rocket.¹⁸⁴ Beginning with Landsat 6, however, both the spacecraft and the launch system were manufactured by Martin Marietta, or its later successor Lockheed Martin.¹⁸⁵ Landsat 7 would once again be developed by Lockheed Martin, however, the U.S. government would return to Boeing for launch services.¹⁸⁶

Truly, Landsat's long history serves to highlight how the commercial space industry gradually shifted to become increasingly dominated by a few, large contractors. By the end of

¹⁸⁰ "Landsat Program Chronology," December 2, 2016,

<https://web.archive.org/web/20161202113747/https://geo.arc.nasa.gov/sge/landsat/lpchron.html>.

¹⁸¹ "Landsat-1 to 3 - EoPortal Directory - Satellite Missions," accessed April 24, 2019,

<https://directory.eoportal.org/web/eoportal/satellite-missions/l/landsat-1-3>.

¹⁸² "Landsat Program Chronology."

¹⁸³ "A Merger of Equals," Lockheed Martin, accessed April 24, 2019, <https://www.lockheedmartin.com/en-us/news/features/history/merger.html>.

¹⁸⁴ "Landsat Fact Sheet," Landsat Fact Sheet (United States Geological Survey, 2015), https://www.usgs.gov/land-resources/nli/landsat/landsat-satellite-missions?qt-science_support_page_related_con=2#qt-science_support_page_related_con.

¹⁸⁵ Rocchio, "Landsat 6 Failure Attributed To Ruptured Manifold," 6.

¹⁸⁶ "Landsat 7 Media Kit."

the 1990s, Boeing, Lockheed Martin, Raytheon, and Northrup Grumman dominated the industry.¹⁸⁷ Greater diversity in the contractors for the Landsat program would not occur again until the Landsat 8 program in the late 2000s.

Implications of the Landsat Program for the Commercial Industry

In total, the Landsat Program highlights how a few key commercial actors played large and ever-evolving role in contracting with NASA and the Department of Defense. Even though the U.S. government would ultimately reassert its control over the program's operations and data management, commercial actors still played an instrumental role in the development and manufacture of the program's component parts. However, a key change in NASA's procurement strategy would increase the risk born by commercial actors pursuing Landsat contracts.

In 2006, NASA would rebrand the Landsat Program as the Landsat Data Continuity Mission (LCDM).¹⁸⁸ This name not only reaffirmed the U.S. government's commitment to data access, it also engendered consequential changes to the types of contracts NASA would award. Previously, NASA commonly awarded Contract-Plus-Award-Fee contracts in which all costs that the contractors incurred in delivery of the service or product are reimbursed by the government, plus an additional award based on the exceptionality of the contractor's performance.¹⁸⁹ This form of contracts placed greater risk on the government and are considered appropriate when it is difficult to accurately forecast costs and risks of the program in advance,

¹⁸⁷ Norman R. Augustine, "Reshaping an Industry: Lockheed Martin's Survival Story," *Harvard Business Review*, May 1, 1997, <https://hbr.org/1997/05/reshaping-an-industry-lockheed-martins-survival-story>.

¹⁸⁸ "NASA GSFC Solicitation: LANDSAT Data Continuity Mission," accessed April 25, 2019, <http://spaceref.com/news/viewsr.html?pid=19712>.

¹⁸⁹ "NASA'S USE OF AWARD-FEE CONTRACTS" (NASA Office of the Inspector General, November 19, 2013), <https://oig.nasa.gov/docs/IG-14-003.pdf>. P1

which is common for NASA projects.¹⁹⁰ However, with the switch to the LCDM program, NASA would begin awarding Firm-Fixed-Price contracts.¹⁹¹ Firm-Fixed-Price contracts are awarded for a fixed price that is not subject to any adjustment based on the contractor's cost experience.¹⁹² This contract type causes the contractor to assume maximum risk and full responsibility for all costs, and any profit or loss, thusly compelling the contractor to control costs to the greatest extent possible.¹⁹³ This change in policy indicates a couple of large shifts in the U.S.'s paradigm in engaging with the commercial space industry. Firstly, this shift indicates that NASA likely felt that the commercial space industry had developed sufficiently at this point to assume more risk in the completion of missions. Furthermore, by increasing the cost-related risks held by the private sectors, the government starkly demonstrated its decreasing trust in the commercial industry to earnestly pursue the optimally cost-effective strategy if the private actors were not liable for losses. It should be noted that adjusting to firm-fixed-price method can increase project risk if there are no adequate regulatory or evaluative bodies ensuring that the commercial entities involved are not skirting project necessities in the pursuit of project completion at the lowest cost.

Chapter Conclusion

Over the long history of the Landsat Program, administrative and operational responsibilities moved across multiple industries, and were even briefly assumed by the private sector, before returning to the auspices of NASA and the USGS. Through this tumultuous period

¹⁹⁰ Ibid.

¹⁹¹ "NASA GSFC Solicitation: LANDSAT Data Continuity Mission."

¹⁹² Joe Boyle, "Selection of Contract Type for Launch Services," n.d., 27.

¹⁹³ Ibid.

of budget uncertainties, the U.S. government would contract with multiple commercial actors, however, the total number of active actors would experience a substantial decrease before becoming dominated by perennial industry actors such as Boeing, Lockheed Martin, and newly formed Northrop Grumman; the result of the Northrop Corporation's purchase of the Grumman Corporation in 1994.¹⁹⁴ When compared to the Space Shuttle Program, the Landsat Program had substantially fewer actors involved. This could just as easily be a result of the difference in project scope as well as the changing commercial landscape at the time. Additionally, the Landsat Program did not experience the same degree of competitor protest that marked the Shuttle Program. This would change with the future Landsat 8 and 9 projects when another award protest would be submitted, but throughout the 1990s, the program remained comparatively calm.¹⁹⁵ Consequently, it would become possible for relational contracts to form between the few actors remaining, however, given the diminished roles afforded to the private industries, the formation of the relationships remained unlikely.

In total, the Landsat Program serves an indication that the space industry is not entirely uniform and there are considerable complexities within a single program, let alone across the industry as whole. Furthermore, the program shows that despite observed operational difficulties, the United States government still insists on tapping into the expertise and resources of the commercial industry whenever possible, but will assume control of programs which it deems critically necessary to national security, especially when it also involves considerable national security and public-use value. In this regard, the United States attempted a more European style

¹⁹⁴ Calvin Sims, "Northrop Bests Martin Marietta to Buy Grumman," *The New York Times*, April 5, 1994, sec. Business Day, <https://www.nytimes.com/1994/04/05/business/northrop-bests-martin-marietta-to-buy-grumman.html>.

¹⁹⁵ "Decision on the Matter of Ball Aerospace & Technologies Corp." (Government Accountability Office, July 16, 2015), <https://www.gao.gov/assets/680/671700.pdf>.

of ownership utilizing one large commercial operator, but instead found public ownership of the program preferable. As a result, the Landsat Program constitutes a unique period in the space industry wherein the U.S. government continued to voice its desire for a robust commercial industry but did not trust the market of the time to effectively manage the Landsat Program. What existed therefore was a market with diminished trust between the government and private operations companies, and a few large, dominant private launch actors.

Chapter 3: The GPS-III System

Throughout the 80s, 90s, and early 2000s, the U.S. government and NASA repeatedly voiced its commitment to expanding the roles and responsibilities of the commercial space industry. The Landsat Program offered a reminder of the circumstances in which the government would acknowledge the benefit of government ownership and operation of a project. The proceeding shifts in how the government would engage in partnerships with private entities would also have lasting impact on the space industry. Shifting to firm-fixed-price contracting can, in theory, prove incredibly cost effective given sufficient commercial competition. Competition in the pursuit of cost reduction and innovative solutions have been long-stated goals for government in the commercial space sector. However, as will become more evident over the course of this chapter, NASA and the Department of Defense's experiences contracting with the commercial sector must still surmount hurdles in the shape of timeliness of delivery, adequate commercial sector competition, and project costliness. The newest iteration of the Global Positioning System's (GPS) infrastructure perfectly captures the culmination of changes presented across the previous two chapters and provides a snapshot of the commercial space industry and its relationship with the U.S. government as it exists today.

Background

The GPS began conception and early development in the 1970s, but the system would not become fully operational until 1993.¹⁹⁶ The GPS system is instrumental in providing accurate geolocation services, invaluable military surveillance information, and the atomic clocks onboard

¹⁹⁶ Thuy Mai, "Global Positioning System History," Text, NASA, May 5, 2015, http://www.nasa.gov/directorates/heo/scan/communications/policy/GPS_History.html.

the satellites provide accurate timekeeping records which are integral to financial systems worldwide.¹⁹⁷ In recent years, NASA and the Department of Defense have engaged in modernization efforts to increase the overall performance of the GPS system.¹⁹⁸ The new satellites and ground-based facilities are part of GPS-III and GPS-III-F (follow-on) systems.¹⁹⁹ The United States Air Force launched the first GPS-III satellite in December 2018, and the second satellite was delivered to Cape Canaveral to prepare for launch in March of 2019.²⁰⁰

Contracting Environment

NASA's decision to pursue firm-fixed contracts instead of cost-award contracts in 2006 sent a signal to the commercial space industry that the U.S. government was making good on its intention to place greater responsibility on private entities. In the same year, Lockheed Martin and Boeing, two of the most well-established names in the defense and commercial space industry would make their own contracting decision that would have a substantial effect on the industry as a whole. Following a dispute as to Boeing's misappropriation of Lockheed proprietary information, the companies decided to end their competition with one another, and created the jointly-operated company United Launch Alliance (ULA).²⁰¹ Since their entrance into the market, ULA has dominated the launch market and has presided over substantial cost increases for launch services.²⁰² Smaller companies, most notably Space Exploration

¹⁹⁷ "GPS.Gov: Timing Applications," accessed April 27, 2019, <https://www.gps.gov/applications/timing/>.

¹⁹⁸ "GPS.Gov: GPS Modernization," accessed April 27, 2019, <https://www.gps.gov/systems/gps/modernization/>.

¹⁹⁹ Ibid.

²⁰⁰ "GPS.Gov: Space Segment," accessed April 27, 2019, <https://www.gps.gov/systems/gps/space/>.

²⁰¹ "About ULA," accessed April 27, 2019, <https://www.ulalaunch.com/about>.

²⁰² Emily Shanklin, "EELV: The Right to Compete," Text, SpaceX, April 29, 2014, <https://www.spacex.com/news/2014/04/29/eelv-right-compete>.

Technologies Inc. (SpaceX), have filed protests to the GAO regarding ULA's effectual monopolization of the market.²⁰³ Indeed, for nearly a decade after its formation, ULA enjoyed a monopoly of launches for military satellites.²⁰⁴ Outside of military launches, ULA, Boeing, and Lockheed Martin still account for a preponderance of contracted services for the space industry.²⁰⁵

In many regards, the U.S. government's reliance on ULA, Boeing, and Lockheed Martin is not entirely unexpected given the long history of collaboration the entities share. Literature on public-private partnership interactions largely indicate that such close ties are to be expected as value and mission alignment strengthen as the relationship evolves over time. Furthermore, the value of previous performance history as a criterion for NASA and DoD sourcing evaluation also supports the reliance on known actors in the industry. However, certain aspects of this relationship between private entities and the U.S. government are contrary to the stated values that have long driven the industry. Namely, the allowance of an effectual monopolization of launch services stands at odds with the government's long touted pursuit of cost effectiveness and fair competition in the commercial space industry. For instance, in their complaint to the GAO, SpaceX notes that contracts with ULA were negotiated outside of public view and have never been made public, thusly negatively impacting the competitive nature of the contracting environment.²⁰⁶ More troubling, receiving copies of the contracts between the government and ULA is incredibly difficult. SpaceX itself noted that it made requests for the contracts using the

²⁰³ Ibid.

²⁰⁴ "Boeing, Lockheed, ULA Corner the Government-Funded Space Market. SpaceX Moving Up," SpaceNews.com, April 22, 2018, <https://spacenews.com/boeing-lockheed-ula-corner-the-government-funded-space-market-spacex-moving-up/>.

²⁰⁵ Ibid.

²⁰⁶ Shanklin, "EELV."

Freedom of Information Act but had not received a response.²⁰⁷ Without these documents, it is extremely difficult or sometimes impossible to know what precisely is required by the contract, and it is therefore difficult to truly understand the nature of the relationship between the entities involved.²⁰⁸

While those specific contracts remain difficult to obtain, this report will examine two related, but different contracts in an attempt to glean information regarding the requirements placed on private entities involved with the GPS-III program. Of the documents examined, first are two separate model contracts that were issued as part of the Request for Proposal for Evolved Expendable Launch Vehicles (EELV) which would be used to place the GPS-III satellite in orbit. These model contracts contain the terms and conditions for fulfilling the delivery of the EELVs or rockets. Since these documents are provided with the RFPs prior to the selection of a successful contractor's bid, these model contracts do not specify the names of the entities or persons involved in the contract's fulfillment. Such information would be entered into the model contract once an award decision had been made and a final contract is created. Nevertheless, each of the associated RFPs were surrounded with controversy as to whether the Department of Defense executed its contracting authority in an acceptable manner, and each of the RFPs offers insight into how the current contracting process operates.

The model contracts explicitly state the stipulations and freedoms placed on commercial entities when they fulfill a contract. By comparing these two model contracts, which were issued approximately one year apart, we can examine the degree to which the contracting process is uniform across projects and contractors. Any noted difference may indicate changing priorities

²⁰⁷ *Ibid.*

²⁰⁸ *Ibid.*

by project or by contractor, while similarities between the contracts can indicate a degree of consistency in the U.S. government's values and concerns.

Last, this chapter will examine a Selected Acquisition Report (SAR) which provides an update on the status and requirements of the contract awarded to Raytheon for the development and installation of the GPS Next Generation Operation Control System (OCX). The OCX is the system which assists with launching future satellites and coordinates the navigation and movement of the satellites into their orbits.²⁰⁹ It is a combination of both hardware and software that is integrated at receiving stations in numerous countries around the world.²¹⁰ The SAR is instrumental as it demonstrates the precise requirements placed on Raytheon for critical components of a project, offers an example of how a project can become beset with cost overruns and delays, and shows how the government responds to development concerns surrounding critical infrastructure. Additionally, this project carries substantial implications for national security because of the GPS's integral role in surveillance and the operations of a multitude of disparate, global industries. Combined, these documents indicate how private entities and the U.S. government interact with one another from the initial RFP, through project development, and up to the final launch as well as the ongoing maintenance of ground-based operational systems which require continuous, forward-looking security enhancements.

In July of 2014, the Department of Defense's Space & Missile Systems Center issued a Request for Proposal for a National Reconnaissance Office Launch vehicle (NROL) in the form of an Evolved Expendable Launch Vehicle (EELV).²¹¹ The RFP contained a model of the

²⁰⁹ "Raytheon: GPS Next Generation Operational Control System," accessed April 27, 2019, https://www.raytheon.com/capabilities/products/gps_ocx.

²¹⁰ *Ibid.*

²¹¹ "EELV PHASE 1A NROL-79 Request For Proposal - 14-093 (Archived) - Federal Business Opportunities: Opportunities," accessed February 13, 2019, <https://www.fbo.gov/index?s=opportunity&mode=form&id=db6fc2f2c2149a12c65b9529655a33cd>.

contract which outlined the products to be delivered, and the specification of all requirements, applicable regulations, and solicitation provisions. The model contract includes 69 specific addenda which lay out the specific terms and conditions of the contract and spans 123 pages. The model contract also references ten additional stand-alone documents which further stipulate information regarding contract data requirements, acceptance criteria, evaluation criteria, property plans, and subcontracting plans.²¹² At first glance, this level of specificity on behalf of the U.S. government indicates the sensitivity of the project and the degree of control and specificity the government had regarding how the contract must be completed. This chapter will highlight aspects of the model contracts which specify how a contractor must address security considerations, as well as any addenda which indicate to what degree the U.S. government or the contractor assumes any liability and risk. The degree to which these considerations are retained by the government or are delegated out to a private entity can serve as an indication as to the level of trust that exists between the government and the commercial entities for certain responsibilities.

The model contract begins by specifying the contract's deliverables and responsibilities. Under this RFP, the Air Force sought a contractor to manufacture, test, assemble, and transport a launch vehicle, ensure that the vehicle met designs to allow for full mission integration, and perform all work associated with supporting launch operations and spaceflight worthiness of the vehicle.²¹³ Having established the basic contract deliverables and responsibilities within the first three pages of the document, the proceeding 119 pages include the various addenda and solicitation provisions which outline the specific contract regulations, instructions, and conditions. It is these addenda that will constitute the focal point of the analysis as they offer the

²¹² *Ibid.*

²¹³ *Ibid.*

most detailed insight into the specific roles, responsibilities, and freedoms afforded to commercial entities.

One of the first addendums of the contract is the ability of the government, Air Force, NRO, and Defense Contract Management Agency to perform in-process inspection or testing of any launch services tendered for acceptance prior to launch.²¹⁴ Notably, it does not explicitly specify when such testing would occur nor the nature of the testing should the testing occur at all. This section of the model contract also states that the government reserves the right to terminate the contract, or any part, for its sole convenience.²¹⁵ The ability to cancel the contract as it deems necessary indicates that the government retains a considerable level of discretion throughout the contract's term. The contract does state that the contractor shall be paid a percentage of the contract price reflecting the percentage of work completed prior to the notice of termination plus any reasonable charges that can be demonstrated to have resulted as a result of the termination, but also states that this stipulation does not give the government any right to audit the contractor's records.²¹⁶ This particular stipulation represents a substantial degree of trust on behalf of the government towards the commercial entity. Given that contracts for launch vehicle can involve hundreds of millions of dollars, the decision to preclude the right to audit the documentation of the contractor's cost in the advent of a termination indicates a degree of faith that a contractor would be honest in reporting costs associated with the work completed. Any degree of dishonesty could carry considerable financial implications.

The government's degree of trust for the commercial contract is further demonstrated in its limitation of the private entity's liability. In one of the first addendums listed within the

²¹⁴ *Ibid.* P4

²¹⁵ *Ibid.*

²¹⁶ *Ibid.* P7

document, the model contract states that unless otherwise provided by an express warranty, the contractor will not be liable to the government for consequential damages resulting from any defect or deficiencies in accepted items.²¹⁷ In limiting the liability the private entity is subjected to, the government is in turn assuming the costs associated with any resultant failure. This carries multiple implications. Firstly, to a certain degree, this indicates that the government trusts the private actor to complete its task reliably and to a certain level of quality. However, this limitation of liability likely is not solely a statement in regard to the government's trust in the private entity to produce high quality, risk-free deliverables. Instead, by assuming this liability itself, the government is lowering the risk and cost for private entities to enter the market as a would-be contractor. If private entities were responsible for liabilities associated with damages, defects, or deficiencies, the risk and cost of engaging in such contracts may be prohibitively high and would limit the number of entities able to bid. As a result, this particular stipulation may constitute an indication to the government's interest in a competitive commercial market more than it constitutes a statement regarding the government's trust in the commercial industry.

In issuing the model contract document, the government also states that any inconsistencies found within the contract or the solicitation are resolved following a specific order of preference. Of the nine items listed as precedence, "the specification" of the contract is listed last.²¹⁸ Interestingly then, the government seemingly assigns the clarity surrounding the specification of the deliverable as the lowest level of importance that is worth enumerating. The top three items in order of precedence as listed in the model contract are: 1) the schedule of supplies/services, 2) the assignments, disputes, payments, invoice, other compliances,

²¹⁷ Ibid. P8

²¹⁸ Ibid. P9

compliance law unique to the government contracts, and unauthorized obligations paragraphs of this clause, 3) the clause at 52.212-5.²¹⁹ The referenced clause dictates certain requirements as necessitated under law or executive order, such as the prohibition of discrimination with respect to ability status, the necessary steps to protest an award, and equal employment requirements.²²⁰ In total, the order of preference demonstrates the government's priorities for the contracting process. By listing the schedule of the project's delivery as the first item in the order of precedence, the government has shown that timely delivery of the items is of utmost importance. Interestingly, any concerns regarding inconsistencies in the assignment, payments or invoice are listed as second-order considerations. Given the history of instances wherein cost-effectiveness was cited by the government as the driving factor for engaging with the commercial industry and PPPs, it could be expected that payment and invoice considerations would be first-order considerations, or would constitute their own consideration distinct from other disputes, compliance issues, and obligations. Following these three considerations, the addenda which make up a predominant majority of the contract document are listed fourth in the list of precedence.²²¹

The contracts afford the commercial entities some leeway regarding adjusting the profit, reimbursable costs, and fees associated with completing the contract. However, if the contractor or any subcontractors make any significant increases in these costs as a result of faulty, inaccurate, or incomplete data submitted in the initial phases of the contract, the government will

²¹⁹ Ibid. P9

²²⁰ "Part 52 - Solicitation Provisions and Contract Clauses | Acquisition.GOV," accessed May 2, 2019, https://www.acquisition.gov/content/part-52-solicitation-provisions-and-contract-clauses#i52_212_5.

²²¹ "EELV PHASE 1A NROL-79 Request For Proposal - 14-093 (Archived) - Federal Business Opportunities: Opportunities."

reduce the value of the contract to reflect these adjustments.²²² All price data must be certified and submitted as soon as practical after agreement on contract price, but prior to the official award.²²³ To remain eligible for future price offsets or reimbursements from the government, the contractor must prove that to the initial data provided were certified by the original “as of” date offered to the government and that the data was accurate to the best of the contractor’s knowledge.²²⁴ In total, the government appears to maintain relatively strict guidelines regarding the monitoring, reporting, and adjusting of price information for private contractors.

At first glance, this would seemingly indicate that the government does not wholeheartedly or blindly trust the commercial industry with regards to pricing, otherwise there would not be a pricing certification requirement, nor would there be restrictions on what is eligible for reimbursements or modifications. This is not unexpected given the repeated emphasis on cost-effectiveness as a driving factor for PPPs. Whether or not these stipulations are effective at deterring cost overruns is not possible to be determined from the contracts alone, however. Persistent news reports of project cost overruns would seemingly indicate that either cost forecasting remains difficult, particularly for projects in the space industry, or that contractors are not exercising adequate diligence to accurately predict project costs. In either case, upon further examination it is not clearly nor consistently reported whether the private entities receive cost reimbursements for the cost overruns which occur. As such, it is difficult to discern from the contract alone how strictly the government enforce the provisions regarding cost modification and reimbursements, and it is, therefore, difficult to determine to what degree the commercial actors retain discretion and trust in pricing.

²²² Ibid. P13

²²³ Ibid. P16

²²⁴ Ibid. P14

The government retains considerable leverage and leeway over private contractors regarding project delays and changes in the fixed prices associated with the contract. If negligence or a failure of the government's officer in charge of managing the contract causes the project to experience a delay, the contractor is permitted an adjustment for any associated cost increases excluding profit and will also be allowed an adjustment to the dates associated with the project as well.²²⁵ An adjustment is not offered for any delay caused by any other cause, including the fault or negligence of the contractors.²²⁶ As a result, the government retains a advantaged position over the contractor. Furthermore, the government contracting officer retains the right to make any changes within the general scope of the contract at any time without notice to the contractors.²²⁷ The contracting officer can allow an adjustment to the price of the contract following any such changes, and the contractor can formally dispute the suggested changes, however the model contract states that nothing in the surrounding clauses excuses the contractor from proceeding with the contract as changed.²²⁸ This means that if a change is dictated by the government, the contractor can dispute the specifics and feasibility, but this dispute does not absolve them from the responsibility of completing the contract. Once again, the wording of this section of the contract demonstrates that the government retains considerable discretion and power throughout the contracting process.

The model contract then devotes considerable time enumerating the requirements regarding the safeguarding of unclassified controlled technical information. The model contract explains that controlled technical information is defined as technical information with military or

²²⁵ Ibid. P18

²²⁶ Ibid.

²²⁷ Ibid.

²²⁸ Ibid.

space application that is subject to controls on the access, use, reproduction, modification, performance, display, release, disclosure, or dissemination.²²⁹ Unclassified in this sense does not necessarily mean that the information is not instrumental to the execution of military operations, which themselves could ostensibly be classified or otherwise invaluable to national security concerns. Consequently, it is stated that the contractor must make protective measures that are commensurate with the consequences and probability of loss, misuse, or unauthorized access to, or modification of information.²³⁰ The determination of what is “adequate”, however, is debatable depending upon how one would assess an associated risk and the severity of potential consequence. The government provide the private entities relatively large discretion in making these determinations themselves. The model contract states that the contractor must at minimum meet the requirement listed by National Institute of Standard and Technology (NIST) SP 800-53, “Security and Privacy Controls for Federal Information Systems and Organizations”.²³¹

However, as stated by NIST itself:

Compliance is not about adhering to static checklists or generating unnecessary FISMA reporting paperwork. Rather, compliance necessitates organizations executing due diligence with regard to information security and risk management. Information security due diligence includes using all appropriate information as part of an organization-wide risk management program to effectively use the tailoring guidance and inherent flexibility in NIST publications so that the selected security controls documented in organizational security plans meet the mission and business requirements of organizations.²³²

As such, the contractor itself is allowed considerable flexibility in how to meet these standards by design. This is a significant demonstration of faith in the contractor with substantial

²²⁹ Ibid. P37

²³⁰ Ibid.

²³¹ Ibid.

²³² Joint Task Force Transformation Initiative, “Security and Privacy Controls for Federal Information Systems and Organizations” (National Institute of Standards and Technology, January 22, 2015), <https://doi.org/10.6028/NIST.SP.800-53r4>.

security implications. By allowing contractors flexibility in how to meet these security considerations, it follows that there are as many approaches to “adequate security” as there are commercial contractors. This then means that the security surrounding these systems are to some degree inconsistent. Inconsistency in of itself is not itself concerning nor detrimental. However, inconsistency necessitates adequate evaluations by oversight or compliance entities to ensure that minimum standards are being met, risk assessments are accurate, and that applied security assurances are commensurate to the risks and consequences identified.

Unfortunately, skepticism of the government’s ability to adequately perform these oversight responsibilities are widespread. The Department of Defense has itself largely corroborated these fears in its Cybersecurity Discipline Implementation Plan of 2015. In response to various successful cyber intrusion across its systems, the DoD initiated an investigation into its cyber readiness.²³³ The investigation revealed “Department-wide, systemic shortfalls in implementing basic cybersecurity requirements established in policies, directives, and orders”.²³⁴ Furthermore, the investigation asserted that leadership at all levels must implement cybersecurity discipline, enforce accountability, and manage the shared risk to all DoD missions.²³⁵ In total, the document’s strong wording is a stark indication as to the DoD’s inability to adequately ensure compliance to its cybersecurity and information assurance requirements.

Ultimately, by January 2015, the request for the EELV was cancelled.²³⁶ The cancellation was followed by heated speculation. The cancellation of such an important proposal and called

²³³ “Department of Defense Cybersecurity Discipline Implementation Plan,” October 2015, <https://dodcio.defense.gov/portals/0/documents/cyber/cyberdis-implan.pdf>.

²³⁴ *Ibid.*

²³⁵ *Ibid.*

²³⁶ “EELV PHASE 1A NROL-79 Request For Proposal - Federal Business Opportunities: Opportunities,” accessed May 1, 2019, <https://www.fbo.gov/index?id=c6d988e402a1305ce750937bd7582b3d>.

into question very nature of the contracting of launch services. Conversation regarding the cancellation reached a fever pitch following statements made by a former United Launch Alliance (ULA) vice president regarding a separate, but related RFP for launch services for the GPSIII system. While hosting a seminar at a university in March of 2016, the former ULA employee insinuated that the Department of Defense had not fairly awarded National Space Security launches because the DoD had given an unfair advantage to ULA over other contractors for EELV programs.²³⁷ In the resulting investigation by the DoD's Office of the Inspector General, it was found that the DoD had not given an unfair advantage nor colluded with ULA for launch services.²³⁸ This determination was based on the fact that the former ULA employee in question had stated that he had misspoke during the presentation in question and did not mean to imply any irregularity regarding the launch contracting process.²³⁹ The report also cited a lack of evidence indicating any collusion and the fact that ULA did not submit a proposal in response to the GPS-III launch in question as indication that no foul play had occurred.²⁴⁰ ULA stated that its decision not to submit a proposal was in response to the DoD's decision to use a "lowest price technically acceptable" structure for the RFP, wherein the lowest cost proposal that met all technical requirement would be accepted.²⁴¹ Such a procurement strategy, according to ULA, did not place ULA at an advantage compared to its competitors.²⁴² ULA argued that since such a contracting method did not allow the DoD to distinguish offerors based on system reliability, schedule certainty, technical capability, or past performance, it did not allow for ULA to truly

²³⁷ "Investigation Regarding Assertions Made by Former United Launch Alliance Executive."

²³⁸ Ibid.

²³⁹ Ibid. P4

²⁴⁰ Ibid. P4

²⁴¹ Ibid.

²⁴² Ibid.

highlight what it considered to be its strengths.²⁴³ Furthermore, ULA was in the midst of transitioning away from its reliance of the Russian-made RD-180 rocket engines which served as the base for ULA launch vehicles because the Russian-made rockets had made certain members of Congress concerned as to the security implications of the vehicles writ-large.²⁴⁴ Ultimately, the contract for the launch vehicle which would place the GPS-III satellite into orbit was awarded to Space Exploration Technologies Corporation (SpaceX).²⁴⁵

While the final SpaceX contract was unable to be obtained for this analysis, the model contract issued with the original RFP is largely similar with the previous EELV model contract, with a few deviations. Many of the deviations that do exist are to ensure that requirements enumerated within the contract also apply to any subcontractors involved in fulfillment, and that the government has access to subcontractor premises for the purpose of reviewing, inspecting, and evaluating property management plans, systems, procedures, records, and support documentation regarding government property.²⁴⁶

The controversies and information brought to light surrounding the launch contract for the GPS-III system allows for a greater understanding as to the importance of the Next Generation Operation Control System (OCX). The OCX is the system which assists with launching future satellites and coordinates the navigation and movement of the satellites into their orbits.²⁴⁷ The Department of Defense awarded the development of the OCX to Raytheon in

²⁴³ Ibid. P16

²⁴⁴ Ibid. P5

²⁴⁵ Ibid. P4

²⁴⁶ Jennifer Lai, "Model Contract FA8811-15-R-0001 For Launch Vehicle for GPS-III" (Space & Missile Systems Center (SMC), September 30, 2015). P31

²⁴⁷ "Raytheon: GPS Next Generation Operational Control System."

June of 2010.²⁴⁸ However, the Selected Acquisition Report (SAR) published in 2014 by the Department of Defense which monitors progress toward contract completion indicates that difficulty regarding software development created cost overruns and development setbacks of the system.²⁴⁹ The first phase of product delivery was estimated to be completed by May 2015, which was still considered on-time.²⁵⁰ However, subsequent setbacks would mean that the first phase of deliveries would not be completed until the end of 2017.²⁵¹ The original timeline had the project delivery completed by the end of 2018, but the SAR stated that unplanned work and rework due to incomplete systems engineering during coding created setbacks, as had information assurance being more difficult than expected.²⁵² These setbacks were compounded by difficulties faced by Lockheed Martin, which was contracted to develop the hardware and many of the other physical components for the satellite portion of system.²⁵³ Current estimations place completion of the OCX delivery in 2021, three years later than originally scheduled.²⁵⁴ The Department of Defense has since stated that the OCX has achieved the highest cybersecurity protections of any DoD space system, and allows for added adaptability so that new capabilities can be added as they become available.²⁵⁵ Raytheon adds that the new cyber-secure system will have improved accuracy with better international availability and will include globally-deployed

²⁴⁸ "Global Positioning System Next Generation Operational Control System Data Sheet," 2016, https://www.raytheon.com/sites/default/files/capabilities/rtnwcm/groups/iis/documents/content/rtn_iis_gpsocx_datasheet.pdf.

²⁴⁹ "Next Generation Operational Control System (GPS OCX)."

²⁵⁰ Ibid.

²⁵¹ "Raytheon: GPS Next Generation Operational Control System."

²⁵² "Next Generation Operational Control System (GPS OCX)."

²⁵³ "GPS III Satellite Delivery Slips Because of Capacitor : GPS World," accessed February 14, 2019, <https://www.gpsworld.com/gps-iii-satellite-delivery-slips-because-of-capacitor/>.

²⁵⁴ "Raytheon: GPS Next Generation Operational Control System."

²⁵⁵ "First GPS III Satellite Successfully Launches," *GPS World* (blog), December 27, 2018, <https://www.gpsworld.com/first-gps-iii-satellite-successfully-launches/>.

receivers with anti-jam capabilities.²⁵⁶ Indeed, the emphasis of the new system's cyber preparedness is an indication to the DoD's redoubled emphasis on cyber discipline. However, this fervent emphasis of the newly installed cyber defense capabilities calls into questions the security of older GPS models still in use. The OCX helps to navigate and control these older systems; however, it remains predominantly a land-based system. As such, vulnerabilities may remain in the space-based assets. As stated by the DoD itself in its Cybersecurity Discipline Plan, vulnerabilities in any aspect of the network threaten the entire system.²⁵⁷

Implications of the GPS-III Program on the Commercial Industry

Given the ongoing nature of this project, it is difficult to accurately state what implications of the GPS-III program will have on the commercial industry. The emergence of private launch and transportation corporations such as SpaceX and Blue Origin indicates that competition may be returning to the commercial space industry. The emergence of these competitors has coincided with more protests to the GAO to ensure compliance and fairness in competition. In this regard, the commercial space industry is beginning resemble the industry as it existed during the Space Shuttle Program. This could prove beneficial so long as the entities continue to act as checks on one another, preventing any one entity from manipulating prices, or providing sub-standard deliverables. Furthermore, commercial entities have a considerable level of discretion when it comes to the specific methods used to meet the cybersecurity requirements of the contracts. The government has by design allowed for considerable flexibility to allow the private entities to use their expertise in determining how best to meet the security demands of a

²⁵⁶ "Raytheon: GPS Next Generation Operational Control System."

²⁵⁷ "Department of Defense Cybersecurity Discipline Implementation Plan."

dynamically changing threat landscape. However, if the government ever feels that this level of discretion and power distribution toward the private industry is unfavorable, Congress can pass new regulations and policies to lower the levels of discretion.

Chapter Conclusion

The various model contracts, RFPs, and SARs show that the United States government retains a considerable amount of power, discretion, and leverage over the contractors involved in the commercial space industry. Specifically, the model contract for launch vehicles serve as potent reminders that the government retains the right to alter or terminate the agreement at any time for its convenience. Meanwhile, private actors are much more beholden to their agreements by comparison. Somewhat contrastingly, the government's continued collaboration with Raytheon despite persistent cost overruns and project delays shows that the United States will not exercise this discretion at the slightest inconvenience, but instead will grant contractors some flexibility in deadlines and deliverables. Indeed, the importance of the projects involved often preclude total termination of a contract from being a realistic course of action. Therefore, the threat of contract termination and the power such a threat would grant the government is effectually muted. While private actors may have reason to be wary of the government and its ability to alter or terminate agreements at any time, commercial entities can be assured that in the case of militarily valuable assets such as the GPS, compensation will be offered so long as the technical requirements are met within a reasonable timeframe.

As it exists currently then, the government continues to shy away from precisely dictating how commercial entities must complete a RFP. This indicates that the government may largely trust the commercial sector to provide technically sufficient and cost-effective products. Similarly, the U.S. government is notably trusting of commercial entities in regards to the application of security and information assurance safeguards and provides private entities the discretion to address these security concerns in any manner they deem appropriate. Given that the government has published many volumes of data assurance guidelines and security protocols and has repeatedly emphasized the paramount importance of cybersecurity modernization, the government feels the need to retain some degree of control over security and safeguarding considerations, albeit the vague wording of the guidelines provided and wide degree of discretion afforded to private entities shows that the government only loosely retains control of security standards. Any semblance of control of security standards will remain ineffectual, however, as long as the DoD remains unable to exercise adequate oversight capabilities to ensure security compliance.

Thesis Implications and Concluding Remarks

The Space Shuttle Program, the Landsat Program, and the GPS-III expansion represent three distinct and enlightening case studies in American space history. Each made use of the expertise of various private entities to turn dreams into realities, and each program created systems and information that serve as the backbone for global scientific research and transcontinental trade and communication. By examining the United States government's contracting processes in the space industry as they have existed and evolved over the decades that these programs have spanned, several trends become apparent. Firstly, the United States government has long believed that collaboration with the private sector could allow for complex projects to be completed more efficiently than if the public sector worked alone. The Shuttle Program in particular offered an indication that many, competing private actors could come together and serve as quality and fairness checks on one another during this process. Furthermore, the Shuttle Program proves that NASA and the Department of Defense have long histories of engaging with a multitude of private interests spanning hundreds of commercial entities, and that a thriving private sector is neither a new development in the space industry, nor is it inherently concerning from a security or quality-assurance standpoint. Indeed, it was the presence of a robust, competitive commercial industry that helped to ensure that security safeguards were adequately considered and satisfied.

While managing the competing interests of a multitude of actors remains difficult, at the center of these many interests is the United States' commitment to competition, cost-effectiveness, and national security. Being as the space industry was born out of defense concerns and is therefore inherently linked with the defense industry, these values likely can be tied to the comparatively longer history of public-private partnerships which has existed within

the American defense industry. The ties between the space industry and the defense industry is supported by the large overlap of private entities which are active in both the defense and space industries. Boeing, Lockheed Martin, and Northrop Grumman represent but three of the largest contractors that dominate both the defense industry as well as the space industry. It is with these entities that a semblance of trust-based, relational contracting appeared at various moments the industry's history, however, changes to the contracting process which lessened the acknowledgement of a bidder's previous contract performance prevents a truly relational system from taking root. Furthermore, the rise of new entrants into the space industry and the scrutiny they impose on industry giants through formal award protests to the GAO has created the conditions required for a truly competitive industry to potentially take shape in the coming years.

Interestingly, the United States government's trust in the private sector to offer services and deliverables that are preferable both in terms of cost and quality is evidenced by the government's continually-stated desire and efforts to create a competitive commercial industry. This overarching goal persisted even after the U.S. government decided to reassert public control over the Landsat Program, which after becoming privately operated experienced intolerable cost increases and diminished service delivery timeframes. Being as the information provided by the Landsat Program was deemed of utmost importance for both international scientific research and U.S. national security interests, the U.S. government felt it had no choice but to resume control of the program in its entirety, all the while expressing the desire to one day transfer operation to the private industry once again.

Amidst the changes to the Landsat Program during the mid-1990s and early 2000s, an effectual oligopoly of launch services developed that is only just now beginning to face disruption by an onslaught of new, private space ventures. As these new space ventures are

founded and begin to enter the market, we may witness an increase in the number of award protests and selection investigations as the entities aggressively vie to secure valuable government contracts. In the midst of this fierce competition, ensuring alignment of values and cooperation will become increasingly difficult. The ongoing GPS-III Program highlights how the shortcomings of one actor can affect the progress of other private partners. Additionally, the GPS-III system exemplifies the degree of discretion that these private entities have when completing development contracts and the implementation of cybersecurity safeguards. As ventures of this type accelerate and become more common, the need for effective evaluation and milestone tracking becomes of paramount importance so as to ensure that the multitude of novel approaches used by private entities do not allow for gaps to form in global cybersecurity preparedness. Unfortunately, the Department of Defense has itself admitted to unable to effectively exercise such oversight functions.

Until the government can develop adequate accountability mechanisms, the industry will continue to rely upon self-regulation to a certain degree. Fortunately, self-regulation within an industry is not completely unheard of. The automobile industry experienced several notable developments, such the inclusion of seatbelts and increased fuel-efficiencies, as a result of competition between manufacturers.²⁵⁸ Nevertheless, implementing cybersecurity regulations remains a challenge in all industries, and the implementation of strict regulations would constitute a rather substantial deviation from how the government has traditional engaged with the commercial space industry. Strict regulations would carry implications towards the competitiveness of these systems on an international scale. Requiring private entities to adhere to stringent safeguarding process could increase development costs. As more and more countries

²⁵⁸ John McIlroy, "Top Innovations That Changed Cars Forever," CNN Style, December 20, 2016, <https://www.cnn.com/style/article/car-innovations/index.html>.

develop their own commercial space industries, such regulations which effectively increase operational costs could damage the competitiveness of American entities, especially if non-American corporations are not held to the same regulatory requirements. This does not imply that such regulations should be avoided altogether. Recent global sentiments towards private corporations' data sharing and security policies have led to the development of a minimum expectation of security and information sharing standards. The most prominent example of such standards is the General Data Protection Regulation created by the European Union and subsequently replicated across the world.

All of these concerns, ranging from increased competition to cybersecurity standards, relate to a few operational difficulties that are common to security industries. As argued by Scott Sagan in his work entitled "*The Limits of Safety*", complex organizations struggle to manage hazardous technological concerns thanks to the inevitable existence of conflicting interests, constraints of organizational learning, and the difficulty of not viewing private sector actors as the de facto measure of safety.²⁵⁹ Much as the Deepwater Horizon Program and the Space Shuttle program showed, many times when the government experiences a failure it leads to a complete disposal of entire programs, thusly hampering organizational learning. At the heart of the desire to engage the private sector is the perceived belief that the commercial industry is inherently better at lower costs and maximizing effectiveness in all areas, security included. As a result, names like Boeing, Lockheed Martin, and Northrop Grumman become synonymous with quality and security, despite repeated indications to the contrary. Recent history regarding the Boeing 737 Max aircraft serves as a timely reminder that no entity is error-proof, no matter how specialized they may be. In the context of the commercial space industry, security and public-

²⁵⁹ Scott D. Sagan, *Limits of Safety: Organizations, Accidents, and Nuclear Weapons* (Princeton University Press, 1993). P255-259

private relationships remain intrinsically connected, and the relationships found at its core are paradoxically ever-changing, historically consistent, and perfectly imperfect.

Bibliography

- 1994 Whitehouse Landsat Remote Sensing Strategy (1994).
<https://eros.usgs.gov/sites/all/files/external/eros/history/1990s/1994%20Whitehouse%20Landsat%20Remote%20Sensing%20Strategy.pdf.pdf>.
- “A Merger of Equals.” Lockheed Martin. Accessed April 24, 2019.
<https://www.lockheedmartin.com/en-us/news/features/history/merger.html>.
- “About « Landsat Science.” Accessed April 21, 2019. <https://landsat.gsfc.nasa.gov/about/>.
- “About ULA.” Accessed April 27, 2019. <https://www.ulalaunch.com/about>.
- Acar, Muhittin, Chao Guo, and Kaifeng Yang. “Accountability When Hierarchical Authority Is Absent: Views From Public–Private Partnership Practitioners.” *The American Review of Public Administration* 38, no. 1 (March 2008): 3–23.
<https://doi.org/10.1177/0275074007299481>.
- Akaka, Daniel K. “H.R.3942 - 98th Congress (1983-1984): Commercial Space Launch Act.” Webpage, October 30, 1984. <https://www.congress.gov/bill/98th-congress/house-bill/3942>.
- Augustine, Norman R. “Reshaping an Industry: Lockheed Martin’s Survival Story.” *Harvard Business Review*, May 1, 1997. <https://hbr.org/1997/05/reshaping-an-industry-lockheed-martins-survival-story>.
- “Boeing, Lockheed, ULA Corner the Government-Funded Space Market. SpaceX Moving Up.” SpaceNews.com, April 22, 2018. <https://spacenews.com/boeing-lockheed-ula-corner-the-government-funded-space-market-spacex-moving-up/>.
- Bora, Irfan. “EU Public Private Partnerships Not Economically Viable, Say Auditors.” Public Finance International, March 20, 2018.
<https://www.publicfinanceinternational.org/news/2018/03/eu-public-private-partnerships-not-economically-viable-say-auditors>.
- Bovaird, Tony. “Public–Private Partnerships: From Contested Concepts to Prevalent Practice.” *International Review of Administrative Sciences* 70, no. 2 (June 2004): 199–215.
<https://doi.org/10.1177/0020852304044250>.
- Boyle, Joe. “Selection of Contract Type for Launch Services,” n.d., 27.
- Brooks, Timothy A. “Regulating International Trade in Launch Services.” *Berkeley Technology Law Journal* 6, no. 1 (n.d.): 51.
- Brown, Trevor L., Matthew Potoski, and David M. Van Slyke. *Complex Contracting: Government Purchasing in the Wake of the US Coast Guard’s Deepwater Program*. Cambridge University Press, 2013.

- . “Trust and Contract Completeness in the Public Sector.” *Local Government Studies* 33, no. 4 (August 2007): 607–23. <https://doi.org/10.1080/03003930701417650>.
- “Decision on the Matter of Ball Aerospace & Technologies Corp.” Government Accountability Office, July 16, 2015. <https://www.gao.gov/assets/680/671700.pdf>.
- Deloitte Research Group. “Closing the Infrastructure Gap: The Role of Public-Private Partnerships,” 2006. https://www2.deloitte.com/content/dam/Deloitte/ie/Documents/Finance/Corporate%20Finance/2006_closing_infrastructure_gap_deloitte_ireland.pdf.
- “Department of Defense Cybersecurity Discipline Implementation Plan,” October 2015. <https://dodcio.defense.gov/portals/0/documents/cyber/cyberdis-impplan.pdf>.
- “EELV PHASE 1A NROL-79 Request For Proposal - 14-093 (Archived) - Federal Business Opportunities: Opportunities.” Accessed February 13, 2019. <https://www.fbo.gov/index?s=opportunity&mode=form&id=db6fc2f2c2149a12c65b9529655a33cd>.
- “EELV PHASE 1A NROL-79 Request For Proposal - Federal Business Opportunities: Opportunities.” Accessed May 1, 2019. <https://www.fbo.gov/index?id=c6d988e402a1305ce750937bd7582b3d>.
- “Ellensburg Daily Record - Google News Archive Search.” Accessed April 21, 2019. <https://news.google.com/newspapers?id=EjkQAAAAIIBAJ&sjid=G48DAAAAIIBAJ&dq=satellite%20congress%20landsat&pg=3918%2C6412636>.
- Ezell, Linda Neuman. “NASA Historical Data Book: Volume IV - NASA Resources 1969 - 1978,” 1985. <https://history.nasa.gov/SP-4012/vol4/ch5.htm>.
- . “Table 1-39: Chronology of Shuttle Solid Rocket Booster Development.” In *SP-4012 NASA Historical Data Book: Volume III Programs and Projects 1969 - 1978*, 1988. <https://history.nasa.gov/SP-4012/vol3/table1.39.htm>.
- . “Table 2.57: Chronology of Shuttle Orbiter Development and Operations.” In *SP-4012 NASA Historical Data Book: Volume III Programs and Projects 1969 - 1978*, 1988. <https://history.nasa.gov/SP-4012/vol3/table2.57.htm>.
- Fidler, David P. “Cybersecurity and the New Era of Space Activities.” Council on Foreign Relations, April 3, 2018. <https://www.cfr.org/report/cybersecurity-and-new-era-space-activities>.
- “First GPS III Satellite Successfully Launches.” *GPS World* (blog), December 27, 2018. <https://www.gpsworld.com/first-gps-iii-satellite-successfully-launches/>.
- Glass, Dan. “What Happens If GPS Fails?” *The Atlantic*, June 13, 2016. <https://www.theatlantic.com/technology/archive/2016/06/what-happens-if-gps-fails/486824/>.

- “Global Positioning System Next Generation Operational Control System Data Sheet,” 2016. https://www.raytheon.com/sites/default/files/capabilities/rtnwcm/groups/iis/documents/content/rtn_iis_gpsocx_datasheet.pdf.
- “GPS III Satellite Delivery Slips Because of Capacitor : GPS World.” Accessed February 14, 2019. <https://www.gpsworld.com/gps-iii-satellite-delivery-slips-because-of-capacitor/>.
- “GPS Satellites.” Lockheed Martin. Accessed June 3, 2019. <https://www.lockheedmartin.com/en-us/products/gps.html>.
- “GPS.Gov: GPS Modernization.” Accessed April 27, 2019. <https://www.gps.gov/systems/gps/modernization/>.
- “GPS.Gov: Space Segment.” Accessed April 27, 2019. <https://www.gps.gov/systems/gps/space/>.
- “GPS.Gov: Timing Applications.” Accessed April 27, 2019. <https://www.gps.gov/applications/timing/>.
- Grady, Monica. “Private Companies Are Launching a New Space Race – Here’s What to Expect.” *Global Policy*, August 8, 2018. <https://www.globalpolicyjournal.com/blog/08/08/2018/private-companies-are-launching-new-space-race-heres-what-expect>.
- Henry, Caleb. “Cyber Experts Say Threats to Satellites Are Legion - SpaceNews.Com,” November 7, 2017. <https://spacenews.com/cyber-experts-say-threats-to-satellites-are-legion/>.
- . “Space Startup Investments Continued to Rise in 2018.” *SpaceNews.com*, February 4, 2019. <https://spacenews.com/space-startup-investments-continued-to-rise-in-2018/>.
- Holeywell, Ryan. “Public-Private Partnerships Are Popular, But Are They Practical?” *Governing Magazine*, November 2013. <https://www.governing.com/topics/transportation-infrastructure/gov-public-private-popular.html>.
- Initiative, Joint Task Force Transformation. “Security and Privacy Controls for Federal Information Systems and Organizations.” National Institute of Standards and Technology, January 22, 2015. <https://doi.org/10.6028/NIST.SP.800-53r4>.
- “Investigation Regarding Assertions Made by Former United Launch Alliance Executive.” U.S. Department of Defense Inspector General, December 5, 2016. https://www.defensedaily.com/wp-content/uploads/post_attachment/150808.pdf.
- Ivanova, Iliana, Oskar Herics, Thomas Obermayr, Pietro Puricella, Enrico Grassi, Guido Fara, Di Hai, et al. “Public Private Partnerships in the EU: Widespread Shortcomings and Limited Benefits.” Audit Report. European Court of Auditors, 2018. https://www.eca.europa.eu/Lists/ECADocuments/SR18_09/SR_PPP_EN.pdf.

- Lai, Jennifer. "Model Contract FA8811-15-R-0001 For Launch Vehicle for GPS-III." Space & Missile Systems Center (SMC), September 30, 2015.
- Lal, Bhavya. "Reshaping Space Policies to Meet Global Trends." *Issues in Science and Technology* XXXII, no. 4 (Summer 2016): 13.
- Land Remote Sensing Policy Act of 1992, Pub. L. No. 105–555, 15 USC 5601. Accessed April 21, 2019. <https://www.govinfo.gov/content/pkg/STATUTE-106/pdf/STATUTE-106-Pg4163.pdf>.
- Land Remote-Sensing Commercialization Act of 1984, Pub. L. No. 98–365, 15 USC 4201. Accessed April 21, 2019. <https://www.govinfo.gov/content/pkg/STATUTE-98/pdf/STATUTE-98-Pg451.pdf>.
- "Landsat 7 Media Kit," May 8, 1999.
<https://web.archive.org/web/19990508193945/http://www.boeing.com/defense-space/space/delta/delta2/Landsat/index.html>.
- "Landsat Fact Sheet." Landsat Fact Sheet. United States Geological Survey, 2015.
https://www.usgs.gov/land-resources/nli/landsat/landsat-satellite-missions?qt-science_support_page_related_con=2#qt-science_support_page_related_con.
- "Landsat Looks and Sees." Text.Article, July 23, 2012.
<https://earthobservatory.nasa.gov/features/LandsatLooks/page2.php>.
- "Landsat Program Chronology," December 2, 2016.
<https://web.archive.org/web/20161202113747/https://geo.arc.nasa.gov/sge/landsat/lpchron.html>.
- "Landsat Science." Accessed April 21, 2019. <https://landsat.gsfc.nasa.gov/>.
- "Landsat-1 to 3 - EoPortal Directory - Satellite Missions." Accessed April 24, 2019.
<https://directory.eoportal.org/web/eoportal/satellite-missions/l/landsat-1-3>.
- "Landsat-6 - EoPortal Directory - Satellite Missions." Accessed April 24, 2019.
<https://directory.eoportal.org/web/eoportal/satellite-missions/l/landsat-6>.
- Mai, Thuy. "Global Positioning System History." Text. NASA, May 5, 2015.
http://www.nasa.gov/directorates/heo/scan/communications/policy/GPS_History.html.
- McIlroy, John. "Top Innovations That Changed Cars Forever." CNN Style, December 20, 2016.
<https://www.cnn.com/style/article/car-innovations/index.html>.
- NASA Content Administrator. "Remembering Space Shuttle Challenger." Text. NASA, March 9, 2015. http://www.nasa.gov/multimedia/imagegallery/image_gallery_2437.html.
- "NASA GSFC Solicitation: LANDSAT Data Continuity Mission." Accessed April 25, 2019.
<http://spaceref.com/news/viewstr.html?pid=19712>.

- “NASA Procurement: The 1973 Space Shuttle Solid Rocket Motor Contractor Selection.” Government Accountability Office, September 1987. <https://www.gao.gov/assets/210/209720.pdf>.
- “NASA Source Evaluation Board Manual,” August 1973. <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19740072598.pdf>.
- “NASA’S USE OF AWARD-FEE CONTRACTS.” NASA Office of the Inspector General, November 19, 2013. <https://oig.nasa.gov/docs/IG-14-003.pdf>.
- “National Space Policy of the United States of America,” June 28, 2010. https://history.nasa.gov/national_space_policy_6-28-10.pdf.
- Neufeld, Michael J. “The ‘Von Braun Paradigm’ and NASA’s Long-Term Planning for Human Spaceflight.” *Acta Astronautica* 63 (2008): 23.
- “Next Generation Operational Control System (GPS OCX),” 2014, 35.
- Nimmen, Jane Van, Leonard C. Bruno, and Robert L. Rosholt. “NASA Historical Data Book 1958-1968 Volume I - NASA Resources,” The NASA Historical Series, 1976, 532.
- “Part 52 - Solicitation Provisions and Contract Clauses | Acquisition.GOV.” Accessed May 2, 2019. https://www.acquisition.gov/content/part-52-solicitation-provisions-and-contract-clauses#i52_212_5.
- “Public-Private Partnership (P3) Basics | Associated General Contractors.” Accessed March 25, 2019. <https://www.agc.org/public-private-partnership-p3-basics>.
- “Raytheon: GPS Next Generation Operational Control System.” Accessed April 27, 2019. https://www.raytheon.com/capabilities/products/gps_ocx.
- Rocchio, Laura. “Landsat 6 Failure Attributed To Ruptured Manifold,” n.d., 1.
- Sagan, Scott D. *Limits of Safety: Organizations, Accidents, and Nuclear Weapons*. Princeton University Press, 1993.
- Savas, Emanuel C. *Privatization and Public-Private Partnerships*. Second. Chatham House, 2000. <http://offcampus.lib.washington.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=35251&site=ehost-live>.
- Shanklin, Emily. “EELV: The Right to Compete.” Text. SpaceX, April 29, 2014. <https://www.spacex.com/news/2014/04/29/eelv-right-compete>.
- Sims, Calvin. “Northrop Bests Martin Marietta to Buy Grumman.” *The New York Times*, April 5, 1994, sec. Business Day. <https://www.nytimes.com/1994/04/05/business/northrop-bests-martin-marietta-to-buy-grumman.html>.

Starr, Paul. "The Meaning of Privatization." *Yale Law and Policy Review* 6 (1988): 6–41.

U. S. Government Accountability Office. "Upheld the Negotiations Under 10 U.S.C. 2304(G) Leading to the Award of a Contract for the Space Shuttle Main Engine B-173677, MAR 31, 1972, 51 COMP GEN 621," no. B-173677 (March 31, 1972).
<https://www.gao.gov/products/462300>.

"[USC02] 51 USC Ch. 509: COMMERCIAL SPACE LAUNCH ACTIVITIES." Accessed April 14, 2019.
<http://uscode.house.gov/view.xhtml?path=/prelim@title51/subtitle5/chapter509&edition=prelim>.

Wall, Mike. "How the Space Shuttle Was Born." Space.com, June 28, 2011.
<https://www.space.com/12085-nasa-space-shuttle-history-born.html>.

———. "NASA's Shuttle Program Cost \$209 Billion — Was It Worth It?" Space.com, July 5, 2011. <https://www.space.com/12166-space-shuttle-program-cost-promises-209-billion.html>.

Wilford, John Noble. "U.S. Halts Plan to Turn Off the Landsat Satellites." *The New York Times*, March 17, 1989, sec. U.S. <https://www.nytimes.com/1989/03/17/us/us-halts-plan-to-turn-off-the-landsat-satellites.html>.