BRIDGING THE GAP BETWEEN SILICON VALLEY AND THE CAPITAL BELTWAY:

LESSONS LEARNED FROM THE U.S. GOVERNMENT'S VENTURE CAPITAL AND STARTUP ENGAGEMENTS IN INTELLIGENCE AND DEFENSE

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ABSTRACT

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Title: Bridging the Gap Between Silicon Valley and the Capital Beltway: *Lessons Learned from the U.S. Government's Venture Capital and Startup Engagements in Intelligence and Defense*

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For many years, in-house U.S. government researchers, academic partners, and military contractors led the creation of revolutionary technologies, ranging from spy planes to the Internet. The speed with which technological innovation occurs in the commercial sector, however, has outpaced the U.S. government's internal innovation capabilities in the past few decades. In order to safeguard national security, the United States is largely reliant on access to superior information and defense technology, and it cannot afford to fall behind in scientific advancements.

By 1999, Central Intelligence Agency leadership recognized that the Agency could not compete in innovation with the same speed and dexterity as others in the commercial marketplace. This led to the creation of In-Q-Tel, the Agency's own venture capital arm that invests in startup technology. Many of the technologies spurring on the information revolution and changing the landscape of business come from startups, and these technologies are also extremely relevant to the intelligence community. Other government agencies have since followed in the Central Intelligence Agency's footsteps.

As more federal departments develop venture-related vehicles to source technology from entrepreneurial businesses, it is important to analyze the lessons learned and best practices of such vehicles as this innovative acquisition strategy is still developing but will without a doubt continue to be utilized as the U.S. engages in the 21st century technological race. The first step in this analysis is to understand the traditional venture capital model and history of U.S. government technological innovation. Then, I will have an appropriate frame of reference to conduct further exploration on startup engagement activity and identify lessons learned by government strategic investment arms.

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INTRODUCTION

"In confronting today's daunting array of security threats, there's one thing we need above all else, and that's a Central Intelligence Agency that's constantly improving and adapting to the times. I'm proud to say that in this regard, we're operating at full throttle."

– Mike Pompeo, former Director of the Central Intelligence Agency (July 11, 2017)

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The United States has long been regarded as a leader in technological innovation for intelligence and defense purposes. During the Cold War, the U.S. government built the world's fastest plane, the Lockheed SR-71 "Blackbird," and developed the first imaging reconnaissance satellite, Corona.[1] For many years, America enjoyed its seat at the head of the table in developing cutting-edge technology to collect information that safeguards our nation. Beyond spy planes and stealth technology, government researchers also laid the foundation for a number of technologies that now permeate our daily lives. The Global Positioning System and the Internet had their roots in government research programs.[2]

The rate of growth in technological innovation, however, has now outpaced the federal government's in-house innovation capacity. U.S. national security is largely dependent on access to superior information and military technology, and the nation cannot afford to lag behind in technological advancements. To bridge this innovation gap, the federal government has looked beyond its four walls to the U.S. commercial sector.

One particular sector that the intelligence community (IC) has looked towards is the startup community. Known for their innovative products, lofty ambitions, and fast-growth,

[1] "CORONA: America's First Imaging Satellite Program — Central Intelligence Agency." n.d. Accessed March 19, 2018. https://www.cia.gov/about-cia/cia-museum/experience-the-collection/text-version/stories/corona-americas-first-imaging-satellite-program.html.

[2] Osama, Athar (Woodrow Wilson International Center for Scholars). 2008. "Washington Goes to Sand Hill Road: The Federal Government's Forays into the Venture Capital Industry." Foresight & Governance Project, no. 1. https://doi.org/10.1016/S1473-3099(14)70981-8.

startups appeared to be and have proven to be a valuable group to engage. Several agencies within the U.S. government have established venture-related arms to source technology from these entrepreneurial businesses to strategically align startup technologies and national security requirements. This innovative engagement strategy is still developing but will doubtless continue to burgeon as the U.S. competes in the 21st century technological race.

As a relatively recent and important development in the U.S. governmental sphere, it is important to closely scrutinize these venture capital models. What makes them effective? Can the models be replicated elsewhere in the government? What are the challenges such investment vehicles face? This thesis seeks to explore these questions and extract lessons and best practices from various U.S. government venture capital and venture-related initiatives.

The methodology for this study will begin with analysis of the traditional venture capital model and the historical development of technology by the IC before the establishment of U.S. government venture capital programs. It is important to understand how these entities came to be and how they fit into the government innovation ecosystem. Then, I will take a deep dive into various venture-related investment vehicles, using data gathered from a literature review and interviews with experts. Evaluating this data, I will identify trends and lessons learned in order to derive best practices. This thesis will aim to present findings to help interested parties better understand the implications of the U.S. government's use of venture capital and startup engagement methods to innovate in the intelligence and defense fields.

CHAPTER 1: WHAT IS VENTURE CAPITAL?

First, it is important to define "venture capital" (VC). VC is a form of financing that investors provide to small, early-stage startup companies that are rapidly growing and believed to have high growth potential.[3] VC is made available by firms to young companies in exchange for equity, or an ownership stake. A VC organization serves as a financial intermediary and is run by general partners (GPs). GPs gather investor capital and invest it in companies. When a venture fund makes an investment in a company, that company becomes part of the VC firm's portfolio. VC firms raise new funds about every three or four years from sources including institutional investors (pension funds, endowment funds, sovereign wealth funds, etc.), family offices, and high net worth individuals (with assets over $1M). These outside sources of capital are known as limited partners (LPs), who invest based on their expectations of the GPs' abilities to make investments that will deliver an attractive return for the LPs. GPs typically receive 2% of invested capital as fees for managing the fund and 20% of fund profits. Traditional VC firm fund sizes range from $100M to $500M.[4]

VC firms generally only invest in privately held companies, or those that are not listed on a public exchange, like the New York Stock Exchange or the Nasdaq Stock Market. For every investment made, VCs may have screened hundreds of companies, and only a few dozen may warrant further attention. Out of these few dozen, even fewer will receive preliminary offers for capital investment. After extensive due diligence performed by the VC firm and negotiations between the VC firm and the startup company, both parties may come to a formal agreement for an investment to be made.

[3] "The Stages in Venture Capital Investing." Accessed November 7, 2017. https://www.investopedia.com/exam-guide/cfa-level-1/alternative-investments/venture-capital-investing-stages.asp.
[4] "Six Myths About Venture Capitalists." Accessed October 2, 2017. https://hbr.org/2013/05/six-myths-about-venture-capitalists.

Once an investment is made, GPs in a VC setting also commonly become involved in the company's operations to improve the startup's chances for success. This involvement usually includes GPs taking at least one position on the boards of directors of their portfolio companies, which allows the VC firms to provide guidance and support at the highest level of the companies. Furthermore, many VC organizations have established significant networks of industry contacts and can draw from these contacts to help young companies attract talent and build other useful business relationships. Numerous VCs claim that these advisory activities are the greatest competitive advantage and value-add that they can provide to their portfolio companies.[5]

The VC investment process involves multiple rounds of funding, typically: Seed, Series A, Series B, and Series C.[6] Seed financing is given at the proof-of-concept stage, and then Series A funding occurs usually after the company has developed a viable business plan. While VC firms do invest in seed rounds, typical VC investment occurs after seed funding. Series A is generally a startup company's first round of institutional financing. Next, Series B funding focuses on expanding market presence for the business. In the Series C round, the company has predictable revenue, and financing involves scaling and perfecting the business. With each round, investors provide cash in exchange for equity in the business and make demands on firm managers between rounds. Investments for each round are not set in stone but typically range from $250K to $2M for seed funding, $2M to $15M for Series A, $7M to tens of millions for Series B, and anywhere from single-digit millions to hundreds of millions

[5] Metrick, Andrew, and Ayako Yasuda. Venture Capital and the Finance of Innovation. John Wiley & Sons, n.d.
[6] "Series A, B, C Funding: How It Works | Investopedia." Accessed November 7, 2017. https://www.investopedia.com/articles/personal-finance/102015/series-b-c-funding-what-it-all-means-and-how-it-works.asp.

for Series C.[7] The U.S. government has been active in all stages of VC investing with firms that offer promising technology.

Because VC firms serve as financial intermediaries, they are supposed to return money to their investors. Thus, the primary goal of a traditional VC is to maximize its financial return by exiting investments. Proceeds of the exit are funneled back into the firm and its investors. An exit may occur through an initial public offering (IPO) of the portfolio company, with an ensuing sale of the VC firm's equity stake in the public market. The IPO has historically been the most lucrative exit option. A typical IPO underwritten by a top investment bank will sell at least $50M of new shares and have a total equity value of at least $200M.[8] Other exit methods include a sale of the company to other investors or a sale of the company to another corporation.

VC firms aim to only make investments for which profitable exit paths can be identified. They look for small companies that have realistic potential for significant growth within five to seven years after the initial investment. This search for rapid growth often leads VC firms to the high-technology industry, where such growth is more conceivable. Given their early-stage status, VC investments are often touted to be at the cutting-edge of innovation. They are inherently risky but have high potential returns on investment. Some cases of very successful VC deals include investments made by VC firms in the messaging service, WhatsApp; social media platform, Facebook; and biotechnology company, Genentech.[9] The following diagram offers a summary of the traditional VC industry and its key stakeholders.

[7] Ibid.
[8] Metrick, Andrew, and Ayako Yasuda. Venture Capital and the Finance of Innovation. John Wiley & Sons, n.d.
[9] "From Alibaba to Zynga: 28 Of The Best VC Bets Of All Time And What We Can Learn From Them." Accessed March 22, 2018. https://www.cbinsights.com/research/best-venture-capital-investments/#Gen.

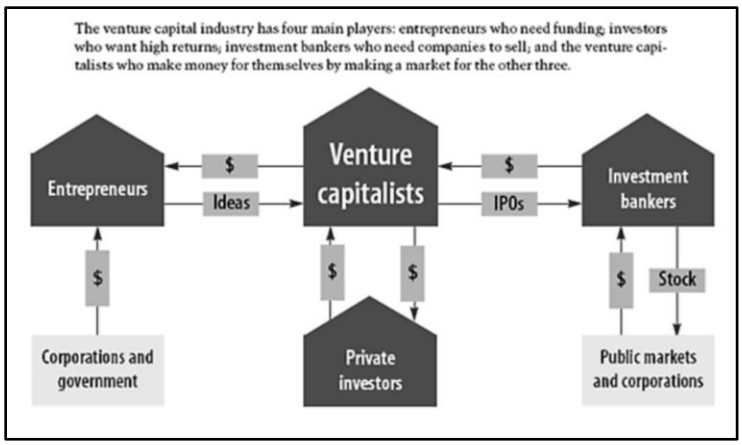

Figure 1. How the Venture Capital Industry Works[10]

In addition to the aforementioned traditional VC model, there also exists a corporate VC model known as strategic investing. VC funds differ slightly from corporations that employ VC strategies because VC funds seek private equity investments for the purpose of generating positive return for their investors who have contributed capital to the funds. Corporations that use VC also seek to maximize return on investment but more importantly seek to develop innovative technologies through their investments. Corporations that use VC include Xerox, Intel, and Microsoft.[11] Despite the significant research and development (R&D) capacities of these large companies, they still utilize VC to innovate more quickly and broadly. Corporate VC efforts often have strategic goals other than financial return. In this respect, the VC models that these large corporations with organic R&D capabilities use served as an exemplar for the U.S. government as it looked to develop VC capabilities.

[10] "How Venture Capital Works." Accessed April 1, 2018. https://hbr.org/1998/11/how-venture-capital-works.
[11] "The History Of CVC: From Exxon And DuPont To Xerox And Microsoft, How Corporates Began Chasing 'The Future' | CB Insights Research." Accessed November 7, 2017. https://www.cbinsights.com/research/report/corporate-venture-capital-history/.

CHAPTER 2: HISTORY OF U.S. GOVERNMENT TECHNOLOGICAL INNOVATION

The U.S. intelligence and defense communities have remarkable legacies of innovation. They pioneered technologies that are now ubiquitous in our daily lives. One area the U.S. has been especially successful in is technical intelligence gathering. Technical intelligence (TECHINT) refers to the "techniques that use advanced technology rather than human agents to collect information."[12] It includes techniques such as overhead imagery, signals interception, communications surveillance, telemetry, electronics, geospatial, and measurements and signatures intelligence.[13] Largely pioneered during the First and Second World Wars, TECHINT saw major growth during the Cold War.

The U.S. continuously developed new technologies throughout the Cold War to remain competitive with the Soviet Union. For example, high-altitude strategic reconnaissance aircraft such as the U-2 were developed and then subsequently outstripped by new, more advanced collection platforms. After the Soviet shoot-down of a U-2 aircraft on May 1, 1960, the U.S. launched the Corona satellites later that year and relied upon them through 1972 for photo-reconnaissance. The Corona satellites were designed by a group of Central Intelligence Agency (CIA), Air Force, and industry experts. The satellites were then produced and operated by the Directorate of Science & Technology (DS&T) within the CIA. The information collected by these satellites was instrumental in allowing the U.S. to sign strategic arms control agreements with the Soviet Union because the U.S. was able to reliably

[12] Shulsky, Abram N. Silent Warfare: Understanding the World of Intelligence. Washington: Brasseyś, 1991.
[13] Ibid.

monitor missile launch sites and production facilities.[14] Throughout most of the 20th century, the U.S. government was the world leader in TECHINT.

Figure 2. SR-71 Blackbird

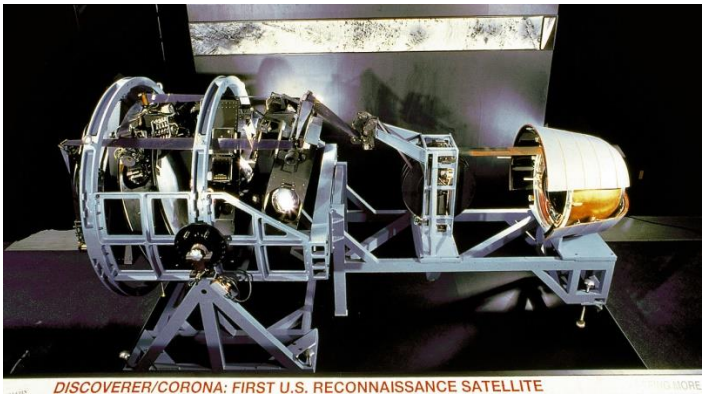

Figure 3. Corona Satellite

The U.S. government has also developed important military and defense technologies for non-intelligence purposes. The Advanced Research Projects Agency (ARPA) was created in 1958 by President Dwight D. Eisenhower in response to the Soviet Union's successful Sputnik satellite launch in October 1957.[15] This agency, now called the Defense Advanced Research Projects Agency (DARPA), focuses on research and development for military technologies, reporting directly to senior officials in the Department of Defense (DoD).

[14] Smith, W. Thomas. Encyclopedia of the Central Intelligence Agency. New York: Checkmark, 2003.
[15] "History and Timeline." Accessed November 17, 2017. https://www.darpa.mil/about-us/darpa-history-and-timeline.

DARPA works with an ecosystem of collaborators drawn from academic, corporate, and government backgrounds. In 1969, the organization developed ARPANET, an early network for sharing digital resources among computers.[16] These technologies paved the way for the development of today's Internet. More recently, in 2003, DARPA worked with SRI International, a research institute, to build an artificial intelligence virtual assistant to assist military commanders. This cognitive assistant would ultimately provide the inspiration and framework for the now pervasive Apple Siri.[17] Over the past few decades, DARPA technologies have not only revolutionized warfighting but also changed the fabric of commercial technology, pioneering innovations like the Internet, the Global Positioning System, and automated voice recognition systems.

In 2006, the Intelligence Advanced Research Projects Activity (IARPA) was created within the Office of the Director of National Intelligence (ODNI) and modeled after DARPA but focusing on national intelligence needs rather than military ones.[18] It has contributed to significant breakthroughs in quantum computing and data science research. The U.S. has undoubtedly demonstrated robust in-house innovation capabilities for both information collection and war-fighting functions.

The landscape for intelligence and national security-related technology has changed however, as technological innovation used to be primarily driven by military needs but is now linked to consumer demand and everyday living. While the government used to be a driver of commercial technology advancements, with the development of capabilities like satellites and the Internet, the roles have flipped, and the commercial sector is now out-innovating the

[16] Ibid.
[17] "SIRI RISING: The Inside Story Of Siri's Origins -- And Why She Could Overshadow The iPhone | HuffPost." Accessed September 8, 2017. https://www.huffingtonpost.com/2013/01/22/siri-do-engine-apple-iphone_n_2499165.html.
[18] "About IARPA." Accessed September 8, 2017. https://www.iarpa.gov/index.php/about-iarpa.

government. Technology is rapidly responding to dynamic consumer preferences. According to the Government Accountability Office, in 1987, 40% of U.S. R&D spending came from the DoD, and by 2013, this figure fell to less than 20%. Meanwhile, commercial R&D spending has increased by 200% between 1987 and 2013.[19]

Innovation is undoubtedly important to many sectors of the government, but the scope of this discussion is limited to initiatives by the U.S. IC, its constituent agencies, and its associated federal departments. The current IC comprises 17 organizations in total, which includes 16 agencies that are either independent or that reside in government departments and other service branches, along with the ODNI, whose role is to coordinate the activity of the whole community. The 16 agencies and their parent departments are listed below.

	Agency	Federal Department	Date Est.
1	Office of Naval Intelligence	Defense	1882
2	Coast Guard Intelligence	Homeland Security	1915
3	Bureau of Intelligence and Research	State	1945
4	Central Intelligence Agency	Independent	1947
5	Air Force Intelligence (Twenty-Fifth Air Force)	Defense	1948
6	National Security Agency/ Central Security Service	Defense	1952
7	Defense Intelligence Agency	Defense	1961
8	National Reconnaissance Office	Defense	1961
9	Army Intelligence and Security Command	Defense	1977
10	Department of Energy Office of Intelligence and Counterintelligence	Energy	1977
11	Marine Corps Intelligence Activity	Defense	1978
12	National Geospatial-Intelligence Agency	Defense	1996
13	Office of Terrorism and Financial Intelligence	Treasury	2004
14	Federal Bureau of Investigation Intelligence Branch	Justice	2005
15	Drug Enforcement Administration Office of National Security Intelligence	Justice	2006
16	Department of Homeland Security Office of Intelligence and Analysis	Homeland Security	2007

Figure 4. Intelligence Community Organizations[20]

While this thesis focuses primarily on engagement with early-stage companies through VC and strategic investments, it is important to understand the broader ecosystem of

[19] "DOD Is Taking Steps to Address Challenges Faced by Certain Companies," 2017. https://www.gao.gov/assets/690/686012.pdf.
[20] "IC Member Agencies | Intelligence Careers." Accessed October 9, 2017. https://www.intelligencecareers.gov/icmembers.html.

government innovation initiatives to understand the role of venture-related innovation. Private sector partnerships are not a novel concept for the government. Innovation in government can come from the following sources: (1) in-house R&D labs and directorates, (2) large government contractors and corporations, (3) federally funded R&D partnerships, (4) startups, and (5) other players. Under the group of "other players," we include small businesses and the general public.

U.S. Government Innovation Ecosystem					
Sources of Innovation	In-house U.S. Government R&D Labs/Programs	Large Contractors & Corporations	Federally Funded R&D Centers	Startups	Other
Examples	National Labs, Army Laboratories, CIA DS&T, DARPA*	Lockheed Martin, Northrop Grumman, HP	University and Research Institutions (e.g. Stanford Research Institute)	Palantir, Keyhole	Small Businesses, General Public
**DARPA brings together world-class experts from industry and academia to work on focused projects.*					

Figure 5. Summary of U.S. Government Innovation Ecosystem[21]

Now that we have established various sources of innovation, we can look at approaches the federal government has taken to engage external sources for innovation. Longstanding contracting methods include broad agency announcements (BAAs) and requests for proposal (RFPs) published in Federal Business Opportunities.[22] BAAs solicit proposals on broad subject matter related to scientific advancement, while RFPs are focused on the acquisition of specific products. These contracting opportunities are generally available to all

[21] "'Special Forces' Innovation: How DARPA Attacks Problems." Accessed March 15, 2018. https://hbr.org/2013/10/special-forces-innovation-how-darpa-attacks-problems.
[22] Cortes-Shrank, Susan. "BARDA Industry Day Washington, DC Broad Agency Announcements (BAA), Request for Proposals (RFP) and Their Differences," 2012. https://www.medicalcountermeasures.gov/media/10507/6_susan_cortes_shrank_broad_agency_announcements__baa___request_for_proposals__rfp_and_their_differences.pdf.

businesses, large and small, and many agencies employ these techniques to solicit innovation. The U.S. government also has contracting programs that engage small businesses specifically, including Small Business Innovation Research and Small Business Technology Transfer.[23] Responses to these solicitations don't necessarily have to demonstrate broad commercial viability. They simply need to respond to the described government need. These processes are often also rather time-consuming under historical Federal Acquisition Regulation, which imposes onerous statutory regulations and restrictions on entities working with the government under this contracting acquisition technique.[24]

Over the last two decades, the proliferation and growth in the capabilities of technology have been astounding. The U.S. government has been forced to move at a faster pace by developing an increased variety of external working relationships in order to stay ahead of its rivals. Relationships with early-stage companies through the VC arms within U.S. government agencies have become more prevalent. The focus of this thesis is the startups category as a source of innovation. As the government cognized the value of the rapid pace at which startups were developing technology and the need to find a faster, more streamlined way to engage these companies, venture capital models were born as the solution.

[23] Molzahn, Wendy. "The CIA's In-Q-Tel Model Its Applicability." Acquisition Review Quarterly — Winter, 2003. http://www.dtic.mil/dtic/tr/fulltext/u2/a423535.pdf.
[24] Ibid.

CHAPTER 3: THE U.S. GOVERNMENT AS A VENTURE CAPITALIST

With the recognition throughout the national security community that there was a need to accelerate innovation, several government bodies have made inroads into venture capital in the last 20 years with varying degrees of success. Within the IC, these inroads include In-Q-Tel by the CIA and OnPoint Technologies by the U.S. Army. Both of these organizations will be examined, with a focus on In-Q-Tel, as it is the more extensive and long-standing venture of the two.

Section 3.1: In-Q-Tel

i. Introduction

The CIA created its own venture capital arm, Peleus Inc., in February 1999 during the early days of the tech boom.[25] The name was later changed to In-Q-It, Inc. and then, finally to In-Q-Tel, Inc. (IQT). The firm's name makes a deliberate nod to James Bond's technology gadget supplier, "Q".[26] Through IQT, the CIA engages the technology sector by investing appropriated government funds in companies that aim to produce commercially viable technologies that could fulfill the IC's technological deficits.[27]

Joanne Isham, former Deputy Director of the DS&T at CIA, played a significant role in the creation of IQT.[28] She and others in the Agency recognized that changes were necessary for the CIA to match the rapid development of technologies in the 1990s as Silicon Valley was coming into its own. During this same time frame, in May 1998, the former

[25] Testa, Bridget Mintz. "How In-Q-Tel Helps CIA Scout For Innovative Technology – A Model For Other Agencies? « Breaking Government - Government News, Analysis and Commentary." Accessed November 1, 2017. https://breakinggov.com/2012/11/29/how-in-q-tel-helps-cia-scout-for-innovative-technology-a-model/.
[26] "In-Q-Tel: The CIA's Tax-Funded Player In Silicon Valley : All Tech Considered : NPR." Accessed March 19, 2018. https://www.npr.org/sections/alltechconsidered/2012/07/16/156839153/in-q-tel-the-cias-tax-funded-player-in-silicon-valley.
[27] Yannuzzi, Rick E. (Defense Intelligence, and Joint Military Intelligence College Foundation). Defense Intelligence Journal. Defense Intelligence College Foundation, 1992. https://www.cia.gov/library/publications/intelligence-history/in-q-tel.
[28] Ibid.

Director of Central Intelligence, George Tenet, launched his "Strategic Direction" initiative, which stated in part: "beginning with the critical field of IT, we will pursue this [new] approach through the creation of an external nonprofit enterprise designed to be electronically connected to leading research throughout the country. This new entity will speed insertion of mature technologies, support rapid development of mission-critical applications, and enhance our ability to attract the skills and expertise vital to our success."[29] The CIA recognized that traditional government contracting models would not allow the Agency to move quickly enough to identify and exploit innovation in information technology generated by the startup community in Silicon Valley. They responded with IQT.

IQT was formed as a nonprofit, non-stock corporation in Delaware. It has since qualified as an organization exempt from federal income taxation under section 501(c)(3) of the Internal Revenue Code.[30] The original mission specified in the corporate charter agreement was "to exploit and develop new and emerging information technologies and pursue R&D that produce innovative solutions to the most difficult problems facing the CIA and Intelligence Community."[31] In terms of organizational structure, IQT has a CEO who reports to a Board of Trustees that provides strategic oversight and direction. The board comprises individuals with backgrounds in technology, academia, defense, finance, and intelligence. The corporation has office locations in Washington, DC and Menlo Park, CA, employing a lean professional staff and external consultants.[32]

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[29] "Accelerating the Acquisition and Implementation of New Technologies for Intelligence: The Report of the Independent Panel on the Central Intelligence Agency In-Q-Tel Venture," 2001. https://www.bens.org/document.doc?id=31.
[30] Ibid.
[31] Ibid.
[32] Yannuzzi, Rick E. (Defense Intelligence, and Joint Military Intelligence College Foundation). Defense Intelligence Journal. Defense Intelligence College Foundation, 1992. https://www.cia.gov/library/publications/intelligence-history/in-q-tel.

There is also an In-Q-Tel Interface Center (QIC) that serves as a liaison between technology end users in the CIA and those who make IQT's primary investment decisions. The QIC consists of a small group of Agency employees. The CIA communicates unclassified problem sets to QIC within IQT, and IQT searches for technologies in the private sector that have potential to satisfy the Agency's needs.[33] Overall, IQT was designed to be agile, problem-driven, solutions-focused, and self-sustaining over time.

The IQT model involves a government agency working side-by-side with the VC community to identify promising startup technology. Its areas of interest include cybersecurity, biotechnology, novel materials, remote sensing, deep learning for data analytics, and more. IQT has promoted new relationships between the IC and technology firms that were not actively seeking government customers and has brought the IC closer to technology companies with practical technology solutions. IQT's technical validation of its portfolio companies' products, its established network of investors and technology users within the IC, and the capital provided to fund product development are highly prized by companies in its portfolio and often contribute to the companies' later commercial success.

In-Q-Tel frequently cooperates on and encourages innovation and integration of new products into U.S. government activities. In 2013, the firm created IQT Labs, an endeavor to further develop mission-critical technologies. There are currently four labs: Lab41, CosmiQ Works, B.Next, and Cyber Reboot.[34] These labs focus on big data analytics, space capabilities, life sciences, and cybersecurity respectively. While centering more on the R&D side and less on VC, these labs nonetheless provide scientific support to portfolio companies when IQT invests in these fields.

[33] Ibid.
[34] "IQT Labs." Accessed October 4, 2017. https://www.iqt.org/labs/.

Many of the technologies of IQT portfolio companies are applicable across a broad range of uses. Technology delivered by IQT has included geospatial web services used to deploy solutions for web mapping, transportation, and telecommunications as well as global climate intelligence and analytics technologies. IQT has also provided semiconductor wafers that improve performance, cost, and availability of cadmium zinc telluride radiation detectors, which have many defense and security applications such as bomb detection, nuclear isotope identification, and airport baggage screening.[35] While tailoring technologies to government needs, IQT also aims to enhance the commercial viability of its portfolio companies.

ii. Investment Strategy

In order to succeed, the CIA had to offer Silicon Valley a business model that the Valley understood, a model that provided those who joined hands with In-Q-Tel the opportunity to commercialize their innovations. This encapsulates the venture capital model.[36] In-Q-Tel invites startups to submit applications for funding through its website, asking for their business pitch, a technology whitepaper, and management overview. IQT issues a press release every time it funds a new company but otherwise remains highly secretive regarding the amount of the investment and specific type of product it is focused on. It is believed that the partnership can lead to the advancement of off-market products tailored specifically for the CIA.[37] Companies are incentivized to work with the U.S. government because the government is a huge market and a well-paying, steady customer. Now, IQT has expanded to serve other IC agencies beyond the CIA. IQT currently has partnerships with eight federal organizations: the CIA, National Security Agency (NSA), Federal Bureau of Investigation

[35] "Portfolio." Accessed September 9, 2017. https://www.iqt.org/portfolio/.
[36] "In-Q-Tel, The CIA's VC Arm, Has Had A Busy Few Years - Mattermark." Accessed September 9, 2017. https://mattermark.com/q-tel-cias-vc-arm-busy-years/.
[37] Ibid.

(FBI), National Reconnaissance Office (NRO), National Geospatial-Intelligence Agency, Defense Intelligence Agency, Department of Homeland Security, and Office of the Secretary of Defense/Joint Chiefs of Staff.[38]

To date, IQT has invested in over 300 startups and developed a network including relationships with over 200 VC firms and 100 labs and research groups. Through this network, IQT has been able to leverage over $10.4B in private-sector funds to support technology innovation for the IC. Commenting on the utility of IQT, former Director of the CIA, John Brennan, remarked that IQT "stimulates real creativity… there are a lot of things that come to In-Q-Tel that are just really unique approaches to issues."[39]

There are however, key differences between In-Q-Tel and other VC firms. These include the fact that IQT uses public money, rather than money from private investors. Because taxpayer dollars are on the line, strict conflict-of-interest rules apply. Furthermore, by virtue of being government-affiliated, In-Q-Tel investments often attract other funding. Each dollar In-Q-Tel invests in a small business typically is matched by $11 to $15 from other firms and venture capitalists. Thus, government support and endorsement makes these small businesses likelier to succeed.

Operationally, IQT manages a fund of approximately $150M every five years. It makes twelve to fifteen investments per year, and it will typically invest between $500K and $3M per investment. Of the investment amount, 15% to 20% is allocated to an equity stake in the company, typically in the form of warrants, and the remainder covers licensing

[38] "National Security." Accessed October 2, 2017. https://www.iqt.org/sectors/national-security/.
[39] John Brennan in discussion with the author, February 2018.

agreements and agency-specific contracts to develop the technology.[40] Equity warrants give the owner the right to purchase a company's stock at a specific price and date, and the stock is issued directly by the company. Congressional requirements limit IQT's ability to buy shares upfront, calling for IQT to primarily receive warrants, which can be converted into equity in the future. IQT's annual investment budget is set at the discretion of the federal government, with a budget of at least $120M today.[41] Detailed figures are not released to the public, but according to tax filings, IQT received government grants of about $91M in 2015 and $128M in 2016. Executives managed net assets of $254M and $327M in 2015 and 2016 respectively. Profit was reported as $38M in 2015 and $31M in 2016.[42]

The IQT Investment Process includes the following steps:

1. Conduct strategic needs assessment. IQT engages in conversation with its IC partners to better understand needs and technology gaps;
2. Survey the commercial market for relevant innovative technologies;
3. Perform due diligence before making an investment;
4. Develop a work program to adapt the company's technology to address specific customer requirements;
5. Deploy capital into the work program that is largely non-dilutive;
6. Evaluate deliverables and transfer the solution to the IC partner agencies.

In terms of similarities to traditional VC firms, IQT also generally serves as an advisor and monitors developments of a given portfolio company. Exit strategies for In-Q-Tel

[40] Reinert, John T. "In-Q-Tel: The Central Intelligence Agency as Venture Capitalist." Northwestern Journal of International Law & Business J. Int'l L. & Bus 33, no. 677 (2013). http://scholarlycommons.law.northwestern.edu/njilb/vol33/iss3/4.
[41] "In-Q-Tel, The CIA's VC Arm, Has Had A Busy Few Years - Mattermark." Accessed September 9, 2017. https://mattermark.com/q-tel-cias-vc-arm-busy-years/.
[42] "Return of Organization Exempt From Income." Accessed October 1, 2017. https://www.guidestar.org/FinDocuments/2017/522/149/2017-522149962-0ee034af-9.pdf.

portfolio companies are no different than those available to any other VC funded firm. If a company goes public, gets acquired, or can operate independently as a viable business, that exit would be considered a factor of success for IQT. Successful exits encourage other venture funds as well as entrepreneurs to continue to work with In-Q-Tel. Furthermore, if technologies that In-Q-Tel invested in become commercial successes, then the U.S. government can buy those technologies off the shelf, which reduces costs, time, and risk in customized applications. Proceeds from exits are used by In-Q-Tel for reinvestment and to support other R&D projects that could benefit the IC.

As a nonprofit though, IQT is focused less on generating the maximum return and more on giving its sponsors, such as the CIA, access to cutting-edge technology from the private sector. When the venture was in its infancy, Rick Yannuzzi, former Director of Business Operations for IQT, commented that "acceptance by Agency components of In-Q-Tel inspired solutions [would] be the most important measure of success" for the firm. Harnessing technology for government use was and remains the primary objective. In these respects, In-Q-Tel is a hybrid organization structured similarly to corporate strategic investment groups, because its model is optimized for access to technology that solves agency problems, rather than focusing on maximized returns.

The flow of funds in IQT to employees does not follow that of the traditional VC model, since IQT is nonprofit. Employees are civil servants who receive a base salary and can receive an annual cash bonus depending on factors that include the uptake of prototype solutions by agency users.[43] Profits are not shared from successful investments to the same degree as seen in traditional VC. The incentive is for IQT staff to shift focus away from

[43] Webb, Tim, Christopher Guo, Jennifer Lamping Lewis, and Daniel Egel. "Venture Capital and Strategic Investment for Developing Government Mission Capabilities." Accessed November 17, 2017. https://www.rand.org/content/dam/rand/pubs/research_reports/RR100/RR176/RAND_RR176.pdf.

financial returns and towards the actual adaptation and solution transfer to end users. This highlights the importance of both the identification of technology and initial investment as well as the prototype work programs that IQT runs. It is important to remember that while IQT is structured as a VC investment operation, it does have more elements of a strategic investor rather than a pure VC, because financial returns are not the sole or primary objective of investments. The diagram below illustrates IQT's operations.

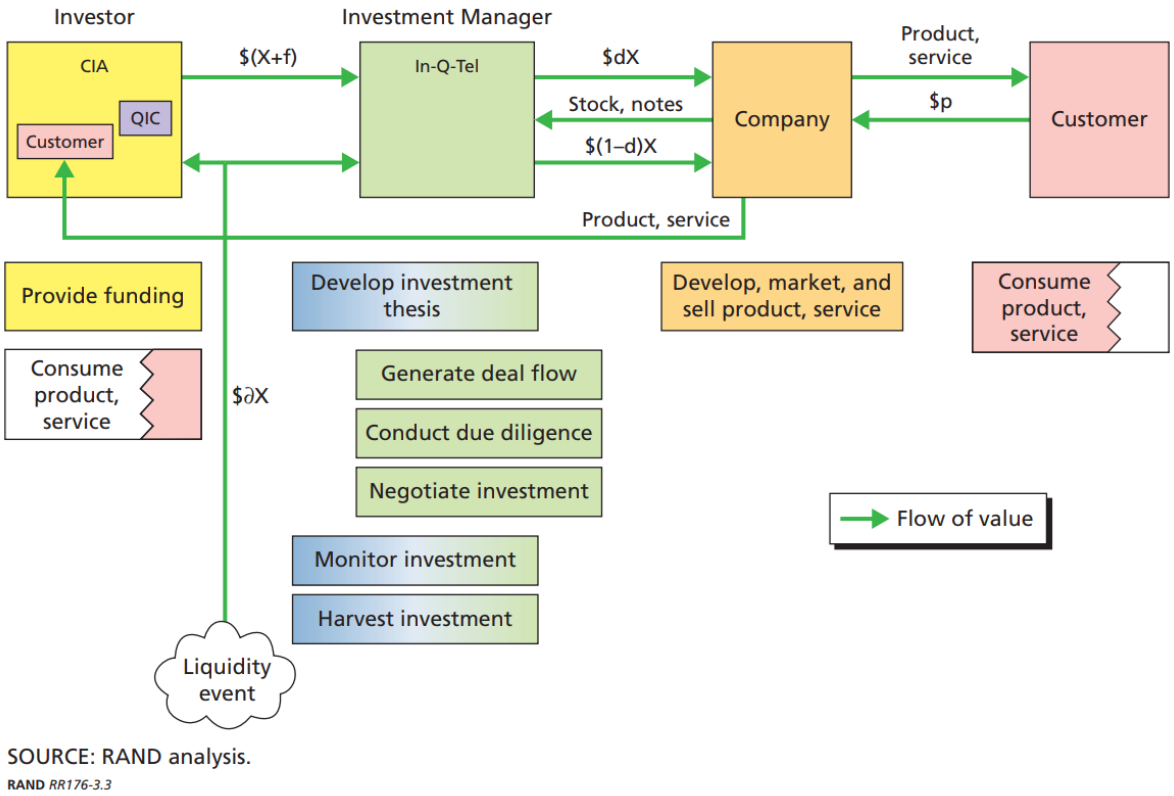


Figure 6. Function and Flows of Value for In-Q-Tel

Section 3.2: OnPoint Technologies

i. Introduction

OnPoint Technologies Inc. (OPT) was chartered by Congress in 2002 to serve as a strategic investing arm of the U.S. Army. It has since expanded to serve other components

across the DoD as well, including the U.S. Navy, U.S. Marine Corps, and U.S. Air Force.[44] As part of a proposal called the Army Venture Capital Initiative, OPT was created following a one-time, $25M allocation in the 2002 Defense Appropriations Bill.[45] OPT supports venture-funded companies that are developing cutting-edge technologies to accelerate development of products for the warfighter. Similar to IQT, OPT was established as a 501(c)(3) nonprofit corporation. It looks for technologies that are commercially viable but also have potential military applications. On average, for each dollar provided by OPT, $22 venture dollars are invested.[46] OPT has invested alongside firms such as Goldman Sachs and VC firm, Fairhaven Capital.[47]

The OPT model, however, differs from that of IQT because OPT outsourced fund management to a for-profit company, MILCOM Technologies, known today as Arsenal Venture Partners (AVP), operating out of Maitland, Florida. Thus, OPT is a nonprofit, managed under contract by a for-profit company that utilizes more traditional RFP processes.[48] Because of its smaller size and a lack of commitment for future funding at the time of its inception, OPT would have experienced difficulties in attracting talent given the lack of strong financial incentives under these circumstances. Outsourcing fund management allowed OPT to have stronger staff at its helm, with incentives more in line with those of a traditional VC fund.

ii. Investment Strategy

OPT breaks down its process flow as follows:

[44] "Army Venture Capital Initiative." Accessed December 5, 2017. http://armyvci.org/.
[45] "U.S. Army Backs Venture Fund To Develop Military Technology - WSJ." Accessed December 5, 2017. https://www.wsj.com/articles/SB105242681933783000.
[46] "Army Venture Capital Initiative." Accessed December 5, 2017. http://armyvci.org/.
[47] Ibid.
[48] Webb, Tim, Christopher Guo, Jennifer Lamping Lewis, and Daniel Egel. "Venture Capital and Strategic Investment for Developing Government Mission Capabilities." Accessed November 17, 2017. https://www.rand.org/content/dam/rand/pubs/research_reports/RR100/RR176/RAND_RR176.pdf.

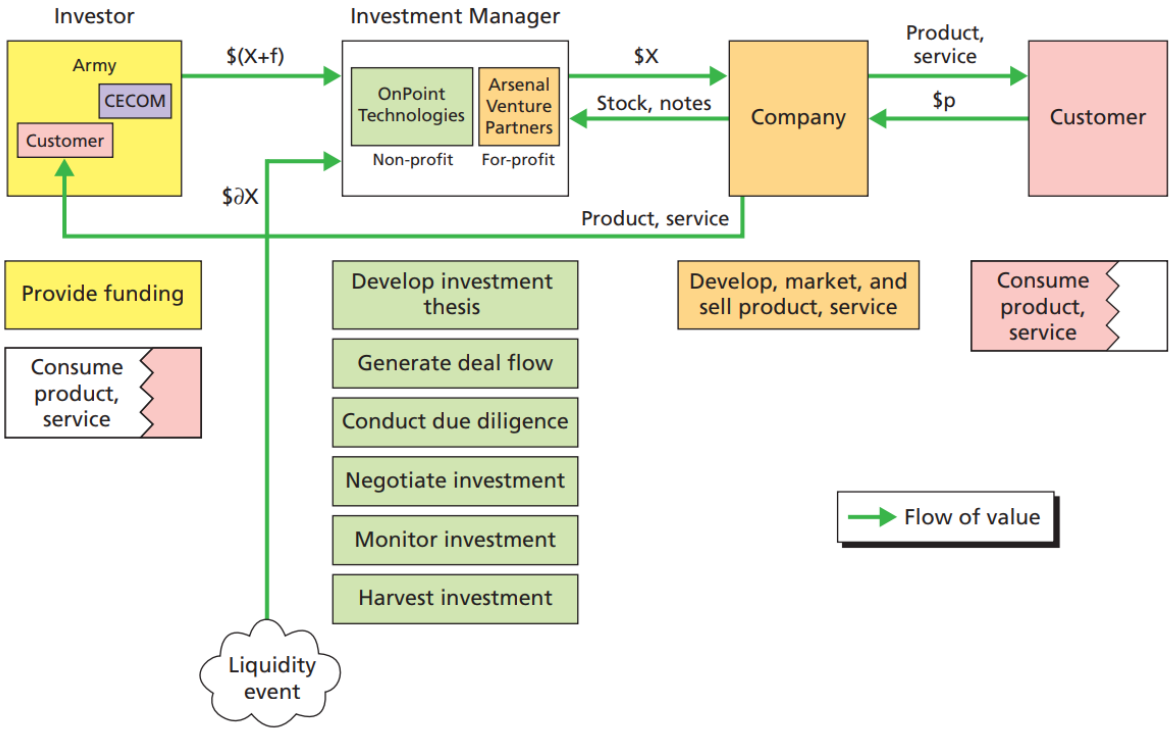
1. Opportunity Identification;
2. Opportunity Validation;
3. Opportunity Execution.

Opportunity identification involves interfacing with the OPT end users, the U.S. Army and DoD. OPT works with the DoD Office of the Deputy Assistant Secretary of the Army for Acquisition, Logistics, and Technology as well as the Office of the Deputy Assistant Secretary of the Army for Research and Technology to assess needs. Next, validation is the process of due diligence that the fund conducts. Execution involves continued evaluation of the product for commercial and technical viability. All investments require the approval of OPT's Board of Trustees. The usual investment size ranges from $500K to $2M.[49] The areas of focus were initially mobile power and energy, but over the years, the fund has expanded to also seek out technologies in the autonomy, cyber, health, and advanced materials spaces.

The U.S. Army (and broader DoD) is the end customer, and OPT also established an interface center, the Communications Electronics Command (CECOM), to serve as the liaison between the Army and OPT. Thus, it is evident that there are many similarities between OPT and IQT—the primary difference is that OPT serves the warfighter, and IQT supports the intelligence collector. Another differentiating factor is that the Army provides investment funding but doesn't have the financing to pay for prototype developments for potential Army users, while IQT does have a work program for developing prototype solutions. To date, OPT has worked with twelve companies in different stages of funding, including Nanosolar, a company that briefly commercialized a printable solar cell manufacturing process,

[49] Ibid.

CounterTack, a cybersecurity solutions company, and Atraverda, a company that manufactures battery systems.[50] The following diagram illustrates OPT's operations.



SOURCE: RAND analysis.
NOTE: In this figure, the split shading associated with the customer box highlights that consumption of portfolio company products and services are shared between Army customers and commercial customers.
RAND *RR176-3.2*

Figure 7. Function and Flows of Value for OnPoint Technologies

[50] "Funding Rounds | Crunchbase." Accessed April 1, 2018. https://www.crunchbase.com/search/funding_rounds/field/organizations/num_investments/onpoint.

CHAPTER 4: BEYOND VENTURE CAPITAL

The government VC model inspired a number of imitators and impressionists from other agencies. Therefore, it is also important to examine other venture-related arms pursued by the U.S. government, including the DoD's Defense Innovation Unit Experimental, the National Geospatial-Intelligence Agency's Outpost Valley, and the Department of Homeland Security's Silicon Valley Innovation Program. Government agencies are increasingly recognizing the importance of public-private partnerships with enterprises that offer mission-critical technologies. While not all of these programs strictly follow the VC investment model, they have elements of VC strategy that make them worthy of examination.

Section 4.1: The Defense Innovation Unit Experimental

The DoD founded the Defense Innovation Unit Experimental (DIUx) just three years ago in 2015. While there is a degree of overlap between DIUx and IQT, DIUx is less like a VC firm and more like a grant program. It doesn't take equity stakes in companies. Rather, it simply provides non-dilutive cash flow to the companies it chooses to invest in. Still, it is focused on investing in developing technologies that could prove useful to the national security community. DIUx has six primary verticals in terms of the types of technology that it seeks: cybersecurity and network security, artificial intelligence, big data analytics, autonomy, new space, and health. Examples of companies that DIUx has invested in include Shield AI, which produces autonomous drones that have applications for surveillance, search endeavors, and warfare; Tanium, an endpoint security and systems management company; and Sonitus Technologies, whose flagship product is a novel hearing aid and radio that can be hidden in the mouth. If DIUx surveys that there is a technology in the private sector that is better than what the U.S. government has in R&D, it will contract with the relevant firms. It will try to

get the company to work with operators or end users as closely as possible so that ultimately, both parties can benefit, and maximum efficiency and innovation can be achieved. It aims to help the government move quickly and build relationships with elements of the market economy for the purpose of gaining access to important technologies.

Like IQT's portfolio companies, those of DIUx are incentivized to enter into contracts for grants with DIUx because the government is a huge customer and pays well. DIUx has also worked to streamline the traditional bureaucratic process for government approval to move at a pace closer to commercial speed in order to further incentivize companies to enter into agreements with it. Operationally, DIUx's process involves posting online that it is interested in a certain capability. Commercial companies can then submit pitch decks for a down select process based on the strength of the solution and alignment with the original solicitation. Similarly to IQT, DIUx is funded by taxpayers through congressional appropriations, so it is important that it is narrowly focused on the DoD mission. DIUx has a set agenda of strategic national security objectives they hope to meet, and it avoids speculation on both its end and the startup end at all costs. DIUx does this by not trying to tailor the companies they invest in to suit their needs exactly. Instead, it looks at what technology already exists and examines how it could be leveraged for the DoD's desired military capabilities. Even if a specific product is tailored to DoD needs, DIUx wants to maintain the integrity and potential for commercial success of the companies it works with by not limiting the company as a whole.

Section 4.2: The National Geospatial-Intelligence Agency Outpost Valley

In recent years, the National Geospatial-Intelligence Agency (NGA) has consistently been the second or third largest investor in IQT. It has utilized products from startup

companies including Orbital Insight and Boundless that provide satellite imagery technology. Still, Robert Cardillo, Director of the NGA, has indicated that there have been occasions in which there is too large a gap between the technologies that IQT is procuring and current missions of IC agencies.[51] Doug Wise, former Deputy Director of the Defense Intelligence Agency (DIA), has expressed a similar sentiment regarding his interactions with IQT during his tenure in the CIA.[52] There is a fundamental disconnect between strategic innovation and its application in operations. Mr. Wise expresses that ventures like IQT may source technologies that could "be really useful in about ten years, but [users] need something in ten days."[53] It is possible that IQT is more long-term thinking, thus spurring the development of other venture-related arms across U.S. intelligence agencies. In addition to its close partnership with IQT, the NGA recently set up its own office in Silicon Valley, NGA Outpost Valley (NOV), in 2017, which employs "tech scouts" who scour for technology that has applications to the organization.

Dr. Benjamin Tuttle, a geographer and the director of the NOV describes it as a vehicle that picks up where IQT leaves off. IQT is typically interested in Series A and Series B funding rounds, and there comes a certain point at which it isn't going to invest in a particular company.[54] NOV seeks to catch those companies that fall into the gap between startups and large contractors. It is important to clarify that the NOV does engage startups and established contractors, but it also engages almost everything in between. It is looking to gain access to the best capabilities, regardless of the source. This is not limited to companies, but also talent and human capital as well as universities. In fact, NOV also supports three new

[51] Robert Cardillo in discussion with the author, February 2018.
[52] Douglas Wise in discussion with the author, September 2017.
[53] Ibid.
[54] Benjamin Tuttle in discussion with the author, April 2018.

recruitment initiatives that reflect NGA's efforts to increase hiring of professionals with science and technology backgrounds. The three initiatives aim to address the NGA's human capital gaps in data science, software development, and broader technical projects.[55] Thus, NOV operates a broader operation than entities like IQT that are specially focused on startup investing.

Section 4.3: The Department of Homeland Security Silicon Valley Innovation Program

The Department of Homeland Security (DHS) Science and Technology Directorate launched its Silicon Valley Innovation Program (SVIP) in 2015 to find new technologies in innovative communities that have an application to national security. The program provides three to four tranches of funding that range from $50K to $200K.[56] Participation in SVIP does not guarantee government procurement contracts. Eligibility for funding awards include stipulations that applicants must have less than 200 employees and not have been a party to any Federal Acquisition Regulation based contracts or grants totaling more than $1M in the last twelve months. These eligibility requirements demonstrate a clear focus on DHS building new relationships with startup companies. Funding can be provided for up to four phases that last for three to sixth months each. The four phases in the SVIP investment cycle include:

1. Demo proof of concept;
2. Demo pilot-ready prototype;
3. Pilot-test prototype in operations;
4. Testing in various operational scenarios.[57]

[55] "NGA Seeks to Attract Tech Talent Via New Silicon Valley Office." Accessed December 2, 2017. http://www.executivegov.com/2017/12/nga-seeks-to-attract-tech-talent-via-new-silicon-valley-office/.
[56] "SVIP | Homeland Security." Accessed January 4, 2018. https://www.dhs.gov/science-and-technology/svip.
[57] "Silicon Valley Innovation Program." Accessed March 9, 2018. http://go.affoa.org/wp-content/uploads/2017/10/SVIP-Overview-Current-Topics-September-20171-1.pdf.

Thus far, SVIP has sought to provide equity-free funding to startups across the entire spectrum of homeland security. They are interested in areas including Internet of Things security, K9 wearables, fintech cybersecurity, big data, drones, identity, and first responder emergency preparedness innovation.[58] SVIP has experienced success under its small unmanned aerial systems program. This program looks for technologies that can aid Customs and Border Protection, such as new sensors, user interfaces, and cybersecurity. Three companies that have been working with DHS SVIP have already collected data on the southwest border with the U.S. Border Patrol team in San Diego.[59] To date, SVIP has received over 200 applications, heard 40 pitches, and funded 22 companies.[60] On April 30, 2018, SVIP announced its first phase 4 award to Ionic Security, a company that is developing a secure, data transfer plug-in for video surveillance systems. Ionic Security is the first company to successfully complete prototype testing and move to the pilot deployment phase with SVIP.[61]

[58] "DHS Silicon Valley Innovation Program First Responders Group | Industry Day | WTIA." Accessed March 9, 2018. https://www.washingtontechnology.org/events/dhs-silicon-valley-innovation-program-first-responders-group-industry-day/.
[59] "Silicon Valley Innovation Program Companies: Enhancing Technology for CBP Agents and Officers | U.S. Customs and Border Protection." Accessed March 9, 2018. https://www.cbp.gov/newsroom/blogs/silicon-valley-innovation-program-companies-enhancing-technology-cbp-agents-and.
[60] "Startups Rave about DHS's Silicon Valley Innovation Program." Accessed April 2, 2018. https://www.fedscoop.com/startups-rave-dhs-silicon-valley-innovation-program/.
[61] "News Release: DHS S&T AWARDS FIRST PHASE 4 AWARD FOR IOT SECURITY | Homeland Security." Accessed May 1, 2018. https://www.dhs.gov/science-and-technology/news/2018/04/30/news-release-dhs-st-awards-first-phase-4-award-iot-security.

CHAPTER 5: MEASURING SUCCESS

Next, this thesis will analyze the aforementioned startup engagement vehicles to derive insights on lessons learned that can translate to best practices for U.S. government agencies as they look to promote innovation. The lessons learned and best practices should be related to furthering success. Therefore, before identifying these lessons, criteria for success must be established. Success equates with satisfying stakeholders. The stakeholders active in this discussion include the venture arms themselves, the end users they serve, and the private companies they engage. The federal government can also be considered a stakeholder, as each venture in the network of venture initiatives is a reflection of the government to the outside community.

Lisbeth Poulos, Chief of Staff of IQT since 2002, asserted in an interview that IQT has two defining factors for a successful investment: technology that is (1) mission-oriented and (2) commercially viable. As a not for profit entity, IQT sees financial return as an added bonus beyond those two criteria. This sentiment appears to apply across all venture related vehicles that were researched. The success factors are all related to anticipating the viewpoints and needs of these strategic investors' major stakeholders: end users and companies engaged. Venture arms want the technologies they are acquiring to be mission-oriented for customers and commercially viable for the portfolio companies. Satisfying both ends is a priority. Thus, it is prudent to focus on lessons learned by venture vehicles in relation to their stakeholders—customers, companies, the broader U.S. government, and the venture vehicles themselves. While a venture vehicle itself cannot be strictly isolated from its relationships with other stakeholders, lessons learned for the vehicles themselves will be limited to internal operational aspects of the ventures.

Under each of the four key stakeholders, analysis will be presented as pertaining to key areas for which lessons learned can be grouped. For each key area, I will discuss activities that government venture arms have executed well and thus should continue to implement moving forward. I will also identify areas in which the status quo could be altered. Supporting evidence will be presented in the form of historical research, case studies, and expert opinions. After analyzing and aggregating the lessons learned, I will derive and present best practices that can be employed by government venture arms.

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CHAPTER 6: LESSONS LEARNED

Section 6.1: In Relation to the User

In order to procure mission-oriented technologies, venture-related initiatives must have a good understanding of the needs of one of their most important stakeholders: the end user. In this section, I will present best practices for satisfying the end user.

1. Interface Centers

Crucial to the success of venture initiatives is comprehension of the needs of their end users. Christy Abizaid, the former head of DIUx's Austin, TX branch, offered an interesting perspective as a former consumer of intelligence who transitioned to working on sourcing products that can contribute to advancing U.S. intelligence collection and military strategy. She observed that the difficulties for DIUx often lie in engaging the DoD to figure out what they actually need.[62] The technology companies are, in her view, the easier of the two parties to engage. Since DIUx is still extremely young, moving forward, it aims to develop more open and organized communication between dispersed elements of the DoD and its venture arm. Engaging the customer is a significant challenge, and to address this challenge, creating an interface center is a potential solution.

IQT first established this with the QIC, and Buzzy Krongard, former Executive Director of the CIA, noted that the QIC is one of the most successful and important components of IQT.[63] The QIC's role is two-fold. On one hand, it engages agency employees to identify what users want and need. It then communicates this information to investment managers so that responsive investments can be made.

[62] Christy Abizaid in discussion with the author, April 2017.
[63] Buzzy Krongard in discussion with the author, March 2018.

On the other hand, the interface center participates in the act of technology discovery. It tries to anticipate technologies that would be helpful to IQT and preemptively provide it. Such technology discovery occurs by QIC employees being active in the startup community and attending events such as technology tradeshows. The QIC then evaluates whether such technology could potentially be helpful to the agencies IQT serves. The QIC is also divided into different groups based on the agency it is serving. For example, NGA's QIC serves the NGA and focuses exclusively on geospatial intelligence solutions. OPT also has a successful interface center, CECOM. It serves a similar purpose to the QIC, but for the U.S. Army. Having a dedicated team that develops the expertise to focus on potential customer needs has proven to be critical to success.

2. Interaction with Users

Customer interaction can be augmented by spending more time with the customer to continue to help with solution transfer of technology into federal agencies. For venture initiatives to be successful, they need buy-in from users. Venture arms need buy-in from senior leadership of the agencies as well as more junior officers in the agencies, as younger folks are more likely to adopt novel technologies. Director Cardillo of the NGA explained that these ventures were "not replacing the analyst but uplifting [him]."[64] Fostering more customer engagement was also emphasized by Lisbeth Poulos, who indicated that there is room for improvement in developing more of a synchronized cadence with the users. This could come in the form of providing technology briefs or whitepapers to keep users updated on the latest technologies or checking in more often to keep the venture arms involved in understanding the user experience and needs.[65]

[64] Robert Cardillo in discussion with the author, February 2018.
[65] Lisbeth Poulos in discussion with the author, February 2018.

Benjamin Tuttle said that many times, the technologies that IQT or NOV bring to the agencies they serve involve a broad systems-wide integration or update rather than a particular product for specific mission use. Thus, it may be harder for users to assess the direct value of the new technology or recognize the venture investment as the catalyst for change.[66] It is sometimes hard for customers to see utility in acquired technologies. Thus, increased interaction between organizations like IQT and the agencies they service would create a more symbiotic relationship, as the venture arm would gain support and concurrently a better understanding of its customers. Solution transfer is usually the most difficult part of the process for these venture arms, so it is critical to find ways to streamline it.

3. Addressing User Challenges vs. Requirements

U.S. government strategic investment vehicles should aim to address user challenges. This does not mean that requirements as detailed by agencies should not be addressed, but rather that venture vehicles should have a more forward-looking perspective. Strategic investments should be made not only for specific detailed requirements but also to anticipate the challenges that end users might face in the future. In this context, U.S. government venture arms can learn from DARPA, whose projects are considered high-risk, "radical innovations" that produce high returns. DARPA goes beyond today's military and national security requirements to envision technologies for the future.

It is easier to check off requirements, which is why more venture arms should look to develop their abilities to anticipate future needs. Congress typically appropriates funds for the ventures under consideration on an annual basis, which makes it harder for both ventures and the government employees they serve to avoid being driven by a near-term event horizon.[67]

[66] Benjamin Tuttle in discussion with the author, April 2018.
[67] Doug Wise in discussion with the author, September 2017.

While government end users may be satisfied with the technology coming in from strategic investments that meets their immediate requirements, it is ultimately more impactful for the users as well as our national security to be more forward-thinking, whether or not the users recognize that.

However, it is also important to recall that there often exists a disconnect between forward-looking ventures and their near-term oriented end users, as explained previously with the sentiment provided by Doug Wise. Venture arms like IQT that have developed a more forward-looking attitude have received criticism for being "too long-term." This is because the government user is still anchored in the near-term view while a venture like IQT has broken from it. Venture arms must strike the proper balance in tackling both long-term user challenges and immediate user requirements because too much focus on one or the other will be met with backlash. As strategic government ventures continue to adapt and develop, finding this balance will remain a key challenge. Increased transparency and interaction between users and venture arms can assist government venture arms with actually addressing challenges in addition to requirements. As more and more users understand the value of longer-term investing, it will be easier for strategic investment vehicles to invest in technologies of the future.

4. Business Model Agility

One way that IQT was able to increasingly address user requirements was to allow its business model room to evolve. IQT was designed to operate in the commercial marketplace with the same agility as private sector peers. Both an agency requirement and commercial potential must be identified before proceeding with an investment. IQT is focused on solutions, not products. Traditionally, if a government agency sought a product from the

private sector, it would initiate a bidding process and award a contract to the winning bidder. The winning bidder would then deliver the product, which would eventually become obsolete. By contrast, IQT departs from this transactional model and aims to develop continuous relationships with the companies it works with to procure technology that will consistently be updated to meet the ever changing needs of the market.

Initially, the firm served primarily as a technology systems integrator, seeking out commercial off-the-shelf (COTS) technologies in the marketplace that could be utilized by the CIA. Over the years, the operational model for IQT has continued to evolve, and today, it acts more as a catalyst for the development of innovative technologies as an early stage investor. It works with its portfolio companies to tailor technology to solving agency needs while concurrently improving its commercial viability. Rather than simply procuring technology that meets mission requirements, IQT has become more forward-looking, and this has served it well overall. Additionally, IQT maintains a degree of independence, which has helped it maintain some autonomy in selecting and executing projects. It does exist to serve its partner agencies, but too much oversight would limit the organization in being able to move quickly and take risks. That is why IQT was established as an independent corporation rather than a normal agency component.

Section 6.2: In Relation to the Startup

Another key stakeholder for U.S. government strategic investing arms is the company that they engage. Venture arms are interested in the intelligence and defense applications, but just as important to these modern ventures is supporting the commercial viability of portfolio companies and maintaining rapidity in managing startup relationships. Before outlining lessons learned in this section, it is valuable to analyze some portfolio company case studies

and perspectives to better understand the working relationship between entities like IQT and the companies they engage.

i. Portfolio Company Case Studies

IQT reports approximately 50 alumni companies that have been acquired or gone public. The typical period of time for an engagement with a company is three to 36 months.[68] OPT reports at least three alumni companies that have been acquired.[69] The research methodology for the following section will involve both qualitative and quantitative analysis in order to derive insights. I will present case studies on investments across the spectrum of success and failure for both IQT and OPT.

a. Case Study Analysis 1: Palantir Technologies

Palantir Technologies, founded by prominent technology entrepreneur Peter Thiel in 2004, is currently one of Silicon Valley's most highly valued companies. The company, however, initially struggled to raise funds from investors, and it received its earliest funding from IQT in 2005. Palantir offers sophisticated software applications for integrating, visualizing, and analyzing data. Its products are widely used by the U.S. IC as well as a host of financial services firms. Its flexible yet powerful tools allow it to derive insights on myriad topics.

For example, it can chart the flow of weapons in certain regions by processing distinct data sets such as manufacturer data, training camp locations, and equipment lot numbers. Palantir operates rather secretively, much like its clients, but there is clear alignment of goals in Palantir's capabilities and the IC's mission. Today, approximately 40% of Palantir's business comes from the federal government. Palantir has landed $1.2B worth of business

[68] "Portfolio." Accessed September 9, 2017. https://www.iqt.org/portfolio/.
[69] "Arsenal Work." Accessed February 2, 2018. http://arsenalgrowth.com/portfolio/#all.

from government clients. This business goes beyond pure intelligence analysis into work with other government agencies in the realms of law enforcement, defense, and national security, largely bolstered by Palantir's existing IQT relationship.

With an enormous valuation and a product that is evidently mission-critical at the large scale that the U.S. government needs, Palantir is clearly an example of a successful IQT investment. The nature of the company and product lends itself to working closely with the federal government and setting up IQT for a successful investment. It is also important to note that Palantir sought out IQT, and IQT was an early sole investor in the company. This differs from many other IQT investments that have been made with other funds in a syndicate process and in the later stages of startups' operations. These are important factors that generated success for both In-Q-Tel and the portfolio company, and I will continue to analyze whether these can be generalized as lessons and best practices for IQT through further analysis of its investment activities over the last two decades.

b. Case Study Analysis 2: Keyhole, Inc.

Keyhole Inc. was a 3-D mapping company founded in 2001 that revolutionized satellite imagery with technology called EarthViewer. IQT, on behalf of the NGA, made an investment in Keyhole in February 2003 and poured capital into product development. Keyhole worked in close collaboration with active defense and intelligence operations. The US IC made use of Keyhole technology in collection missions over Iraq. The satellite imagery technology was utilized to track troop movement in Iraqi warehouses and camps (Figure 9). While the technology had its roots in the NGA, its applications in the private sector allowed it to truly flourish. Google bought Keyhole in November 2004 for $35M, utilizing the technology to advance its mapping products including Google Earth. According to an IQT

press release, “within two weeks of In-Q-Tel’s engagement with Keyhole,… the technology [was adapted] to support… the Pentagon’s [mission].”[70] EarthView technology had a clear mission-critical importance, and IQT invested in the relatively later stages of funding, after Series B. Other financial backers included Sony Corp.’s Broadband Entertainment Unit, and Nvidia Corp.

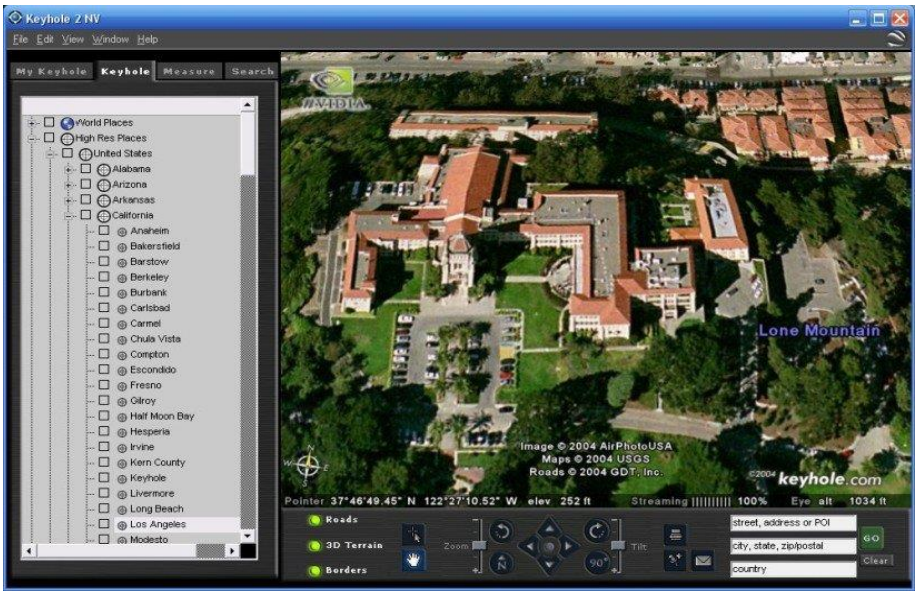

Figure 8. San Francisco, California as seen by EarthViewer, 2004

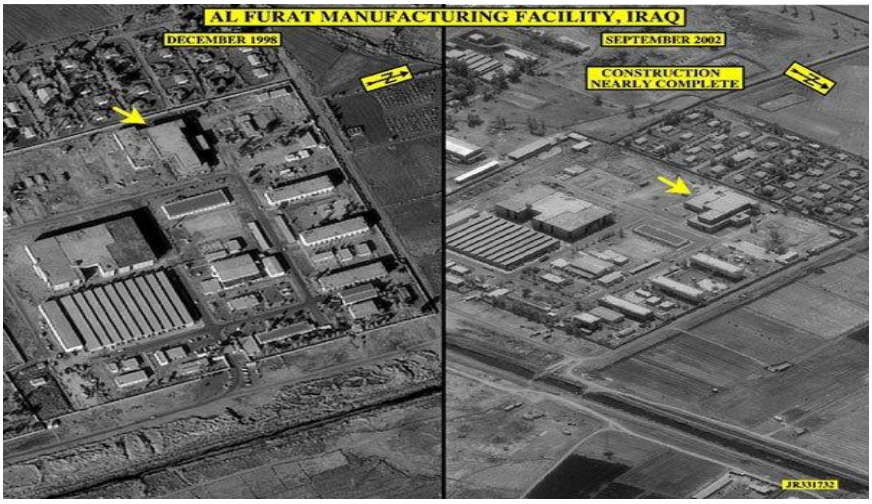

Figure 9. Al Furat Manufacturing Facility, Iraq as seen by EarthViewer, 1998 & 2002

[70] “IN-Q-TEL ANNOUNCES STRATEGIC INVESTMENT IN KEYHOLE.” Accessed December 2, 2017. https://www.iqt.org/in-q-tel-announces-strategic-investment-in-keyhole/.

c. Case Study Analysis 3: Inktomi Corp.

Inktomi Corp. was a developer of scalable network infrastructure software that was invested in by IQT in early 2002 so that it could deliver targeted search solutions that supported multiple languages for government use.[71] There was a clear mission in this investment—to utilize the company's enterprise search content and linguistic analysis to be able to better tackle the volume of information in foreign languages across the globe. In late 2002, the company was acquired by Yahoo to fuel Yahoo's search engine. Not much information has been released to the public about this investment, but Inktomi was sold to Yahoo for a significant discount to the market capitalization it had when IQT held it in its portfolio, so this illustrates a case in which financially, an IQT investment did not end well. The technology, however, was still somewhat viable.

d. Case Study Analysis 4: Nanosolar

Nanosolar was an OPT investment. OPT invested in multiple rounds of funding with them from 2005 to 2012. This investment, however, should be considered unsuccessful because the company itself failed and never delivered on its technical and commercial undertakings over the course of a decade. The company was founded in 2002 and had developed a printing process to make solar cells out of copper, indium, gallium, and selenium. It received seed funding from Google founders and raised over $450M in venture dollars.[72] Nanosolar had developed an innovative process, but it lost its cost advantage to traditional solar cells. Because no technology with application to OPT came out of the relationship, it is considered to be an unsuccessful investment.

[71] "Portfolio." Accessed September 9, 2017. https://www.iqt.org/portfolio/.
[72] "Thin-Film Solar Upstart Nanosolar Slims down - MIT Technology Review." Accessed April 1, 2018. https://www.technologyreview.com/s/511441/thin-film-solar-upstart-nanosolar-slims-down/.

e. Case Study Analysis 5: Trust Digital

Trust Digital is a software company that OPT invested in. The company focuses on managing and securing mobile assets and data. Trust Digital builds enterprise mobility management and security software solutions for hundreds of businesses and government organizations worldwide. It allows enterprises to secure and manage smartphones while also having the ability to assist the users. Trust Digital was acquired by computer and software security company McAfee in 2010 so that McAfee could deliver the industry's first comprehensive mobile security solution. It used Trust Digital's technology to help businesses secure, deploy, and manage applications on smartphones.[73] While no financial figures are released regarding OPT's Trust Digital investment, it can be considered a successful investment because the government was able to utilize the company's technology to bring industry-leading data protection to its organizations, and there was clear commercial value with the growing demand for smartphone security solutions as the prevalence of smartphones in businesses continues to grow.

ii. Portfolio Company Perspectives

It is also important to consider the responses of organizations that have worked with the venture arm. IQT reports that approximately 70% of the companies it works with wind up with some sort of government business. Dr. Robert Metcalfe of The University of Texas at Austin worked with IQT in two deals during the mid-2000s—one for battery company, Infinite Power Solutions (IPS), and the other for Ember Corporation, a company that provides ad hoc networking solutions. Dr. Metcalfe was complimentary of his interactions with IQT staff. IQT first invested in IPS in August 2006, and the IPS team enjoyed collaborating with

[73] "Arsenal Work." Accessed February 2, 2018. http://arsenalgrowth.com/portfolio/#all.

the experts in the CIA's own power solutions group.[74] IPS produces thin-film batteries for embedded applications and provides revolutionary power and efficiency in energy storage. IPS initially applied to IQT for funding, and after IQT conducted sufficient due diligence, IPS was granted several million dollars in exchange for warrant coverage. IQT worked with IPS to improve the efficiency of its batteries and eventually secured a manufacturing right. Later, all investors just "about got [their] bait back in an exit event."[75] One lingering concern in this relationship, however, was that IPS was never awarded a large government order as had been discussed during its working relationship with IQT.

The conclusion here is that there are instances in which an investment in a portfolio company can be financially positive but perhaps not successful from a mission-oriented perspective. The ultimate purpose of IQT is to put technologies in the hands of government customers, and this investment didn't appear to do so.

Regarding Ember, the wireless networking solutions it provides are low-cost and low-power, thus able to serve a variety of commercial and intelligence applications. For example, its solutions can automate homes as the semiconductor chips that it produces are placed into devices and then enable the devices to communicate with each other. The smart meter on a house can wirelessly send data about power consumption to the house's power grid provider. While the exact usage of Ember by IQT and its partner agencies remains classified, Dr. Metcalfe did work with United States Special Operations Command (SOCOM) during the tenure of Ember's relationship with IQT. SOCOM never told Ember what its technologies would be used for, but Ember technologies were later renewed several times by IQT. The company can be considered a successful investment as it was later acquired by Silicon Labs in

[74] Robert Metcalfe in discussion with the author, February 2018.
[75] Ibid.

2012, providing a positive financial exit for both the company and IQT. More importantly, the technologies appeared to serve a mission-critical purpose for the U.S. government. Now that I have discussed some important cases, we can look at lessons learned regarding venture arm interactions with startup companies.

1. Commercial Viability of Portfolio Companies

The best performing portfolio companies had commercial applications in addition to intelligence ones. They were desired by the commercial world, leading to successful financial exits for the companies' investors. Making sure that the venture arm doesn't tailor a solution to the agencies they serve at the expense of broader commercial viability is key. This is helped in part by providing companies with nimble, responsive teams that work at the speed of startups.

DHS SVIP has received positive feedback from the companies it has worked with, concerning the speed of the pitch and award process. The Director of the Cyber Security Division in the DHS Directorate of Science and Technology summarizes the SVIP process as shortening a three or four month proposal process to 30 minutes.[76] The process is very streamlined, involving a 10-page application, an invite-only 15 minute oral pitch follow-up, and 15 minutes of question and answer. A decision is made immediately after the startup leaves the pitch session. The average award timeframe is 45 days.[77] SVIP has addressed the need for processes to move quickly in the commercial sector to remain competitive. Other venture organizations can look to SVIP and adapt relevant practices to become more nimble as well.

[76] "Startups Rave about DHS's Silicon Valley Innovation Program." Accessed April 2, 2018. https://www.fedscoop.com/startups-rave-dhs-silicon-valley-innovation-program/.
[77] Robert Cardillo in discussion with the author, February 2018.

2. Funding Opportunity Timelines

DHS SVIP has invested in small unmanned aerials systems (sUAS) companies, which have myriad promising applications in the commercial world. Applications include inspecting infrastructure, supporting rescue efforts, and even delivering packages. DHS SVIP has stated that one of its main priorities is ensuring its staff can provide companies the attention they need to succeed. Due to the overwhelming interest in working with SVIP from companies with sUAS technology applications, SVIP actually closed its funding opportunity for these companies early. This was done so that SVIP could focus on its current and pipeline portfolio companies in order to maintain a quality experience for all companies. It is very important for fund managers to realize what the investment vehicle can bear in terms of operating capacity.

3. Level of Investment Risk

Lisbeth Poulos emphasized that while it would be beneficial to bump up the success rate of companies in terms of eventual transfer of products or services to government usage from 70% to a range of 75% to 80%, it is important to continue to take risks. Not all investments will work out, but this helps IQT remain at the cutting-edge of innovation. Gilman Louie, former CEO of IQT expressed a similar sentiment. He called for organizations like IQT to "embrace disruptive activity."[78] As institutions grow older, they tend to grow more conservative, and it is important that government venture-related arms don't fall prey to this trend. Furthermore, even though OPT doesn't provide as much financial support for solution development as IQT does, OPT has indicated that it employs a higher level of risk

[78] Gilman Louie in discussion with the author, March 2018.

tolerance than a traditional VC because it is primarily seeking solutions for the Army rather than financial return.[79]

IQT typically reduces risk by partnering with other successful VC groups and corporations and investing in relatively later stage startups. Maximizing the probability of achieving a successful investment is undoubtedly important, but if the criteria for success includes acquiring mission-oriented and commercially viable technologies, it may be worth exploring a larger number of earlier stage companies. Earlier stage companies are inherently more risky but could produce more outsized returns, not only financially but more importantly in their mission utility. Nonetheless, as in the OPT case of Nanosolar, it is necessary to carry out sufficient due diligence to avoid investing in startups that will not come to fruition.

The level of risk tolerance should be different for the different models of investment however, as IQT works with its companies to foster development while OPT simply provides funding. That could also be a contributing factor as to why Nanosolar wasn't successful. It would have been quite difficult to foresee the failure of Nanosolar's technology, but if OPT had been working alongside the company over the period it was making investments, from 2005 to 2012, it may have been able to identify future issues and not made the later investments. Perhaps in this scenario in which only capital is invested compared to resources and time, the risk tolerance should be lowered to arrive at a "healthy level of risk." Risk is largely dependent on the operational model and tolerance of the VC entity. OPT also is structured more like a traditional VC firm, which often records a lower percentage of successful investments as 30% to 40% of high potential start-ups end up liquidating all

[79] Webb, Tim, Christopher Guo, Jennifer Lamping Lewis, and Daniel Egel. "Venture Capital and Strategic Investment for Developing Government Mission Capabilities." Accessed November 17, 2017. https://www.rand.org/content/dam/rand/pubs/research_reports/RR100/RR176/RAND_RR176.pdf.
[79] Ibid.

assets.[80] This contrasts with the 70% success rate as defined by eventual solution transfer to the government reported by IQT. IQT is clearly much less risk-averse and much more invested in the solution development process.

4. Additional Resources to Offer

During an interview, Director Cardillo pointed out that IQT has demonstrated strong leanings towards technologies that are able to best harvest insights from data.[81] Big data startups have been some of the most successful IQT investments in terms of both IC utilization and private sector valuation. The current technological environment is one that demands the ability to parse through and develop insights from immense amounts of data, and the IC is no exception. Director Cardillo recently proposed a model for partnerships with companies that may possess useful technology for intelligence applications by offering unique data rather than capital to companies. There is immense value in data, particularly that collected via unique government capabilities, and Cardillo has proposed a "data investment model," giving companies data to develop algorithms in exchange for access to those algorithms. This differs from the traditional VC model of investing funds into startups. Instead of dollars, data would be made available to support a company's R&D processes. Whether this model will come to fruition remains to be seen, but it does highlight the importance of data innovation as a key aspect of potential success in startup-intelligence agency partnerships. There remains a great deal of bureaucratic red tape regarding providing government data to external organizations.

[80] "Report: 75% of Venture-Backed Start-Ups Fail | Inc.com." Accessed April 1, 2018. https://www.inc.com/john-mcdermott/report-3-out-of-4-venture-backed-start-ups-fail.html.
[81] Robert Cardillo in discussion with the author, February 2018.

A pioneering model for this practice, however, is DIUx's xView Detection Challenge, which was a collaboration with NGA. The contest awarded $100K to creators of effective computer vision tools. Registered contestants trained their programs using xView, one of the DoD's largest publicly available datasets of hand-annotated overhead imagery.[82] The winning algorithms were to be freely available for use by the government, and the final testing dataset would be classified.

5. Equity Positions in Portfolio Companies

Various IC leaders have offered their vantage points on IQT's operational ability. Former CIA Director, General David Petraeus remarked at the 2012 In-Q-Tel CEO Summit that the "partnership with In-Q-Tel is essential to helping identify and deliver groundbreaking technologies with mission-critical applications to the CIA and to our partner agencies. [The CIA doesn't] necessarily ask [companies] to be diabolical—[companies] can leave that to [the agency]—but [the companies'] creativity is vital."[83] General Petraeus is a strong proponent of the government's engagement with startups and VC. During a Q&A session at The University of Texas at Austin in February 2018, he expressed his support for investment vehicles such as IQT and advocated for the fledgling DIUx to pursue equity positions in firms of interest, thereby making it more similar to IQT.

While taking an equity stake is not a one-size-fits-all model, it is a method through which the agencies can have more leverage and gain increased insight and influence on the development of products and solutions. This does not mean that there is increased specialization of a solution to serve IC needs at the expense of commercial viability. It simply

[82] "The Pentagon Announces xView Detection Challenge | Trajectory Magazine." Accessed April 4, 2018. http://trajectorymagazine.com/pentagon-announces-xview-detection-challenge/.
[83] "Remarks by Director David H. Petraeus at In-Q-Tel CEO Summit — Central Intelligence Agency." Accessed February 7, 2018. https://www.cia.gov/news-information/speeches-testimony/2012-speeches-testimony/in-q-tel-summit-remarks.html.

creates more buy-in with the companies a venture arm is working with, creating an arguably stronger relationship with the portfolio company to help with the development of mission-critical technologies.

Section 6.3: In Relation to the Government

1. A Collaborative Innovation Ecosystem

IQT, DIUx, DHS SVIP, IARPA, and DARPA frequently cooperate on and encourage innovation and integration of new products into U.S. government activities. Informal as well as more formal information sharing is commonly done between IQT and other government R&D organizations. When IQT was founded in 1999, it was the exclusive asset of the CIA. Since then, it has taken on new partners including the NSA, NGA, DHS, and FBI, among others.

Interdepartmental partnerships are generally positive, but many agencies doing similar things could raise concerns about efficiency. IQT serves NGA and DHS, but they have their own venture-related arms as well. Building relationships to foster technology transfer from the private to public sector is undoubtedly important to the U.S. government, but the presence of so many similar entities raises the question of what missions each of the venture organizations is actually fulfilling. There could very well be redundancies, but given that most of these ventures are still young and evolving, it will take some time for them to each find focus.

In 2015, the CIA established a Directorate for Digital Innovation (DDI), which focuses on ensuring that the Agency integrates cutting-edge, mission-critical digital technology across the enterprise.[84] Teresa Smetzer, current director of Digital Futures at DDI, works on linking technology acquisition activities between various venture arms of the U.S.

[84] Teresa Smetzer in discussion with the author, March 2018.

government. She describes DDI as a bridging organization that works across startups, academia, corporations, and more to make certain that the U.S. government is in touch with the most important technologies available. On a temporal scale, they work to have a turnaround of a few months, on average shorter than the technology lifecycle of IQT that spans three to 36 months. DDI works to bridge the gaps between innovation organizations because it realizes that all of these venture arms, even if they are from different areas of the government, reflect on each other in the eyes of the startup companies they are trying to engage.

Many organizations work together on deals as long as there is overlap of interests. For example, NOV frequently works with IQT and DIUx. DIUx and DHS SVIP have made investments in the same company together, as they both had interests in the technology. It is often optimal to work alongside other agencies for operational contracts so that resources can be pooled. Different agencies could be looking at building a tool they all need. Joint investing also spreads risks across each organization involved. On the other side of the table, the company itself can have a more positive experience in a working relationship with multiple government agencies because it can receive perspectives from various users. While this may again raise the question of redundancies in the system, Teresa Smetzer explains that currently, the important question related to the presence of all of these organizations is one of alignment and integration rather than redundancy.[85]

Government VC arms need to educate the innovation community on their mission and value propositions. They need to promote that working with government VC arms entails a lot of potential for scale and a fast track into the government, with intellectual property protected under the most advanced cybersecurity measures. The goal right now is to develop strong

[85] Ibid.

relationships in Silicon Valley overall and to continue to educate VCs on the government VC value proposition. In Smetzer's view, the larger the workforce committed to that mission, the better. The historic perspective from many startups is that the government market is slow-moving and difficult to access. Many companies also fear that they lack personnel with government sales experience.[86] Therefore, while the mission of education about government VC remains to be completed, the many investment vehicles available will help serve this purpose. It is also valuable to remember that government bureaucracy creates some hurdles that won't disappear anytime soon, and as many venture organizations are still in their infancy, it is important to continue to monitor their development in the years to come. Eventually, if federal venture arms are able to build a collaborative community, perhaps once they are more established and become well-known players in the commercial world, the U.S. government can explore reorganization methods to streamline technology acquisition by scientific vertical (i.e. geospatial, biotechnology, cybersecurity, etc.) rather than by agency.

Section 6.4: In Relation to the Strategic Investment Vehicle

1. Looking to Other Organizations

In 2006, the National Aeronautics and Space Administration (NASA) announced a partnership with venture fund Red Planet Capital (RPC). RPC was to serve as the nonprofit venture capital arm of NASA, focusing on helping NASA create relationships with companies that didn't traditionally do business with the government and access emerging technologies. The mission slightly differed from that of IQT, as NASA sought technologies that may not have been directly related to aerospace technologies but were still relevant in other ways. The intent was to invest in the IT, biomedical, environmental, energy, and advanced materials

[86] Belko, Michael. "GOVERNMENT VENTURE CAPITAL: A CASE STUDY OF THE IN-Q-TEL MODEL." Accessed September 10, 2017. http://www.dtic.mil/dtic/tr/fulltext/u2/a423132.pdf.

sectors.[87] Two committees were created, the Subject Matter Experts Committee that would identify NASA needs and requirements and scour for technologies, as well as the NASA Interface Committee, which would facilitate the transfer of technologies back into NASA. The fund was to receive $75M in taxpayer dollars over five years.[88]

After one year, however, the fund was disbanded. The George W. Bush Administration's Office of Management and Budget decided to discontinue funding for RPC in 2007. Before the fund was discontinued, RPC had made only one investment. The Bush administration had been concerned that government-sponsored VC would eat into private funding, and RPC had not demonstrated clear mission-oriented technology engagement with the private sector. The lesson learned here is that sometimes timing is suboptimal, as RPC did not get a chance to prove its model at a time when funding was tight. A government venture organization is largely subject to the whims of the federal government and budget policy and can be dismissed due to little fault of its own. Thus, it is important for venture organizations to always remain mission-oriented and prove their worth to maintain the best chances at longevity.

Another organization existing VC arms can look toward is the DoD's Defense Venture Catalyst Initiative (DeVenCI). DeVenCI was launched in 2006 and departs from the aforementioned investment models in that it simply involves engaging the VC community through supporting R&D actions rather than by directly funding or performing the work. DeVenCI focuses on knowledge brokering by facilitating regular interactions among venture capitalists, small innovative companies, and DoD mission managers. It provides timely

[87] Ibid.
[88] Osama, Athar (Woodrow Wilson International Center for Scholars). 2008. "Washington Goes to Sand Hill Road: The Federal Government's Forays into the Venture Capital Industry." Foresight & Governance Project, no. 1. https://doi.org/10.1016/S1473-3099(14)70981-8.

information to the DoD regarding emerging commercial technologies to improve understanding between DoD participants with specific capability needs and innovative companies. DeVenCI has focused on facilitating the purchase of field-ready products and services by DoD, rather than on the development of new capabilities.[89] It provides another unique avenue through which the government has attempted to engage VCs, while not being of the VC investment model. If government VCs are ever short on investment dollars but still want to engage the VC community, or if they simply want to bolster their methods to engage the VC community, they can turn to DeVenCI as a model.

2. Human Capital Management

Buzzy Krongard and Gilman Louie both remarked on the incredible team that came to the table to help get IQT off the ground. It was invaluable for the first government VC arm to have a well-represented, distinguished board of directors who could help with understanding the complexity of challenge. Lee Ault, former chairman of the IQT board states that he "doesn't think there was a better board in the whole country."[90] The first IQT board consisted of the following individuals:

- Lee A. Ault, III, Former Chairman and CEO, Telecredit, Inc. (Chairman)
- Norman R. Augustine, Former Chairman and CEO, Lockheed Martin Corporation
- John Seely Brown, Former Director, Xerox Palo Alto Research Center Michael Crow, Executive Vice Provost and Professor of Science and Technology Policy, Columbia University

[89] "Pentagon Turns to Silicon Valley for Leads." Accessed April 1, 2018. https://www.reuters.com/article/venture-pentagon/pentagon-turns-to-silicon-valley-for-leads-idUSN1E79C21O20111014.
[90] Lee Ault in discussion with the author, March 2018.

- Stephen Friedman, Senior Principal, MMC Capital Inc.; Retired Chairman, Goldman Sachs & Co.
- Paul G. Kaminski, Chairman and CEO, Technovation, Inc.; Senior Partner, Global Technology Partners
- Jeong Kim, President, Optical Networking Group, Lucent Technologies, Inc.
- Alex Mandl, ASM Investments, LLC
- John N. McMahon, Former Deputy Director of Central Intelligence; Former President and CEO, Lockheed Missiles & Space Co.
- Dr. William J. Perry, Professor, School of Engineering, Stanford University

It is clear that IQT had true titans of industry on its founding board. There is no formula for finding the best mix of people, but it is important to maintain a balance of leaders from the technology industry, financial industry, academia, and IC. On that front, it is also critical for these VC arms to continue to attract strong talent. The government is contending with top corporations and other career avenues for the best and brightest in science, technology, and business to staff and support its VC elements. Thus, it should devote efforts to promoting its organizations to remain competitive in attracting top human capital.

CHAPTER 7: BEST PRACTICES

Based on the previous discussion of lessons learned, the following is a summary of best practices in terms of how government venture organizations can better engage their major stakeholders.

I. In Relation to the User

1. Establish an interface center.
2. Increase overall interaction with users.
3. Address user challenges in addition to requirements.
4. Have an agile business model.

II. In Relation to the Startup Company

1. Work to ensure the commercial viability of portfolio companies.
2. Close funding opportunities early if necessary.
3. Maintain a healthy level of investment risk
4. Explore additional resources that can be offered to companies.
5. Pursue equity positions in portfolio companies.

III. In Relation to the Government

1. Build a collaborative innovation ecosystem.

IV. In Relation to the Strategic Investment Vehicle

1. Learn from other organizations.
2. Build a great team of people.

CONCLUSION

Technological innovation is crucial to the intelligence and defense communities, and it is an area in which the U.S. government has historically excelled. Government researchers, university partners, and military contractors created revolutionary technologies, ranging from photoreconnaissance satellites to the Internet. By 1999, however, CIA leadership recognized that the Agency could not compete in innovation with the same speed and dexterity as others in the commercial marketplace, whose businesses were driven by profit potential. This led to the creation of In-Q-Tel, the government's first venture capital arm.

Several of the fundamental technologies spurring on the information revolution are also extremely relevant to the intelligence community, particularly social media insights and big data capabilities that can parse through immense amounts of data, freeing up human resources for more efficient resource allocation. Other areas of the government recognized this need to create market-based solutions to participate in the technology race and followed in the CIA's footsteps.

External threats to the U.S. are also evolving, so intelligence targets are changing, inciting the need for new technology to meet those targets. In addition to traditional military competitors, the United States now must also be more cognizant of developments of weapons of mass destruction, transnational terror networks, and cyber capabilities. New technologies are needed to keep up with intelligence collection for these new threats.

The inception of VC and strategic investment vehicles within U.S. government agencies to engage the startup community has proliferated over the past two decades. Despite some initial skepticism from federal agencies, venture arms such as IQT, DIUx, and DHS SVIP are steps in the right direction for the intelligence community and have proven to be

beneficial thus far. Many challenges still lie ahead, however, and relationships between these programs and their parent agencies or departments will need to be strengthened to tackle them. Government venture arms will need to keep pace with the venture capital community and continue to adapt to changing policy and business environments. The lessons and best practices presented in this thesis apply to all of the relevant stakeholders in government venture investment relationships—the users, the startup companies, the U.S. government as a whole, and the investment vehicles themselves. America's national security in the future could very well depend on the government's successful engagement with the nation's vibrant community of technology innovators.

APPENDIX

*Exhibit 1. In-Q-Tel Investments**

Startup	Employees	Total Funding	Location
Palantir Technologies	920	$301,000,000	Palo Alto
FireEye	867	$85,450,000	Bay Area
Cloudera	413	$141,000,000	Bay Area
Apigee	321	$107,100,000	Bay Area
10gen	268	$73,400,000	New York
Veracode	241	$74,260,328	Boston
Tenable Network Security	199	$50,000,000	Columbia
Pure Storage	171	$245,856,468	Bay Area
Huddle	146	$38,200,000	United Kingdom
Elemental Technologies	124	$27,600,000	Portland
RedSeal Networks	120	$29,100,000	Santa Clara
Delphix	115	$44,500,000	Menlo Park
QD Vision	102	$70,000,000	Boston
OpenSpan	101	$31,000,000	Alpharetta
Cleversafe	96	$91,400,000	Chicago
Mocana	94	$35,500,000	Bay Area
NetBase Solutions	90	$50,700,000	Bay Area
Goal Zero	87	$7,000,000	Bluffdale
ThreatMetrix	83	$36,200,000	Bay Area
Visible Technologies	83	$80,500,000	Seattle
Tendril	82	$111,190,000	Boulder
Adaptive Computing	80	$19,999,999	Provo
3VR	73	$53,000,000	Bay Area
D-Wave Systems	69	$66,223,982	Canada
GainSpan	64	$76,821,324	Bay Area
InnoCentive	56	$30,300,000	Boston
LucidWorks	53	$31,999,999	Bay Area
Platfora	52	$27,200,000	Bay Area
OpGen	49	$63,132,442	Gaithersburg
Adapx	47	$30,000,000	Seattle
Cloudant	46	$16,250,000	Boston
Lingotek	45	$4,997,122	Lehi
T2 Biosystems	44	$83,500,000	Boston
MedShape Solutions	43	$11,557,026	Atlanta
Pixim	42	$45,100,000	Bay Area
Recorded Future	42	$20,900,000	Boston
WiSpry	41	$48,300,000	Irvine
TerraGo Technologies	41	$18,729,962	Atlanta
Cambrios Technologies	38	$31,500,000	Sunnyvale
Quanterix	37	$41,499,999	Boston
Pelican Imaging	36	$37,000,000	Bay Area
Narrative Science	36	$9,550,000	Chicago
Bay Microsystems	34	$8,400,000	Bay Area
OpenGeo	33	$3,000,000	New York
Contour Energy Systems	31	$20,000,000	Los Angeles
LensVector	27	$30,000,000	Sunnyvale
Power Assure	24	$34,750,000	Bay Area
Biomatrica	23	$5,000,000	San Diego
SiOnyx	23	$20,150,000	Boston
Surveylab Group	18	$1,390,000	NZL
Microchip Biotechnologies	15	$22,600,000	Bay Area
Carnegie Speech	14	$14,886,399	Pittsburgh
Quantum4D	7	$200,000	Bay Area
Lime Microsystems	7	$343,000	United Kingdom
Mersive	5	$2,819,647	Denver

**adapted from CrunchBase and publicly available information, may not be exhaustive*

*Exhibit 2. In-Q-Tel Co-Investors and Portfolio Companies Shared**

Number of Companies Shared with IQT	Firm	Companies
7	HarrisHarris	SiOnyx, OpGen, Cambrios Technologies, Contour Energy Systems, Nextreme Thermal Solutions, nanosys, D-Wave Systems
7	Intel	Adaptive Computing, SignaCert, 10gen, Mocana, Quantum4D, nanosys, GainSpan
6	Polaris	T2 Biosystems, SiOnyx, nanosys, Infinite Power Solutions, Seventh Sense Biosystems, Veracode
5	Samsung	LensVector, Cambrios Technologies, Microchip Biotechnologies, Pure Storage, IntegenX
4	DAG	3VR, Huddle, FireEye, Cloudera
4	Sutter	RedSeal Networks, Pure Storage, Platfora, Forterra Systems
3	Battery	Delphix, Narrative Science, Platfora
3	Flagship	Seventh Sense Biosystems, T2 Biosystems, Quanterix
3	Greylock	Pure Storage, Cloudera, Delphix
3	Norwest	Elemental Technologies, FireEye, Apigee
2	Accel	Tenable Network Security, Cloudera
2	Atlas	Recorded Future, Veracode
2	Avalon	Cambrios Technologies, Cloudant
2	DFJ	D-Wave Systems, Power Assure
2	Flybridge	T2 Biosystems, 10gen
2	Highland	OpGen, QD Vision
2	Ignition	Visible Technologies, Cloudera
2	IntelCapital	HyTrust, Adaptive Computing
2	Lux	Cambrios Technologies, nanosys
2	Matrix	Huddle, OpenSpan
2	Menlo	LensVector, 3VR
2	Meritech	Veracode, Cloudera
2	NEA	10gen, Cleversafe
2	Sequoia	FireEye, 10gen
2	Shasta	Mocana, LucidWorks
2	SigmaPrime	OpenSpan, CallMiner
2	SV Angel	Cloudera, Mocana
2	USVP	Contour Energy Systems, ThreatMetrix
2	VantagePoint	3VR, Tendril
2	Venrock	RedSeal Networks, nanosys
1	3MVentures	Mersive
1	AH	Platfora
1	Aisling	T2 Biosystems
1	AlsopLouie	Cleversafe
1	Altos	NetBase Solutions
1	August	ThreatMetrix

Number of Companies Shared with IQT	Firm	Companies
1	Bain	Quanterix
1	BaldertonCapital	Recorded Future
1	Crosslink	SiOnyx
1	DataCollective	Platfora
1	DavidSacks	Palantir Technologies
1	DCM	SignaCert
1	DFJEsprit	Lime Microsystems
1	Eden	Huddle
1	ElDorado	nanosys
1	FoundersFund	Palantir Technologies
1	GeneralCatalyst	Elemental Technologies
1	GoldenSeeds	Carnegie Speech
1	GoogleVentures	Recorded Future
1	GSV	Palantir Technologies
1	IA	Recorded Future
1	Index	Pure Storage
1	InterWest	Pelican Imaging
1	KeithRabois	Palantir Technologies
1	KPCB	3VR
1	Lightspeed	Delphix
1	Lowercase	MotionDSP
1	Mayfield	Pixim
1	MDV	Pixim
1	Nokia	Pelican Imaging
1	NorthBridge	QD Vision
1	NYAngels	Carnegie Speech
1	NYC	10gen
1	Omidyar	InnoCentive
1	s	Pelican Imaging
1	Redpoint	Pure Storage
1	RRE	Tendril
1	Tenaya	ThreatMetrix
1	USV	10gen
1	Vanedge	OpenGeo
1	YC	Cloudant

**adapted from CrunchBase and publicly available information, may not be exhaustive*

Exhibit 3. Interviews Conducted with Experts

Below please find a short biography of each expert consulted as well as the date of the interview (in chronological order).

Christine "Christy" Abizaid (4/20/17)

Christine Abizaid was selected to serve as the Austin Presence Lead for the Defense Innovation Unit Experimental (DIUx) in September 2016. She left in the spring of 2017 to pursue academic interests. Prior to joining DIUx, Christy was the Deputy Assistant Secretary of Defense for Afghanistan, Pakistan, and Central Asia. Ms. Abizaid also previously served on the National Security Council Staff as both a Director for Counterterrorism and Senior Policy Advisor to the Assistant to the President for Homeland Security and Counterterrorism.

Douglas "Doug" Wise (9/13/17)

Douglas Wise served as Deputy Director of the Defense Intelligence Agency from August 2014 until August 2016. Following 20 years of active duty in the Army where he served as an infantry and special operations officer, he spent the much of his career at CIA.

Joanne Isham (10/13/17)

Joanne Isham served as the Deputy Director of the National Geospatial-Intelligence Agency from 2001 to 2006. She led the CIA Directorate of Science and Technology as Deputy Director from 1997 to 2001. She now serves as the Chief Executive Officer and Managing Partner of NextFED, Inc., a consulting firm that serves companies and key decision makers focused on national security.

Robert Cardillo (2/6/18)

Robert Cardillo is the sixth Director of the National Geospatial-Intelligence Agency (NGA). He became the NGA's director on October 3, 2014. Prior to this assignment, Mr. Cardillo served as the first Deputy Director for Intelligence Integration, Office of the Director of National Intelligence, from 2010 to 2014. He also served as the Deputy Director of the Defense Intelligence Agency (DIA) and the Deputy Director for Analysis, DIA, from 2006 to 2010.

David Petraeus (2/7/18)

General Petraeus served over 37 years in the U.S. military, culminating his career with six consecutive commands, five of which were in combat, including command of coalition forces during the Surge in Iraq, command of U.S. Central Command, and command of coalition forces in Afghanistan. Following his service in the military, General Petraeus served as the Director of the CIA during a period of significant achievements in the global war on terror.

Robert Metcalfe (2/8/18)

Robert Metcalfe is an engineer, technology executive, and venture capitalist. He is widely recognized as the inventor of the Ethernet. He attended MIT and Harvard University, studying mathematics and computer science, before joining Xerox's Palo Alto Research center. It was there that he was inspired to invent the Ethernet in 1973. He now serves as a Professor of Innovation and Murchison Fellow of Free Enterprise at The University of Texas at Austin.

John Brennan (2/16/18)

John Brennan was the Director of the CIA from March 2013 to January 2017. Before becoming Director, he served at the White House for four years as Assistant to the President for Homeland Security and Counterterrorism. Mr. Brennan began his service in government at the CIA, where he worked from 1980 to 2005. He spent most of his early career in the Agency's main analytic arm, the Directorate of Analysis, specializing in the Near East and South Asia before directing counterterrorism analysis in the early 1990s.

Lisbeth Poulos (2/27/18)

Lisbeth Poulos currently serves as Chief of Staff and Executive Vice President of In-Q-Tel. She has been with In-Q-Tel since June 2002 and is responsible for raising awareness of the In-Q-Tel model among government agencies and other stakeholders. Ms. Poulos also manages the day-to-day activities of IQT's staff as well as the organization's relationships with its Board of Trustees and Intelligence Community interface centers.

Alvin "Buzzy" Krongard (3/5/18)

Buzzy Krongard was appointed as the Executive Director of the Central Intelligence Agency in 2001 and served until 2004. Prior to this, Mr. Krongard had been a longtime consultant to multiple Directors of Central Intelligence, and he joined the Agency full-time in February 1998, following a 29-year business career. During his private sector career, he served as Chief Executive Officer and Chairman of the Board of Alex. Brown & Sons, the nation's oldest investment banking firm, and Vice Chairman of the Board of Bankers Trust.

Teresa Smetzer (3/13/18)

Teresa Smetzer is the Director of Digital Futures at the CIA's Directorate of Digital Innovation. She began her career at CIA and served in various roles such as analyst, technologist, and senior manager over a 17-year period. Smetzer then left federal service and worked as vice president of business development at General Dynamics for three years. After that, she established and led Jasmah Consulting as CEO until its acquisition by nonprofit government consulting services company LMI in 2008.

Gilman Louie (3/14/18)

Gilman Louie is a technology venture capitalist and was the first CEO of In-Q-Tel. Prior to In-Q-Tel, Louie was highly active in the interactive entertainment industry. He founded and ran the company Spectrum HoloByte, where he designed the popular Falcon F-16 flight simulator. He is currently a founding partner of the venture capital firm Alsop Louie Partners.

Lee Ault III (3/20/18)

Lee Ault was chairman of In-Q-Tel's board of trustees from 1999 to 2002. He spent four years as a Marine Corps officer and pilot. In 1968, Mr. Ault became CEO of Telecredit, a leader in the payment services industry. He served as CEO for 23 years, until Telecredit was sold to Equifax. Lee served on the Equifax board for 15 years. Mr. Ault holds a Bachelor of Arts degree from Yale University.

Reginald Hyde (3/27/18)

Reginald Hyde was the former Deputy Undersecretary of Defense for Intelligence and Security in the U.S. Department of Defense. He now serves as the executive director of the Cyber Institute at The University of Alabama. He has decades of national security career experience, having worked in senior positions at the CIA and within the Intelligence Community.

Benjamin Tuttle (4/3/18)

Benjamin Tuttle is the current Director of Outposts of the National Geospatial-Intelligence Agency (NGA). He previously worked for NGA Research. He holds a Ph.D. in Geography from the University of Denver and has done extensive work in geospatial intelligence.

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BIOGRAPHY

Macy Huang was born and raised in Plano, Texas. She graduated from The University of Texas at Austin in the spring of 2018 with a B.A. in Plan II Honors and a B.B.A. in Business Honors and Finance. Macy was active in several communities on campus, including the Honors Business Association, Titans of Investing, and Wall Street for McCombs. She also co-founded a student dance troupe, the Austin Chinese Dance Company, in 2014. While in college, Macy held internships in commercial banking and investment banking. She also worked with a startup accelerator and served as a teaching assistant for a university course on entrepreneurship and innovation. Macy will begin her career at Goldman Sachs in New York during the summer of 2018 as an investment banking analyst.