NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

PROTECTION, PROFIT, OR PRIVACY: EXPLORING STRATEGIC SOLUTIONS FOR INTEGRATING UNMANNED AERIAL SYSTEMS (UAS) AND THE DELICATE BALANCE BETWEEN COMMERCIAL OPPORTUNITY AND PUBLIC SAFETY

by

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December 2016

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Unmanned aircraft systems (UAS) and their meteoric rise in popularity among hobbyists and commercial users have created a sense of urgency among lawmakers to develop a strategic policy to facilitate domestic UAS integration into the national airspace.

Local municipalities and state agencies are initiating legislative efforts to develop "best practices," ordinances, and policies in the absence of a structured legal framework for UAS expansion. The city of Phoenix is among those seeking solutions to the question of how the city and police department can develop and implement a strategic guidance policy governing UAS integration to best serve the interests of government and community.

This research effort utilizes the five-step process contained within the multi-goal policy analysis research design method. This process is ideal for conducting policy analysis in which there are multiple policy outcomes or when these outcomes cannot be comparatively quantified equally.

This academic effort constructs the identified alternative outcome solution within a specified problem segment to present a solution compliant with industry standards and directed toward the intelligent non-specialist end user. The product deliverable results in a strategic policy guidance strategy that is transparent and falls within an accountability framework.

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ABSTRACT

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Local municipalities and state agencies are initiating legislative efforts to develop "best practices," ordinances, and policies in the absence of a structured legal framework for UAS expansion. The City of Phoenix is among those seeking solutions to the question of how the city and police department can develop and implement a strategic guidance policy governing UAS integration to best serve the interests of government and community.

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LIST OF ACRONYMS AND ABBREVIATIONS

AGL	above ground level
APS	Arizona Public Service
ATC	air traffic control
BLOS	beyond line of sight
BSIA	British Security Industry Association
BYU	Brigham Young University
CAD	computer aided dispatch
CEA	Consumer Electronics Association
CCTV	close circuit television
CI/KR	critical infrastructure—key resources
CDT	Center for Democracy and Technology
CNN	Central News Network
COA	certificate of authorization
COTS	commercial off the shelf
CPTI	Community Policing Trust Initiative
CRS	Congressional Research Service
CTA	Consumer Technology Association
DIY	do it yourself
EASA	European Aviation Safety Agency
EU	European Union
FAA	Federal Aviation Administration
GAO	Government Accountability Office
HDB	Homeland Defense Bureau
HVE	homegrown violent extremists
IED	improvised explosive device
IRA	Irish Republican Army
IR	infrared
MEMS	microelectromechanical systems
NAS	national air space
NASA	National Aeronautical and Space Administration

NOAA	National Oceanographic and Atmospheric Administration
NPA	notice of proposed amendment
NPRM	notice of proposed rule making
OEM	Office of Emergency Management
PFD	Phoenix Fire Department
ROC	regional operations center
RPAS	remotely piloted aircraft system
SAC	special airworthiness certificate
SLAR	side-looking airborne radar
TC	Transport Canada
UAS	unmanned aerial systems
UK	United Kingdom
USSS	United States Secret Service
VLOS	visual line of sight

EXECUTIVE SUMMARY

A. INTRODUCTION

The age of innovation and technology is upon us and continues to shape our world as we know it in awe inspiring ways. As new technologies are discovered and developed, society demands that creative and innovative methods be identified to facilitate the integration of this newfound technology into our daily lives. Few technological innovations have demonstrated the ability to influence our society as dramatically as the emergence of domestic unmanned aircraft systems (UAS) have done.

The combination of advancements in technology coupled with the human spirit of ingenuity has thrust the United States into mainstream domestic policy discussions regarding UAS. Furthermore, the prolific rise in the use of the domestic UAS has created a significant sense of urgency now facing lawmakers and government officials alike as they seek solutions to the complex challenges that lay ahead.

The passage of the Modernization Reform Act of 2012, also referred to as Public Law 112–95, marked a formal acknowledgement by Congress in its forecasting that domestic UAS platforms had the potential for continued economic growth spanning a broad spectrum of commercial applications.[1] Congress directed the Federal Aviation Administration (FAA) Secretary, Anthony Foxx, to develop and implement a governance framework to effectively regulate the safe deployment of UAS platforms operating within the domestic national airspace (NAS) by September 30, 2015.[2]

Developing a national governance framework has proven challenging for lawmakers as they grapple with society's opposing perceptions and varying degrees of societal acceptability when establishing a new policy framework to guide UAS integration. Lawmakers must give careful consideration to how UAS integration will impact privacy, civil liberties, and public safety while promoting a sound business

[1] White House Office of the Press Secretary, "Promoting Economic Competitiveness While Safeguarding Privacy, Civil Rights, and Civil Liberties in Domestic Use of Unmanned Aircraft Systems" [memorandum], February 15, 2015, https://www.hsdl.org/?view&did=762711, 1.

[2] Ibid.

environment supporting economic growth within a transparent and accountable framework.[3]

Recent events like the Boston bombing and the San Bernardino shooting have demonstrated to America that acts of terrorism no longer happen only on foreign shores. The resurgent activities of homegrown violent extremists (HVE), along with U.S. foreign fighters recruited by terrorist organizations to launch attacks at home and abroad, continue to change the discursive narrative regarding the U.S. defense posture on homeland security. The government and the private sector continue to assess the integration of UAS technology deployed domestically and its potential to influence homeland security issues.

B. RESEARCH QUESTION

As we stand in the midst of a technology of limitless variability, society and government alike are torn between the enormous technological benefits of UAS and the skeptical concern of a constitutionally skittish nation fearful of government overreach and the oppressive tyranny that gave birth to our nation. The FAA was directed by the Obama administration to develop guidance to integrate UAS into the national airspace by September, 2015[4] but has yet to do so. In this absence, local and state agencies and jurisdictions continue to self-legislate interim policies and guidance protocols to effectively address issues specific to UAS and the challenges these present to their respective jurisdictions and communities.

It is the intent of this research to aid in the development of strategic policy guidance for the Phoenix Police Department and the City of Phoenix. It also intends to develop a best practices model that is replicable for other agencies and municipalities nationwide. Establishing a policy response framework that provides each community the flexibility to customize the alternative outcome solutions to best fit their individualized

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[3] Ibid.

[4] *FAA's Progress and Challenges in Integrating Unmanned Aircraft Systems into the National Airspace System*, 113th Cong., 2 (2014) (statement of Matthew Hampton, Assistant Inspector General for Aviation, U.S. Department of Transportation), http://transportation.house.gov/uploadedfiles/2014-12-10-hampton.pdf.

needs is essential. In the spirit of this effort, this research strives to answer the research question: How can the Phoenix Police Department develop and implement strategic policy governing UAS integration that enhances public safety response, investigative capabilities, and current threat management? Given the vast divide between competing objectives, my intended approach is to construct alternatives outcome solutions from the varying viewpoints and perspectives of the impacted UAS stakeholders.

C. METHOD

This research effort utilizes the *five-step* process contained within the *multi-goal policy analysis* research design method, which uses practical criteria displayed within an outcomes matrix commonly used to conduct comparative analysis of multiple policy options as described by author Eugene Bardach.[5] This process is ideal for conducting policy analysis of situations in which there are multiple policy outcomes or when one or more of these outcomes cannot be comparatively quantified equally.

This research product was designed to conduct a comparative analysis of scenario-based decision models for city leadership to consider as future strategic guidance policies are developed and implemented. This deliverable is further intended to serve as a replicable decision-making template for other cities and jurisdictions to consider as they address these critical issues related to UAS impacting their respective communities.

D. FINDINGS

The role of public safety and law enforcement is to serve as the gatekeepers of economic prosperity and as guardians against dark hearted evil doers who perpetuate the cycle of terror. Now more than ever it is up to law enforcement and city leadership to provide the governance framework that permits UAS operation within the City of Phoenix. Providing a comprehensive strategic policy will promote commercial business growth and opportunity and provide public safety with an enhanced tool that reduces costs and mitigates risk in a manner that conforms with existing state laws and FAA

[5] Eugene Bardach, *A Practical Guide for Policy Analysis: The Eightfold Path to More Effective Problem Solving*, 4th ed. (Thousand Oaks, CA: Sage Publications, 2012), 41, 59.

guidelines. This research examines the criticality of the emerging and multifaceted UAS issues to construct set of policy options to address a variety of potential outcomes for city leadership and elected officials to consider. Comparative analysis of each of these positive attributes against the possible range of alternative solutions for UAS integration within the City has identified Alternative Solution A as the best fit for the City of Phoenix.

Each solution was compared against the same attributes of risk/threat to public safety, cost, legality, political acceptability, challenges of integration, and the ability to support economic growth. The solutions presented offered scenarios in which public safety was paramount over all else, where cost was a limiting factor to effective integration of a policy, where the City took a "wait and see" approach and chose not to act, and a scenario where an open and supportive environment exists to promote economic growth and prosperity as the primary consideration. Analysis of these scenarios against the common attributes led to the emergence of Solution A as the best fit for the City of Phoenix.

The challenges facing the City of Phoenix are not unique to it alone. Other agencies and jurisdictions across the nation must also face critical decision points as they develop their own strategic guidance policies to meet the needs of their respective communities where commercial UAS integration is concerned. It is the wholehearted intent for this research to serve as a replicable policy roadmap for law enforcement agencies searching for a policy design option. The law enforcement and public safety community stand at the forefront of this cutting edge UAS technology. The next generation of public safety and homeland security professionals will judge the efficacy of today's actions as the cornerstone of a strategic guidance policy that defined the ground rules for UAS integration into the national airspace.

E. KEY ISSUES

The integration of the UAS platform represents another rapidly evolving technology. The level of focused innovation and design directed at these platforms continues to yield new and improved levels of domestic application spanning a broad

spectrum of functional use and design. The versatility of UAS platforms has created increased demand by hobbyists and commercial innovators alike and placed a sense of urgency on elected officials, lawmakers, and public safety to prepare for the challenges associated with UAS integration in the absence of a formalized government framework. This void creates several issues of concern now facing local, state, and federal jurisdictions as they struggle to find the balance required for domestic UAS integration. These issues include the challenges of integrating UAS in a commercially active setting within a large metropolitan environment for the purposes of agribusiness, mapping, surveying, meteorological sensing, photography, and real estate, as well as uses for public safety among other uses. There are additional concerns about the current lack of an appropriate legal authority and investigative framework to enforce issues related to privacy, civil liberties, and protection of critical infrastructure vulnerabilities from the developing threat posed by malicious actors.

F. STAKEHOLDER ENVIRONMENT

As lawmakers and policy strategists ponder the implications for integrating UAS into the NAS on a national level, local and state jurisdictions must approach the UAS issue from two diametrically opposed fronts amidst competing political agendas. City leaders and elected officials must balance competing UAS objectives: the strategic promotion of economic growth on one hand and on the other the integration of a responsible public safety plan to manage the UAS threat potential thus ensuring community safety.

There is little disagreement among stakeholders about the multitude of benefits and limitless potential of leveraging UAS technologies to enhance the "greater good" of society. However, there are polarizing discussions about how to integrate this technology in a safe, secure, and responsible manner that reflects the interests of all involved.

G. LEGAL ISSUES

The release of the FAA's Part 107 commercial guidelines took effect August 29, 2016 and provided long-awaited federal guidance and clarity regarding the "rules of the

road" for the commercial UAS community.[6] While not the panacea many were hoping for, Part 107 is the FAA's first crack at creating a permissive environment that carefully balances the need for economic growth and technological advancement with the need for safety in integrating UAS into the national airspace. Release of Part 107 by the FAA also helps to address the patchwork of policy and legislative efforts across the country under one umbrella. Moreover, this effort by the FAA represents that critical first step toward the institutionalization of legal parameters and standardization of expectations for users and law enforcement alike.

Even with the release of FAA guidelines, local and state agencies will likely experience challenges with legal interpretation and deconfliction at their levels during the initial "soak period" of initial implementation. Local and state agencies will need to work closely with their city and county prosecutors to ensure they have identified a mutually agreeable charging doctrine related to the civil and criminal charges they intend to pursue.

H. PRIVACY ISSUES

Evaluating the full extent to which UAS will adversely impact an individual's right to privacy remains to be seen. Much of the conversation has been centered on the public's perception of increased government overreach should UAS be integrated into the public safety inventory as an enhanced capability. National watchdog groups like the American Civil Liberties Union have opined on the matter suggesting even though there are valid applications for UAS in public safety, their benefits are likely to be outweighed by "mission creep" and used for more controversial purposes.[7]

According to Richard Thompson of the Congressional Research Service, for lawmakers to solve the issues surrounding UAS and privacy, governmental direction

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[6] Federal Aviation Administration, "Fact Sheet—Small Unmanned Aircraft Regulations (Part 107)," press release, June 21, 2016, https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=20516.

[7] Laura W. Murphy, Christopher Calabrese, Jay Stanley, and Catherine Crump, *The Future of Drones in America: Law Enforcement and Privacy Considerations* (Washington, DC: American Civil Liberties Union Washington Legislative Office, 2013), https://www.aclu.org/future-drones-america-law-enforcement-and-privacy-considerations-aclu-statement-record-senate, 6.

from federal lawmakers and judiciary must determine exactly what "privacy" means.[8] The public requires clarity and specifics from lawmakers to provide legal context and interpretation as to what defines an individual's expectation of privacy and how that impacts the public. Some guidance concerning privacy and UAS is provided in case law as cited in California v. Ciraolo, Florida v. Riley, and United States v. Knotts.[9] Analysis of previous cases provides a starting point for discussion between government officials and the public they represent, but ongoing discussion and consensus building will enable all stakeholders to identify a middle ground for UAS integration. Research suggests though, until specific cases have worked their way through the legal system, privacy implications surrounding UAS integration remains largely speculative and relatively unknown.

I. THREAT ENVIRONMENT

Today's threat environment is rapidly evolving and the associated UAS technology has created a heightened sense of urgency given the complex and multifaceted nature of its integration into NAS. The exploitation of UAS platforms by malicious actors who elect to modify these devices presents a significant public safety concern. The use of a UAS over large crowds or events, to access restricted critical infrastructure areas, or to serve as a delivery platform for bio-toxins or explosives is of paramount concern. I would suggest the need for these concerns be resolved by lawmakers and policy strategists.

J. ANALYSIS

Analysis of the UAS issue for the City of Phoenix reveals several important requisite components, which are identified as critical to the successful development of a strategic guidance policy for the city. Among them was the need to establish a commercially friendly environment that was not overly restrictive or that created additional barriers to entry for UAS technology. City leadership and elected officials

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[8] Richard M. Thompson II, *Domestic Drones and Privacy: A Primer* (Washington, DC: Congressional Research Service, 2015), https://fas.org/sgp/crs/misc/R43965.pdf, 1.

[9] Murphy et al., *The Future of Drones in America*, 6, 12.

have adopted a firm stance supporting less regulation of UAS at the local, state, and federal levels of government. The city has been transparent in stating its intent to implement UAS related policies that encourage and support economic growth and prosperity for small business, while continuing to actively pursue and attract large-scale events to the city to boost its tourism industry.

It will remain important for the city to continue to regularly monitor the impact of UAS integration into city airspace and to regularly assess areas of concern or policy gaps with its identified stakeholders. Policy implementation on this topic will likely manifest itself as a living document that can be modified as needed in response to the needs of the community served.

K. ALTERNATIVE SOLUTION SUMMARY AND CONCLUSION

This thesis has identified Alternative Solution A as the most viable course of action for the City of Phoenix to facilitate the integration of UAS into the city's airspace. This course of action emerged as the highest scoring solution offered after being assessed among a series of six different categories of evaluative criteria. Each category was assigned a numeric value and placed within an assessment matrix to determine a comprehensive value assessment for the four solution options presented.

Alternative Solution A is defined as: *An alternative solution that calls for less regulation and authorizes commercial use of UAS to spur economic growth and attract new business*. When compared against the pool of affected stakeholders, this solution offers the most viable solution to meet the diverse needs of a disparate group with multiple competing agendas. It simply offers the most benefit to the most people.

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The decision to embark upon a second master's degree program as an adult learner working a full-time assignment was a difficult prospect to reconcile. The delicate balance required to engage meaningfully in the course work, complete a homeland security thesis of relevance to the field, while adding contributory value to my organization demanded no less than the full measure of my commitment to complete. I would be remiss if I did not acknowledge the unrelenting support of the following people without whose help this thesis would not have been possible:

- My wife, for her constant encouragement and willingness to read my seemingly endless ramblings at all hours of the night as I fumbled along this journey. Her willingness to stand alone as the family CEO, which enabled me to focus singularly on meeting the writing demands, was instrumental to my successful completion of the program.
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I am forever grateful to each of you.

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I. INTRODUCTION

The saddest aspect of life right now is that science gathers knowledge
faster than society gathers wisdom.

—Isaac Asimov

The age of innovation and technology is upon us and continues to shape our world as we know it in awe inspiring ways. As new technologies are discovered and developed, society demands that creative and innovative ways to integrate these newfound technologies be identified so they can be incorporated into our daily lives. Few technological innovations have demonstrated the ability to influence our society as dramatically as the emergence of domestic unmanned aircraft systems (UAS) have done.

Defining a UAS for the purpose of this research includes a broad base of primarily multi-rotor wing technology platform designs ranging from commercial off-the-shelf (COTS) models to the hobbyist do-it-yourself (DIY) design kits. The ability to easily modify these platforms with equipment to perform a variety of mission specific objectives has given them increased popularity.

The combination of advancements in technology coupled with the human spirit of ingenuity has thrust the United States into mainstream domestic policy discussions regarding UAS. The prolific rise in the use of domestic UAS has created a significant sense of urgency now facing lawmakers and government officials alike as they seek solutions to the complex challenges that lay ahead.

The passage of the Modernization Reform Act of 2012, also referred to as Public Law 112–95, marked a formal acknowledgement by Congress in its forecasting that domestic UAS platforms had the potential for continued economic growth spanning a broad spectrum of commercial applications.[1] Congress directed the Federal Aviation

[1] White House Office of the Press Secretary, "Promoting Economic Competitiveness While Safeguarding Privacy, Civil Rights, and Civil Liberties in Domestic Use of Unmanned Aircraft Systems" [memorandum], February 15, 2015, https://www.hsdl.org/?view&did=762711, 1.

Administration (FAA) Secretary, Anthony Foxx, to develop and implement a governance framework to effectively regulate the safe deployment of UAS platforms operating within the domestic national airspace (NAS) by September 30, 2015.[2]

Developing a national governance framework has proven challenging for lawmakers as they grapple with society's opposing perceptions and varying degrees of societal acceptability. Careful consideration must be given to the potential implications UAS integration will have on civil liberties, privacy, and public safety while promoting a sound business environment supporting economic growth within a transparent and accountable framework.[3]

Recent events like the Boston bombing and the San Bernardino shooting have demonstrated to America that acts of terrorism no longer happen only on foreign shores. The resurgent activities of homegrown violent extremists (HVE) along with U.S. foreign fighters recruited by terrorist organizations to launch attacks at home and abroad continue to change the discursive narrative regarding the U.S. defense posture on homeland security. The government and the private sector continue to assess the integration of UAS technology deployed domestically and its potential to influence homeland security issues.

A. PROBLEM STATEMENT

The introduction of unmanned aircraft systems (UAS) and their subsequent meteoric rise in popularity among hobbyist enthusiasts and commercial end users has created a sense of urgency among lawmakers to develop a sound strategic plan to facilitate the successful integration of UAS into the NAS domestically within the United States. In the meantime, local and state agencies and municipalities are in engaged in various legislative efforts across the country to develop "best practices" ordinances and policies for their respective jurisdictions to address the immediate need for legal guidance and a structured governance framework in response to UAS expansion. A secondary consequence to this effort is the mixed bag approach to policy development. This often results in misinterpretation by local and state lawmakers and runs the risk of falling out of

[2] Ibid.

[3] Ibid.

alignment with existing FAA regulations. The FAA recently commented on this issue by stating that the new UAS registration program is the sole means by which the FAA can identify aircraft operating in the navigable airspace, and it emphasized that no local or state agency has the authorization to impose additional registration requirements without FAA approval.[4] It further cited as an example that this "patchwork quilt" of multiple differing restrictions limits the FAA's ability to control the navigable airspace safely.[5]

B. EVALUATIVE CRITERIA

The Phoenix Police Department and the City of Phoenix, like many agencies nationwide, are struggling with the prospect of how best to develop and implement a strategic policy to govern UAS integration into local airspace. The Phoenix Police Department and the City of Phoenix seek to leverage UAS technology to enhance public safety and emergency management response to incidents, increase existing investigative and intelligence capabilities, and more effectively manage the current threat environment.

The research presented in this thesis provides a set of alternative policy solutions to fit a range of desired outcomes as identified by the elected officials for the city of Phoenix based on a specific set of evaluative core criterion. This process is covered in greater detail in Chapter IV, but the core criteria detailed below have been identified based on the potential impact each is likely to contribute to the overall strategic policy discussion.

(1) Private Sector Economic Impact

The United States is poised to see a significant increase in the use of UAS technology ranging from the hobbyist enthusiast to a wide range of commercially based applications spurring economic growth. Identifying the impact within Phoenix will be important to the development of a governance model.

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[4] Office of the Chief Counsel, *State and Local Regulation of Unmanned Aircraft Systems (UAS) Fact Sheet* (Washington, DC: Federal Aviation Administration, 2015), https://www.faa.gov/uas/regulations_policies/media/UAS_Fact_Sheet_Final.pdf, 2.

[5] Ibid.

(2) Challenges of Technological Integration

Integration of new technology is inherently challenging and can be prohibitive based on the environment into which it is being adopted. This research is intended to identify potential pitfalls that local, state, or federal agencies should be mindful of during integration within a municipal environment like the city of Phoenix. Examples may include lessons learned from countries like the United Kingdom (UK) and Canada.

(3) Risk/Threats to Public Safety

Despite the many advantages of UAS integrative technologies, the United States can ill afford to deny the significant risk and threat associated with UAS operations within the NAS. Public safety and government officials are continually faced with new levels of increased threat potential associated with UAS platforms deployed by malicious actors intent on using this technology for nefarious or terroristic purposes. This increased threat picture includes the use of UAS to conduct pre-operational planning and surveillance of critical infrastructures as well as the potential for deployment of modified or weaponized UAS platforms within the domestic NAS.

(4) Availability of Existing Laws/Ordinances

As independent state agencies and municipalities scramble to develop enforcement protocols for safe UAS operations within their respective jurisdictions, it is necessary for them to assess the existence of laws and ordinances. The City of Phoenix and state of Arizona must also examine whether or not current city ordinances, state laws, or applicable federal laws are in place to effectively regulate use, support appropriate investigative efforts of violations, or contain the requisite elements to impose penalties on offending violators.

(5) Assessing the Impact to Private Citizens

Of paramount concern to society across the United States are the perceptions that UAS will promote a deterioration of citizens' rights to privacy or violate citizens' constitutionally protected Fourth Amendment rights, which protect against unreasonable

search and seizure. The city of Phoenix is no different; therefore, developing any strategic guidance policy on UAS integration must to take these concerns into account.

(6) Cost

Integration of any new technology will impact businesses and communities in different ways and to varying degrees. This research considers the costs associated with such integration as unintended consequences or second order cascading impacts in policy development discussion. These costs may present as either potential increases for the purchase or integration of UAS platforms commercially (*including police, fire, and emergency management use*) or costs to the city for integrating UAS deterrent strategies, etc.

Once applied, these criteria were assessed with a numeric point value for each category identified within a specific alternative outcome solution. After each criterion was assessed, each was placed within an evaluative matrix for final scoring. The intent of the scoring is to aid elected officials and strategic policy decision makers in identifying which solution presents the most viable option for successful integration based on their prioritization for a specific desired outcome.

C. DEFINING THE ROLE AND IMPACT OF DOMESTIC UAS INTEGRATION

As lawmakers and policy strategists ponder the implications for integrating UAS on a national level, local and state jurisdictions must approach the UAS issue from two diametrically opposed fronts amidst competing political agendas. City leaders and elected officials must balance competing UAS objectives—the strategic promotion of economic growth on one hand and the integration of a responsible public safety plan to manage the UAS threat potential ensuring community safety on the other.

There is little disagreement among stakeholders about the multitude of benefits and limitless potential of leveraging UAS technologies to enhance the greater good of society. However, there are polarizing discussions about how to integrate this technology in a safe, secure, and responsible manner reflective of the interests of all involved. While the business community may see UAS restrictions as an impingement of its ability to

conduct free trade in an open economic market, law enforcement and public safety, tasked with preserving the safety and security of the public, are deeply concerned with the broad spectrum of airborne threats (*intentional and unintentional*) that UAS integration presents. Other specific considerations germane to the discussion are detailed below.

(1) Commercial Considerations

Modest price points, adaptable platforms, and a utilitarian design continue to inspire innovation and an entrepreneurial spirit promoting business and economic growth opportunities across a broad spectrum of commercial UAS applications. Domestic utility may include areas such as search and rescue, weather forecasting, real estate marketing, photography and videography, agribusiness, infrastructure monitoring, and public safety applications.[6]

(2) Economic Growth Potential

The wide range of commercial applications for UAS integration is expected to inspire an extended economic demand well into the future. Although early indicators vary by market segment and individual manufacture's projections, there is consistency and market agreement as to the strong sales future of UAS based on existing market indicators. For instance, the Aerospace Industries Association projects the growth of UAS platforms for both the military and civilian applications to continue for the next decade, citing a projected increase in sales from $6.6 billion to $11.4 billion in annual sales. Additionally, it predicts this field will generate more than $89 billion in sales over the next decade.[7]

(3) Privacy

There is a prevailing perception among public and watchdog groups that the benefits of public safety use of UAS are likely to be outweighed through mission creep

[6] Aerospace Industries Association, *Unmanned Aircraft Systems: Perceptions and Potential* (Arlington, VA: Aerospace Industries Association), accessed October 15, 2016, http://www.aia-aerospace.org/report/unmanned-aircraft-systems-perceptions-and-potential/, 8.

[7] Ibid., 5.

and that UAS will instead be used to violate citizens' rights to privacy through UAS use in the performance of official duties.[8] The development of a strategic guidance policy within the United States will face stronger opposition than has been experienced by other countries like the UK. It is important that lawmakers and policy strategists have a comprehensive understanding of the fear driving these concerns so they can build consensus concerning and acceptability of this technology, especially where use by law enforcement and government entities is concerned.

A review of the UK's use of closed circuit television (CCTV) surveillance techniques provides some insight into the level of acceptance demonstrated by its citizens in comparison the United States. According to the British Security Industry Association (BSIA), the UK has one of the largest CCTV surveillance network systems in the world with an estimated 4 to 5.9 million cameras currently in use.[9] If we examine the level of violent incidents and terrorist attacks that have plagued the UK over the last three decades, we can achieve a greater perspective and perhaps understand the concessions its public is willing to accept to enhance the level of homeland security.

The ongoing attacks from the Irish Republican Army (IRA) beginning in the 1970s can be linked to the shift in culture in favor of implementing CCTV and other electronic surveillance techniques as a protective measure against these attacks. According to *The Guardian*, the onslaught of IRA bombing campaigns since 1973 has continually served to create a culture of fear over an extended period.[10] In 1973 alone, London was hit with 36 bombs,[11] which has perhaps contributed to the overall culture and perpetuation of fear and paranoia in the UK.

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[8] Laura W. Murphy et al., *The Future of Drones in America: Law Enforcement and Privacy Considerations* (Washington, DC: American Civil Liberties Union Washington Legislative Office, 2013), https://www.aclu.org/future-drones-america-law-enforcement-and-privacy-considerations-aclu-statement-record-senate, 1.

[9] "CCTV: Too Many Cameras Useless, Warns Surveillance Watchdog Tony Porter," *BBC News*, January 26, 2015, http://www.bbc.com/news/uk-30978995, 2.

[10] Donald MacLeod, "London: Past Terror Attacks," *The Guardian*, July 7, 2005, http://www.theguardian.com/uk/2005/jul/07/terrorism.july73, 1.

[11] Ibid.

Another explanation for the UK's level of public acceptance for increased government surveillance can be found by examining the UK's parliamentary form of government as opposed to the US' constitutional form of government. Author James Lewis for the Center for Strategic and International Studies suggests the US' federal form of government and the constitutional separation of powers prevents the United States from matching the level of flexibility afforded to the UK's parliamentary system, in which the home secretary is entrusted with great discretion over the use of electronic surveillance techniques and investigations regarding terrorism.[12] This is exactly the form of parliamentary rule that American revolutionaries sought to avoid when they fled Great Britain. The absence of one person with centralized power remains the central to the construct of our form of democratic government, wherein no one person exerts the power and authority over all others.

D. UNDERSTANDING THE THREAT

UAS integration presents a significant level of threat for which public safety must prepare. Current UAS platforms have increased payload capacities that can accommodate a variety of weaponized options including explosive/incendiary, chemical, and firearm capabilities.[13] In addition, enhanced flight capabilities make UAS ideal for critical infrastructure / key resource (CI/KR) and cyber intrusions by people intent on engaging in criminal or terroristic behaviors. This was recently demonstrated on January 26, 2015 when a UAS successfully intruded on the White House lawn, arguably one of the most iconic symbols of CI/KR in the country.[14]

Another consideration for UAS integration into the NAS is the increased levels of congestion within the airspace. In addition to the intentional threat posed by a malicious

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[12] James A. Lewis, *Combating Terrorism: Lessons Learned from London* (Washington, DC: Center for Strategic and International Studies, 2006), http://csis.org/files/attachments/ts060919jimlewis.pdf, 2.

[13] Kieran Corcoran, "Terrifying Video Shows Home-made Drone Made by a Teenager Equipped with a Handgun Opening Fire in the Woods," *Daily Mail*, July 16, 2015, http://www.dailymail.co.uk/news/article-3164261/Terrifying-video-shows-home-drone-teenager-equipped-HANDGUN-opening-fire-woods.html.

[14] Alejandro Sanchez and Cameron McKibben, "Worst Case Scenario: The Criminal Use of Drones," Council on Hemispheric Affairs, February 2, 2015, http://www.coha.org/worst-case-scenario-the-criminal-use-of-drones/, 5.

actor with a UAS platform, we must also consider the consequences when a UAS malfunctions and control by the operator is lost. Technical or mechanical malfunctioning of a UAS presents yet another concern for public safety. For example, a UAS (less than 55 lbs.) that suddenly loses connectivity with its operator or suffers a catastrophic failure will endanger the safety of citizens on the ground who would be left vulnerable to the equivalent of a bag of cement freefalling to the ground from up to 400 feet. This very concern has prompted jurisdictions to enact laws and ordinances prohibiting the use of UAS over large crowds or sporting venues.

Recent examples across the country have continued to surface illustrating the very nature of the dangers associated with UAS platforms deployed over large crowds or sporting events. For instance, in October 2015, a UAS operator was charged with reckless endangerment when a UAS he was operating crashed into a crowd during a Seattle parade and knocked a woman unconscious.[15] Another incident shortly thereafter in December 2015 drew international attention during the World Cup downhill slalom race at Madonna di Campiglio in Italy. CNN reported that skier Marcel Hirscher was in the middle of his run when a large remote controlled UAS platform modified with a camera crashed just inches behind him on the slope.[16] Examples such as these continue to concern public safety officials charged with protecting the unsuspecting public from these airborne threats.

E. RESEARCH QUESTION

As we stand in the midst of a technology of limitless variability, society and government alike are torn between the enormous technological benefits of UAS and the skeptical concern of a constitutionally skittish nation fearful of government overreach and a return to the oppressive tyranny that gave birth to our nation. The Federal Aviation Administration (FAA) was directed by the Obama administration to develop guidance to

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[15] Steve Miletich, "Drone Operator Charged with Knocking out Woman at Pride Parade," *The Seattle Times*, October 28, 2015, http://www.seattletimes.com/seattle-news/crime/drone-operator-charged-with-knocking-out-woman-at-pride-parade/.

[16] Matias Grez, "Drone Crashes onto Piste, Misses Champion Skier by Inches," *CNN*, December 23, 2015, http://edition.cnn.com/2015/12/23/sport/marcel-hirscher-drone-crash/index.html, 1.

integrate UAS into the national airspace by September 2015[17] but has yet to do so. In the absence formal guidance, local and state agencies and jurisdictions continue to self-legislate interim policies and guidance protocols to effectively address UAS specific issues and the challenges these present to their respective jurisdictions and communities.

It is the intent of this research to aid in the development of strategic policy guidance for the Phoenix Police Department and the City of Phoenix. It is also intended to develop a best practices model that is replicable for other agencies and municipalities nationwide. It is essential to establish a policy response framework that provides each community the flexibility to customize the alternative outcome solutions that best fit their individualized needs. In the spirit of this effort, this research strives to answer the following research question: How can the Phoenix Police Department develop and implement strategic policy governing UAS integration that enhances public safety response, investigative capabilities, and current threat management? Given the vast divide between competing objectives, my intended approach is to construct alternative outcome solutions from the varying viewpoints and perspectives of the impacted UAS stakeholders. The core criteria have been previously identified and are likely to be germane to the discussion when analyzing the specific details that a new policy should contain to include input from varying stakeholder perspectives.

F. METHODOLOGY

For this research effort, I intend to utilize the five-step process contained within the multi-goal policy analysis research design method. This process is ideal for conducting policy analysis in situations wherein there are multiple possible policy outcomes or when one or more of these outcomes cannot be comparatively quantified equally. This process provides the supportive framework required to conduct my analysis as detailed under each of the following five categories related to UAS integration.

[17] *FAA's Progress and Challenges in Integrating Unmanned Aircraft Systems into the National Airspace System*, 113th Cong., 2 (2014) (statement of Matthew Hampton, Assistant Inspector General for Aviation, U.S. Department of Transportation), http://transportation.house.gov/uploadedfiles/2014-12-10-hampton.pdf.

1. Select Impact Categories
   - Impact to business community and stakeholders
   - Impact to public safety (police, fire, and emergency management)
   - Impact to FAA/transportation sector
   - Impact to investigative and prosecutorial sector
   - Impact to citizens and citizens' privacy rights
2. Policy Alternatives
   - Alternatives presented to address a specific desired outcome where cost savings, public safety, increased commercial business opportunity, etc., is the desired outcome.
   - Deferred jurisdictional authority to federal level (e.g., wait and see approach).
   - Alternatives will present the causal relationship and identify concessions (illustrating by-product consequence of a selected option).
   - Possibility of a phased policy implementation over time (if cost is the desired outcome).
3. Impact Prediction
   - By identifying desired outcome criteria, an array of predictive results can be determined (public safety will increase/decrease, threat/risk will be reduced/increased, commercial business will become more/less profitable).
   - Push back from elected officials, business community stakeholders, and citizens can be anticipated based on the alternative solution selected.
   - Technology comprehension challenges (identifying the technology learning curve to maximize results/efficiencies).
4. Impact Valuation
   - Can be measured monetarily if cost is the desired outcome of the alternative selected.
   - Can be measured internally as enhanced organizational efficiencies (workflow processes or filling a gap that previously existed).
   - Improved public safety can be observed through feedback from the citizen's in terms of their perception of enhanced public safety and improved quality of life (do they feel safer in their community—i.e., are crime rates are down).

- Issues can be valued quantitatively, qualitatively, and monetarily by examining the alternative solutions from the differing perspectives of the stakeholders involved.

5. Modification Evaluation
   - Accomplished by establishing evaluative criteria categories to weigh each option against (identified under point 2).
   - Conduct a scored analysis and placement of each alternative solution within a grid matrix for visual representation.
   - Based on the desired outcome (cost, safety, economics, etc.), select the alternative solution that best fits this outcome for recommendation. This model enables the researcher to comparatively assess dissimilar categories of options for analysis.

G. EVALUATIVE CRITERIA

For the purpose of evaluating the research for this thesis, I use an evaluation matrix based on pre-identified core criteria, which are determined to be relevant to the all stakeholders involved. This matrix will help isolate a given alternative solution based on the desired outcome as a visual representation of the data. The solution that best meets the desired outcome based on the criteria collected will be used to identify the most viable (*and potentially palatable*) alternative solution for recommended implementation.

1. Legality: Considers whether or not current conditions provide a legal basis for the recommended or proposed action to be implemented without additional legal concern
2. Politically acceptable: Considers the likelihood the proposed solution would be deemed acceptable to the elected officials of a given council district on behalf of their constituency's best interests.
3. Cost: Considers the financial impact to the (city, organization, department, etc.) responsible for acting upon the recommended alternative solution. Can include physical costs, personnel costs, etc.
4. Complexity: Considers the overall level of difficulty to be encumbered if the proposed alternative solution is implemented by the organization. Also considers systems and work flow processes, etc.
5. Effectiveness: Determines whether the implemented alternative solution was successful in answering the research question or fixing the policy issue. Effectiveness rating will likely be deferred until the solution has been implemented and undergone a soak period to properly determine its effectiveness.

Table 1 provides an illustration of the type of evaluation matrix to be considered in terms of (high, medium, and low rankings of core criteria against the evaluative criteria matrix) for determining the most viable alternative solution.

Table 1. Alternative Solution Evaluation Matrix

Solution	Legality	Politically Acceptable	Cost	Complexity	Effectiveness
Example 1	High	High	High	High	Low
Example 2	High	Medium	High	High	High
Example 3	Medium	Low	High	Medium	Low
Example 4	High	High	High	Low	Low

H. THESIS OVERVIEW

The following sections examine the various components of this research effort and provide a structure for identifying the core criteria for comparative analysis against the alternative solution scenarios constructed. Utilizing this format, an output objective is discussed and the scope of this research will be defined. Finally, a proposed deliverable is outlined to illustrate the intent of this research effort.

(1) Output

The intent of this thesis is to provide readers with enhanced situational awareness of the multifaceted complexities of UAS integration into the U.S. domestic NAS. I hope this research effort will foster a deeper understanding of the potential impacts and consequences policy makers must consider when developing a strategic policy for their respective agencies and jurisdictions. This is done through promotion of a common operating picture upon which to base strategic policy decisions. The primary deliverable of this thesis is a set of alternative outcome solutions for consideration by my city's elected leadership and organizational executives. These solutions represent viable strategic policy options to achieve a desired outcome and enhance the quality of life within the city of Phoenix.

In selecting the research design method, there is a primary weakness to the overall process in that public safety is not the final determining authority for selecting an alternative solution. This academic effort constructs the identified alternative outcome solutions within a specified problem segment to present a solution compliant with industry standards and focused toward the intelligence non-specialist end user. The end product deliverable is a strategic policy guidance strategy that is transparent and falls within a transparent accountability framework.

(2) Scope of Research

The scope of this research has been refined to several critical areas. These include the current threat UAS pose to citizens from a public safety perspective and the challenges of enforcement. It examines the privacy concerns associated with UAS integration and considers the potential impact and potential concessions to be considered in developing a strategic guidance policy for the city of Phoenix.

This thesis is not heavily focused on UAS history and its military pedigree. This subject has already been vigorously researched and its content has been presented on multiple occasions. Little has changed to support additional research on this particular segment. A brief overview of the legislative context to date is required to set the stage for discussion on policy development, but limited time is spent here because there has been a significant period of legislative stagnancy.

(3) Deliverable

This thesis produces a set of alternative outcome solutions to a variety of strategic policy options as selected by the City of Phoenix elected officials and executive leadership. These sample solutions detailed below can vary based on the prioritization of the elected body who wish to seek a solution with a specific outcome in mind.

Example 1: If the desired alternative is to allow for less regulation and authorized commercial use of UAS platforms to spur economic growth and attract new business and tourism, then the following example may be the best alternative but secondary consequences may also apply:

> Potential increased cost for public safety to create a new investigative detail to work these types of cases. It may cost more in target hardening costs to protect the city's critical infrastructure/key resources and interests.

Example 2: If the desired alternative is make public safety the paramount objective for governing UAS integration, then the following alternative may provide the best option for accomplishing this but will also secondary consequences that need to be divulged:

> This option may also cost public safety more up front to develop its investigative unit to maximize enforcement ability to carry out this objective. This option may be less popular with the elected officials and their constituents because it is more restrictive in its application. This enhanced public safety and enforcement posture will be more restrictive to citizens and the hobbyist community.

Example 3: If the desired alternative is to provide a strategy that reduces costs to the city and to the business community, then this might be the best alternative to accomplish this, but it also comes with concessions that might have to be considered if selected:

> This option may increase the level of risk to the private citizen due to lack of specialized regulatory efforts. Critical infrastructure—key resources may lack the level of enhanced target hardening they require to ensure protection from threat. Reduced costs remove barriers to entry for purchasing UAS, which will lead to increased risk and threat with an insufficient institutional framework to address the new end state.

Example 4: Another alternative solution might be to embrace the current "steady state" through adoption of a "wait and see" approach. It could be the collective opinion of the city's elected officials to refrain from selecting an integration strategy at present time. This decision could be motivated due to the newness of the UAS issue or a lack of enough incidents within our community to warrant action now. However, inaction may also be met with unintended consequences that could have a detrimental impact down the road to our city. Based on the rapid growth and popularity of the hobbyist and commercially motivated UAS operator, our city could quickly find ourselves behind the integration curve and expose the city to potential liability should it fail to respond appropriately. The fourth and final example is:

Each solution presented will further include a consequence analysis that can be expected if this solution is implemented illustrating the cause and effect relationship of such complex decisions.

I. CHAPTER SUMMARY

This chapter has introduced the topic of UAS and briefly touched on the role it is expected to play as an emerging technology for a wide and diverse user base. This chapter provides a basic snapshot of the issue and serves as a subsequent roadmap for the research contained in this thesis. Chapter II of this thesis takes a comprehensive look at the available research on the topic of UAS and its subsequent integration within the national airspace and provides a foundation upon which to further explore this topic.

II. LITERATURE REVIEW

The emergence of the domestic unmanned aerial system (UAS), commonly referred to as "drones," has erupted in popularity among hobbyist enthusiasts and commercial end users. Recent advancements in technology combined with the ingenuity of the human spirit have thrust the topic of UAS center stage for ongoing domestic policy discussion within the United States.

As the favorability of UAS platforms grow in popularity, so too does the amount of literature on this topic. Research for this effort spanned a broad base of user groups and practitioners, including technical institutions, Government Accountability Office (GAO) reports, Congressional Research Service (CRS) reports, government testimony and hearings, legislative updates and drafts, various news reports, industry advocates, and civil rights watchdog groups.

There is a growing sense of urgency for the federal government to develop and provide a national framework for local and state agencies to operate within, a framework that provides guidance and direction for the safe integration of UAS within the NAS. Despite the multitude of positive attributes and possibilities associated with the commercial integration of UAS, there are other segments of the population very concerned over the potential negative impact such integration is likely to produce. The potential for UAS platforms to violate a person's privacy or civil liberties remains of paramount concern among these groups. The ability for government and public safety officials to mitigate the threat potential represented by UAS platforms operated by malicious actors is critical to the preservation of homeland security. These are among the many challenges facing the United States as the growth and integration of UAS continues to develop.

A. UAS USERS

Today's domestic UAS bears little resemblance to its military predecessors. Modest price points, adaptable platforms, and a utilitarian design continue to inspire innovation and an entrepreneurial spirit promoting business and economic growth

opportunities across a broad spectrum of commercial UAS applications.[18] Current user groups include hobbyist enthusiasts and the marketing, real estate, photography, videography, and agribusiness professions. Local, state, and federal public safety agencies have also identified a wide range of UAS applications, including inspection of critical infrastructure/key resource (CI/KR) assets as well as search and rescue among others.

B. THE MILITARY ORIGINS OF UAS

Other advancements in technology can trace their roots of origin to a military application typically born out of necessity to provide a particular technical or tactical advantage to the war effort. The concept of remotely piloted vehicles was initially developed by George Westinghouse and electrical engineer Nikola Tesla during the Spanish-American War as an effort to design the "teleautomaton,"which was intended to be used as torpedo delivery platform.[19] Continued development of the aeronautical gyroscope by Elmer Sperry and advancements to airframe design by Glenn Curtiss set the stage for the first aerial testing of torpedoes during 1909–1920.[20] It was not until World War I that Charles Franklin Kettering moved the aerial torpedo named the "Bug" into the next stage of evolution. The Bug was capable of carrying a payload of 200 pounds for a distance of 50 miles and represented the first UAS capable of a pre-determined flight pattern.[21]

The United States was not alone in its efforts to design an UAS platform. The UK was actively involved in the development of the "Queen Bee" during the 1930s and 40s, which was later bestowed the moniker of "drone" based on the sound it made during flight.[22] Inventor and enthusiast Reginald Denny continued the development of the Radioplane-1 (RP-1), but the German development of the V-1 cruise missile re-defined

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[18] Aerospace Industries Association, *Unmanned Aircraft Systems*, 8.

[19] Evan Baldwin Carr, *Unmanned Aerial Vehicles: Examining the Safety, Security, Privacy and Regulatory Issues of Integration into U.S. Airspace* (Dallas, TX: National Center of Policy Analysis, 2013), http://www.ncpa.org/pdfs/sp-Drones-long-paper.pdf, 4–5.

[20] Ibid., 5.

[21] Ibid.

[22] Ibid.

the evolution of UAS, while competing head to head with the Queen Bee during the 1940s.[23]

As the U.S. entered the age of the Cold War during the 1950s and 60s, the military began to shift its attention to the development of a long-range UAS platform capable of carrying a payload and returning to base while avoiding self-termination at its target. It can be said this was the dawn of the surveillance age as UAS platforms were outfitted to carry camera systems and equipped with infrared(IR) sensors capable of nighttime photography. These platforms were equipped with side-looking airborne radar (SLAR) that provided real-time visual imagery to a ground base.[24]

It was not until the Vietnam War that UAS carved out its place in the military theatre of battle. The AQM-34 Lightning Bugs and Firebees were responsible for maintaining an 84 percent surveillance mission success rate during this period.[25] During the 1970s, Israel was in a position of dominance in the field of UAS development and was the first nation to conduct UAS surveillance missions in combat.[26] The United States and Israel joined forces as long-time allies and developed the Hunter and Pioneer UAS models, which were deployed during the Gulf War and in the Balkans and Kosovo conflicts.[27]

As UAS research continued to evolve during the 1990s, the mission had shifted once again to developing a platform that could sustain elevated flight above 50,000 feet (ft.) above ground level (AGL) for at least 24 hours at a time. It was the National Aeronautics and Space Administration (NASA) and AeroVironment Corporation that answered the call and developed Pathfinder and Helios, which unveiled advancements in solar power energy.[28] Continued advancements would later include autonomous flight

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[23] Ibid.

[24] Ibid.

[25] Ibid.

[26] Ibid., 7.

[27] Ibid., 8.

[28] Ibid.

and vertical landings and takeoffs, but it was not until the aftermath of 9/11 that UAS experienced resurgence in design and military application.

Following 9/11, the state-of-the-art Predator UAS was outfitted with Hellfire smart missiles, and its first combat engagement taking place in Yemen in response to the bombing of USS *Cole* docked in port. The Predator was utilized to target and conduct a precision strike on a vehicle carrying a senior al-Qaeda operative responsible for the attack on USS *Cole*.[29] This mission marked what would become the first of many lethal precision strikes carried out by the U.S. military utilizing this cutting edge UAS technology.

Despite the decades of research and development, we are reminded of how much we still do not know about UAS technology and its capabilities. Peter Singer, with the Brookings Institute, made a comparison about how the Predator UAS in on the same level as the Model T Fords and Wright Flyers; this is just the first generation as compared to what is currently in prototype development. He also commented that we are at the "horseless" stage of this technology.[30] In addition, Singer made another comparison between the MQ-1 Predator and the newer MQ-9 Reaper UAS platforms in terms of comparative assessment of the advancements in technological capabilities. The MQ-9 Reaper maintains the ability to conduct autonomous flights and landings, conduct mission waypoints, and carry smart sensor technology, which enables the Reaper to make sense of what it is seeing.[31] Furthermore, Singer contests this evolution is comparable to the advancements experienced between the B-17 and the B-24 bomber planes of World War II. The increase in range, speed, and payload capacity made the B-24 the superior version.[32]

Although the military represents the birthplace of UAS development and deployment as a tactical weapon of lethality, small-to-medium domestic UAS platforms

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[29] Ibid., 9.

[30] Peter W. Singer, *The Predator Comes Home: A Primer on Domestic Drones, Their Huge Business Opportunities, and Their Deep Political, Moral, and Legal Challenges* (Washington, DC: Brookings Institute, 2013), http://www.brookings.edu/research/papers/2013/03/08-drones-singer, 2.

[31] Ibid., 6.

[32] Ibid.

have burst onto the scene to fulfill an ever-expanding catalog of commercially based applications. Integration of new technology has given rise to the next generation of UAS designed to be operated with the U.S. NAS.

C. WHAT IS ALREADY KNOWN

The United States is not alone in its haste to keep pace with a globally trending UAS insurgence. For instance, within the European Union (EU), specifically the United Kingdom, the Remotely Piloted Aircraft System (RPAS) steering group was enacted in June 2013 to present a roadmap for UAS integration within European airspace.[33] This effort was followed soon after by the Canadian government, which in April 2014 published its report to the privacy commissioner of Canada to specifically address the privacy concerns associated with the spread of UAS in Canada, specifically as it relates to the commercial segment.[34]

The continuing proliferation of UAS around the globe shows no sign of slowing. Indeed, the technology of these advanced systems continues to far exceed the abilities of governments and law enforcement organizations to enact timely policies and appropriate legislative guidance to address the litany of new challenges UAS bring with them.

Increasing interest by hobbyists and technology enthusiasts is only matched in intensity by the burgeoning commercial market. Market segments across the board have engineered cost effective applications for UAS to increase efficiencies and enhanced productivity. By comparison, the evolution of FAA policy guidance regarding UAS use is no longer commensurate with the domestic demand utilizing these platforms. Under these circumstances, local and state public safety jurisdictions have had to apply existing ordinances or state statutes or create additional legislation to address the rapidly evolving issues related to UAS in the absence of a timely federal response.

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[33] House of Lords, *Civilian Use of Drones in the EU*, 7th Report of Session 2014–15 (London, England: House of Lords: European Union Committee, 2015), http://www.publications.parliament.uk/pa/ld201415/ldselect/ldeucom/122/122.pdf, 7.

[34] Ibid., 5–7.

In October 2015, it was announced the Department of Transportation Secretary, Anthony Foxx would convene a UAS task force to develop a process that would require UAS owners to register their UAS devices.[35] It remains unknown at this time how implementing a registration requirement will impact the delivery of the FAA's overall guidance criteria originally required under the Modernization Reform Act of 2012. Despite national similarities over the need for legislative guidance, ensuring consistency of interpretation among so many jurisdictions nationally will remain a challenge until federal guidance is provided.

Further literature considered in this review includes "Da Vinci's Children Take Flight: Unmanned Aircraft Systems in the Homeland," a 2014 Naval Postgraduate School thesis by Jeanie Moore.[36] In this work, the author provides a comprehensive look at the UAS timeline and a current snapshot of the legislative environment governing UAS authorization and enforcement guidelines to date. Moreover, the paper provides a more detailed overview of the current challenges the United States will continue to face concerning the issue of privacy until final legislative direction can be provided. A closer look at civil liberty organizations and watchdog groups present a common operating picture for consideration. Moore also emphasizes lessons learned from our EU and UK counterparts during their ongoing integration;[37] however, specific differences in cultural acceptance are further identified.

One area left unaddressed in Moore's thesis involves the threat profile posed by UAS to the public and law enforcement and also the dangers inherent to both by malicious actors who are intent on deploying these platforms for nefarious purposes. Of these, the growing cyber environment remains at the forefront of concern along with the integration of future technological developments, such as 3-D printing, autonomous and self-aware robotics, and the Internet of Things.[38]

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[35] Mary Coleman, "New Drone Regulations to Take Flight Soon," *KFDA News Channel 10*, October 22, 2015, http://www.newschannel10.com/story/30329692/new-drone-regulations-to-take-flight-soon, 1.

[36] Jeanie Moore, "Da Vinci's Children Take Flight: Unmanned Aircraft Systems in the Homeland" (master's thesis Naval Postgraduate School, 2014), https://www.hsdl.org/?view&did=753798.

[37] Ibid., 21.

[38] Ibid., 9, 72.

D. REGULATORY FRAMEWORK AND TIMELINE

With the passage of the Modernization Reform Act of 2012, the FAA was directed to produce a roadmap for successful UAS integration within the year, in essence creating the expectation it would be completed by February 2013. However, this roadmap was not produced until November 7, 2013, more than nine months overdue.[39] To accomplish this five-year roadmap, the Federal Aviation Administration (FAA) created the Unmanned Aircraft Systems Integration Office to facilitate UAS integration in a safe and efficient manner within the NAS.[40] The goal of this effort was to integrate UAS into the NAS "without reducing existing capacity, decreasing safety, negatively impacting current operators, or increasing the risk to airspace users or persons and property on the ground any more than the integration of comparable new and novel technologies."[41]

Under current guidelines, UAS civil operators must obtain authority to operate a UAS under one of three programs. UAS operating as a public aircraft must obtain a certificate of waiver or authorization (COA), assessed on a case-by-case basis. UAS operating as civil aircraft within the private sector must obtain authority from a special airworthiness certificate (SAC), which provides only limited and provisional coverage for operations. Model aircraft are governed by the Interpretation of the special rule for model aircraft under FAA §336.[42] As described by Yakabe in *Homeland Security Affairs*, the waiver protocols and restrictive operational conditions make it cumbersome for law enforcement and academic institutions.[43] Obtaining COAs permitting UAS operation in public airspace is difficult to obtain. Currently, this level of authorization has only been made available to the military, the Department of Homeland Security, the Energy Department, agriculture sector, Departments of Interior and Justice, the Federal Bureau of

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[39] John Abizaid, Rosa Brooks, and Rachel Stohl, *The Task Force on U.S. Drone Policy* (Washington, DC: Stimson Center, 2014), http://www.stimson.org/content/recommendations-and-report-stimson-task-force-us-drone-policy-0, 24.

[40] Federal Aviation Administration, *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap, National Airspace Integration Roadmap* (Washington, DC: U.S. Department of Transportation, 2013), https://www.faa.gov/uas/media/uas_roadmap_2013.pdf, 4.

[41] Ibid.

[42] Alison Yakabe, "UAS on Main Street: Policy and Enforcement at the Local Level," *Homeland Security Affairs* 11, Article 4 (2015): 2.

[43] Ibid., 4.

Investigation, the National Oceanographic and Atmospheric Administration (NOAA), and several universities conducting approved research.[44]

In the United States, current regulatory authority rests solely with the FAA. The passage of the FAA's Modernization Reform Act of 2012 on February 14, 2012 established Public Law 112–95. This act mandates that the FAA give prioritization to the successful integration of civil unmanned aircraft (UAS) into the national airspace by September 30, 2015.[45]

To date, no such policy guidance has been provided; however, additional guidance was made available in June 2016 for commercial UAS applications. The Modernization Reform Act of 2012 initially was designed to promote and facilitate the use of civilian unmanned aircraft and as such contained multiple mandates and restrictions.[46]

In the interim, UAS operators wishing to pursue a safe and legal option to introduce the UAS into the NAS for commercial applications can apply for an FAA § 333 exemption under the Modernization and Reform Act of 2012. According to the FAA's website, as of May 9, 2016, there was a total of 5,188 § 333 exemption petitions filed, and only 1,517 petitions closed out to date. In addition, the FAA has stated due to the high volume of § 333 petitions received, it is experiencing delays in processing them all.[47] Stimson's June 2014 recommendations report noted the FAA should consider a modified approach by using the exemptions defined under § 333 as the grounds for permitting commercial UAS operations, as the entire country awaits a more permanent

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[44] Carr, *Unmanned Aerial Vehicles*, 29.

[45] Yakabe, "UAS on Main Street," 2.

[46] Bart Elias, *Pilotless Drones: Background and Considerations for Congress Regarding Unmanned Aircraft Operations in the National Airspace System* (Washington, DC: Congressional Research Service, 2012), https://www.fas.org/sgp/crs/natsec/R42718.pdf, 5.

[47] Federal Aviation Administration, "Section 333 of the FAA Modernization and Reform Act of 2012,"accessed October 15, 2016, https://www.faa.gov/uas/legislative_programs/section_333/, 1.

operational framework from the FAA.[48] In doing so, Stimson's report acknowledged the temporariness of this option as a potential interim solution.[49]

The FAA is granting this authority on a case-by-case review until the final small UAS rule, which has been delayed since the September 30, 2015 deadline, is finalized. Rumors of the FAA releasing the final report were believed to be set for June 2016; however, with the current election cycle in full swing, it was not expected to be released until after the presidential elections in November 2016, according to UAS industry reports.[50] However, the FAA did release the Summary of Small Unmanned Aircraft Rule (Part 107) on June 21, 2016, which goes into effect in August 2016.

The FAA has also been tasked with developing a program for integrating UAS into the NAS at six different test ranges; i0ts anticipated due date was August 12, 2012. Completion of this project did not occur for another 16 months before its completion on December 30, 2013.[51] Over the course of 10 months, 25 proposals were received from 24 different states vying for the opportunity to be selected as a test site. Consideration was given to geography, climate, and location of ground infrastructure, research needs, airspace use, safety, aviation experience and risk.[52] The sites chosen included the University of Alaska, state of Nevada, New York's Griffiss International Airport, North Dakota Department of Commerce, Texas A&M University at Corpus Christi, and Virginia Polytechnic Institute and State University (Virginia Tech).[53] In October 2015, Transportation Secretary Anthony Foxx and FAA Administrator Michael Huerta announced the FAA was organizing a task force to develop a UAS registration program for all small UAS platforms by November 20, 2015.[54] The program was finalized, and it

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[48] Abizaid, Brooks, and Stohl, *The Task Force on U.S. Drone Policy*, 49.

[49] Ibid.

[50] "Recent UAS Developments," *Rotor & Wing Magazine*, February 23, 2016, http://www.aviationtoday.com/rw/eletters/Recent-UAS-Developments_87262.html, 1.

[51] *FAA's Progress and Challenges in Integrating*, 4 (Table 1).

[52] Federal Aviation Administration, "FAA Announces Six UAS Test Sites," May 15, 2016, http://www.faa.gov/uas/legislative_programs/test_sites/, 1–2.

[53] Ibid.

[54] Miriam McNabb, "DOT Makes Official Statement on Drone Registration," *Drone Life*, October 19, 2015, http://dronelife.com/2015/10/19/dot-makes-official-statement-on-drone-registration/, 1.

was formally announced on December 14, 2015 that registration would open on December 21, 2015.[55] It was anticipated by the FAA the holiday season would cause a spike in projected numbers of UAS taking to the skies. All UAS owners and operators had 60 days to register their platforms before they would be subject to civil penalties and fines assessed by the FAA.[56]

Despite the FAA's acting on the recommendations of the Drone Task Force to initiate a registration program, the effort was not well received by hobby enthusiasts and the UAS industry. Most of the dissent centered on the $5 registration fee and questioned how effective this program was likely to be in improving UAS safety. One industry representative, Douglas Johnson, the vice president of Technology of the Consumer Technology Association (CTA), was quoted as saying:

> We appreciate the FAA's decision to embrace many of the Task Force's recommendations regarding a consumer drone registration system. However, we disagree with the decision to impose a five-dollar registration fee—a 'drone tax,' which will hamper registration and discourage compliance.[57]

E. LEGAL AND PRIVACY ISSUES

The introduction of domestic UAS applications within the United States has created a sense of urgency among lawmakers to develop a sound strategic plan to facilitate the successful integration of UAS into the NAS within the United States. In the meantime, local and state agencies and municipalities are engaged in various legislative efforts across the country to develop best practices ordinances and policies for their respective jurisdictions to address the immediate need for legal guidance and a structured governance framework for UAS expansion. A secondary consequence to this effort is the mixed bag approach to policy development. This often results in a lack of consistent

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[55] Ibid.

[56] Sean D. Hamill, "Hobbyist Upset with FAA Requiring All Unmanned Aircraft Owners to Register," *Pittsburgh Post-Gazette*, December 16, 2015, http://www.post-gazette.com/news/nation/2015/12/16/Hobbyists-upset-with-FAA-requiring-all-unmanned-aircraft-owners-to-register/stories/201512160089, 2–3.

[57] Miriam McNabb, "Reaction to Drone Registration: Overwhelmingly Against," *Drone Life*, December 15, 2015, http://dronelife.com/2015/12/15/reaction-to-drone-registration-overwhelmingly-against/, 1.

application and interpretational clarity or run afoul with aligning with existing FAA regulations.

The FAA recently commented on this issue by stating that the new UAS registration program is the sole means by which the FAA can identify aircraft operating in the navigable airspace, and it emphasized that no local or state agency has the authorization to impose additional registration requirements without FAA approval.[58] It further cited as an example that this "patchwork quilt" of multiple differing restrictions limits the FAA's ability to control the navigable airspace safely.[59]

Developing a national governance framework has proven challenging for lawmakers as they grapple with society's opposing perceptions and varying degrees of societal acceptability. Careful consideration must be given to the potential implications UAS integration into airspace will have on civil liberties, privacy, and public safety while also promoting a sound business environment supportive of economic growth within a transparent and accountable framework.[60]

Evaluating the full extent to which UAS will adversely impact individuals' rights to privacy remains to be seen. Much of the conversation has been centered on the public's perception of increased government overreach should UAS be integrated into the public safety repertoire. National watchdog groups like the American Civil Liberties Union (ACLU) have opined on the matter, suggesting even though there are valid applications for UAS in public safety, their benefits are likely to be outweighed by mission creep and their use for more controversial purposes.[61]

I reviewed several bodies of literature concerning varying perspectives on the topic of UAS integration within a public safety environment and the challenges of preconceived beliefs in the premise that government will widen the gap of mistrust through abuse of civil liberties.

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[58] Office of the Chief Counsel, *State and Local Regulation*, 2.

[59] Ibid.

[60] White House Office of the Press Secretary, "Promoting Economic Competitiveness," 1.

[61] Murphy et al., *The Future of Drones in America*, 6.

According to Richard Thompson with the Congressional Research Service, in order to resolve the issues surrounding privacy, we must determine exactly what "privacy" means.[62] The public lacks understanding regarding what constitutes a person's reasonable expectation of privacy and how it applies to the individual. Some guidance is provided in case law as cited in California v. Ciraolo, Florida v. Riley, and United States v. Knotts.[63]

Furthermore, Thompson describes the second issue of concern with regard to privacy as identifying which regulatory authority should be responsible for this role. Given that the FAA has taken a predominantly passive role in this effort to date, Thompson is hopeful the anticipated presidential privacy directive for UAS use will provide an initial privacy regulatory framework.[64]

In addition, Thompson also discusses the concern expressed by President Obama on the issue of privacy and the protection of civil liberties.[65] The president has tasked the federal agencies to identify the extent to which each contributes to the narrative of public distrust by the government's use of UAS in the hopes of developing a best practice model to mitigate societal discourse on this issue.[66] In a similar fashion, the Washington Center for Democracy and Technology (CDT) has elevated its position on the protection of privacy and civil liberties as they relate to law enforcement use of UAS. According to the CDT, since the practice of policy review falls under the purview of the FAA, it should be a top priority to consider law enforcement agency requests to implement UAS technology in a public safety capacity.[67] The CDT also represents an ideology pushing for congressional amendments to the existing Modernization and Reform Act of 2012 in

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[62] Richard M. Thompson II, *Domestic Drones and Privacy: A Primer* (Washington, DC: Congressional Research Service, 2015), https://fas.org/sgp/crs/misc/R43965.pdf.

[63] Murphy et al., *The Future of Drones in America*, 6, 12.

[64] Thompson II, *Domestic Drones*, 1.

[65] Ibid.

[66] Ibid.

[67] Ann Cavoukian, *Privacy and Drones: Unmanned Aerial Vehicles* (Ontario, Canada: Privacy by Design, 2012), https://www.ipc.on.ca/wp-content/uploads/Resources/pbd-drones.pdf, 3.

hopes of achieving a more comprehensive approach to protecting civil liberties and oversight.[68]

Gregory McNeal of the Brookings Institute highlights the sense of urgency felt by privacy advocates to quell UAS integration nationally.[69] These advocates remain committed to creating barriers to entry for law enforcement as evidenced by their successful lobbying of 13 states to create very restrictive laws governing law enforcement use of UAS[70] —11 states first require law enforcement to obtain a warrant before it can even deploy a UAS in a professional capacity.[71] This demonstrates the continued angst associated with UAS deployments for fear of "persistence surveillance" by government officials or local law enforcement authorities. Absent from this discussion is the applicability of UAS use in an emergent situation in which there is insufficient time to obtain a search warrant as has been legislated by at least 11 of the first 13 states to enact UAS governance.

Wells C. Bennett, Fellow in National Security Law at Brookings Institute, positioned recently that state legislators are primarily focused on only those UAS flown by governments rather than expressing equal concern for "public" privacy.[72] Wells posits the idea private actors will soon operate more UAS systems than the government, suggesting the greater threat to privacy is from the public rather than government or law enforcement.[73] It will remain largely incumbent upon states to utilize existing state laws already in place to address privacy issue negating the need for additional laws. A second

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[68] Ibid.

[69] Gregory McNeal, *Drones and Aerial Surveillance—Considerations for Legislators* (Washington, DC: Brookings Institute, 2014), http://www.brookings.edu/research/reports2/2014/11/drones-and-aerial-surveillance, 1.

[70] Ibid.

[71] Ibid.

[72] Wells C. Bennett, *Civilian Drones, Privacy, and the Federal-State Balance* (Washington, DC: Brookings Institute, 2014), http://www.brookings.edu/research/reports2/2014/09/civilian-drones-and-privacy, 2.

[73] Ibid.

area of concern as noted by Wells is the inconsistency of interpretation of trespassing and surveillance violations in the same manner.[74]

The literature identified to this point remains largely speculative in nature given the lack of official guidance from the FAA. Research suggests until specific cases have worked their way through the legal system or more definitive guidance is passed, issues surrounding the privacy implications associated with UAS operation remain largely unaddressed. Legal literary sources currently identified have discussed possible scenarios concerning how the legal community might respond to UAS integration, but the topic remains highly speculative at this time.

A more likely scenario that will frame the legal narrative includes legal cases that have yet to make their way through the legal system. The outcomes of these cases will serve to create legal precedence and further establish case law.

In the absence of federal guidance and a legal framework, local and state jurisdictions have aggressively pursued options to establish legislative governance for their respective jurisdictions. The state of Arizona is among the first states to grapple with the legal issues UAS integration is likely to create. However, before states like Arizona can begin the process of self-legislation, the state must ensure the appropriate deconfliction efforts have taken place so as not to violate existing federal law agency oversight.

F. CURRENT FAA REGULATORY FRAMEWORK

As authorized under the Modernization Reform Act of 2012, the FAA is the federal agency responsible for integrating these UAS platforms into the NAS. The FAA is responsible for all U.S. airspace safety from the ground up.[75] The rules governing UAS integration are focused on three distinct categories of UAS application. According to the

[74] Ibid., 5–6.

[75] Federal Aviation Administration, "Busting Myths about the FAA and Unmanned Aircraft," May 21, 2016, http://www.faa.gov/news/updates/?newsld=76240, 1.

FAA's model aircraft operations policy, rules and restrictions governing recreational use by hobbyists dictate a variety of restrictions under which a UAS can be operated.[76]

Civil UAS platforms are defined as non-governmental with a specified use intended for engaging in commerce activities or for academic and research purposes. There are currently two methods under which UAS operators may operate these platforms. The first method is to file a petition to obtain a § 333 Exemption and a civil certificate of waiver or authorization (COA) from the FAA. Under this exemption, the operator is authorized to utilize UAS for commercial applications while operating in low-risk environments.[77]

The second method is to submit an application for a special airworthiness certificate (SAC) from the FAA. This process requires the UAS operators to provide detailed documentation regarding the type of UAS platform they intend to operate. Specifics about how the UAS is designed and manufactured, the type of materials used, the electronic controls systems, and developmental software are required by the FAA to ensure the UAS meets the requisite quality control and safety guidelines for flight.[78]

The FAA draws its authority to regulate the operation of public aircraft from Title 49 U.S.C. § 40102(a) (41) and § 40125, which identify the qualifications required for this limited aircraft status.[79] The deployment of UAS platforms for public operations is best described as governmentally operational in purpose and is intended for use by local, state, and federal government functions, including use by law enforcement and emergency first responders.[80]

Under these parameters, the FAA requires public entities to apply for a COA. If granted, this COA provides public agencies with the appropriate authorization to operate

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[76] Federal Aviation Administration, "Model Aircraft Operations," June 20, 2015, https://.www.faa.fov/uas/model_aircraft/, 1.

[77] Federal Aviation Administration, "Civil Operations (Non-Governmental)," May 21, 2016, http://www.faa.gov.uas/civil_operations/.

[78] Ibid.

[79] Federal Aviation Administration, "Public Operations (Governmental)," May 21, 2016, https://www.faa.gov/uas/model_aircraft/.

[80] Ibid.

a specific type of UAS within a defined block of airspace for a specific purpose over a given period. Typically, most public operations COAs are valid for a period of up to two years.[81] This type of application is commonly supported today by law enforcement, fire department search and rescue, and other emergency first responder agencies in the performance of their official agency's operational mission objectives.[82]

Efforts are currently underway by the FAA to provide additional interpretation and guidance to the UAS community in what has become known as the FAA's "Small UAS Notice of Proposed Rulemaking" (NPRM) under proposed Part 107.[83] This amended document by the FAA is intended to provide additional operational clarity and regulatory direction for the expanded use of UAS across the country.[84] The intent of the proposed NPRM is to effectively create a supportive infrastructure for the use of small UAS in a safe and responsible manner preserving the integrity of the NAS while efficiently facilitating UAS integration.

To date, the FAA has provided a summary of the proposed adjustments the upcoming NPRM is likely to contain upon its completion along with the potential impact to UAS community operators. These proposed recommendations include but are not limited to the following:[85]

- Small UAS must weigh less than 55 lbs. (25 kg)
- May only be operated utilizing visual line of sight (VLOS) between the UAS and operator
- May only be operated during daylight hours
- UAS must always yield right of way to other aircraft, manned or unmanned

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81 Ibid.

82 Ibid.

83 Federal Aviation Administration, *Overview of Small UAS Notice of Proposed Rulemaking* (Washington, DC: Federal Aviation Administration, 2016), http://www.faa.gov/regulations_policies/rulemaking/media/021515_sUAS_Summary.pdf, 1.

84 Federal Aviation Administration, *Operation and Certification of Small Unmanned Aircraft Systems* (Notice No. 15–01) (Washington, DC: Federal Aviation Administration, 2016), https://www.faa.gov/regulations_policies/rulemaking/recently_published/media/2120-AJ60_NPRM_2-15-2015_joint_signature.pdf, 1.

85 Federal Aviation Administration, *Overview of Small UAS*, 1.

- May not exceed maximum speed of 100 mph (87 knots)
- May not operate at an altitude of more than 500 feet above ground level (AGL)
- May only operate in Class G airspace without Air Traffic Control (ATC) permission
- May only operate in Class B, C, D, and E airspace with ATC permission
- UAS will never operate in Class A airspace (18,000 feet and above) AGL
- UAS may not be operated in a careless or reckless manner

The integration of the proposed NPRM would mark the next iterative step towards effectively integration UAS in the NAS and would further open the door for a broader spectrum of UAS application nationally.[86]

G. THE LAW ENFORCEMENT RESPONSE

With the number of UAS steadily increasing across the country, law enforcement, especially at the both the local and state levels, is now confronted with a new and prolific challenge of how best to enforce the multitude of violations occurring between both private and commercially deployed UAS platforms within their respective jurisdictions. The FAA has realized it is neither equipped with the personnel nor the resources to address the growing number of UAS violations being committed nationally. It further recognizes that in almost all cases, it is the local or state law enforcement agency representatives who will be in the best position to make initial contact with the violator, conduct the initial investigation, and intercede to prevent and deter the dangerous operation of a UAS and its operator.[87] While the FAA retains the responsibility for enforcing UAS violations of FAA regulations, its intent remains to foster a collaborative relationship with local and state law enforcement agencies to address violations and ensure the safe and responsible operation of UAS platforms within the NAS.[88]

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[86] Federal Aviation Administration, *Operation and Certification*.

[87] Ibid.

[88] Ibid.

In this capacity, the FAA must continue to ensure its agency's focus remains on the administrative safety enforcement function and not criminal law enforcement.[89] Typically, the incidents involving violations of FAA regulations are adjudicated by virtue of administrative enforcement measures,[90] as it remains the philosophy of the FAA to seek voluntary compliance through public information and educational messaging in conjunction with administrative notification to operators. The FAA will pursue egregious violations through punitive civil fines as a matter of last resort in most circumstances.

As part of the initial response to incidents involving the illegal use of UAS, the FAA seeks to enlist the support of local and state law enforcement (LE) agencies to initiate the investigative process by first identifying the suspect operator, gathering insight as to the operator's intention for the flight, and conducting any subsequent interviews of witnesses to the offense. The FAA recognizes the importance of local LE to gather initial evidence, including possible video obtained from the UAS, to be considered in totality when determining the level of threat potential or type of offense committed by the UAS operator.[91] In determining if a crime has been committed, specific consideration should be given to evaluating the venue of the offending UAS operator. These details might include whether the UAS platform was being operated over a large sporting venue or crowd of people, flying intrusively over sensitive critical infrastructure or key resource locations of particular significance, or in violation of current FAA regulatory guidelines governing flight.[92]

Upon the completion of all initial investigation by local LE agencies, all reports are forwarded to one of the FAA's regional operations center (ROC) for investigative follow up.[93] While seemingly sound in theory, this investigative protocol is flawed in its

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[89] Federal Aviation Administration, *Law Enforcement Guidance for Suspected Unauthorized UAS Operations* (Washington, DC: U.S. Federal Aviation Administration), https://www.faa.gov/uas/resources/law_enforcement/media/FAA_UAS-PO_LEA_Guidance.pdf, 5.

[90] Ibid.

[91] Ibid., 5–6.

[92] Ibid.

[93] Ibid., 6.

approach and leaves local and state LE holding the bag in terms of enforcement responsibilities to protect the public's safety and welfare.

Many agencies lack the investigative infrastructure to support and facilitate the transferring of investigations for FAA follow up due to a lack of readily available FAA investigators. At best, the FAA is only able to provide a contact phone number for LE to contact with questions. This mechanism lacks timeliness by FAA investigators to conduct the requisite follow up and provides no immediacy of relief for the investigating LE agency. This matter is further compounded by the FAA's conservative approach to enforcement by mostly promoting non-enforcement, educational-based philosophy that does little to increase UAS operator safety or to encourage effective behavior modification through enforcement efforts.

H. ARIZONA'S UAS LEGISLATIVE EFFORTS

In 2015, the town of Paradise Valley, Arizona was among the very first towns to initiate local legislation in the form of drafting a city ordinance that would effectively govern the operation of UAS platforms within the town. These regulations were pursued in earnest amid complaints from concerned citizens regarding how UAS would be permitted within their community and who would enforce the rules and address subsequent violations.[94]

Equally important to the town was need to create a balance between the competing interests of privacy and public safety and the need to develop an environment conducive with enabling recreational use and commercial application of UAS.[95] In response, the town's leadership elected to construct a draft to address three categories of UAS operations; commercial, recreational, and emergency.

On May 28, 2015, the town of Paradise Valley elected to postpone a June 11, 2015 vote to allow for more time for city leadership and council members collect and digest input from a variety of private and public stakeholders, including representatives

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[94] "Unmanned Aerial Vehicles," Town of Paradise Valley, AZ, "Unmanned Aerial Vehicles," May 22, 2016, http://www.paradisevalleyaz.gov/547/Unmanned-Aerial-Vehicles, 1.

[95] Ibid.

of the UAS manufacturing industry. This postponement was to be readdressed again in the fall before moving forward with the existing ordinance as approved.[96] Finally, the town of Paradise Valley officially adopted Ordinance No. 691 on December 3, 2015.

Section 10–12-3.A of the ordinance describes UAS operation to be unlawful over private property without the owner's consent at an altitude of zero to 500 feet AGL. Violations of this order are classified as criminal trespass pursuant to subsection 10–12-4 and Article 1–9 of the town code.[97] The use of a UAS over public property within the town's limits is unlawful unless the operator has obtained a special event permit pursuant to § 8–8-3 of the Paradise Valley Town Code.[98]

Commercial operation of a UAS on private or public property requires both property owner's permission and/or the obtaining of a special event permit. It also requires proof of UAS registration and notification, detailing the purpose of the UAS flight and anticipated duration. This information must be provided to the Paradise Valley Police Department at least four hours in advance of flight operations via online portal. This is a forward facing portal allowing the public to query a location where a UAS is observed in operation to gather details about its operation.[99]

Ordinance 691 also addresses use of UAS by first responders under § 10–12-3.D.2. This section defines the exceptions that authorize emergency first responders to utilize UAS platforms as part of their official duties in response to an emergent incident or after obtaining a lawful search warrant based on probable cause.[100] Law Enforcement is the only recognized emergency first responder agency authorized under this ordinance to deploy this technology.

At the start of the legislative session in the fall of 2015, Senator John Kavanagh, a Republican representative out of neighboring Fountain Hills, Arizona introduced Senate

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96 Ibid., 1.

97 Press, "Paradise Valley AZ Drone Ordinance Update," *SUAS News; The Business of Drones*, May 29, 2015, http://www.suasnews.com/2015/05/paradise-valley-az-drone-ordinance-update/.

98 Ibid., 3.

99 Ibid.

100 Ibid.

Bill (SB) 1449. The spirit of this bill was to enact state legislation that would preempt local municipal jurisdictions from creating their own legal patchwork regulating UAS operations as Paradise Valley had done.[101]

Senator Kavanagh hoped to consolidate all stakeholder concerns into one piece of legislation governing UAS operations and regulations throughout the entire state of Arizona instead of all 74 different jurisdictions in the state creating their own regulatory framework, which would make it difficult for UAS operators to be compliant as they cross jurisdictions. Arizona Governor Doug Ducey signed SB 1449 into law on Wednesday, May 11, 2016.[102] SB 1449 took effect on August 6, 2016 and serves to render any existing laws or ordinances enacted by individual municipalities invalid (such as the one enacted by Paradise Valley). Furthermore, it prevents any other communities from attempting to create their own in the future.[103]

Other Arizona cities, such as Glendale, have actively pursued the creation of local city ordinances in response to concerns about how best to deal with UAS technology and its impact to its residents. In late 2015 and early 2016, the City of Glendale drafted Ordinance No. 2971 (New Series) to provide community-based safety requirements and to impose restrictions governing the use of UAS in the city of Glendale. The proposed draft amendment was scheduled to fall within the Glendale City Code Chapter 27, Article III, Division 2 and would be added as a new section under 27–56.[104]

Glendale's proposed ordinance combined the use of a UAS and model aircraft together and provided additional clarity in terms of when and how they could be flown.

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[101] Jacob McAuliffe, "Arizona Bill Would Preempt Local Drone Regulations; New FAA Rules Could Preempt State," *BBC News*, May 9, 2016, http://kjzz.org/content/303472/arizona-bill-would-preempt-local-drone-regulations-new-faa-rules-could-preempt-state.

[102] Associated Press, "Arizona Gov. Ducey Signs Statewide Rules on Drones,"*3TV News*, May 11, 2016, http://www.azfamily.com/story/31952452/arizona-gov-ducey-signs-statewide-rules-on-drones.

[103] Howard Fischer and Mike Christy, "Ducey Signs Bills about Drones Crime Witnesses and Service Animals," *Arizona Daily Star*, May 11, 2016, http://tucson.com/news/state-and-regional/ducey-signs-bills-about-drones-crime-witnesses-and-service-animals/article_ec0b356a-3e6c-51df-b506-b5c2b537bfd7.html, 3.

[104] City of Glendale Arizona, Ordinance No. 2971, Chapter 27, Article III, Division 2, § 27–56, Unmanned Aircraft Systems, https://www2.municode.com/library/az/glendale/codes/code_of_ordinances?nodeId=PTIICOOR_CH27PARE_ARTIIIPARU_DIV2GERE.

This draft proposed the use of UAS within the city of Glendale limits could only occur during day light hours, at an elevation of not greater than 400 feet AGL utilizing VLOS only, the acknowledgement of temporary flight restrictions (TFRs) around the University of Phoenix Stadium during game days, and not within 5 miles of the nearest Luke Air Force Base.[105] The Glendale proposed ordinance further outlined that any UAS operation cannot be conducted in a careless or reckless manner and that violators would be guilty of a Class 1 misdemeanor.[106] The final execution of this ordinance was placed on hold pending the outcome of Arizona's state legislative efforts surrounding SB 1449, which took effect on August 6, 2016.[107] Glendale's current city code under Chapter 27, Article III, Division 2 shows a reserved placeholder for § 27–56 of this Draft Ordinance No. 2971 for possible future inclusion.[108] This effort was later deemed irrelevant with the passage of SB 1449 and no ordinance took effect.

Beginning in the fall of 2015, the City of Phoenix also initiated efforts to develop a city ordinance in response to the rising popularity of UAS platforms and to provide some general guidance for UAS operations within the city of Phoenix. I served as a participating member of this policy development group representing the police department's Homeland Defense Bureau. The city manager's office invited various city department heads to convene a task force comprised of a wide and diverse group of citizens, community partners, and stakeholders. All of whom participated under the direction of the city managers representative overseeing the development of this ordinance. Representative membership from the city's elected leadership, legal, privacy watchdog groups (including the Goldwater Institute), the insurance industry, citizen advocates, business sector, and UAS industry members all participated in this active and evolving process.

With the city of Phoenix, the UAS issue was driven by a need identified by the elected officials of the city council to provide guidance and clarity for UAS operations

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105 Ibid., Chapter 27, Article III, Division 2, § 27–56: 3.

106 Ibid.

107 Fischer and Christy, "Ducey Signs Bills," 3.

108 City of Glendale Arizona, Ordinance No. 2971, Chapter 27, Article III, Division 2, § 27–56.

that accomplished two specific mission objectives. The first was to create an environment that was supportive of commercial UAS applications within the city to foster economic growth and expand business opportunities. Second, the city was intent on establishing a policy that would clearly outline the regulations for law enforcement and public safety officials to follow when using UAS in a manner respectful of the individual citizens' right to privacy and the preservation of Fourth Amendment rights under the Constitution.

Over the course of several months, Draft Ordinance No. G-6086 underwent nine different iterations as the development group continued to refine the ordinance. Critical components of this draft identified and defined critical infrastructure and other sensitive locations wherein UAS operations conducted by other than public safety were prohibited.[109] The ordinance further opened the door for expanding the commercial use of UAS within the city, including for journalistic intent, photography, and media use.[110] Use of UAS by law enforcement or public safety first responders had been relegated to the following scenarios: For use during exigent circumstances, use to conduct search and rescue operations, and either with consent or after obtaining a search warrant on private property based upon probable cause.[111]

The ordinance further compelled law enforcement utilizing UAS to provide notification to the public of its use and required law enforcement to provide a written statement to the city manager within 30 days of deployment to provide specific justification and overview of the circumstances surrounding the decision to deploy UAS.[112] As with many other legislative efforts regarding UAS, the Phoenix ordinance also contained a default clause that all use approved by the City of Phoenix as defined was lawful provided it did not conflict with existing FAA regulations currently in place.[113]

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[109] City of Phoenix, "Ordinance No. G-6086," § 1, Chapter 23; City of Phoenix, Ordinance No. G-6086, § 2, Chapter 24 (Draft, Version 9, City of Phoenix, Phoenix, AZ), 2.

[110] Ibid., § 1, Chapter 23; § 2, Chapter 24: 5.

[111] Ibid., § 1, Chapter 23; § 2, Chapter 24: 6.

[112] Ibid., § 1, Chapter 23; § 2, Chapter 24: 10.

[113] Ibid.

Following the ninth revision of Phoenix's draft ordinance in January 2016, the decision was made by city leadership to place this project on hold pending the outcome of current legislation defined under SB 1449, which was already introduced in the current legislative session. As a result of SB 1449 being signed into law,[114] efforts to move forward with City of Phoenix Draft Ordinance No. G-6086 has been suspended indefinitely.

The significance of SB 1449 for the state of Arizona can be found in its identification of three main elements. One, it prohibits the operation of UAS in a manner that interferes with emergency first responders performing their duties in an official capacity. Two, it prohibits the use of UAS to take images of sensitive locations or critical infrastructure locations as defined by the jurisdiction. Three and perhaps most importantly, SB 1449 preempts any local jurisdiction or municipality within the state of Arizona from enacting its own laws regulating UAS operations.[115]

I. THE NATIONAL OUTLOOK

During the 2016 legislative session, at least 41 states have either considered or introduced legislation, while 10 states have passed 14 separate pieces of legislation. These states include Arizona, Idaho, Indiana, Kansas, Oklahoma, Oregon, Tennessee, Utah, Virginia, and Wisconsin.[116] These efforts follow the flurry of activity occurring in 2015 during which 45 states considered 168 bills or resolutions governing UAS operations within their respective jurisdictions.[117]

By reviewing the various pieces of state legislation enacted thus far, it becomes evident just how significant the impact of UAS technology is for our nation. Few technology-based systems have had the ability to influence such a broad base of user groups in the way UAS integration has. The challenge of integrating UAS into the NAS

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[114] Fischer and Christy, "Ducey Signs Bills," 3.

[115] National Conference of State Legislatures, "Current Unmanned Aircraft State Law Landscape," May 19, 2016, http://www.ncsl.org/research/transportation/current-unmanned-aircraft-state-law-landscape.aspx.

[116] Ibid.

[117] Ibid., 2.

involves addressing the wide range of acceptable practices by very diverse communities and user groups. While there are similarities that can be found in recently enacted legislation by various states, still others have opted to address very specific issues impacting their communities.

For example, states like Idaho's SB 1213 and Indiana's House Bill (HB) 1013 seek to enforce the protection of wildlife while prohibiting the use of UAS for scouting game or harassing wildlife in their natural habitat.[118] States like Arizona, Utah, and California have prohibited utilizing UAS in a manner interfering with emergency first responders during an emergency as identified in Arizona's SB 1449, Utah's HB 126,[119] and California SBs 167 and 168 introduced in 2015 during wildfire season.[120]

States like New Hampshire have expressed great regard for the preservation of an individual's right to privacy by recently challenging the existing Supreme Court case law under Florida v. Riley and California V. Ciraolo.[121] Both previous case laws have yielded justice opinions that there is no reasonable expectation of privacy in a person's backyard; however, the New Hampshire House of Representative recently passed a bill to tighten the this position and provide greater clarity for the acceptable use of UAS by law enforcement by prohibiting UAS use for surveillance purposes.[122] HB 602FN has been years in the making for the state of New Hampshire and reflects the state's acknowledgement of how determined the residents are when it comes to protecting their privacy and civil liberties.[123] Still other states like Kansas with the passage of SB 319

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118 Ibid., 1.

119 Ibid.

120 "California Bill Lets on the Job Firefighters Take out Drones," *CBS Los Angeles*, July 20, 2015, http://losangeles.cbslocal.com/2015/07/20/bill-would-allow-officials-to-disable-drones-interfering-with-firefighting-efforts/.

121 Matthew Feeney, "Lawmakers in 'Live Free or Die' State Tackle Drone Privacy Issues," *Forbes*, April 5, 2016, http://www.cato.org/publications/commentary/lawmakers-live-free-or-die-state-tackle-drone-privacy-issues.

122 Ibid., 2.

123 Miriam McNabb, "NH Latest State to Consider Drone Regulation," *Drone Life*, January 27, 2016, http://dronelife.com/2016/01/27/nh-latest-state-to-consider-drone-regulation/.

have chosen to focus more specifically on anti-stalking protections to prevent harassment of residents.[124]

J. THE GLOBAL OUTLOOK

The United States is not alone in its efforts to integrate UAS into its jurisdictional airspace. Faced with similar challenges, countries like the UK, as part of the European Union (EU), and Canada continue to grapple with similar issues facing their populations.

1. UAS in the UK

In October 2012, the European Commission established the Remotely Piloted Aircraft Systems (RPAS) Steering Group tasked with developing a European strategy to serve as the roadmap for integrating RPAS into the European airspace. In June 2013, the steering group presented its recommendations outlining the specifics of its approach to integration.[125] In April 2014, the commission published an updated communication addendum entitled "A New Era for Aviation," which set out to expand upon the current integration strategy and to provide a framework upon which to create an environment that will "enable the growth of the commercial RPAS market while safeguarding the public interest."[126]

In January 2016, the European Aviation Safety Agency (EASA) rendered a technical opinion concerning the future of UAS in EU. This opinion broke UAS platforms into three specific categories or classes and provided 27 recommendations for consideration to improve air safety for UAS operations within the EU airspace.[127] The three categories identified by EASA were defined as follows:

- *Open Category*: Includes the consumer-grade UAS platforms not requiring aviation authority utilizing VLOS only at a defined maximum altitude

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[124] National Conference of State Legislatures, "Current Unmanned Aircraft."

[125] House of Lords, *Civilian Use of Drones in the EU*, 7.

[126] Ibid.

[127] National Business Aviation Association, "Region V: Europe EASA Lays out Possible Roadmap for UAS Airspace Integration," January 28, 2016, https://www.nbaa.org/ops/intl/eur/20160128-european-aviation-safety-agency-lays-out-possible-roadmap-for-unmanned-aircraft-systems-airspace-integration.php.

away from airports or large crowds, and they must weigh less than 500 grams (17.67 ounces).[128]

- *Specific Category*: Includes UAS platforms used commercially by media, and those requiring specific operational risk assessment (similar to the FAA's COA approval process), and those that are operationally governed by air type and specific operational parameters.[129]
- *Certified Category:* Includes UAS platforms capable of international transport operations and would require certification of the UAS and licensing of the pilots in order to conduct operations.[130]

2. UAS in Canada

Much of the same can be said about Canada's efforts to create its own UAS regulations. Canada's version of the U.S. Department of Transportation is known as Transport Canada, and it is in the process of introducing more restrictive regulations to more effectively respond to the rapid growth of the consumer UAS industry.[131] Current Canadian regulations allow for the use of UAS platforms weighing less than 2 kg (4.4 pounds) without permission in a recreational capacity, but they must comply with common sense exemption requirements limiting flight access over restricted or controlled airspaces and must be flown in a safe and responsible manner.[132]

Transport Canada's newly proposed amendments more specifically address UAS platforms weighing less than 25 kg. Their intention is to ensure safe and reliable operations within Canadian airspace by establishing a lower threshold of UAS classification category, providing clarity in terminology, and implementing an aircraft registration requirement for Canadian operations.[133] This is very similar to the FAA's registration introduced in December 2015 within the United States.

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128 Ibid.

129 Ibid.

130 Ibid.

131 Miriam McNabb, "Canadian Drone Regulations to Tighten," *Drone Life*, January 28, 2016, 1, http://dronelife.com/2016/01/28/canadian-drone-regulations-to-tighten/.

132 Ibid.

133 Ibid.

In many respects, Canada has taken the lead over the United States in developing and integrating UAS regulations on a national level. This has occurred even though the U.S. and Canada are working under a collaborative agreement put into effect in 2014, known as the Joint Forward Plan, which is designed to coordinate UAS regulations between the two countries.[134]

Under the Joint Forward Plan, the Canadian Regulatory Cooperation Council (RCC) and Transport Canada will continue to work collaboratively with the United States and the FAA even as the NPRM is awaiting publication ensuring consistency between the two countries operating in the navigable airspace.[135]

During 2015, Canada continued its developmental progress by releasing the Notice of Proposed Amendment (NPA), which is designed to provide a risk-based regulatory framework for UAS platforms weighing less than 55 pounds (25 kg).[136] Under this framework, the NPA has developed three distinction operational categories for UAS operations differentiated by the inherent level of risk involved. These three categories are defined as follows:

- *Complex Operations*: Includes UAS flight operations in heavily urbanized environment, near or adjacent to airports and would require operators and pilots to licensed. Also would require registration of UAS platforms in accordance with the design standards of the system operated while under VLOS operation only.[137]
- *Limited Operations*: Includes UAS operations in a geographic location with less risk, operating at a maximum altitude of 300 feet AGL, at a top speed of 87 knots (100 mph) during daylight hours and within a specifically designated airspace class. Operator is not required to be licensed.[138]

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[134] Ibid.

[135] Ibid.

[136] Jennifer E. Trock and Graham Keithley, "Canada Working on UAS Regulations," *UAS Law Blog*, April 12, 2016, http://www.uaslawblog.com/2016/04/12/canada-working-uas-regulations/.

[137] Ibid., 1–2.

[138] Ibid., 2.

- *Very Small UAS Operations*: Would require operators to meet control and supervision, training, security, maintenance, manuals, and procedures consistent with the operator's organization. Would allow operators to operate within 5 nautical miles (nm) of urbanized areas without the need for insurance.[139]

If we were to compare the U.S. regulatory framework to that of the Transport Canada (TC), a few distinct differences begin to emerge. While the U.S. has positioned itself behind a one size fits all approach to UAS regulation, TC has opted to regulate these platforms based on a tiered risk approach. While the United States has not proposed regulations that would permit UAS night operations, TC has built this option into the classification category covering complex and limited operations requiring the appropriate pilot permitting and medical certificates for licensed pilots.[140]

K. TECHNOLOGY AND ECONOMIC IMPACT

Many of the advancements in UAS technology are attributed to manufacturing and production breakthroughs impacting the miniaturization process as well as reducing costs associated with production and supply chain management. Trade publications, such as *Drone Life*, have showcased how the consumer demand for smaller and more powerful cell phones has led to the development of microelectromechanical systems (MEMS). This process enables microscopic silicon simple machines to be built on the same chips as the electronics to read them. This process makes it possible for a chip smaller than a dime to be able to measure acceleration in all three spatial directions.[141]

Current literature has identified several commercial entities, such as Google and Amazon, as intent upon incorporating UAS into their corporate business strategies. Currently, Amazon has obtained FAA permission for experimental testing for its UAS delivery concept, while filing its patent application with the U.S. Patent and Trademark

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139 Ibid.

140 Ibid., 3.

141 "Why Are There So Many Drones All of a Sudden?," *Drone Life*, June 30, 2015, http://dronelife.com/2015/06/30/why-are-there-so-many-drones-all-of-a-sudden/.

Office in March 2015.[142] As the free market enterprise continues to integrate UAS into the commercial arena, policy makers are slow to respond widening the gap between opportunity and effective legislation.

Technology based industries, such as IMSAR LLC based in Utah, have developed a small collision-avoidance system for multiple small UAS platforms. IMSAR's synthetic aperture radar technology will be available in the coming year.[143] Technology breakthroughs such as this continue to update the UAS industry impacting the platforms operating domestically, while others continue to develop technology to mitigate UAS operations by targeting the need to develop "sense and avoid" technology to increase UAS safety, which is expected to become a mandatory requirement in the near future.

There are multiple manufacturers developing advanced anti-UAS technology systems utilizing advanced imaging and sensor technologies. For example, Lockheed-Martin has developed a ground based system called ICARUS to detect, locate, and mitigate an approaching UAS threat from a ground-based location; it is designed to address a UAS threat in restricted airspace.[144] Batelle Innovations has developed a shoulder-mounted rifle anti-UAV device. Still others like Blighter Surveillance and its Anti-UAV Defense System, and Israel Aerospace Industries and its Drone Guard system continue to make technological contributions to the field.[145] Continued research and development into equipping UAS with sensor technology and various optical imaging platforms will continue to eliminate barriers to entry for even small- to mid-size commercial applications.

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[142] Rene Marsh, "Amazon Drone Patent Application Imagines Delivery That Comes to You with One Click," *CNN Politics*, May 12, 2015, http://uas.asprs.org/ index.php?option=com_content&view=article&id=2514:amazon-drone-patent-imagines-delivery-that-comes-to-you-with-one-click&catid=39:cnn-rss&Itemid=143.

[143] Luke Geiver, "Nanoradar System for UAS Collision Avoidance Set for 2016," *UAS Magazine*, October 15, 2015, http://www.uasmagazine.com/articles/1284/nanoradar-system-for-uas-collision-avoidance-set-for-2016.

[144] Ibid.

[145] Miriam McNabb, "Drone Defense Systems Rushing to Market," *Drone Life*, October 20, 2015, http://dronelife.com/2015/10/20/drone-defense-systems-rushing-to-market/.

With the rapidly expanding market for UAS-related technologies, market projections on UAS growth for the foreseeable future continue to surpass even the most aggressive estimates. Available market research reviewing the potential for worldwide spending on UAS over the next 10 years is expected to nearly double from $6.4 billion annually to $11.5 billion, totaling almost $91 billion over the next decade according to the Teal Group's Philip Finnegan.[146]

Recent spending estimates provided by the *Insurance Journal* estimate the current global market sales for commercial UAS applications and technology to increase dramatically. The consulting group of PricewaterhouseCoopers LLP stated in a May 2016 report that current UAS sales of $2 billion are expected to increase to as much as $127 billion by 2020.[147]

According to the *Insurance Journal*, this increase is linked to the falling cost of integrating UAS technology, making it affordable to an ever-widening audience.[148] When coupled with the extremely broad variety of applications spanning multiple business segments within the public and commercial realm, we can expect there will not be a decline in global UAS sales for some time in the distant future.

Still other estimates, such as one released by the Grand View Research Inc. in a recent report, are much more conservative. This report estimates the UAS market size to reach sales of $4.19 billion by 2024. This report attributes this increase, modest in comparison to other estimates, to the number of hobbyist enthusiasts becoming actively engaged in UAS photography and racing clubs as a recreational activity.

Ongoing research and development of hydrogen fuel cells for UAS application are gaining interest by researchers that would expand the longevity of onboard power

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[146] Teal Group, "Teal Group Predicts Worldwide UAV Market Will Total $91 Billion in Its 2014 UAV Market Profile and Forecast," press release, July 14, 2014, http://tealgroup.com/index.php/about-teal-group-corporation/press-releases/118-2014-uav-press-release.

[147] Wojciech Moskwa, "World Drone Business to Grow More than 6000% by 2020 in $127B Market: PwC," *Insurance Journal*, May 10, 2016, http://www.insurancejournal.com/news/international/2016/05/10/408021.htm.

[148] Ibid.

cells, which would make longer flight times possible.[149] Consumer Electronics Association (CEA), Vice President Douglas Johnson projected the global market for consumer UAS will approach $130 million in revenue in 2015; this figure is more than 50 percent from 2014.[150]

Much of the available economic research consists primarily of consumer spending projections, both actual and forecast models. As UAS platforms continue to be modified to fit a broadening spectrum of public and commercial applications, it is likely these projections will continue to increase and demonstrate sustainable growth within the industry. However, it remains to be seen how impending legislation and the NPRM regulatory framework will impact future sales of UAS.

L. THE UAS THREAT

Recent examples of local and state law enforcement encountering UAS have been well documented as they pertain to the significant threats UAS pose to large crowds in sporting venues or soft target locations at which large numbers of people gather. Incidents of UAS intrusion within sensitive or critical infrastructure locations cause further concern for LE and city leadership regarding their ability to maintain infrastructure security for its citizens. The enhanced level of airborne access that UAS are capable of has also given rise to the citizen concern over privacy violations. The potential for threat posed by UAS will be the focus of greater detail later in this chapter and the discussion on privacy is expounded upon within its own section as well.

This threat section represents the most significant area of concern addressed within this thesis. Analysis of the current threat picture closely represents an amalgamation of political agendas and ideologies, and it fails to address the myriad of vulnerabilities the proliferation of a domestic UAS program represents.

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149 "UAS Market Projected to Exceed $4 Billion by 2024," *Aviation News Today*, May 10, 2016, http://aviationnews.net/index.html?do=headline&news_id=254727.

150 Laura Hubbard, "CEA Applauds FAA Decision to Expand Beyond-Line-of-sight UAS Testing," press release, May 6, 2015, https://www.cta.tech/News/Press-Releases/2015/May/CEA-Applauds-FAA-Decision-to-Expand-Beyond-Line-of.aspx.

A litany of incidents within the U.S. and abroad has highlighted the capabilities of UAS to access even the most impenetrable CI/KR locations. Current research has identified modifications to weaponize UAS platforms to enable remote firing from an airborne UAS.[151] Advancements in payload capabilities have broadened the range of intended uses for these platforms, and this significantly expands the threat spectrum of those persons intent on using UAS for nefarious purposes. The literature review has revealed that U.S. authorities remain concerned over the growing problem that UAS can be modified to conduct attacks against U.S. citizens or other soft target locations utilizing explosives or through airborne dispersal of chemical weapons.[152]

Continuing analysis of available literature suggests a new and potentially dangerous hybrid threat has arrived in the form of cyber crimes. Traditionally, cyber threat attacks have involved malicious attacks against various electronic databases, systems, or data exfiltration. Now enter the UAS. The standard of technology for UAS continues to be refined, and these platforms now more closely resemble airborne computers than innocent looking tools of entertainment. John Villasenor of the Brookings Institute recently posited on the misperception that the threat of cyber attack is relegated solely to computer devices.[153] Villasenor points out that from a cyber security standpoint, one must consider the enhanced level of cyber threat posed when the cyber world meets the physical world as seen in the emergence of UAS.[154] The U.S. National Science Foundation defines this condition as "the tight conjoining of and coordination between computational and physical resources."[155]

Research has identified how this application can be easily adapted to deploy UAS for the purpose of conducting penetration testing of unsecured devices and network

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[151] Corcoran, "Terrifying Video Shows Home-made Drone."

[152] Jack Nicas, "Criminals, Terrorist Find Uses for Drones, Raising Concern," *Wall Street Journal*, January 28, 2015, http://www.wsj.com/articles/criminals-terrorists-find-uses-for-drones-raising-concerns-1422494268, sec. Business.

[153] John Villasenor, *Cyber Physical Attacks and Drone Strikes: The Next Homeland Security Threat* (Washington, DC: Brookings Institute, 2011), http://www.brookings.edu/research/papers/2011/07/05-drones-villasenor.

[154] Ibid.

[155] Ibid.

systems enabling the platform to collect, store, or transmit data to malicious cyber actors.[156] This combination of both a cyber and physical system in the hands of a malicious actor now represents a significant security threat requiring the need to reexamine the current national security and defense posture in response to this next phase of UAS evolution.

M. CHAPTER SUMMARY

Available literature reviewed in this chapter was intended to highlight the multi-faceted and complex issues surrounding the integration of UAS into the national airspace on local and national levels. The relevant categories associated with UAS integration contained in this chapter serve as the building blocks for city leadership, elected officials, and the community stakeholders to consider in the development of a strategic guidance policy for the City of Phoenix.

Chapter III further explores the implications of UAS integration at both the local and national level. The chapter sets the stage for developing a better understanding of the specific issues important to the City of Phoenix and its community members. The identification of these key components is essential to the development of alternative policy solutions for integrating UAS within the City of Phoenix that is presented in subsequent chapters of this thesis.

[156] Roberto Baldwin, "This Drone Can Steal Data While Hovering above Your Office," *Engadget Magazine*, August 17, 2015, http://www.engadget.com/2015/08/17/hacking-drone/.

III. IMPLICATIONS OF UAS INTEGRATION

A. VARIOUS DOMESTIC AIRSPACE APPLICATIONS

The integration of the UAS platform represents another rapidly evolving technology with the potential to dramatically impact industry and hobbyists alike. The level of focused innovation and design directed at these platforms continues to yield new and improved levels of domestic application spanning a broad spectrum of functional use and design. This chapter examines the multitude of uses for UAS in a domestic capacity currently in use with a trending eye toward those designs that lay just beyond the horizon. As the hobbyist and commercial industry anxiously await federal guidance to define the rules and regulations applicable to UAS deployment, the UAS industry continues to accelerate its efforts to enhance UAS design while refining the wide range of practical uses to further support UAS integration within the NAS.

1. Agribusiness

One of the growing domestic applications of UAS includes the use of UAS to further support the country's agribusiness. UAS platforms have continued to demonstrate advancements in precision farming.[157] Emerging UAS capabilities are now making it possible for the agribusiness sector to monitor crop sizes prior to harvest to help farmers better gauge annual crop yields and further serve as an early detection tool for evaluating crop infestation or unhealthy growing conditions. The state of Georgia is but one example illustrating the growing importance of the UAS role in agribusiness. According to the Director of the Georgia Center of Innovation for Agribusiness, Bo Warren, the farming and agricultural industry in Georgia accounts for the state's $13.9 billion in revenues annually and is poised for extensive growth in the immediate future.[158] The agricultural success identified in the state of Georgia illustrates the versatility of UAS in an agribusiness environment. The ability to streamline business efficiency models to both

[157] Aerospace Industries Association, "Unmanned Aircraft Systems," 8.

[158] Drone Select, "Georgia to Reshape Agricultural Future—AUVSI Atlanta Chapter AG Conference," June 9, 2014, http://droneselect.com/drone-articles/uas-use-in-agriculture/.

maximize cost savings and harvest yields represent what will likely become the next iteration in agribusiness innovation.

2. Ground Mapping and Surveying

In addition to finding a role in agribusiness, UAS platforms have shown significant promise as a low-cost option for conducting ground mapping and surveying at a fraction of the cost of flying fixed wing aircraft for the same purpose. Ascending Technologies have developed its Falcon 8 model UAS for this very purpose.[159] These platforms carry the ability to automatically adjust speed, altitude, and photo positioning based on pre-programmed GPS data input.[160] This application utilizes laser technology and provides the ability to map existing infrastructure, site plans, or contour mapping with accuracy.[161]

3. Meteorological Sensing

The use of UAS by the National Oceanic and Atmospheric Administration (NOAA) has been expanded to include meteorological sensing and storm prediction modeling. By targeting specific regions, NOAA is using UAS technology to help identify storms and other weather-related hazards through a program called Sensing Hazards with Operational Unmanned Technology (SHOUT).[162] The project has partnered with the NASA to conduct data collection and to predict the potential impact of dangerous storms to identify response and operational strategies to better mitigate and remediate the effects of such weather-related events.[163]

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[159] Ascending Technologies, "UAV Surveying and Mapping," http://www.asctec.de/en/uav-uas-drone-applications/uav-surveying-mapping-orthophoto-photogrammetry/.

[160] Ibid.

[161] Ibid.

[162] National Oceanic Atmospheric Administration, "Sensing Hazards with Operational Unmanned Technology (SHOUT)," accessed October 15, 2016, http://uas.noaa.gov/shout/.

[163] Ibid.

4. Real Estate/Videography/Photography

One of the burgeoning commercial applications for UAS is within the real estate market. As reported by the National Association of Realtors, the FAA's release of the "Small UAS Rule," Part 107 on June 21, 2016, now provides for the widespread use of commercial UAS applications that will have a significant impact on the real estate community.[164] The use of UAS platforms equipped with high definition digital camera systems will likely change the face of the real estate, photography, and videography industries now that the FAA's Rule 107 is in effect.

B. UAS IN PUBLIC SAFETY APPLICATIONS

The integration of UAS within an LE or public safety environment is gaining in popularity among agencies nationwide. This is due mainly because of the wide range of applications for UAS technology in the first responder community. The following sections discuss the potential for integrating UAS technology as an emerging tool and to further mitigate risk to first responders.

1. An Emerging Tool

Unique to the UAS discussion is determining the viability of deploying UAS platforms within the public safety/first responder community. Law enforcement and the public safety community are among those professions evaluating the potential benefits of integrating UAS technology as a tool.[165] This does represent an interesting dichotomy for public safety. On one hand, they stand to benefit just as the commercial sector when they must also be responsible for enforcing its use by the public. This is discussed more in subsequent chapters.

According to the United States Department of Agriculture, Agricultural Research Service, the use of UAS has expanded to include use for obtaining imagery of fire and disaster landscapes via remote sensing technology. As an emerging technology,

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[164] Erin Stackley, Stephanie A. Spear, and Russell Riggs, "FAA Releases Small UAS Rule," National Association of Realtors, June 23, 2016, http://www.realtor.org/articles/faa-releases-small-uas-rule.

[165] McNeal, *Drones and Aerial Surveillance*, 1.

integration of UAS has already demonstrated significant promise for public safety and first responders in a variety of applications. Although each discipline has differing approaches to meeting its respective agency's mission objectives, the majority of uses can be categorized as outlined in the following subsections.

a. Law Enforcement: Emergent Incident

Within the police community, response efforts are typically categorized into either emergent or investigative classifications. As such, each is approached in a very different way from the other though they share a common set of benefits under the UAS methodology. Multiple examples across the country have illustrated the advantages of deploying UAS technology in place of liver personnel for high-risk incidents. These situations could and often do include deployment to hostage barricade or active shooter incidents. These are incidents in which situational awareness and intelligence gathering are critical to the development of pre-operational plans that govern the deployment of personnel and resources to bring a violent incident to a successful conclusion.

For example, deploying a UAS equipped with a high-definition camera provides real-time intelligence on a suspects' location within a structure as well as the overall layout of a property or structure. This intelligence aids in the identification of any additional hazards officers must be aware of as part of their operational response. This low-cost option for obtaining accurate imagery eliminates the need to expose tactical operators to the line of sight of potentially armed suspects.

Furthermore, the use of UAS in the search for missing persons, lost children, or injured hikers has proven beneficial as a low-cost alternative to more expensive helicopter or fixed wing aircraft searches. Additionally, UAS are an effective supplement to traditional search and rescue options currently employed by emergency first responders since they offer the additional benefit of increased time over target and the flexibility of searching both interior and exterior environments. The deployment of a UAS by law enforcement under conditions of exigency would not require the agency to obtain a search warrant in their efforts to preserve life safety in accordance within their organizational objectives.

Research is currently underway at Brigham Young University (BYU) to develop algorithm models that will enable autonomous UAS flight patterns to aid in the search of lost persons or injured and stranded hikers.[166] For context, the City of Phoenix Fire Department typically responds to more than 200 rescues a year from the city's mountain trails.[167] Much of this searching must be done on foot, which is time consuming. These rescues become more technical and dangerous when they are performed at night in remote and secluded locations. In each case, a UAS could be deployed to search a larger area more quickly.

Deployment of a UAS is not limited to search and rescue operations for individuals who are lost or injured. Law enforcement is regularly presented with opportunities where UAS could be deployed to assist with searches for fleeing felons and has proven effective in locating suspects who might otherwise escape capture. For instance, police in Wisconsin demonstrated the effectiveness of this application in July 2015. In this incident, an armed robbery suspect stole a vehicle and fled from police before abandoning the vehicle and escaping on foot into a swampy marsh virtually inaccessible to law enforcement vehicles. Middleton, Wisconsin police officers partnered with the Middleton Fire Department, which loaned them an inflatable raft upon which they deployed a UAS to conduct a grid search of the marsh area; this led to locating of the suspect, who was ultimately taken into custody.[168]

b. Law Enforcement: Investigative Tool

UAS deployment by law enforcement has demonstrated significant value as an investigative support tool. For example, UAS could provide the unique benefit of an aerial viewpoint of a location where it is believed a crime has occurred. Deployment

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166 "UAVs Perform Autonomous Search-and -Rescue Operations," *Homeland Security News Wire*, July 19, 2010, http://www.homelandsecuritynewswire.com/uavs-perform-autonomous-search-and-rescue-operations.

167 Max Walker and Raquel Cervantes, "Phoenix Firefighters Respond to Mountain Rescues at Camelback, Papago," *ABC 15 News*, April 9, 2016, http://www.abc15.com/news/region-northeast-valley/paradise-valley/phoenix-firefighters-respond-to-woman-injured-while-hiking-camelback.

168 Ed Treleven, "Man Tracked down by Drone Charged with Robbery, Auto Theft," *Wisconsin State Journal*, July 2, 2015, http://host.madison.com/wsj/news/local/crime_and_courts/man-tracked-down-by-drone-charged-with-robbery-auto-theft/article_a04c556a-eec8-5da6-8c33-31c67ef7f6ab.html.

under these non-emergent investigative conditions would require the consent of the property owner or a search warrant as the industry standard for use under these conditions. Once legally authorized to deploy, a UAS vantage point may enable law enforcement to gather the intelligence it needs without the need to make its presence known to the suspect, thereby further reducing the risk of exposure or potential for a violent confrontation.

In today's high risk homeland security environment, LE has found a functional application for UAS as a tool for monitoring CI/KR locations within a given jurisdiction or community. Law enforcement is faced with the challenge of safeguarding CI/KR locations and the ability to deploy UAS technology represents a sound defense strategy for detecting malicious activity by those with nefarious intent. An example of law enforcement's ability to deploy UAS platforms to CI/KR locations might include providing over watch capabilities for the city of Phoenix's fuel tank farms. These high capacity tanks are responsible for storing70 percent of the fuel coming into the Phoenix metropolitan area from California via the Kinder Morgan pipeline.[169]

The deployment of UAS to effectively monitor communications CI/KR is yet another opportunity to integrate UAS as a monitoring and security tool for LE. The ability for a law enforcement jurisdiction to conduct inspections of critical communications infrastructure, including cell towers and repeaters, to ensure connectivity and the operational integrity of the network infrastructure is of paramount importance. This includes the ability to assess and evaluate the physical condition of our water treatment plants and monitor perimeter security as a deterrent to intrusion or penetration by prohibited persons or devices. Application of a UAS to evaluate any elevated critical infrastructure platform offers the ability to further reduce both threat and risk to its personnel.

In the aftermath of the San Bernardino shooting at the Inland Regional Center on December 2, 2015, Police Chief Jarrod Burguan announced it was his intention to begin purchasing UAS platforms for use within his agency. Moreover, Burguan emphasized the

[169] City of Phoenix, *Phoenix Regional Standard Operating Procedures: Tank Farm* (M.P. 206–08) (Phoenix: City of Phoenix, 2004), https://www.phoenix.gov/firesite/Documents/074818.pdf, 1.

value of this tool in conducting complex investigations of this magnitude.[170] In addition, the UAS platforms are useful in conducting crime scene photography and scene reconstruction. Burguan notes the value of utilizing technology to avoid placing live personnel in harm's way if it can be avoided. The model Burguan's department is currently considering for San Bernardino is the DJI Inspire I product costing $6000–$7000 per unit. Burguan contends his agency's use of UAS would be consistent with the Fourth Amendment requirements concerning privacy, and his department's use of UAS as an investigative tool would be in conjunction with the requisite search warrant as needed.[171]

The pursuit of UAS for its investigative benefit is not confined to just law enforcement; it is also actively pursued by the public and private sector communities. The ability to deploy a low-cost tool to visually inspect elevated platforms like power grid transfer stations, power lines or remote sections of pipelines delivering fuel and chemicals is critically important to ensure the integrity of delivery systems and that they remain intact without being compromised.

Within the greater Phoenix metropolitan area, utilities such as the Salt River Project, delivering water to the valley via a complex network of dams, reservoirs, and canal systems. Another example is the Arizona Public Service (APS), which provides the valley with the majority of its electrical power. Both infrastructures would be well suited for UAS deployment to aid the managing utility company in the maintenance, inspection, and security of their network systems. Deploying UAS like this provides value as they reduce risk to employees who would otherwise have to perform elevated repairs or inspections. UAS provide additional value when used to collect recorded digital imagery to aid in the prevention and investigation of acts of malicious penetration or sabotage.

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[170] Ryan Hagen, "San Bernardino Police Department Applies for Drone Use," *The San Bernardino Sun*, January 19, 2016, http://www.sbsun.com/government-and-politics/20160119/san-bernardino-police-department-applies-for-drone-use.

[171] Ibid.

c. Fire Service

Also within the public safety theme for UAS deployment, the fire service community also stands to benefit greatly from the use of this technology. As mentioned for law enforcement, the fire service also recognizes the inherent benefits of utilizing UAS for search and rescue missions. The ability to deploy UAS in search of missing, lost, or injured persons in areas that are largely inaccessible represents a utilitarian benefit. These locations might include the canals, river banks, or densely overgrown areas of underbrush inaccessible to vehicles or even personnel on foot.

An example of the UAS utilitarian deployment occurred in Mechanic Falls, Maine on July 2, 2015 as reported by the Associated Press. The Auburn Fire Department deployed a UAS to deliver a drag line with a life vest attached to it for two boys stranded in the middle of a raging river when their inner tube overturned. The UAS successfully delivered the line to the boys without putting the firefighters into the water unnecessarily. This effort led to the safe rescue of the two boys with no injuries to any of the parties involved.[172]

2. Public Health Benefits

As recently as July 2015, the state of Virginia began conducting test deliveries utilizing UAS platforms to deliver medical supplies and medicines for its residents in rural central Appalachia. Residents in these economically disadvantaged areas are among those in strongest need for medical and health care that currently does not exist. It is the intent by public health experts to conduct a series of tests delivering medicine to the Wise County Fairgrounds, and if successful, this enhanced public health delivery system would be among the first to utilize UAS technology to enhance humanitarian efforts in the world.[173]

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[172] Associated Press, "Firefighters Use Drone in Maine River Rescue," *Fire Rescue News*, July 2, 2015, http://www.firerescue1.com/fire-products/technology/articles/2235275-Firefighters-use-drone-in-Maine-river-rescue/.

[173] Jenna Portnoy, "Drones to Deliver Medicine to Rural Virginia Field Hospital," *The Washington Post*, July 3, 2015, https://www.washingtonpost.com/local/virginia-politics/drones-to-deliver-medicine-to-rural-virginia-field-hospital/2015/07/01/80abd362-1f3d-11e5-aeb9-a411a84c9d55_story.html.

C. DEFINING THE THREAT OF UAS INTEGRATION

Despite the multi-functional value of UAS integration discussed thus far, consideration must be given to the potential threat UAS technology poses when used by malicious actors to cause harm. The following sections will discuss various ways in which UAS technology has the potential to manifest itself as a significant threat for LE and the emergency first responder community.

D. UAS AS A TERROR TOOL

Despite the multiple advantages associated with utilizing UAS to enhance public safety emergency first responders, these same dynamic attributes are just as easily converted to potential delivery platforms for evil intent. Although a relatively new phenomenon here within the domestic United States, UAS or commercial off-the-shelf (COTS) remotely piloted devices have played a role in the attempted commission of several terrorism related acts at the global level.

One is example occurred in the early 1990s. Even prior to the 1994 Tokyo subway attack in Japan, members of the cult Aum Shinrikyo, founded by Shoko Asahara, unsuccessfully experimented with a remotely piloted helicopter as a delivery platform to disperse the Saran nerve agent upon the unsuspecting civilian population.[174]

Al-Qaeda and affiliated groups have also utilized COTS products as potential improvised explosive device (IED) delivery platforms. For example, in 2001 they used such a scheme to target then-President George Bush in 2001 during the G8 conference in Italy.[175] Two additional attempts in 2002 included al-Qaeda plans to deliver anthrax to the English House of Commons and the targeting of a civilian airliner.[176]

Yet another example of a potentially deadly incident involving UAS occurred in September 2013. At a campaign rally in Dresden, German Chancellor Angela Merkel,

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[174] Larry Friese, *Emerging Unmanned Threats: The Use of Commercially-Available UAVs by Armed Non-State Actors* (Perth, Australia: Armament Research Service, 2016), http://armamentresearch.com/wp-content/uploads/2016/02/ARES-Special-Report-No.-2-Emerging-Unmanned-Threats.pdf, 36.

[175] Ibid.

[176] Ibid.

along with members of her cabinet, were confronted during an event by a Parrot AR rotary wing UAS hovering directly in front of their podium.[177] Even though this incident did not result in injury to anyone, it demonstrated the difficulty in securing and controlling the space around a protected dignitary. Had this UAS been laden with explosives and detonated, significant injuries and death would likely have resulted.[178] Although these attempts mentioned here all proved unsuccessful, it is evident that efforts to weaponize COTS UAS remotely piloted devices or now UAS platforms is a very real issue for public safety and homeland security as a whole.

Concerns about the threats UAS pose if deployed by malicious actors to engage in acts of terrorism continue to garner the attention of U.S. authorities. As reported by the *Wall Street Journal* in January 2015, U.S. authorities have expressed concern over the threat potential UAS platforms pose to the public once modified as a payload delivery system carrying explosives or chemical weapons.[179] This was evidenced by a UAS operator flying a UAS alongside President Obama's motorcade in Kailua, Hawaii during a family vacation in December 2015. The United States Secret Service had no way to discern whether it was just an interested citizen looking to capture video imagery of the motorcade or a suspect intent on nefarious action. Fortunately, in this case it was determined the citizen represented the former and not the latter.[180]

E. INCREASED THREAT TO PUBLIC SAFETY

Not every threat posed by the integration and use of UAS in the national airspace is a threat to just dignitary officials. Some would argue everyday use of UAS pose an even greater threat to the health and public safety of our citizens. Even an airborne aerial

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[177] Ibid., 49.

[178] Sean Gallagher, "German Chancellor's Drone 'Attack' Shows the Threat of Weaponized UAVs," *Ars Technica*, September 18, 2013, http://arstechnica.com/information-technology/2013/09/german-chancellors-drone-attack-shows-the-threat-of-weaponized-uavs/.

[179] Jack Nicas, "Criminals, Terrorists Find Uses for Drones, Raising Concerns," *Wall Street Journal*, January 29, 2015, http://www.wsj.com/articles/criminals-terrorists-find-uses-for-drones-raising-concerns-1422494268, sec. Business.

[180] Sneha Shankar, "Drone Flying alongside Obama's Motorcade in Hawaii Stopped by Secret Service," *International Business Times*, December 29, 2015, http://www.ibtimes.com/drone-flying-alongside-obamas-motorcade-hawaii-stopped-secret-service-2242123.

platform (even those under the 55lb maximum) with no modifications or attachments presents a serious safety concern for those persons on the ground below. A malfunction of a UAS device or crash due to an inexperienced operator can have disastrous results. Recent events have illustrated how this concern is occurring with regularity across the country. Examples are explored below.

1. Threat of Weaponized UAS Platforms

The versatility of the commercially available UAS platform has been highly touted for its multi-functional design and ease of modification. However, it is this very concept of versatility that makes the UAS platform such a significant threat to the American public by those who are intent on using them to conduct nefarious activity. To date, multiple examples of how these platforms can be modified have been identified calling into question the concern on how best to regulate this activity.

For instance in July 2015, an 18-year-old in Connecticut posted a video clip demonstrating the effectiveness of his homemade modification to his UAS platform. He made it capable of firing live ammunition rounds after he mounted the weapon, which he controlled remotely, to the UAS platform.[181] A few months later in December 2015, the same Connecticut teen posted another video on YouTube demonstrating his do it yourself conversion wherein he successfully mounted a flamethrower, purchased from Amazon, to his UAS platform and used it to effectively roast a turkey.[182]

In terms of modifications, the limits of creativity appear to be the only boundary when it comes to the utilitarian conversion of today's UAS platform. We continue to see these platforms modified to accept equipment such as full-automatic weapons or modified to serve as delivery systems carrying illicit drugs across the border from Mexico. Although presumably not what companies like Google and Amazon had in mind for the development of their home and business delivery service, these rudimentary trial and error conversion attempts are laying the foundational groundwork that tests the full

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[181] Corcoran, "Terrifying Video Shows Home-made Drone."

[182] Ben Popper, "The Teenager behind the Drone Gun Now Has a Drone-Mounted Flamethrower," *The Verge*, December 8, 2015, http://www.theverge.com/2015/12/8/9871732/drone-flamethrower-austin-haughwout.

limits and capabilities of the COTS UAS products. UAS has provided a functional design that can be easily modified and made available at modest price points making it an attractive low-cost option to the masses; however, the threat lies in the intent of the user.

Even the best of intentions is unable to prevent harmful events or injury from occurring while using UAS technology. In December 2015, it was reported a UAS operator was flying over the Thanksgiving Day road race in Andover, Massachusetts when his UAS crashed into a pack of runners below causing minor injuries to two people.[183] On September 3, 2015, a teacher was arrested in New York City when he crashed a UAS into an open section of seating at the U.S. Open tennis tournament. At the time of the event, there were approximately 10,000 attendees in the stadium, and fortunately no one was injured as a result.[184] In October 2015, a UAS operator was charged with reckless endangerment when the UAS he was operating collided into a woman who was watching a Pride Parade in downtown Seattle. It knocked her out when it struck her in the head.[185]

Operation of a UAS can be equally dangerous to the operator as well. In September 2013, a 19-year-old man in Brooklyn was killed when the remotely piloted helicopter UAS platform he was operating became unresponsive and fell to the ground on top of him. The rotor blades struck his head and neck killing him.[186]

Of even greater concern is the idea a UAS operator inclined to conduct an attack can utilize these UAS platforms as a guided missile device. A platform that is laden with even a small amount of explosives, a bio-toxin, or other dangerous chemical may simply be flown directly into its intended target and becomes an airborne weapon and payload

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[183] Associated Press, "Drone Falls into Crowd, Injures Runners during Road Race," *The Washington Post*, December 1, 2015, http://www.pressherald.com/2015/12/01/drone-falls-into-crowd-injures-runners-during-mass-road-race/.

[184] Associated Press, "NYPD: Teacher Arrested for Allegedly Flying Drone at U.S. Open," *MSN News*, September 4, 2015, http://www.msn.com/en-us/sports/tennis/nypd-teacher-arrested-for-allegedly-flying-drone-at-us-open/ar-AAdWr8r.

[185] Miletich, "Drone Operator Charged."

[186] Thomas Tracy, Edgar Sandoval, and Bill Hutchinson, "Queens Man, 19, Killed by Model Helicopter Shred Passion for Remote-controlled Fliers with Father," *New York Daily News*, September 6, 2013, http://www.nydailynews.com/new-york/queens/teen-killed-remote-controlled-helicopter-slices-throat-article-1.1447068.

delivery device all in one. This option represents a more pragmatic approach for suspects likely to engage in acts of domestic terrorism.

2. Threat to Critical Infrastructure/Key Resources

The ongoing challenge facing public safety officials in protecting the critical infrastructure/key resource locations within their respective jurisdictions where the integration of UAS is concerned remains of paramount importance. While the location and specific resource identified by each jurisdiction may vary, the threat remains the same.

Law enforcement and municipalities have become hypersensitive to the prospect of UAS platforms operating near CI/KR locations on a national level. Much of the paranoia is justified due to the inability of law enforcement of public safety in general to identify by type of craft or identify the operators to determine the intent of their flight mission. This issue will likely continue to expand as the UAS industry promotes UAS operation that includes beyond line of sight (BLOS), which will also make identification of operators even more difficult.

Operation near or over government complex facilities, water treatment plants, communications network infrastructure, power transfer stations, etc., all give rise to the concern a malicious actor may be conducting pre-operational planning and surveillance in an effort to identify a potential target. The high-definition camera systems have capabilities to provide aerial intelligence that is restricted and might otherwise not be readily available to the public as it is likely to reveal architectural information or identification of personnel. This could potentially lead to the exploitation of intelligence to conduct an attack. Continued caution and care must be considered when UAS encounters are identified near or over these potentially vulnerable yet significant infrastructure locations.

3. Threat of Cyber Attack

An emerging threat for consideration regarding the integration of UAS into the national airspace is the cyber threat this new technology poses. Typically, a cyber attack

is considered to be a malicious attack against a computational network or device initiated by a malicious actor. The Brookings Institute has identified a less widely known threat to be in the form of a physical attack launched by way of cyber-physical systems.[187] John Villasenor cited The U.S. National Science Foundation who defines a cyber-physical system as "the tight conjoining of and coordination between computational and physical resources."[188] This merging of both the physical and cyber systems represents a significant threat to maintaining cyber security.

Dennis Gromley of the Middlebury Institute of International Studies at Monterey, as cited in a Brookings Institute article authored by John Villasenor, discussed how the national security threat that UAS poses has been considered for some time. The article further states how Gromley during testimony before the House of Representatives subcommittee in 2004, noted this type of attack could possibly be used by terrorist organizations or actors.[189]

Security technicians are developing new technology in the field to identify the best methods to detect the integrity of their own company's software security. UAS platforms are once again leading this effort in a non-traditional deployment method. The Aerial Assault drone is one such example of how this technology is evolving through the use of open source information readily available to anyone over the internet. The system essentially defeats any physical barriers or perimeter security by equipping a UAS device with hardware components designed to conduct penetration testing of open and unsecured corporate networks and exfiltrate data that can be easily captured on various types of electronic memory storage incorporated onto the UAS platform.[190] This methodology enables exterior penetration testing capable of ascending multiple floors of a building undetected and without physical contact of the targeted network. The hardware required for this initial penetration testing was approximately $2,500 and is readily

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187 Villasenor, *Cyber Physical Attacks and Drone Strikes*.

188 Ibid.

189 Ibid., 1–2.

190 Baldwin, "This Drone Can Steal."

available over the internet from a variety of computer software and hardware specialty vendors.[191]

4. Threat to Privacy

Evaluating the full extent to which UAS will adversely impact individuals' rights to privacy remains to be seen. Much of the conversation has been centered on the public's perception of increased government overreach should UAS be integrated into the public safety inventory as an enhanced capability. National watchdog groups like the American Civil Liberties Union have opined on the matter suggesting even though there are valid applications for UAS in public safety, their benefits are likely to be outweighed by "mission creep" and they will be used for more controversial purposes.[192]

This demonstrates the continued angst associated with UAS deployments for fear of "persistence surveillance" by government officials or local law enforcement authorities.

5. Threat to Aircraft Operations

Perhaps the most prolific impact of UAS integration within the national airspace is the impending danger and impact on the aviation industry. This is not just a local or national issue, but a global concern issue with which countries around the world struggle.

Airports in multiple cities across the country began experiencing an increase in the number of reported encounters aircraft were having with UAS being operated near their air operations in early 2015. In Arizona in February 2015, preparations for the upcoming Super Bowl XLIX were well underway. Due to the increased frequency of UAS sightings within the Phoenix metropolitan area, the City of Glendale, which was hosting the game, gave substantial consideration to declaring the airspace over the

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[191] Ibid.

[192] Murphy et al., *The Future of Drones in America*, 6.

University of Phoenix Stadium a "no-drone" zone. This restriction took into account not only the stadium but also nearby Glendale Airport and Luke Air Force Base.[193]

UAS encounters with aircraft are occurring with heightened frequency involving commercial and private aircraft experiencing "near misses" with UAS operating in close proximity to airports during their approach. Current FAA guidelines prohibit UAS from operating within 5 miles of an airport or at an elevation above 400 feet above ground level (AGL).[194]

This has become a serious concern for public safety and firefighting aircraft as well. Over the past two summers (2015 and 2016), there have been multiple encounters with UAS operating over wild land fires in California and Nevada. In 2015, U.S. Forest Service firefighters were battling a series of fires in the San Bernardino Mountains when the DC-10 jets laden with fire retardant had to be turned away without completing their drop missions over their targets due to the number of UAS operating in the area over the fire in extremely poor visibility conditions.[195] According to one article by the *Homeland Security News Wire*, the cost of abandoning these flights near the Nevada border was between $10,000 and $15,000 and significantly extended the life of these respective fires.[196]

Recent national activity has identified a growing trend of UAS operators interfering with firefighters and other military and emergency first responders when carrying out their duties extinguishing wild land fires. The State of California was among the first to enact legislation prohibiting UAS operators from the activity and holding them criminally liable for their acts of interference. Senate Bills 167 and 168 were enacted in California during 2015 amid a very active wild land fire season. Senate Bill 167 was

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[193] Peter Corbett, "Glendale Considers No-Drone Zones near Airport, Stadium, Luke AFB," *The Arizona Republic*, October 22, 2015, http://www.azcentral.com/story/news/local/glendale/2015/10/22/no-drone-zone-glendale-university-phoenix-stadium/74359600/.

[194] H.R. 658–62, Public Unmanned Aircraft Systems, § 334, Federal Aviation Administration, www.faa.gov/uas/programs_partnerships/uas_arctic/media/Sec_331_336_UAS.pdf, 5.

[195] "Fighting Fires in California Hobbled by Hobby Drones," *Homeland Security News Wire*, July 2, 2015, http://www.homelandsecuritynewswire.com/dr20150702-fighting-fires-in-california-hobbled-by-hobby-drones.

[196] Ibid.

enacted February 5, 2015 and made it a misdemeanor crime to use a UAS in a way would interfere or delay a firefighter's ability to extinguish a fire in a timely manner.[197] Senate Bill 168 limited the civil liability for the emergency first responders for any damages to a UAS platform due to interferences provided that the first responders were lawfully conducting their official activities and duties during an emergency incident.[198] This was especially significant in the summer of 2015, during the firefighting efforts to quell the wild land fire that eventually overtook the El-Cajon pass and freeway forcing the evacuation of at least 20 vehicle occupants as the fire jumped the highway and continued its path of destruction.[199]

Many have asked why the concern over such a small UAS and asked how much damage could it possibly do to a large commercial aircraft. At first glance this seems like a reasonable question since after all, aircraft have contended with bird strikes for years, so why should this be any different? The reality is that UAS incidents are different and current researchers are addressing how and exploring the extent of damage that can occur in these incidents.

Researchers at Virginia Tech have been developing software that enables them to measure the cumulative effects a UAS collision has on the jet turbine engine. Their purpose is twofold. The first is to identify the impact on turbine engines as related to today's industry standard. The second is to identify critical vulnerabilities with the current aircraft design so that new engineering ideas can be implemented to fortify and enhance the level of resiliency these types of impact will have on aircraft in the future.[200]

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[197] Senate Bill No. 167, 2015, https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB167.

[198] Senate Bill No. 168, 2015, http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB168.

[199] Paul Vercammen, Michael Martinez, and Ben Brumfield, "Above Spectacular Wildfire on Freeway Rises New Scourge: Drones," *CNN*, July 19, 2015, http://www.cnn.com/2015/07/18/us/california-freeway-fire/.

[200] Patrick C. Miller, "Simulation Shows Effects of Drone Hitting an Airline Engine," *UAS Magazine*, November 5, 2015, http://www.uasmagazine.com/articles/1313/simulation-shows-effects-of-drone-hitting-an-airliner-engine.

One of Virginia Tech's computer simulations examined the effects of an 8 pound UAS impacting the turbo fan of an airliner during takeoff. The research revealed that UAS debris spinning around the engine housing can reach speeds of 715 mph.[201] The force generated by these pieces impacting the fan blades ultimately compromises their structural integrity and leads to a catastrophic engine failure.[202]

Armed with the situational awareness presented thus far at the national level, this thesis further examines the potential impact of UAS integration within the city of Phoenix.

F. UAS IMPACT TO CITY OF PHOENIX

To more closely examine the frequency with which UAS calls for service are impacting local public safety jurisdictions, I collected data to illustrate the current UAS environment in place within the city of Phoenix to establish a baseline to better assess the impact of UAS integration within the city's airspace.

1. Phoenix, Arizona

Phoenix Police Department is considered the parent agency for this thesis and so a deeper look into the number of calls for service involving UAS was conducted through a citywide query of the department's Computer Aided Dispatch (CAD) system. The query parameters were defined as occurring between the time periods of January 1, 2015, through April 30, 2016 (a span of approximately 15 months). The start date of this query is intended to correspond with the operational deployment of resources and personnel in the days leading up to the valley's hosting of Super Bowl XLIX. This period marks the initial introduction of UAS sightings within the city of Phoenix and surrounding jurisdictions. The results of this analysis are detailed in the Table 2.

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201 Ibid.

202 Ibid.

Table 2. Phoenix Police Department Calls for Service[203]

Final Call Type	Departmental Report	No Action Required	Other Report	Total
Abandoned Vehicle	0	1	0	1
Assault	1	0	0	1
Burglary Residential	2	2	0	4
Call by Phone	0	1	0	1
Check Welfare	2	14	2	18
City Ordinance Offense	0	3	0	3
Civil Matter/Standby	1	4	0	5
Criminal Damage	2	0	0	2
Drunk Disturbing	0	0	1	1
Drunk Driver	1	0	0	1
Fights	0	4	0	4
Found Property	5	5	0	10
Generic	0	3	1	4
Generic Broadcast	0	1	0	1
Harassment	0	2	2	4
Injured/Sick Person	0	1	0	1
Loud Noise Disturbance	0	2	0	2
Mentally Ill Subject	0	2	0	2
Neighbor Dispute	0	9	2	11
Peeping Tom	0	1	0	1
PR Contact	0	1	0	1
Sexual Assault Supp.	0	1	0	1
Shoplifting	1	0	0	1

203 "City of Phoenix Police Department Dispatched/Self-Initiated Calls for Service (with Remarks containing 'drone,' 'UAS,' or 'UAV')" (internal document, Phoenix Police Department, Phoenix, AZ, 2016), 11, This is a customized internal Phoenix Police Department crime analysis report created by author's specific request for the information.

Final Call Type	Departmental Report	No Action Required	Other Report	Total
Subject Stop	0	2	0	2
Suspicious Person	5	12	4	21
Suspicious Person/ Vehicle	0	4	1	5
Theft	9	2	0	11
Traffic Hazard	1	1	0	2
Unknown Trouble	0	2	0	2
Total	**30**	**80**	**13**	**123**

The total of 123 calls for service made some sort of reference to a “drone” or “UAS” type issue during the initial receipt by radio dispatch. The final call type indicates what the appropriate classification for that particular call resulted in and whether or not an official police report was made of the incident.

Table 3 indicates the breakdown of total “drone” or “UAS” related calls for service by month of year during the same periods. The results indicated in this table are consistent with the observable increase in UAS activity documented by Phoenix Police Department. It is also worthy of mention there was significant increase in the UAS related calls for service beginning in December 2015 through the first quarter of 2016. Part of this spike in user activity can be attributed to the increased number of UAS purchased during the 2015 Christmas holiday season and their subsequent use during the first quarter of 2016.

Table 3. Phoenix Police Department UAS-Related Calls for Service[204]

Year	Month	Total
2015	January	6
	February	4
	March	3
	April	3
	May	5
	June	3
	July	1
	August	5
	September	6
	October	9
	November	6
	December	16
2016	January	11
	February	15
	March	19
	April	11
Total		**123**

2. Phoenix Fire Department

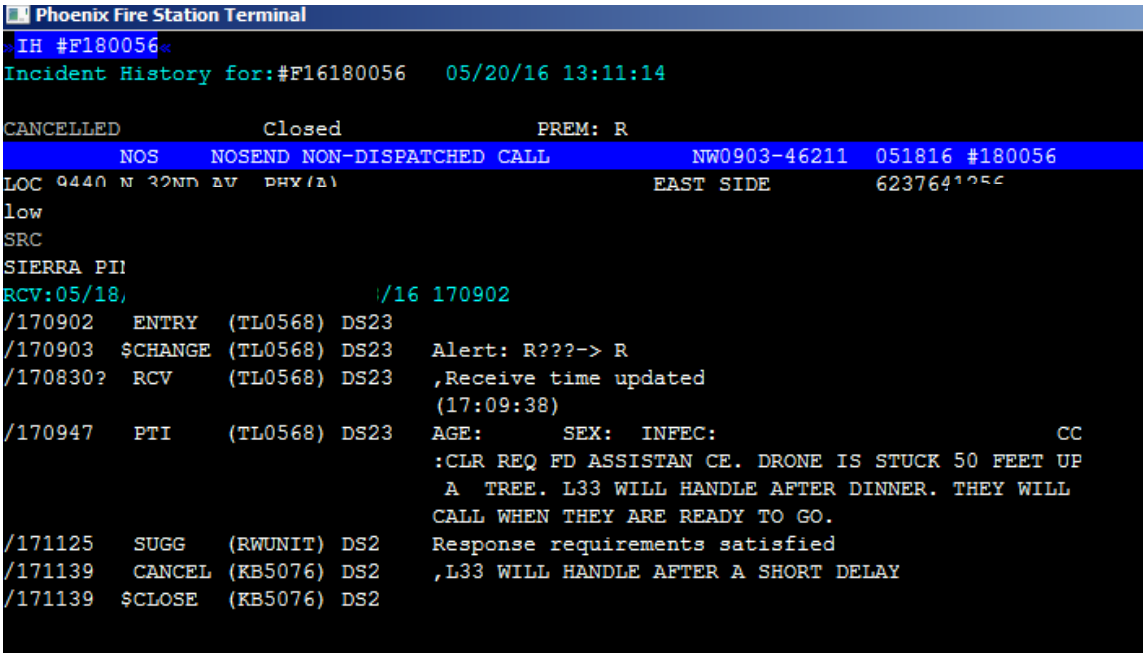
A similar CAD query of the Phoenix Fire Department during the same periods of January 1, 2015 through April 30, 2016 yielded only one call for service in which the fire department was dispatched to an incident involving the use of a UAS platform.[205] This is not unlikely given the current CAD infrastructure within the Phoenix Fire Department and lack of a primary medical component to the call. Absent these elements, the call would be routed to the police department as displayed in the Table 2. However, on May

[204] Ibid.

[205] David Follett, email message to author, May 20, 2016.

20, 2016, following the initial CAD data request, Phoenix Fire Department Captain David Follett provided additional information documenting a single UAS related call to the fire department. The request was for assistance by a UAS operator in retrieving his UAS device from a tree as noted on the CAD call in Figure 1.

Figure 1. Phoenix Fire Department UAS CAD Call for Service[206]



```
Phoenix Fire Station Terminal
»IH #F180056«
Incident History for:#F16180056   05/20/16 13:11:14

CANCELLED           Closed                PREM: R
         NOS    NOSEND NON-DISPATCHED CALL          NW0903-46211  051816 #180056
LOC 9440 N 32ND AV  PHX(A)                        EAST SIDE        6237641256
low
SRC
SIERRA PI
RCV:05/18/                    /16 170902
/170902   ENTRY   (TL0568) DS23
/170903  $CHANGE  (TL0568) DS23   Alert: R???-> R
/170830?  RCV     (TL0568) DS23   ,Receive time updated
                                  (17:09:38)
/170947   PTI     (TL0568) DS23   AGE:      SEX:  INFEC:                          CC
                                  :CLR REQ FD ASSISTAN CE. DRONE IS STUCK 50 FEET UP
                                   A  TREE. L33 WILL HANDLE AFTER DINNER. THEY WILL
                                  CALL WHEN THEY ARE READY TO GO.
/171125   SUGG    (RWUNIT) DS2    Response requirements satisfied
/171139   CANCEL  (KB5076) DS2    ,L33 WILL HANDLE AFTER A SHORT DELAY
/171139  $CLOSE   (KB5076) DS2
```

3. Sky Harbor UAS Incident Data

For this thesis, I conducted a similar query of the Sky Harbor Airport Aviation Department to identify an UAS related calls reported either to the Air Traffic Control Tower (ATC) or directly to the FAA spanning the period of January 2016 through July 2016. The results of this query are recorded in Table 4.

206 Ibid.

Table 4. Additional Data from January 2016–July 2016[207]

Date and Time	Incident Remarks
7-6-2016, 1547 hrs	Native Air Flight (Tail #N562NA) Pilatus PC-12/45 Aircraft: Pilot reported a black drone flew over the top of the aircraft near ASU Stadium in Tempe, Arizona
6-30-2016, 1605 hrs	Medivac Flight (Tail #N8989) Helicopter: Pilot reported an 18" black quadcopter drone 1.5 miles east of runway 7R—required pilot to take evasive action at altitude of 22K Ft. AGL
5-19-2016, 1839 hrs	American Airlines Flight 2998 (CRJ2 Aircraft): Pilot reported a white colored drone w/ lights approx. 100 yards north of the aircraft—1 mile east of Runway 26 at an altitude of 1,100 ft. AGL
4-23-2016, 1130 hrs	Undisclosed pilot reported to Sky Harbor that a quadcopter was seen 6 miles north of Sky Harbor at an altitude of 4,200 ft. AGL
4-1-2016, 1328 hrs	FAA reported to the Sky Harbor Communications Center, Oscar 30, Aviation PD, and Phoenix PD that a drone was operating ½ mile west of the approach to Runway 7R at an altitude of 1,000 ft. AGL
4-1-2016, 1250 hrs	FAA Tower reported a pilot had advised of a drone operating south of Veterans Memorial Coliseum, 4 miles from final approach to Runway 8 at an altitude of 800 ft. AGL
3-31-2016, 1115 hrs	Air National Guard pilot of KC135 aircraft reported a drone sighting 3 miles west of airport on approach to Runway 7R flight path at an altitude of 1,000 ft. AGL—An *American Airlines* pilot also reported the same incident with no further details
3-20-2016, 1659 hrs	Undisclosed pilot reported to Phoenix PD sergeant once on ground that he observed either a drone or some type of balloon 3 ½ miles east of the airport over Mill Avenue and University Drive in Tempe, Arizona on final approach to runway 25L at an altitude of 600–700 ft. AGL
3-20-2016, 1659 hrs	FAA Tower and Cutter Aviation pilot advised of possible drone south of approach to Runway 25L at an altitude of 600–700 ft. AGL (Related to above)

[207] Adapted from: Everett Brady, email to author, July 18, 2016.

Date and Time	Incident Remarks
3-20-2016, 1659 hrs	Pilot for former POTUS Bill Clinton advised Phoenix Sky Harbor Tower, police, and airside operations of a drone operating south of the approach to Runway 25L at an altitude of 600–700 ft. AGL (related to above)
2-17-2016, 1500 hrs	Medivac 9 Helicopter pilot reported a drone operating near the coliseum next to the I-17/I-10 freeway interchange at an altitude of 2,000 ft. AGL

G. FAA REPORTED UAS SIGHTINGS WITHIN THE STATE OF ARIZONA

According to the FAA's UAS sightings report, there was a total of 582 UAS incident sightings reported to the FAA between August 21, 2015, and January 31, 2016. Of those 582 reports, the nine Arizona incidents (listed in the Table 5) were extracted from the FAA sightings report and represent only those incidents documented within the state of Arizona during this time.[208]

[208] Federal Aviation Administration, "UAS Sightings Report" [Excel], August 7, 2016, http://www.faa.gov/uas/resources/uas_sightings_report/.

Table 5. Reported FAA UAS Sightings in Arizona[209]

Date and Time	City and State	Incident Remarks
1-23-2016 1514 hrs	Scottsdale, Arizona	Prelim info from FAA OPS: Scottsdale, AZ/UAS incident/1514M/ Cessna C172, reported seeing a white UAS at 500 feet vicinity Scottsdale ARPT. No evasive action taken. Scottsdale PD was notified.
1-18-2016 1434 hrs	Tucson, Arizona	Prelim info from FAA OPS: Tucson, AZ/UAS incident/1434P/Tucson Air Traffic Control (ATC) reported skywest 2958, CRJ2, PHX-TUS, was southeast bound at 3,700 feet on final for runway 11L when a large orange UAS passed 100 yards to the right of the ACFT. No evasive action taken. UAS was large enough to be seen by ATC personnel in the tower from 3 miles away. Tucson PD notified. MOR Alert for TUS Type: Other Date/Time: Jan 18, 2016, 2234Z A/C: SKW2958 (CRJ2) Summary: SKW2958 ON A 3 mile final runway 11L, 3700' MSL reported a drone orange in color 100 yards right of final same altitude. Tucson Police Department and DEN notified. Tower controllers were able to see the drone with binoculars and it appeared to be a large UAS.
1-1-2016 1119 hrs	Phoenix, Arizona	Prelim info from FAA OPS: Phoenix, AZ/UAS incident/0119M/helicopter, reported seeing a UAS or small balloon at 1,800 feet 6 W Phoenix. No evasive action taken. Unknown if law enforcement officer (LEO) was notified. MOR Alert for PHX Type: VFR A/C in proximity to terrain/obstructions affecting safety of flight Date/Time: Jan 1, 2016, 0819Z A/C: (HELO) Summary: HELO reported a drone or small balloon over the stacks about six miles west of the airport at 1800FT. No actions taken by the pilot

[209] Adapted from: Federal Aviation Administration, "UAS Sightings Report."

Date and Time	City and State	Incident Remarks
12-8-2015 1931 hrs	Phoenix, Arizona	Prelim info from FAA OPS: Phoenix, AZ/UAS incident/1233M/Phoenix-Mesa Gateway ATCT advised Robinson R22, reported an unidentified UAS while southwest bound at 2,000 4 NE Phoenix-Mesa. No evasive action taken. MESA PD notified. MOR Alert for IWA Type: Public inquiry or concern (including all pilot reported NMACs) Date/Time: Dec 8, 2015, 1931Z A/C: (HELO). Summary: HELO reported UAS activity 4NM NE of IWA at 021. No other information was received. DEN notified.
11-26-2015 2338 hrs	Phoenix, Arizona	MOR Alert: the Phoenix Police contacted PHX tower in reference to possible drone activity in the vicinity of his house located near state Route 51 and Glendale in phoenix. He stated that around 2101 local, he observed a small object become airborne over his house with green and red lights. Shortly after, he observed another similar looking object become airborne in the same area. AT 2116 local, both objects disappeared from view. Officer was concerned that the objects were possibly drones operating inside the class bravo airspace. Drone activity was not reported by any aircraft during that timeframe.
11-2-2015 0000 hrs	Phoenix, Arizona	Prelim info from FAA OPS: PHX/UAS incident/ 1125M/PHX ARPT PD received phone call reporting 2 UNKN type UAS operating S of PHX Heading E. No conflict with ACFT reported. MOR Alert for PHX Type: Date/Time: Nov 2, 2015, 1825Z A/C: drone (drone) Summary: phone call from airport communication center. The Airport Police Department received a report of 2 drones being flown just south of the airport operations area, eastbound along the river bed. Notified the DEN.

Date and Time	City and State	Incident Remarks
10-3-2015 1518 hrs	Scottsdale, Arizona	Prelim info from FAA OPS: Scottsdale, AZ/UAS incident/1518P/Scottsdale ACFT reported Robinson R22, observed a UAS (no description provided) on his right side about 50 feet below ACFT while northbound at 1,850 feet 1.5 SW Scottsdale near a mall. No evasive action taken. Scottsdale PD notified. MOR Alert: At 2218Z the local controller was informed by helicopter that a drone, approximately 1850 MSL, was in the vicinity of Paradise Valley mall.
9-23-2015 1557 hrs	Phoenix, Arizona	Prelim info from FAA OPS: Phoenix, AZ/UAS incident/1557P/Phoenix-Deer Valley reported Cessna C172, on downwind for runway 25R, over 7th Street, observed a UAS at 700 feet. No description of UAS. No evasive action was taken. LEO not notified.
8-28-2015 0000 hrs	Prescott, Arizona	prelim info from FAA OPS: Prescott, AZ/UAS incident/1540P/Embry Riddle RDDL38, Cessna c172, reported a UAS passed 100 feet below them over the Embry Riddle campus at 5,900 ft, 1.5 SW Prescott. No evasive action reported. Unknown if LEO notified. MOR Alert: RDDL38 1.5 miles SW OF PRC AT 5900' MSL over the Embry Riddle campus reported a remote control airplane in close proximity approximately 100 feet below them.

H. FAA AND NATIONAL REPORTED UAS INCIDENTS

FAA Administrator Michael Huerta has said the number of UAS encounters his agency received has more than doubled from 2014 to 2015.[210] Between the months of November 2014 and August 2015, the FAA reported 764 UAS encounters by aircraft with 23 of those incidents occurring in Arizona. In all, Arizona ranked the ninth highest in the nation with 23 incidents, while 22 of them were reported between the months of

[210] Tom Blanton, "Drone Encounters with Aircraft Grow in Arizona, Nationwide," *Arizona Daily Sun*, October 19, 2015, http://azdailysun.com/news/local/drone-encounters-with-aircraft-grow-in-arizona-nationwide/article_ed43c768-9da6-543a-a6cb-9290d34dfe02.html.

February and August 2015.[211] Roughly four states accounted for the 764 incidents at the national level including California, Florida, New York, and Texas.[212]

I. REGISTERED UAS IN THE STATE OF ARIZONA

According to a report by the FAA, the number of UAS registrations has been broken down into both the hobbyist and non-hobbyist categories.[213] The hobbyist category is broken into 433 different cities, states, and zip codes within the United States.[214] In Arizona alone, there are a total of 769,603 registered UAS platforms.[215] The non-hobbyist category is substantially smaller given the previous restrictions imposed upon this group by the FAA. This category only represents a total of 166 registered UAS platforms at the time of this report.[216] This number is expected to grow significantly as a result of the FAA's release of the "Summary of Small Unmanned Aircraft Rule," Part 107 on June 21, 2016.[217] This revision now allows commercial use of UAS without the need for a 333 Exemption as was previously required. This long-awaited response from the FAA in what some in the industry have called a landmark step in the successful integration of UAS into the national airspace, which went into effect on August 29, 2016.[218]

J. CHAPTER SUMMARY

The final impact of commercial UAS integration as introduced by the FAA may not be fully realized for some time. As long as UAS technology continues to evolve and

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[211] Ibid.

[212] Ibid.

[213] Federal Aviation Administration, "UAS Registration Report by City, State, and Zip Code" [Excel], May 12, 2016, http://www.faa.gov/foia/electronic_reading_room/media/Reg-by-City-State-Zip-12May2016.xlsx.

[214] Ibid.

[215] Ibid.

[216] Ibid.

[217] Federal Aviation Administration, "Summary of Small Unmanned Aircraft Rule (Part 107)," *FAA News*, June 21, 2016, https://www.faa.gov/uas/media/Part_107_Summary.pdf, 1.

[218] Lucy Schouten, "Half a Million Drones in the US, Now Poised to Go Mainstream," *Christian Science Monitor*, August 3, 2016, http://www.csmonitor.com/Technology/2016/0803/Half-a-million-drones-in-the-US-now-poised-to-go-mainstream.

commercial aircraft find themselves navigating a shared airspace, there will continue to be threats of midair collisions. Effectively managing this congested airspace continues to present significant challenges for public safety and emergency first responders and requires sound strategic policy to ensure there is an appropriate balance between business and community. This is currently the space in which the city of Phoenix now finds itself.

This chapter has presented a variety of industry applications for UAS platforms, but it is the public safety community that is uniquely challenged with leveraging UAS technology as an enhanced capability as well as representing the enforcement agent governing the improper use of UAS platforms that jeopardize public safety. This conundrum illustrates the inherent need for clarity and strategic policy guidance as it applies to the city of Phoenix. Central to the policy discussion on UAS integration is the acknowledgement of the potential threat risk UAS pose to the public and the relative ease with which these devices may be exploited for nefarious or terrorist acts leveled against an unsuspecting populous.

Four different alternative solutions are presented and the impacts of each reviewed against established criteria to illustrate the viability of a potential alternative solution. Chapter IV incorporates elements of the current environment within the city of Phoenix to identify the alternative solution that presents the best fit for the city based on the outcome desired.

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IV. VARIANT ALTERNATIVE SOLUTIONS FOR DESIRED OUTCOMES

The target space for this thesis is to identify a series of best response options that outline a strategic policy developmental approach for UAS integration within the city of Phoenix. Integration of a UAS strategic policy will serve as the supportive framework to enable oversight and governance over the safe integration of UAS within the city's airspace.

Furthermore, the UAS application spectrum continues to expand and with it comes the need to respond to the dynamic and fast pace of an evolving technology. As discussed in Chapter III, the city of Phoenix has experienced an increase in the number of UAS sightings in and around the Phoenix metropolitan area. This is further supported by the FAA's report of the number of UAS registrations throughout the state of Arizona. The implementation of the FAA's "Small UAS Rules," Part 107 drives the number of commercially utilized UAS platforms even higher under this FAA directive. Based on the data provided, the City of Phoenix must be prepared to manage effectively the evolving threat environment, which now includes UAS operations.

This research approaches this challenge by developing alternative solution outcomes based on a comparative analysis of multiple stakeholder perspectives. The alternative solutions developed within this chapter represent the current UAS environment within the city of Phoenix. Consideration has been given to identify the pros and cons to these alternatives based on the affected stakeholder segments among a varying and disparate field of competing agendas. The following alternative outcome solutions are designed to account for the wide and disparate perceptions of the public stakeholders, elected officials, and city leadership. These alternative solutions are meant to be viewed from a common perspective among multiple stakeholders with an interest in UAS integration within the city of Phoenix.

A. ALTERNATIVE SOLUTIONS

The following section presents four different solution options that City of Phoenix is likely to be confronted with while developing an acceptable strategic guidance policy given a number of policy option scenarios and conditions. This section is intended to reflect the problem spaces associated with the selection of any one solution option given the subsequent cause and effect conditions that naturally emerge under these policy discussions. The solution options do not necessarily present a one-size-fits-all approach to policy making; rather, they are in essence a snapshot of the geopolitical environment of the city of Phoenix.

Each solution option discussion is evaluated against a set of criteria intended to balance out the discussion and represent both sides of the issue likely to occur during policy development discussions. This approach examines the cause and effect relationship associated with each solution option to reveal and promote ongoing dialogue between city leadership, the elected officials, and the community at large so an informed policy guidance decision can be selected. Table 6 identifies the six criteria applied to each of the four solution options presented in this chapter.

Table 6. Solution Option Evaluation Criteria

Criterion	Unit of Measurement
Risk/Threat to Public Safety: Includes police, fire, and emergency first responders.	Potential for injury or loss of life if carried out
Cost Classified within three cost categories for consideration.	Cost to City of Phoenix: <$250K, $250–$750K, and $750–$1 million +
Legality: Laws/ ordinances currently exist, laws/ordinances in process, or if future laws/ordinances would be required.	Measured by the current availability of existing laws/ordinances or by the need for new legislative efforts to occur.

Criterion	Unit of Measurement
Politically Acceptable: Classified by gauging the likelihood the recommended solution will be well received by elected officials and public based on current political environment.	Measured by the level of community engagement and feedback received from the impacted stakeholders as well as the elected officials who represent the public.
Challenges of Technological Integration: (Complexity)—Assess difficulty and potential for successful implementation. Can be implemented within 12 months; —can be implemented within 1–3 years; can be implemented within 3–5 years.	Assessed in the time it takes in years to implement the alternative solution selected.
Supports Economic Growth: Solution provides growth opportunities within first 12 months; within 1–3 years; within 3–5 years for small business.	Assessed in the time in years it takes for new or existing business to implement UAS as part of their business model.

B. SOLUTION OPTION A

Alternative solution A calls for less regulation and authorizes commercial use of UAS to spur economic growth and attract new business. The evaluation criteria below were applied to Solution option A as part of its overall analysis assessment.

1. Risk/Threats to Public Safety

The threat classification of solution option A consists of privacy concerns, CI/KR, cyber intrusion, and weaponized attack. The unit of measurement for this criterion is assessed in terms of potential injury or loss of life if the act was carried out. To determine effectively the appropriate level of risk/threat associated with the commercial integration of UAS, one must view it across a sliding scale spectrum to classify effectively what the threat represents. This threat spectrum ranges from pre-operational planning to a full scale dynamic attack. Increased incident data suggests UAS integration within the city of Phoenix airspace will increase both from the hobbyist community and commercial business sector, as previously detailed.

Along this risk/threat spectrum, the privacy debate is expected to increase and consist of primarily neighbor on neighbor disputes or complaints regarding surreptitious videotaping of another without their consent. As such, this would represent the lowest level of risk/threat to public safety.

Concerns about the use of UAS above or near CI/KR locations remain a constant concern for public safety in the protection of homeland security interests. Much of the anxiety surrounding these intrusions is centered on the current inability of LE to identify either the UAS or the operator in a timely manner to discern the intent of the operator. In many cases, these intrusions could be considered acts of pre-operational surveillance or unauthorized photography or videography of critical resource locations where operational tradecraft is not released to the public and the intrusion of a UAS has the potential to compromise the integrity and security of a particular asset. This risk/threat profile represents a mid-level and ongoing concern for public safety.

Perhaps the most concerning risk/threat profile UAS present to the public safety first responder is that of a weaponized UAS used in conjunction with an attack against public order. The thesis has identified the highly diverse nature of UAS platforms and the ease with which they can be modified to enhance their existing capabilities by a malicious actor intent on using the UAS for nefarious acts. UAS platforms could be deployed as a delivery system for the dispersal of a chemical or biological agent, modified to fire several types of firearms at stationary or moving targets, or for use as an improvised explosive device (IED). When properly equipped and laden with explosives, a UAS platform itself becomes a deadly weapon of mass destruction. The use of a UAS in this manner represents the highest level of concern for public safety due to the difficulty in identifying the device and the operator's intent prior to the UAS becoming airborne.

2. Cost

The cost to the City of Phoenix to implement alternative option A is classified as less than $250K, $250–$750K, and $750–$1 million or more. The unit of measurement of

this criterion is assessed in terms of dollars to determine the overall cost to the City of Phoenix as a component to a given alternative solution.

Assessing the cost to the City of Phoenix for the integration of alternative solution A in support of commercial UAS operation will likely be incurred over time once the solution is implemented. First steps for the City of Phoenix might include partnering with the business community and business management companies like the Phoenix Downtown Partnership Inc. to conduct a public information and education campaign. The purpose of the campaign would be to present unified and consistent messaging to both the public and commercial entities contemplating the use of UAS as a business strategy. A comprehensive messaging campaign provides a platform for the successful introduction of the FAA's new Part 107 amendment released in late June 2016. This document provides the initial set of guidelines governing the use of commercial UAS within the national airspace.

As part of a calculated strategy, the City of Phoenix can expect to commit an initial cost outlay of approximately $250K for its initial launch of information. This cost can be negotiated within the collaborative group of partners to some degree, but it will be incumbent upon the city to lead this effort and assume the unsupported costs of this messaging effort. Once the initial campaign of approximately 12 weeks has expired, the city should repeat this messaging again after about six months to ensure market saturation of the message. This second phase of advertising can build upon the efforts of the first messaging campaign to maintain momentum; however, an additional expense of approximately $100–$150K may be required to reinforce the message.

To reach the broadest audience, the City of Phoenix might consider utilizing multi-modal messaging approach that includes radio, television, web pages, and other digital media formats. In doing so, the city can reach multiple demographic segments of its population, thus offering greater continuity and unity of messaging citywide. This includes the addition of this UAS information on the city's public facing portal and on continual loop via the city's contract with Cox Communication's public safety television channel. Again, this cost can be implemented as part of a phased approach over time and as a reinforcement tool accessible to the public.

Given the flexibility of available advertising and marketing price points, the city maintains the option to customize its marketing and advertising investment strategy in a manner that more easily conforms to the budgeted funds available at any given time. Examples of marketing and advertisement investments might also include leveraging the transportation sector's light rail, metro buses, electronic billboard, print media, radio and television spots, etc. (Note: Additional expenses are likely to be incurred by the police department in terms of organizational restructuring to conduct UAS investigations and enforcement and is discussed further under the Challenges of Integration Section).

3. Legality

Does the current legal environment support the recommended alternative? The legality of alternative option A is determined if laws/ordinances currently exist, laws/ ordinances are in process, or if future laws/ordinances would be required. The unit of measurement for this criterion is a bit more abstract than other criteria. It seeks to identify the availability of a legal framework for UAS to operate within and is applicable to every alternative solution presented. Additionally, this criterion can be measured by the current availability of existing laws/ordinances or by the need for new legislative efforts to occur.

With the release of the FAA's Part 107 guidelines in late June 2016, a foundational set of rules governing the use of UAS within jurisdictions nationwide is now available. Under Part 107, commercial use of UAS is permitted provided it does not conflict with existing FAA guidelines. This includes visual line of sight (VLOS) operations only, not exceeding 400 feet above ground level (AGL), daytime operations only, not flying over a large crowd, not flying in a careless or reckless manner, and prohibition of operation within 5 miles of an airport.[219]

A key piece of the supportive infrastructure for UAS related incidents involves city officials working closely with city and county prosecutor's offices in advance to ensure they have the support of the judges and magistrates. As is the case in other types of specialized investigations, a clear and comprehensive understanding of the guidelines

[219] Federal Aviation Administration (FAA), "Fact Sheet—Small Unmanned Aircraft Regulations (Part 107)," press release, June 21, 2016, https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=20516.

and protocols required by prosecutors must be conveyed to LE to ensure the chargeable elements of the crime meet prosecutorial expectations.

Though the FAA remains the enforcement arm for the investigative and punitive aspect of UAS violations, it is understood local and state municipal law enforcement agencies will likely be the first point of contact with violators and as such, must assess the initial violation and take the appropriate enforcement action.[220] Local and state agencies are relegated to the enforcement of existing local and state statutes under these circumstances.

The state of Arizona currently has sufficient civil and criminal statutes at its disposal to render disposition on these cases as they arise. These cases may include issues surrounding privacy violations, reckless or careless UAS operation, or assault/aggravated assault in the event significant or serious injury resulting from the operator's negligent or intentional actions. The FAA may choose to follow up or assess civil sanctions at its discretion.

Given this, there is currently sufficient legal and supportive framework in place within the city of Phoenix to facilitate the enforcement of UAS related incidents that rise to the level of civil or criminal charges.

4. Politically Acceptability

Political acceptability of alternative option A is classified by gauging the likelihood the recommended solution would be well received by elected officials and public based on current political environment. The unit of measurement for this criterion is also a bit abstract, but it would have relevance within every alternative solution under consideration. In addition, this criterion can be measured by the level of community engagement and feedback received from the impacted stakeholders as well as the elected officials who represent the public.

[220] Federal Aviation Administration, *Law Enforcement Guidance*; Federal Aviation Administration, "FAA Issues UAS Guidance for Law Enforcement," last modified January 8, 2015, https://www.faa.gov/news/updates/?newsId=81244.

Calculating the level of political acceptability is an abstract concept at best, but one that is critical to understanding of the current environment within which this alternative solution is likely to be introduced. The level of acceptance will continue to move to the left or the right along a sliding scale throughout the terms of the effected politicians.

Key influencers are likely to include the presence of significant commercial business industry within each of the eight existing council districts. The level of public sentiment regarding the use of UAS within a geographic area will be critical as to how a elected representative elects to vote on behalf of his/her constituents. It is likely that districts with more commercial industry would be in favor than those in districts with more residential neighborhoods. Another important factor to consider is the value set and/ or business experience the individual council members bring to the table. This elected body tends to be an eclectic group with varying levels of experience, education and business acumen upon which their political platforms are predicated. The ability to factor elements such as the human condition into the strategic guidance policy is difficult to achieve, but it is extremely important to gauge effectively the potential viability of any alternative outcome solution that is selected.

According to the 2016 annual report by the National League of Cities, the Brookings Institute has referred to the "non-federal drone regulation as the Wild West."[221] The report states that many city and local agencies have been hesitant to act in the absence of federal guidelines and have opted to wait unless forced to because of a specific incident that has yet to occur.[222] The city of Chicago was among the first to implement its "smart regulations" drone policy in November 2015 as did the city of Miami, Florida. Both cities focused their ordinances on general enforcement of critical infrastructure locations within their respective jurisdictions.[223] The recency of UAS

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221 National League of Cities, *Cities and Drones: What Cities Need to Know about Unmanned Aerial Vehicles (UAVs)* (Washington, DC: Center for City Solutions and Applied Research, 2016), http://www.nlc.org/Documents/Find%20City%20Solutions/City-Solutions-and-Applied-Research/ NLC%20Drone%20Report.pdf, 26.

222 Ibid.

223 Ibid., 27.

integration within cities nationwide has yet to produce significant political issues, due largely in part to the restrictive nature of the commercial exemption process. This is likely to change given the issuance of the new FAA Part 107 directives.

5. Challenges of Technological Integration (Complexity)

The challenges of technological integration (complexity) assesses the difficulty of and potential for successful implementation. The option can be implemented within 12 months, can be implemented within one to three years, or—can be implemented within three to five years. The unit of measurement for this criterion will be assessed in the time it takes in years to implement the alternative solution selected.

Technological integration of this alternative outcome solution will be minimal on the part of the City of Phoenix as a whole; however, there are likely to be some integration elements that must be met by the Phoenix Police Department. As with many other reclassifications of crime types, the CAD system would need to be updated to include a new radio code related to UAS incident types. This is more of an administrative function involving information technology (IT) related personnel hours to perform system updates. Any potential cost would be negligible and absorbed within the police department's existing budget.

Another potential challenge lies in the potential for increased volume of calls for service investigated and the subsequent reports requiring detective follow up generated by this new UAS integration citywide. These will by comparison be delayed costs and not immediately known. Currently, these reports will be routed internally to the Assaults Bureau within the police department's Investigations Division for triage and potential follow up. Should the volume of additional reports the new UAS program generates exceed existing investigative capabilities, the department may be required to either add additional detectives to meet the rising demand or consider the possibility of creating another squad of detectives and a supervisor to focus on the UAS issue citywide.

The exact cost of this effort will be entirely dependent on the assessed increase in workload that UAS integration has contributed to and will only be determinable after

some time following UAS integration. Under these conditions, this category would rank low on the complexity scale and could easily be implemented within 12 months or less.

6. Supports Economic Growth

This solution provides growth opportunities within first 12 months, the solution provides growth opportunities within one to three years, or the solution provides growth opportunities within three to five years for small business. The unit of measurement for this criterion will be assessed in the years it takes for new or existing business to implement UAS as part of their business model.

The City of Phoenix's decision to select this alternative solution that favors the commercial integration of UAS within the city's airspace to spur economic growth and business development can be expected to provide a wide range of benefits to the city. These benefits include the ability to showcase Phoenix as a business friendly and progressive business market embracing and engaging in cutting edge technologies as part of a sound business platform supporting a wide range of economic strategies. The ability of the commercial and business sectors to utilize UAS to promote advertising and marketing strategies will directly benefit both the independent business and management companies like the Phoenix Downtown Partnership Inc.[224]

The ability for commercial use of UAS in the fields of real estate, photography, and videography provide the platform for next generation aerial marketing capitalizing on the vast array of scenic photography options the city of Phoenix and vibrant desert surroundings offers year round. Commercial UAS use is an effective recruitment tool to attract new and budding business as well as those already established elsewhere.

A secondary and cascading consequence of the commercial use of UAS is the ability to capitalize on the State of Arizona's booming tourism. Potential opportunities existed for UAS use during nationally significant events in the Phoenix metropolitan area such as Super Bowl XLIX, NCAA College Football Championship Playoff Game, and the upcoming NCAA Final Four Championship Tournament in March of 2017. Each of

[224] Downtown Phoenix Partnership Inc., "Downtown Phoenix Partnership," August 13, 2016, http://dtphx.org/about/downtown-phoenix-inc/downtown-phoenix-partnership/.

these events, coupled with the existing prosperous business community, presents an unbridled opportunity for future growth and economic expansion that can only be enhanced by the decision to integrate UAS into the city of Phoenix's airspace.

C. SOLUTION OPTION B

Solution B is an alternative in which public safety is the paramount concern and will involve increased regulation.

1. Risk/Threats to Public Safety

The threat classification of solution option B consists of privacy concerns, CI/KR, cyber intrusion, and weaponized attack. The unit of measurement for this criterion is assessed in terms of potential injury or loss of life if the act was carried out. To determine effectively the appropriate level of risk/threat associated with the commercial integration of UAS, one must view it across a sliding scale spectrum to classify effectively what the threat represents.

This threat spectrum ranges from pre-operational planning to a full scale dynamic attack. Increased incident data suggests UAS integration within the city of Phoenix airspace will increase both from the hobbyist community and commercial business sector as previously detailed.

Selection of this alternative outcome is the best scenario to support of public safety interests. This alternative would support an enhanced level of acceptable enforcement within a more restrictive, zero tolerance environment. Enforcement and investigation would be actively pursued at all levels of the prosecutorial system. In addition, privacy concerns would continue to represent the lower end of the threat spectrum, but this option would involve less officer discretion for educational contacts with violators.

Implementation of this solution would equate to an enhanced security posture for the police department and is one that would take a more proactive role in securing CI/KR assets of importance throughout the city. This would include target hardening at these critical locations to prevent and deter intrusive penetration. Protecting the CI/KR

component within our city represents a significant investment in personnel and resources to accomplish and considered a priority risk assignment.

Under this scenario, the highest priority for the police department and emergency first responders is the preservation of life safety for its citizens against a weaponized UAS threat. This may present itself in one of many various forms, including an attack over a large crowd as has been seen multiple times across the country. Because this threat represents the most difficult to prevent, it would also require the maximum level of organizational attentiveness at the ready. The number and frequency of high profile and nationally significant events that take place in the greater Phoenix metropolitan area make this location a prime target for a malicious actor intent on inflicting harm against the citizens of our city.

2. Cost

The cost to the City of Phoenix to implement alternative option B is classified as less than $250K, $250–$750K, and $750–$1 million or more. The unit of measurement of this criterion to determine the overall cost is assessed in terms of dollars.

This alternative solution has a significant cost to the taxpayers if it were to be truly followed to the letter. The final cost of this effort is incalculable until a prioritized security posture is identified and implemented on a case-by-case basis. Enhancing security measures at CI/KR locations will quickly become cost prohibitive absent a prioritized schedule based on leveraged intelligence to identify where in the city the greatest needs is within the city's CI/KR profile.

A profile of this nature might include upgrading keycard access to buildings and installing magnetometers at entry/exit points within a building's footprint. The addition of multiple CCTV cameras within the downtown government complex would be essential to an enhanced security posture at these venues. The addition of dual-authentication and bio-metrics to specific floors and access to computers would greatly increase the security and integrity of data stored at these sights. Examples of measures could include enhanced perimeter fencing, motion detection sensors, and CCTV at water treatment facilities,

electrical power substations, valley dams and reservoirs, and the fuel tank storage farms would remain essential to fortifying existing systems in place.

3. Legality

Does the current legal environment support the recommended alternative? For alternative option B, this is classified by determining if laws/ordinances currently exist, laws/ordinances are in process, or if future laws/ordinances would be required. The unit of measurement for this criterion is more abstract than that of some other criteria and seeks to identify the availability of a legal framework for UAS to operate within. Moreover, this criterion can be measured by the current availability of existing laws/ ordinances or by the need for new legislative efforts to occur.

The newly released FAA Part 107 guidelines in June 2016 have provided both the commercial UAS operator and law enforcement with a foundational set of rules governing the use of UAS within jurisdictions nationwide. Adherence to Part 107 by UAS operators is allowable provided their operation does not conflict with existing FAA guidelines previously cited.[225]

The City of Phoenix currently maintains the necessary elements of supportive infrastructure within its judiciary at both the city and county prosecutor's levels. Continued collaboration between the prosecuting officials and the police department will ensure consistency in the case development and charging elements of each UAS case brought before the court. Communication of prosecutorial objectives will be critical to successful prosecution of these cases and to ensure prosecutorial efforts are in alignment with local and state laws to meet the needs of the community.

Local law enforcement efforts are conducted with the understanding the FAA remains the responsible investigative agency for all UAS violations. Under this framework the FAA recognizes that in most cases, local or state law enforcement will likely have the initial contact with the violator and conduct the preliminary investigation

[225] FAA, "Fact Sheet—Small Unmanned Aircraft Regulations (Part 107)."

to render the appropriate disposition in accordance with appropriate local and state laws.[226] Additional follow up or civil sanctions by the FAA may occur at its discretion.

Given this assessment, there is currently sufficient legal and supportive framework in place within the city of Phoenix to facilitate the enforcement of UAS related incidents that rise to the level of civil or criminal charges.

4. Politically Acceptability

Political acceptability of alternative option B is classified by gauging the likelihood the recommended solution would be well received by elected officials and public based on current political environment. The unit of measurement for this criterion is also a bit abstract, but will have relevance within every alternative solution under consideration. This criterion can be measured by the level of community engagement and feedback received from the impacted stakeholders as well as the elected officials who represent the public.

There is a strong likelihood that if this alternative outcome solution is selected, it will face division between the elected officials currently in place and the citizens they represent. While there is strong support for public safety across the board, the City of Phoenix has long maintained a delicate and productive balance with its community in a collaborative problem solving relationship as part of a cooperative strategy. This effective relationship has been demonstrated in the City of Phoenix and the police department's proactive efforts to embrace and implement the recommendations from the Community Policing Trust Initiative (CPTI) Task Force.[227] Proactive and non-adversarial relationships with the community groups and citizens alike comprise the cornerstone of effective policing strategies for the city. Maintaining these critical relationships with community partners is paramount to the future of policing in Phoenix and cannot be taken for granted.

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[226] Federal Aviation Administration, *Law Enforcement Guidance*, 1.

[227] City of Phoenix, "Community & Police Trust Initiative," August 13, 2016, https://www.phoenix.gov/trust.

With this in mind, this alternative outcome solution could create an adversarial relationship with the community based on the solution's premise of unconditional enforcement and zero tolerance within the community. Implementing a solution with a sole focus on security at all costs represents a dangerous strategy that runs counter to the inherent way the City of Phoenix conducts business with its community. It would be expected that the community would become divisive over the need for such an enhanced security profile putting the citizens as a low priority for the city. This solution could create pockets of dissention and force residents to choose between zero tolerance enforcement and a more balanced community policing relationship they currently enjoy.

5. Challenges of Technological Integration (Complexity)

The challenges of technological integration (complexity) for option B assess difficulty and potential for successful implementation. It can be implemented within 12 months, within one to three years, and within three to five years. The unit of measurement for this criterion is assessed by the time it takes in years to implement the alternative solution selected.

Assessing the challenges of technological integration of this solution would occur over an extended period in a tiered or phased approach. As mentioned under the Cost section, the security enhancements would have to be prioritized to determine the level of priority for the city and the police department before any integration could occur. The city and the police department would need to identify which enhancements could be implemented in the short-term based on the level of complexity and the cost to implement. For these reasons, this section would be closely linked to the cost criterion (previously discussed) as one has a direct impact on the other moving forward. Once the security projects are prioritized, they can then be placed into a subsequent phase for implementation typically involving periods of less than 12 months, one to three years, and three to five years for final implementation.

Policy changes or adjustments would serve as examples of enhancements that could be implemented at little to no cost and within less than 12 months. Mid-level projects, such as additional CCTV cameras and camera infrastructure upgrades, would be

subject to existing budget restrictions or postponed to a later date to allow for budget reallocation of funds to begin project implementation. These would serve as an example of a one to three year project for the city. Larger security enhancements, such as network expansion of downtown government complex enhanced access card readers, addition of magnetometers and building redesign of ingress and egress routes for each building, would constitute a larger commitment of funds and architectural build time to complete. The independent funding streams for these types of project will often dictate the timeline for project kickoff. With larger capital improvement projects, there may be a need for the city to request authorization to hold a special bond election to identify the funding required. This process may significantly delay a project kickoff date and would also impact the final implementation date of the project. For these reasons, these types of projects would likely fall under the three to five-year implementation window.

6. Supports Economic Growth

Alternative option B provides growth opportunities within first 12 months, opportunities within one to three years, and others within three to five years for small business. The unit of measurement for this criterion is assessed in the years it takes for new or existing businesses to implement UAS as part of their business model.

The decision to implement this alternative outcome solution may to adversely impact future companies that may be currently considering moving their business to the city of Phoenix once they learn the city's approach to commercial UAS integration is a heavily enforced activity enhanced security posture of the city's CI/KR as priority above all else. This may also dissuade businesses that currently reside in Phoenix, and they may decide take their business interests to a place with a local government environment that places value on community and business partners. Although the immediate adverse impact would involve those businesses who seek to integrate UAS technology into their business strategy, this security centric and law enforcement based solution may easily be interpreted as a heavy-handed approach by the city and the police department, which may find the business community isolated rather than the active cooperative partners as they

currently are. The result of this adopted option may eventually permeate other business segments, which may elect to take their businesses elsewhere.

D. SOLUTION OPTION C

Option C is an alternative solution in which reduced cost to the city and business community is desired.

1. Risk/Threats to Public Safety

The threat classification of solution option C consists of privacy concerns, CI/KR, cyber intrusion, and weaponized attack. The unit of measurement for this criterion is assessed in terms of potential injury or loss of life if the act was carried out. To determine effectively the appropriate level of risk/threat associated with the commercial integration of UAS, one must view it across a sliding scale spectrum to classify effectively what the threat represents.

This threat spectrum ranges from pre-operational planning to a full scale dynamic attack. Increased incident data suggests UAS integration within the city of Phoenix airspace will increase both from the hobbyist community and commercial business sector as previously detailed.

The decision to select alternative option C raises some real concerns for both public safety first responders and the citizens of Phoenix. An approach by city leadership to adopt a reduced cost option both for the city and the business community supports the idea that an enhanced security posture virtually unattainable. Perhaps more important than the reduced cost option is the adoption of a citywide philosophy that translates directly to reduced security. While cost can certainly be a limiting factor to the level of security enhancements attainable, it is not the only factor that determines the final security posture the city adopts.

A reduced cost approach would impact the police department in terms of the number of available detectives it might otherwise be able to add to address the increased work load related to UAS integration within its jurisdiction. This additional workload would have to be absorbed internally with no additional accommodations. The impacts of

this decision would be revealed in time once the UAS integration was fully implemented. The additional workload would take the form of additional departmental reports on crimes occurring directly related to UAS. This includes the privacy complaints and neighbor-on-neighbor confrontations that could likely ensue.

A low cost or reduced budget approach by the city would likely adversely impact the police department's ability to conduct security enhancements to the level previously discussed. Additionally, the city would seek to identify the low hanging fruit that could be immediately implemented to impact current security practices at CI/KR locations, including the downtown government complex. Implementing change under these restrictions could be carried out through departmental internal policy reorganization to streamline efficiency at these locations. This might also include reassessment of staffing and posting locations to maximize the security posture through more effectively deploying existing resources.

Operations under reduced budget conditions is not new to the City of Phoenix as it has successfully managed to shrink its labor forces over the course of the last six years without adversely impacting the level of customer service delivery. This becomes particularly important now as the City of Phoenix has resumed its hiring efforts to fill more than 600 police officer vacancies, which have gone unfilled since the recession of the Phoenix area in 2008.[228] Even though hiring is currently underway, it will take years for a recovery of this magnitude to be implemented department wide. In the meantime, it remains important for the City of Phoenix to continue its do more with less philosophy to consolidate and combine work responsibilities. This effort also translates to a shared employee approach to our goal of an enhanced security posture. The See Something, Say Something campaign encourages people to question suspicious behavior and notify law enforcement of its occurrence.[229] This option enables law enforcement to leverage its resources more effectively to support critical assets within the city.

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[228] Megan Cassidy, "Phoenix Police Seek to Diversify as Hiring Begins," *The Arizona Republic*, March 9, 2015, http://www.azcentral.com/story/news/local/phoenix/2015/03/09/phoenix-police-seek-diversify-hiring-begins/24633149/.

[229] Department of Homeland Security, "If You See Something, Say Something," August 13, 2016, https://www.dhs.gov/see-something-say-something/about-campaign.

The alternative option C does not provide the appropriate funding for enhancing the existing physical security, which will likely remain unchanged until the current financial environmental conditions improve.

2. Cost

The cost of this option to the City of Phoenix to implement is classified as less than $250K, $250–$750K, and $750–$1 million plus. The unit of measurement of this criterion is assessed in terms of dollars to determine the overall cost to the City of Phoenix.

To select this alternative outcome solution, the city must first identify what level of financial commitment it is prepared to make under the current threat environment. Once a budget is identified, the process of project prioritization must be completed. Organizationally, all projects must be evaluated to determine which project has the greatest impact to the city and falls within the prescribed budgetary restrictions identified. Special consideration should be focused on the immediacy of impact of the projects selected to maximize the improvement to city's security posture.

Another consideration for the city is to explore federal grant opportunities to fund CI/KR enhancements and upgrades to its critical infrastructure to enhance the overall resilience capacity and security posture among the 16 critical infrastructure sectors identified within the Department of Homeland Security's 2013 *National Infrastructure Protection Plan* (NIPP).[230] Although grants are not always available on a continuous basis, they are an opportunity for agencies to offset the funding restrictions many cities face in launching their projects.

The City of Phoenix should also consider collaborative partnerships with the private sector, which may share a vested interest, as well as partnerships to support city and the business community in successfully integrating UAS into the city's airspace under these current budgetary restrictions. Along with this effort, the city should continue

[230] Department of Homeland Security, *2013 National Infrastructure Protection Plan* (Washington, DC: Department of Homeland Security, 2013), https://www.dhs.gov/see-something-say-something/about-campaign, 17.

its existing partnership with the academic community for the purpose of gathering data to monitor the effectiveness of the UAS integration within its jurisdiction as part of an efficiency model that could be replicated by other agencies considering such UAS integration under similar circumstances.

3. Legality

Does the current legal environment support the recommended alternative? Legality of option C is classified by determining if laws/ordinances currently exist, laws/ ordinances are in process, or if future laws/ordinances would be required.

The unit of measurement for this criterion is somewhat abstract but seeks to identify the availability of a legal framework for UAS to operate within. This criterion can be measured by the current availability of existing laws/ordinances or by the need for new legislative efforts to occur.

Should alternative outcome solution C be selected, there is little to no change expected to occur directly related to this policy option. The current legal framework in place is more than adequate to address the potential increase in cases generated through the implementation of UAS as previously detailed. There are no unanticipated challenges to the current legal or judicial institution that would be directly related to the selection of this alternative outcome solution.

4. Politically Acceptability

Political acceptability of alternative solution C is classified by gauging the likelihood the recommended solution would be well received by elected officials and public based on current political environment. The unit of measurement for this criterion is also somewhat abstract. This criterion can be measured by the level of community engagement and feedback received from the impacted stakeholders as well as the elected officials representing the public.

The political impact of this alternative outcome solution is expected to be looked upon favorably. Recognizing the reduced budget restrictions imposed by the selection of this solution, the elected officials are easily able to justify this approach to their citizen

constituents. The impacts to the city's ability to affect a wide range or sweeping changes brought about by the implementation of UAS within the city will be negligible.

Integrating UAS within the city of Phoenix under this solution provides the benefit of a slower paced integration. This enables the citizens, the business community, and public safety first responders to gradually evaluate the overall impact to normal public safety operations and to evaluate any new concerns or issues that arise as a result of this UAS integration. This slower paced model is more in alignment with the approach of existing city leadership to effect change over time rather than all at once. This also provides city leadership to receive feedback from its citizen constituents to more effectively evaluate the impacts of how UAS integration has impacted them both positively or negatively.

5. Challenges of Technological Integration (Complexity)

The challenges of technological integration (complexity) for option C assess the difficulty and potential for successful implementation. It can be implemented within 12 months, within one to three years, and within three to five years. The unit of measurement for this criterion is assessed by the time it takes in years to implement the alternative solution selected.

The unit of measurement for this criterion is assessed in in the years it takes to implement the alternative solution selected.

Selection of this alternative outcome solution would likely have little impact on the technological challenges associated with UAS integration. The reduced budget for security enhancements and marketing of this solution would allow for a slow-paced integration process. The low-cost security enhancement projects identified could typically occur within less than 12 months. In addition, funding restrictions will prohibit additional and more complex projects that would extend the project schedule timetable. These more complex projects would be tabled for future consideration when the economic conditions improve.

In advance of the 2015 holiday season and the mandatory UAS registration program rolled out by the FAA, Phoenix's Sky Harbor Airport developed a UAS registration public facing web portal, which provides up-to-date guidelines and recommendations for UAS operations and the legal construct under which these devices could be operated in accordance with the FAA's national guidelines. This portal has been successfully deployed and continues as a resource and educational tool for the public to consult prior to operation of a UAS.[231] Given that this portal has already been created and is operational, there are no additional or readily identifiable technological challenges the selection of this alternative outcome solution would require.

6. Supports Economic Growth

Alternative option C provides growth opportunities within first 12 months, opportunities within one to three years, and others within three to five years for small business. The unit of measurement for this criterion is assessed in the years it takes for new or existing business to implement UAS as part of their business model.

Selection of this alternative outcome solution would still allow the integration of UAS within the city of Phoenix airspace, but the budget restrictions imposed by the elected officials as defined in this solution provide limited means for the city or law enforcement to engage in additional enhancements to the city's security posture. The selection of this solution is one that favors the use of UAS within the city of Phoenix and represents a business friendly commitment by the city. This posture by the city to support UAS within the business segment would convey goodwill and would be a strong factor for consideration by the existing business community. Moreover, it would have the potential to attract future businesses to the Phoenix metropolitan area.

This solution would provide a permissive environment for UAS integration with little to no additional change by city leadership or the police department in terms of their approach and response to potential issues surrounding the use of UAS. Although affected by budgetary constraints, this solution would allow for a gradual UAS transition across

[231] Sky Harbor International Airport, "Fly Your Drone Responsibly," August 13, 2016, https://skyharbor.com/Business/RulesAndRegulations/drones.

the business segment and would provide time for evaluation of UAS effectiveness. It is more likely than not the impacts of this option would fall within the one to three-year period to allow for the business segment to adjust strategies or pivot their individual business models in a manner that is more UAS inclusive.

E. SOLUTION OPTION D

Option D is an alternative that embraces the current steady state and adopts a wait and see approach.

1. Risk/Threats to Public Safety

The threat classification of solution option D consists of privacy concerns, CI/KR, cyber intrusion, and weaponized attack. The unit of measurement for this criterion is assessed in terms of potential injury or loss of life if the act was carried out. To effectively determine the appropriate level of risk/threat associated with the commercial integration of UAS, one must view it across a sliding scale spectrum to effectively classify what the threat represents.

This threat spectrum ranges from pre-operational planning to a full scale dynamic attack. Increased incident data suggests UAS integration within the city of Phoenix airspace will increase both from the hobbyist community and commercial business sector as previously detailed.

The selection of this alternative outcome solution by city leadership carries with it second and third order consequences the city, which it must be prepared to act upon as they relate to the current risk/threat profile for the city. This may include a lack of sufficient law enforcement investigative resources in place to address the increase in the number of UAS related investigations. It may also include a greater risk to public safety given the number of UAS in use, and that there is no previously identified plan to manage them effectively. In either case, the lack of a proactively developed strategic policy may create unanticipated issues related to UAS integration.

Under this alternative solution D, the city and the police department would no longer poised to engage in proactive response to the new challenges UAS integration

inherently produces. The current rate at which UAS technology is advancing would put the city and the police department at a significant disadvantage if they adopt a wait and see approach and continue the status quo regarding UAS.

2. Cost

The cost of this option to the City of Phoenix to implement is classified as less than $250K, $250–$750K, and $750–$1 million plus. The unit of measurement of this criterion will be assessed in terms of dollars to determine the overall cost to the City of Phoenix as a component to a given alternative solution.

Under the parameters of this solution, the city and the police department would not be poised to incur any additional costs not current underway. This solution includes the premise that UAS integration would not impact the city's or the police department's current operational tempo. There no current expenses identified that are directly attributable to the integration of UAS within the city.

3. Legality

Does the current legal environment support the recommended alternative? Legality of option D is classified by determining if laws/ordinances currently exist, laws/ ordinances are in process, or if future laws/ordinances would be required. The unit of measurement for this criterion is somewhat abstract but seeks to identify the availability of a legal framework for UAS to operate within and would be applicable to every alternative solution presented. This criterion can be measured by the current availability of existing laws/ordinances or by the need for new legislative efforts to occur.

Adoption of this solution assumes the integration of UAS within the city of Phoenix airspace would have no bearing on the current way the city conducts business. It further assumes the UAS integration is commensurate with existing legal environment at the local, state, and federal level as directed by the FAA.

However, one concern city leadership and policy makers should consider before adopting this approach is the public's perception and the impact to public safety confidence in the event of an incident involving a UAS that causes serious injury, death,

or significantly compromises the city's homeland security posture. The city must be prepared to defend its selection of this alternative outcome solution, which may fail to adequately prepare for or thoughtfully consider a cogent public safety response to a new and emerging UAS technology, which includes an enhanced level of threat capability. In this regard, the City of Phoenix could find itself subject to legal recourse for failing to meet the needs of the community's public safety needs.

4. Politically Acceptability

Political acceptability of alternative solution D is classified by gauging the likelihood the recommended solution would be well received by elected officials and the public in the current political environment. The unit of measurement for this criterion is also a bit abstract. This criterion can be measured by the level of community engagement and feedback received from the impacted stakeholders as well as from the elected officials who represent the public.

From a political perspective, this alternative solution is the easy answer as it simply maintains the position of status quo. This solution does not require anything directly from its elected officials or city leadership to implement. It represents the safe alternative as the solution provides for the integration of UAS in support of the business community and supports economic growth opportunities, but it demands nothing of the public safety community other than to address the potential issues as they occur. While this solution represents the easiest option to adopt, it also illustrates the significant gap in the city's level of preparedness. Additionally, it is woefully short sighted in its public safety approach to managing advancements in technology within a homeland security environment.

5. Challenges of Technological Integration (Complexity)

The challenges of technological integration (complexity) for option D assess the difficulty and potential for successful implementation. It can be implemented within 12 months, within one to three years, and within three to five years. The unit of measurement for this criterion is assessed by the time it takes in years to implement the alternative solution selected.

The unit of measurement for this criterion is assessed in the years it takes to implement. Since it the option maintains the status quo, it would take no time to implement.

The selection of this alternative solution does not present any challenges associated with the technological integration of UAS for the city as presented. As previously discussed, the city is maintaining the status quo and no additional efforts would commence on behalf of the city because of the ongoing UAS integration to operate within the city's airspace. It is possible that the city and the police department may experience unanticipated challenges down the road as a result of their lack of pre-implementation planning for UAS integration. Based on the premise of this solution, additional research is needed to conduct post-implementation to better determine the full extent to which UAS integration has impacted the city and the police department.

6. Supports Economic Growth

Alternative option D provides growth opportunities within first 12 months, opportunities within one to three years, and others within three to five years for small business. The unit of measurement for this criterion is assessed in the years it takes for new or existing business to implement UAS as part of their business model.

In terms of evaluating this alternative solution, there are no readily identifiable barriers to entry for UAS integration within the city. UAS is free to conduct business within the commercial segment and the city is not currently countering efforts to integrate this technology. Under these conditions, it is likely the UAS industry will experience immediate growth potential within the first 12 months. Expansion by other businesses will take a longer as they conduct analysis and evaluate the merits of integrating UAS technology under existing or revised strategies before adoption as part of their new business model. This process is more likely to occur within the one to three-year period.

F. CHAPTER SUMMARY

Each of the four alternative solutions presented in this chapter are intended to represent the range of considerations likely to be considered by City of Phoenix

leadership, elected officials, and citizen stakeholders regarding regulation of UAS. This chapter has explored the potential impact and segment of the community affected by a desired outcome. Chapter V presents the methodology for scoring each of the four alternative solutions as compared against the six categories of established criteria before placement within a values assessment matrix for final selection.

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V. MULTI-GOAL POLICY ANALYSIS AND MATRIX PLACEMENT OF EVALUATION CRITERIA

A. STEPS OF ANALYSIS

This research effort utilizes the five-step process contained within the multi-goal policy analysis research design method using practical criteria displayed within an outcomes matrix commonly used to conduct comparative analysis of multiple policy options as described by author Eugene Bardach.[232] This process is ideal for conducting policy analysis in situations in which there are multiple policy outcomes or when one or more of these outcomes cannot be comparatively quantified equally. This process provides the supportive framework required to conduct my analysis as detailed under each of the following five categories related to UAS integration.

B. SELECTED IMPACT CATEGORIES

The research conducted identifies the potential impact to various stakeholders brought about by the selection of any one of the recommended alternative solutions. As each solution is focused towards a specific desired outcome, this section identifies the effects of a given selection on remaining stakeholders.

(1) Policy Alternatives

The alternatives presented are focused on addressing a specific desired outcome as determined to be the priority by city leadership based on the articulated needs of the community. This research analyzes and develops a series of alternative solution response options with differing desired outcomes. The solutions presented also consider the consequences of each model and identify corresponding concession associated with the selection of a specific solution. This research provides implementation recommendations that may consider a phased approach or tier-based model over a given period.

[232] Eugene Bardach, *A Practical Guide for Policy Analysis: The Eightfold Path to More Effective Problem Solving*, 4th ed. (Thousand Oaks, CA: Sage Publications, 2012), 41, 59.

(2) Impact Prediction

By identifying the desired outcome criteria, an array of predictive results can be determined prior to its implementation once an alternative solution is selected. By comparing the solution against the affected stakeholder group, the beneficiary stakeholder becomes evident as do those segments that benefit less or not at all by the selected solution. There will likely be pushback from these disenfranchised stakeholders who seek a return greater than what the selected solution offers. This research must also consider the impact that technology comprehension will have among those responsible for selecting the alternative solution. Maximizing results and efficiencies can be directly linked to challenges experienced with technological unfamiliarity and a steep learning curve for decision makers.

(3) Impact Valuation

The selection of a given solution can be measured in a variety of ways to determine its effective value. If viewed monetarily, cost in dollars can be identified as money saved or spent in excess of an anticipated outcome. In addition, value can be defined in terms of enhanced organizational efficiencies that result in personnel hours saved or workflow processes enhanced as a result of selected outcome solution. Furthermore, value can be measured qualitatively in terms of an increase or decrease in the perception of public safety and quality of life by the community or quantitatively through a change in crime rate statistics based on the selected solution over a given period.

(4) Modification Evaluation

This aspect of the research is presented through comprehensive analysis of identified common core criteria, which are essential to all solutions offered for consideration. Each criterion is assigned a point value and placed within a scoring matrix to numerically assess the viability of a given solution based on the desired alternative outcome sought.

(5) Selection Criteria and Rationale

Given the vast divide between competing objectives, the intended approach is to construct alternative solutions from the varying viewpoints and perspectives of the impacted UAS stakeholders. For the purpose of this research, the following core criteria have been identified and are expected to be germane to the discussion when conducting analysis of multiple stakeholder interests. Additionally, these criteria represent central themes important to the range of stakeholders and can be compared to one another based on their perceived level of importance to any one solution. Also, these criteria are evaluated against all solutions presented and placed within a scoring matrix to assess the comparative viability of each solution against a desired outcome. The core criteria listed below represents the individual elements evaluated within each alternative outcome solution and defines the unit of measurement applied to each.

C. CORE CRITERIA

1. Risk/Threats to Public Safety

The threat classification of solution option C consists of privacy concerns, CI/KR, cyber intrusion, and weaponized attack. The unit of measurement for this criterion is assessed in terms of potential injury or loss of life if the act was carried out. To effectively determine the appropriate level of risk/threat associated with the commercial integration of UAS, one must view it across a sliding scale spectrum to effectively classify what the threat represents.

This threat spectrum ranges from pre-operational planning to a full scale dynamic attack. Increased incident data suggests UAS integration within the city of Phoenix airspace will increase both from the hobbyist community and commercial business sector as previously detailed.

Example: An act carried out that amounted to a privacy violation by an operator flying a UAS over a neighbor's backyard would score on the low end (1–4) in terms of its potential to cause loss of life; whereas an operator with a weaponized UAS platform hovering over a large crowd at a sporting event would score at the high end (8–10) of the matrix.

2. Cost

The cost to the City of Phoenix to implement is classified as less than $250K, $250–$750K, and $750–$1million or more. The unit of measurement for this criterion will be assessed in terms of dollars to determine the overall cost to the City of Phoenix as a component to a given alternative solution.

Example: The cost in dollars for a selected solution that would cost the City of Phoenix less than $250K to implement would rank on the low end (1–4) in terms of its impact to the budget; whereas a solution with a cost criterion of $750K to $1 million to implement would rank at the high end of the matrix.

3. Legality

Does the current legal environment support the recommended alternative? This is classified by determining if laws/ordinances currently exist, laws/ordinances in process, or if future laws/ordinances would be required. The unit of measurement for this criterion is more abstract than for other criteria, and it seeks to identify the availability of a legal framework for UAS to operate within and is applicable to every alternative solution presented. This criterion can be measured by the current availability of existing laws/ ordinances or by the need for new legislative efforts to occur.

Example: Under an alternative solution where a restrictive set of policy guidelines were selected, this criterion would score at the low end (1–4) based on the non-existence a specialized local, state, and federal laws to enforce the solution as presented. However, a solution that favored a more relaxed approach would tend to score on the higher end (8–10) of the matrix since enforcement can be conducted under existing legal options currently in place where less specificity is required.

4. Politically Acceptability

Political acceptability is classified by gauging the likelihood the recommended solution will be well-received by elected officials and public based on current political environment. The unit of measurement for this criterion is also a rather abstract, but it has relevance to every alternative solution under consideration. This criterion can be

measured by the level of community engagement and feedback received from the impacted stakeholders as well as the elected officials who represent the public.

Example: An alternative solution that is restrictive and is perceived as punitive to stakeholders because it is heavy on the enforcement spectrum scores on the low end (1–4) based on public sensitivity to more government enforcement. On the other hand, a solution that encourages small business growth and shows collaboration with law enforcement to provide UAS operating locations scores on the higher end (8–10) of the matrix.

5. Challenges of Technological Integration (Complexity)

The challenges of technological integration (complexity) assess the difficulty and potential for successful implementation. It can be implemented within 12 months, within one to three years, and within three to five years. The unit of measurement for this criterion is assessed by the time it takes in years to implement the alternative solution selected. The unit of measurement for this criterion is assessed in years it takes to implement the alternative solution selected.

Example: An alternative solution that favors immediate results to impact a given strategy would score on the high end (8–10) if a less technologically complex solution was desired and could be implemented within 12 months as opposed to a solution requiring longer implementation time.

6. Supports Economic Growth

Support of economic growth of an option is a solution that provides growth opportunities within first 12 months, opportunities within one to three years, and others within three to five years for small business. The unit of measurement for this criterion is assessed in the years it takes for new or existing businesses to implement UAS as part of their business model.

Example: An alternative solution that enables the business sector immediate access with few barriers to entry for UAS operations scores on the high end (8–10) of the

matrix, while a solution that is less business friendly or one that requires a longer time to implement scores low (1–4) on the matrix.

D. NUMERIC ASSESSMENT TABLE

The numeric assessment table (Table 7) is used to determine the assigned point value of each core criterion and is applied to each alternative solution presented. The low, medium, and high performance metric indicates the scaled value (1–10), to which each criterion is determined to contribute.

Table 7. Numeric Value Assessment by Criteria: Scale: 1–10

Defined as Numeric Value of	**Low (1–4) Points**	**Medium (5–7) Points**	**High (8–10) Points**
Risk/Threat to Public Safety	(1–4) Privacy violations	(5–7)) CI/KR intrusions	(8–10) Weaponized attacks
Cost to city to implement	(1–4) < $250K	(5–7) $250K–$750K	(8–10) $750K–$1 million +
Legality as an enforcement framework	(1–4) Laws/ordinances exist now	(5–7) Laws/ordinances in process	(8–10) Future laws/ ordinances required
Politically Acceptable to elected officials, public safety, business sector and citizens	(1–4) Solution does ***not*** account for all stakeholders –(only a few will benefit)	(5–7) Solution adequately meets needs of ***some***, but ***not all*** stakeholders	(8–10) Solution accurately achieves consensus among stakeholders
Complexity of integration	(1–4) Can be implemented in < 12 months	(5–7) Will take 1–3 years to implement	(8–10) Will take 3–5 years to implement
Supports Economic Growth for small business community	(1–4) Provides growth in first year	(57) Provides growth in 1–3 years	(8–10) Provides growth in 3–5 years

The scoring matrix utilizes a low, medium, and high classification with a numeric scoring value assigned to each category. Each core criterion can be assigned a point value as it relates to a given alternative solution presented. Once all elements of the core criteria have been numerically weighted for each alternative solution, the total points can then be placed within the scoring matrix to determine which solution offers the most viable recommendation for implementation based on the selected desired outcome.

E. ALTERNATIVE SOLUTION SCORING MATRIX

The scoring matrix identified in Table 8 represents the final placement of each of the four alternative solution options presented in this research. Each of the solution options were scored against the same evaluative criteria and assigned a numeric assessment ranking for subsequent placement in the scoring matrix. This placement depicted the final identification of the most suitable alternative solution option for the city of Phoenix to consider regarding UAS integration.

Table 8. Alternative Solution Scoring Matrix

Solutions	Risk/ Threat	Cost	Legality	Politically Favorable	Complexity	Supports Economic Growth	Total
Solution A	7	5	4	9	7	7	39
Solution B	3	8	3	4	4	2	24
Solution C	7	2	2	2	3	2	18
Solution D	7	1	2	3	2	2	17

The total score for each alternative solution represents the viability of each solution when compared against each of the categories and other solutions to achieve a desired outcome. The results of this assessment reveal alternative solution A scores numerically at the highest end of the matrix and alternative solution D scores the lowest.

F. POLITICAL CONSIDERATIONS

An important limitation to consider is that public safety is not the final determining authority for selecting an alternative outcome solution. Public safety must collaborate with elected officials, business community, private industry, citizens, and the FAA to develop a strategic policy that effectively balances the interests of all UAS stakeholders. The elected officials who comprise the city council under the direction of the mayor have the deciding vote on the selected alternative outcome solution.

The current public safety environment within the city of Phoenix is comprised of the city's Office of Emergency Management (OEM), the police department's Homeland Defense Bureau (HDB), the Phoenix Fire Department (PFD), and the Maricopa County Public Health Liaison. These entities work collaboratively on public safety issues and emerging trends and challenges impacting our community. The OEM, police department, fire service, and public health are poised to address issues requiring legal intervention and enforcement, strategic policy development and guidance, or concerns involving health safety.

Under this configuration, it is logical that public safety should take the lead in policy development to bring awareness to the substantive threat UAS pose to the community if deployed by malicious actors with nefarious intent. Conversely, the city's elected officials and business community stakeholders have a vested interest in promoting UAS industry operations that spur economic growth and development. The issues is the need for a clear and concise policy defining authorized UAS use and by whom, under what conditions and purposes, subject to a specific penalty of public safety enforcement.

The alternative solutions developed and presented for consideration represent the diverse and broad spectrum of stakeholder interests and are not be singularly focused on the will of the public safety community at the exclusion of all others.

G. POST-ASSESSMENT RESULTS

The results of the scoring matrix assessment identify alternative outcome solution A: An alternative solution that calls for less regulation and authorizes commercial use of

UAS to spur economic growth and attract new business, as the highest scoring solution based on all six categories of evaluative criteria. Alternative outlook solution D: An alternative that embraces the current steady state and adopts a wait and see approach is the lowest scoring solution.

H. COMPARATIVE SUMMARY

Comparing and contrasting the differences between alternative solutions A and D provides additional clarity and perspective regarding the level of importance for UAS integration within the city of Phoenix airspace. The overwhelming support for solution A is in favor of commercial UAS integration and is in alignment with the city's vision as supported by its' elected officials, city leadership, the business sector, and tourism industry. Despite the positive intent, there will be a significant cost for the city and the police department to work through to enhance their existing homeland security defensive posture. Selection of this solution is expected to increase the workload for the police department and demand for service that will be generated as a byproduct of UAS integration and subsequent rapid economic growth and activity within the city.

Other affected stakeholders include various communities and residents who are not in favor of increased UAS activity overhead within their neighborhoods and who perceive them as an ongoing threat to their constitutional right to privacy. The underlying take away message is the City of Phoenix has realized the untapped potential of integrating UAS in the commercial business sector and is willing to provide a supportive environmental framework to spur continued economic growth and technological innovation.

By comparison, alternative solution D scored as the lowest of the four options. These results are somewhat surprising because this solution requires the least amount of effort, technological challenge, integration time, or funding to complete. This provides insight into the discursive narrative at play within the city of Phoenix. The collaborative stakeholders and city leadership all recognize the dangers of innovative stagnancy and are not willing to settle for today's status quo. This pioneering spirit has contributed to the city of Phoenix remaining one of the most revered destinations in the country. The

significance of this solution's score further suggests the level of understanding by city leadership and public safety first responders regarding the current threat picture and the role UAS technology will have if utilized by malicious actors who are intent on causing harm to citizens. The prominence of this solution's score further reflects the commitment to homeland security within the city of Phoenix and the lengths to which the city is willing to go to remain on the cutting edge of UAS integration.

Other affected stakeholders who support a conservative or minimalist approach will likely be disenfranchised with the idea this solution scored so poorly. These stakeholders comprise a representatively small outgroup that are resistant to change, public spending, or infrastructure growth and development. This viewpoint is not necessarily representative of the city's leadership and policy makers or the affected business community.

I. CHAPTER SUMMARY

This chapter has examined all four alternative solutions utilizing a multi-goal policy analysis model designed to score each solution against a given set of evaluative criteria. Each solution was then placed within a scoring matrix where it was numerically assessed a point value to identify the best alternative solution given the criteria it was evaluated against. This model provides the policy framework for comparing dissimilar criteria in a manner that promotes the development of a strategic guidance policy.

The final chapter identifies the recommended alternative solution for submission to the City of Phoenix leadership for review and consideration. The chapter also identifies areas where additional research related to UAS integration is required in the future.

VI. ALTERNATIVE SOLUTION SUMMARY AND CONCLUSION

A. ALTERNATIVE SOLUTION JUSTIFICATION

This thesis identifies alternative solution A as the most viable course of action for the City of Phoenix to facilitate the integration of UAS into the city's airspace. This course of action emerged as the highest scoring solution offered after assessment among a series of six different categories of evaluative criteria. Each category was assigned a numeric value and placed within an assessment matrix to determine a comprehensive value assessment for the four solution options presented.

Alternative solution A is defined as: An alternative solution that calls for less regulation and authorizes commercial use of UAS to spur economic growth and attract new business. When compared against the pool of affected stakeholders, this solution offers the most viable solution to meet the diverse needs of a disparate group with multiple competing agendas. It simply offers the most benefit to the most people.

Ironically, the selection of this solution is the one that requires the most effort by city leadership and the public safety community to enhance the city's homeland security posture. This effort is necessary for the city to better position itself to meet the rising demands this level of commercial UAS integration will produce. It is also the solution that requires the greatest level of resource investment to fully integrate within our existing city infrastructure.

When compared against alternative solution B, the strength of emphasis shifts from supporting economic growth and prosperity to public safety as the primary sector of paramount importance. Implementing solution B would require increased levels regulation that would stifle and suppress the city's position to align policy with economic growth and commercial integration of this technology.

Alternative solution C carries a primary focus towards a fiscally restrictive posture by the city regarding UAS integration. While solution C does not take a contrarian position against solution A, the lack of appropriate fiscal commitment will do

little to create the supportive infrastructure the business community and the citizens would expect from their city government.

Adoption of Solution D endorses a current state of status quo while failing to acknowledge or plan for the anticipated challenges UAS integration will likely produce. The absence of a formally recognized strategic guidance policy or plan will do little to support the future economic ambitions of city beyond their current state. While solution D presents as the most immediate cost effective option for the city, it may well place the city in jeopardy down the road in its ability to respond to the rapidly evolving issues surrounding this technology.

Each alternative solution presented in this thesis contains the same key components for consideration in developing a strategic guidance policy for the city of Phoenix. What becomes critically important is interpreting the city's current trends, vision, and political environment to strike the right balance between policy and intent. In this regard, alternative solution A has emerged as the solution that is the most directly aligned with each of these key stakeholder positions.

Alternative solution A corresponds seamlessly with the mayor and city manager's vision for future economic development for the city of Phoenix, and it is dependent upon the commercial industry and tourism sectors to maintain the city's economic viability. The prevailing philosophy of the elected city council members is strongly correlated among their constituency in support of promoting ongoing economic growth and commercial industry. The current political environment is such that the city of Phoenix is reaping the rewards from hosting Super Bowl XLIX in February 2015, the NCAA College Football National Championship Playoff game in March 2016, and is currently poised to host the NCAA Final Four Tournament in March 2017. Events to date have been extremely successful and highly lucrative for Phoenix and the metropolitan area. In addition, these events have provided a worldwide platform to showcase all that Phoenix has to offer. The city's leadership has positioned itself to continue to actively solicit large scale high profile events and conventions to the city as part of an active recruitment strategy to entice the settlement of new and emerging industry to the valley.

Adoption of this solution does include a heightened risk profile and would include discussion with the public safety and emergency first responder community regarding the potential risk and threat profile UAS integration presents before moving forward in support of this approach. A review of the City of Phoenix *Comprehensive Annual Financial Report* (for the fiscal year (FY) that ended June 30, 2015) indicates a very healthy positive cash flow position for the city. The city reported, "$378 million available at the City's discretion and has been categorized as committed, assigned or unassigned."[233] Effective July 1, 2016, the city's new budget for FY 2016/17 went into effect. The current timing of this solution implementation is such that reasonable funding could be made available for security enhancements based on current and prioritized needs identified by the public safety community.

B. ANTICIPATED CHALLENGES TO SOLUTION IMPLEMENTATION

Implementing alternative solution A as proposed would provide the closest version of a win-win scenario between residents, the business community, and local government. The solution favors the wishes of the majority of public opinion; namely the business sector, and as such, is not viewed antagonistically by the masses. The political body identified as the elected council members represents this same community and will therefore find themselves in alignment with the popular opinion posited within this alternative solution. Given the level of political agreement from the elected officials and the constituency they represent, Solution A is most likely to receive positive acceptance. This solution is palatable for the elected officials, the commercial interests of the business industry, and the community.

C. PUBLIC SAFETY CHALLENGES

On the other end of the spectrum, the interests of the public safety and emergency first responder community will face some impending challenges as a direct result of the implementation of this alternative solution. The concerns expressed regarding an

[233] Denise Olsen, *City of Phoenix, Arizona Comprehensive Annual Financial Report: For the Fiscal Year Ended June 30, 2015* (Phoenix, AZ: City of Phoenix, 2015), https://www.phoenix.gov/financesite/Documents/FINAL%20CAFR%202015.pdf, 36.

enhanced threat picture created by the commercial integration of the UAS technology remains a real concern that must be managed in a timely and responsive manner as the threat evolves in real-time. Law enforcement will face challenges with identifying the appropriate funding to implement target hardening efforts to enhance prevention and mitigation strategies impacting the city's homeland security posture. Administratively, the police department will face challenges surrounding its investigative business practice and allocation of the appropriate staffing levels in response to the increased UAS activity.

The increase in UAS activity is expected to involve privacy concerns and complaints from citizens, which are expected to increase as well. There is a need for education and also a period of normalization that will have to occur over a period of time before these concerns can be expected to level off. In the meantime, the police department will need to anticipate these challenges and prepare to address them appropriately.

D. LEGAL CHALLENGES

The release of the FAA's Part 107 commercial guidelines took effect August 29, 2016 and provided long-awaited federal guidance and clarity regarding the rules of the road for the commercial UAS community.[234] While not the panacea many were hoping for, Part 107 is the FAA's first crack at creating a permissive environment that carefully balances the need for economic growth and technological advancement with the need for safety in integration UAS into the national airspace. Release of Part 107 by the FAA also helps to address the patchwork of policy and legislative efforts across the country under one umbrella. This effort by the FAA represents that critical first step towards the institutionalization of legal parameters and standardization of expectations for users and law enforcement alike.

Even with the release of FAA guidelines, local and state agencies will likely experience challenges with legal interpretation and deconfliction at their levels during the initial soak period of initial implementation. Local and state agencies will need to work closely with their city and county prosecutors to ensure they have identified a mutually

[234] FAA, "Fact Sheet—Small Unmanned Aircraft Regulations (Part 107)."

agreeable charging doctrine related to the civil and criminal charges they intend to pursue. It will be incumbent upon them to incorporate a local or state liaison to work with their federal counterparts to ensure cases are properly forwarded to the FAA for tracking and additional follow up as appropriate.

E. TECHNOLOGICAL EXPANSION CHALLENGES

The rate of technological expansion that UAS development is currently experiencing will represent an ongoing challenge locally as well as at the national level for an undetermined period. The rapid pace of current UAS integration within the public/ private and commercial sector will far exceed the capabilities of local, state, and federal agencies to pivot in response to the constant state of change within their respective communities.

The challenge for the business sector will be to continue to adapt their business models to effectively integrate UAS technology as an efficient strategy. The field of potential business applications increases almost daily and as best practices and updated models are identified, these modalities will become more and more prevalent. Overcoming the learning curve will be an issue for the business sector to overcome, but it will be a more significant challenge for the public safety and legal community to address as technologies become operationalized within the commercial arena.

The public safety and law enforcement community will face technological challenges on two different fronts regarding UAS integration. A comprehensive understanding of UAS technology is critical to developing the appropriate prevention and mitigation strategies to enhance the city's homeland security posture in the protection of its citizens. This technical expertise is vital to the investigative aspects associated with law enforcement's role as the enforcement arm of this strategic guidance policy.

Law enforcement today is now faced with assuming a duality of roles regarding UAS integration. Primarily, law enforcement remains vigilant in its role as defender of the public against threats posed by UAS platforms. However, law enforcement is now faced with the proposition of actively engaging in the role of UAS consumer seeking to adopt the very same technology UAS integration presents. The diverse nature of

application by law enforcement and fire department personnel have been demonstrated and are expected to increase (similarly to that of the commercial business sector) as proficiency with the technology advances. Challenges of the public safety community include the development of internal policy regulations governing the conditions under which deployment of UAS resources can be utilized and for what purpose.

Under these scenarios, the public safety community will have to remain flexible and adaptable on several fronts to ensure they keep pace with the rapid advance of technology and to continually update their policy guidelines to remain commensurate with national trends. One option the City of Phoenix should consider is the creation of an ad-hoc committee, consisting of community stakeholders from across the entire spectrum of UAS integration, to maintain an agile group of decision makers with the ability to come together quickly to respond to new and emerging issues not previously considered and make sound policy recommendations that will serve the entire UAS community.

F. SEGMENTS FOR FUTURE RESEARCH CONSIDERATIONS

Creating a strategic guidance policy solution for a major metropolitan city is a significant undertaking in today's current technological and threat environment. The thought of an integrated UAS strategy impacting our daily lives seemed highly unlikely two years ago; however, today the emergence of UAS represents the norm rather than the exception. As society revels in the seemingly unlimited commercial UAS vector, we must remain equally committed in our efforts to further understand the significance of the threat UAS technology carries with it.

1. Collision Avoidance and Detection

As the free market enterprise continues to integrate UAS into the commercial arena, technology based industry is committed to the development of technologies to ensure the integration process can be done safely, specifically in the field of collision avoidance systems and advanced ground-based detection and remediation systems. While the positive attributes of commercial UAS integration cannot be understated, managing the threat potential in this environment must not be overlooked.

Technology-based companies, such as IMSAR LLC based in Utah, have developed a small collision-avoidance system for multiple small UAS platforms. IMSAR's Synthetic Aperture radar technology will be available in the coming year.[235] Technology breakthroughs such as this continue to improve UAS platforms operating domestically, while others continue to develop technology to mitigate UAS operations by targeting the need for an operable sense and avoid technology to increase UAS safety, which is expected to become a mandatory requirement in the near future.

The field of collision avoidance sense and avoid technology, detection, and disruption devices remain in their infancy stages at this time. Many of them are not yet available to the public for purchase and remain relegated to laboratory testing and developmental stages of completion. However, given the wide range of weaponized options for UAS design, additional research into this technology is required to better ascertain the breadth and depth of the threat potential presented by a weaponized domestically introduced UAS.

2. Cyber-Intrusion

Continuing analysis of available literature suggests a new and potentially dangerous hybrid threat has arrived in the form of cyber exploitation utilizing modified UAS platforms. Traditionally, cyber threat attacks have involved malicious attacks against various electronic databases, systems, or data exfiltration. Now enter the UAS. The standard of technology for UAS continues to be refined and these platforms now more closely resemble airborne computers.

Additional research in this area is required to determine the actual impact to the public over time from cyber-attack and to proactively develop mitigation strategies to protect against this malicious act.

G. CONSUMER SPENDING PROJECTIONS

Available research on consumer spending projections would indicate there is justification to be concerned with the number of UAS platforms expected to enter the

[235] Geiver, "Nanoradar System," 1.

national airspace.[236] Economic projections remain consistent within the civil UAS market segment indicating strong and sustainable growth over the next several years. Although much of the available economic research consists primarily of consumer spending projections, analysis of this research remains consistent among varied authors and industry practitioners. These projections require additional monitoring over time to further assess the actual impact on consumer spending on this technology and its relative impact as a result of FAA guidelines and future legislation.

H. CONCLUSION

The dawn of the UAS has arrived. The impact to daily life is inevitable and may not be fully realized for years to come. The nation and society must prepare itself for the eventuality of this technology. Despite the celebrated potential of UAS technology, there is an avenue for evil that lurks in the darkest corners and recesses of the criminal mind intent on committing acts of extreme depravity and horror against an unsuspecting populous.

In response, the role of public safety and law enforcement is to serve as the gatekeepers of economic prosperity and as guardians against evil to all who might otherwise fall victim to the dark hearted intentions of those who perpetuate the cycle of terror. Now more than ever it is up to law enforcement and city leadership to provide the governance framework that enables a strategic guidance policy solution to emerge. This research has examined the criticality of the emerging and multifaceted UAS issue to construct set of policy options to address a variety of desired outcomes as determined by city leadership and elected officials.

Analysis of the UAS issue for the city of Phoenix reveals several important requisite components identified as critical to the successful development of a strategic guidance policy for the city. Among them is the need to establish a commercially friendly environment that was not overly restrictive or that created additional barriers to entry for UAS technology. City leadership and elected officials adopted a firm stance supporting less regulation at the local, state, and federal levels of government. The city is transparent

[236] Teal Group, "Teal Group Predicts Worldwide UAV Market."

in stating its intent to implement policies that encourage and support economic growth and prosperity for small business, while continuing to actively pursue and attract large-scale events to the city boosting its tourism industry. Finally, the release of the FAA's Part 107 in August 2016 provided the regulatory framework at the federal level to support the widespread commercial use of UAS across a wide spectrum of applications.

This crucial piece of FAA guidance opened the door for commercial industry use including agri-business, real-estate, surveying/mapping, and use by public safety for critical infrastructure protection and search and rescue efforts. Comparative analysis of each of these positive attributes against the possible range of alternative solutions led to the emergence of alternative solution A as the best fit for the city of Phoenix.

The challenges facing the city of Phoenix are not unique to it alone. Other agencies and jurisdictions across the nation must also face critical decision points as they develop their own strategic guidance policies to meet the needs of their respective communities, where commercial UAS integration is concerned. It is the wholehearted intent that this research serve as a replicable policy roadmap for law enforcement agencies in search of a policy design option. The law enforcement and public safety community stand at the forefront of this cutting edge UAS technology. The next generation of public safety and homeland security professionals will judge the efficacy of today's actions as the cornerstone of a strategic guidance policy that defined the ground rules for UAS integration into the national airspace.

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