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FIFTY FEET ABOVE THE WALL: CARTEL DRONES IN THE U.S.–MEXICO BORDER ZONE AIRSPACE, AND WHAT TO DO ABOUT THEM

by

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Over the last decade, the U.S. military and homeland security research groups have contemplated the issue of how to counter unmanned drones. Recently, border security agencies responsible for securing the U.S.–Mexico border are having to contend with the emerging threat of Mexico's drug cartel narcotics-smuggling drones, also known as narco-drones. Narco-drones are an example of cartel innovation for smuggling, among other deviant purposes, that U.S. border security will need a strategy to counter. This study aimed to build on the conceptual framework related to hostile drones in the airspace and specifically to find a strategy that the Department of Homeland Security could pursue to manage the narco-drone problem in the border-zone airspace.

The author argues that the Mexican drug cartels adopt innovative drone tactics in response to border security measures or lack thereof, as well as through organizational learning. This thesis concludes that leveraging U.S. military experience, anti-drone doctrine, and detection assets developed for countering terrorist drones in the war zones of Iraq, Syria, and Afghanistan is an effective strategy for countering narco-drones at the U.S.–Mexico border.

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LIST OF ACRONYMS AND ABBREVIATIONS

3DLR	three dimensional long range
ADIZ	Air Defense Identification Zone
AGL	above ground level
ATC	air traffic control
BVLOS	beyond visual line-of-sight
CBP	Customs and Border Protection
COTS	commercial-off-the-shelf
C-UAS	counter unmanned aerial system
DEA	Drug Enforcement Agency
DHS	Department of Homeland Security
DJI	Dajiang Innovation
DoD	Department of Defense
FAA	Federal Aviation Administration
FBI	Federal Bureau of Investigation
HSE	homeland security enterprise
ICAO	International Civil Aviation Organization
ICE	Immigration and Customs Enforcement
IED	improvised explosive device
ISIS	Islamic State
ISR	intelligence, surveillance, reconnaissance
JIDO	Joint Improvised Threat-defeat Organization
NAS	National Airspace System
POE	point-of-entry
PTDS	Persistent Threat Detection System
RAID	Rapid Aerostat Initial Deployment
ROE	rules of engagement
SAMS	surface-to-air missile system
SBI	Secure Borders Initiative
TARS	Tethered Aerostat Radar System
TCO	transnational criminal organization

TSA	Transportation Security Administration
TTPs	techniques, tactics, and procedures
UA	unmanned aircraft
UAV	unmanned aerial vehicle
VLOS	visual line-of-sight
WMD	weapons of mass destruction

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I. INTRODUCTION

A. RESEARCH QUESTION

This thesis answers the question: What strategy can the Department of Homeland Security (DHS) adopt to police the low-altitude airspace on the U.S.–Mexico border from the emerging threat of drug cartel drones?

B. ON BORDER WALLS

Commercial drones employed by the Mexican drug cartels as drug smuggling platforms among other deviant uses is not fully understood, and the threat assessment continues to develop as more instances of cartel drones are encountered at the U.S.–Mexico border. The consensus about the preparedness of the United States about the new threat of hostile commercial drones is stated succinctly by former U.S. Army Special Forces Commander Michael Waltz. He contends, "unfortunately, I don't think we're ready right now…We don't have the technology—both the detection technology and the countermeasure technology—in place yet."[1]

When we think about border security, most people think about land borders. In the United States, the land border that gets the most security attention is the one between the United States and Mexico. Border security measures on the U.S.–Mexico border before the 9/11 terrorist attack are inextricably linked to drug smuggling and illegal immigration.[2] The post-9/11 border security discourse injected the threat from terrorism into the discussion and raised the level of expected interdiction of illegal inflows at U.S. borders to 100 percent.[3] At the core of U.S. border security's purpose according to the Department of

[1] Bryan Llenas, "Terrorist Drone Threat: US Unprepared for Growing Danger, Experts Say," Fox News, April 6, 2017, http://www.foxnews.com/tech/2017/04/06/terrorist-drone-threat-us-unprepared-for-growing-danger-experts-say.html.

[2] Peter Andreas. "A Tale of Two Borders: The U.S.-Mexico and U.S.- Canada Lines After 9-11." (working Paper 77, Center for Comparative Immigration Studies, 2003), https://ccis.ucsd.edu/_files/wp77.pdf.

[3] Ibid., 4–6.

Homeland Security is control of legal and illegal inflows and outflows whether above, below, or through the U.S. borders.[4]

The prevailing perception in America may be the government does not have control over the majority of the land border with Mexico. It does not matter how the government lost control of the border, or if the government ever had control at any time in history. It only matters that sections of the U.S.–Mexico contiguous border are unmonitored, and therefore, the government and those agencies charged with securing the Homeland are ignorant to the amount of drugs and terrorist contraband coming into the United States.

This "loss-of-control" narrative, according to Peter Andreas, is compelling in politics related to law enforcement.[5] The narrative causes alarm in society and justifies the escalation of forces and resources; argued as necessary to gain and maintain control of the border.[6] The state needs to have a certain level of control to enforce border security measures while at the same time facilitating trade. The idea of a border wall as a means of controlling inflows may be appealing as a way to constrain and control how goods and people enter the country. If anything, a wall is a tangible symbol of security from days past. However, drug smugglers tend to find ways to defeat security barriers, and we find that time and again even the most secure border or prison walls are not impenetrable. They can be, and often are circumvented, tunneled under, or flown over by the persistent security adversary.

Critics of border walls point to their futility because transnational criminal organizations like drug cartels in no small part thrive because of their unique skill sets they obtain while attempting new ways to circumvent border walls.[7] For the drug cartels, the building of border walls perhaps will increase their use of tunnels, aircraft, and boats to

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[4] "Border Security Overview," Department of Homeland Security, July 19, 2012, https://www.dhs.gov/border-security-overview.

[5] Peter Andreas, *Border Games: Policing the U.S.-Mexico Divide* (Ithaca NY: Cornell University Press, 2012), 7, https://market.android.com/details?id=book-i48RP__LuOMC.

[6] Ibid.

[7] Michael Dear, "Why Walls Won't Work: Repairing the US-Mexico Divide (EXCERPT)," Huffington Post, March 19, 2013, https://www.huffingtonpost.com/michael-dear/why-walls-wont-work-repai_b_2902953.html.

circumvent security barriers. The methods for smuggling contraband across the U.S.–Mexico border may be shaped by the very defenses put in place to stop it.[8] A border wall may be a costly reminder that static symbols of security like walls have peaked in innovation and utility. A vision for the future of border security measures looks to build on collaboration, innovation, and integration as essential to border security operational planning for the near future.[9] It is here where the genesis of this thesis begins.

C. PROBLEM STATEMENT

The research question raises three problems for consideration: (1) the threat and risk posed by transnational criminal organizations (TCOs) using drones on the U.S.–Mexico border; (2) the evolution of aerial narcotics trafficking and the lack of a strategy to detect, track, and interdict them; and (3) the use of military capabilities in the form of active and passive countermeasures in support of the Homeland Security enterprise to improve "operational control" of the low-altitude airspace over the border.

First, transnational criminal organizations are adapting their tactics and using new technology such as unmanned aircraft to ferry contraband across the border. The Department of Homeland Security (DHS) has said transnational criminal organizations in Mexico, mainly drug cartels, are continuing to expand in "size, scope, and impact," and are a threat to national and international security.[10] This thesis intends to examine the claim by assessing what types of drones are used, for what purpose, and how they are changing the dynamics of border security.

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[8] Kimball Taylor, "The One Thing Walls Can't Stop," Motherboard, April 14, 2016, https://motherboard.vice.com/en_us/article/3dakkb/walls-cant-stop-creativity-border-lines.

[9] U.S. Customs and Border Protection, *Vision and Strategy 2020: U.S. Customs and Border Protection Strategic Plan*, CBP Publication Number 0215-0315 (Washington, DC: U.S. Customs and Border Protection, 2015), 8, https://www.cbp.gov/sites/default/files/documents/CBP-Vision-Strategy-2020.pdf.

[10] *Combating Transnational Gangs through Information Sharing: Hearing before a House Committee on Homeland Security, Subcommittee on Counterterrorism and Intelligence*, (2018) (statement of Raymond Villanueva, ICE Homeland Security Investigations International Operations Assistant Director).

Drones as smuggling aircraft challenged border security since first observed coming across the U.S.–Mexico border in 2010.[11] Between 2012 and 2014, unconfirmed reports suggest the Drug Enforcement Agency (DEA) registered around 150 narco-drones coming across the border.[12] While the cartels have used foreign-made drones in the past, the need to carry heavier payloads of narcotics has created a homegrown innovative drone market in Mexico tailored explicitly to drug smuggling.[13] Nelson Balido, Chairman of the Border Commerce and Security Council, and one of the leading authorities on U.S. border security issues see the potential threat of drones shifting from illegal smuggling to more devious operations such as surveillance and attacks on Customs and Border Protection (CBP) agents patrolling the border. Balido believes lawmakers in Washington DC, and officials in the Department of Homeland Security are not paying sufficient attention to the new threat, which is apparent by the lack of investment in technology to counter the drone threat on the border.[14]

The possible use of drones as weapons for targeted killings or explosive delivery systems may be more troubling given possible future uses of small drones by criminal organizations. Nevertheless, drones offer unique advantages to cartels today because of their low-cost, ease of operation, and low probability of detection. The lack of regulation coupled with the widespread availability of recreational drones in the United States and Mexico suggests a pressing need for a strategy to control drones that enter and exit the airspace along the border. A strategy that encompasses all border security stakeholders' capabilities is the most prudent. However, the U.S. military may offer unique advantages in employing and coordinating counter-drone technology on the border.

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[11] Alejandro Sanchez, "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/.

[12] Camilo Mejia Giraldo, "Mexico's Cartels Building Custom-Made Narco Drones: DEA," July 11, 2014, http://www.insightcrime.org/news-briefs/mexico-s-cartels-building-custom-made-narco-drones-dea.

[13] Ibid.

[14] Nelson Balido, "Nelson Balido: Mexican Cartels Patrol Border with Drones – and U.S. Has No Response," February 19, 2016, http://www.foxnews.com/opinion/2016/02/19/nelson-balido-mexican-cartels-patrol-border-with-drones-and-us-has-no-response.html.

Second, aerial trafficking on the Southwest border has evolved to include drone technology, and the Department of Homeland Security needs a strategy to counter it. Cartels have evolved through different phases of aerial trafficking from conventional aircraft to ultralight aircraft to unmanned aerial vehicles (UAVs) or drones.[15] Small drones, like the ones used for smuggling, fly low to the ground and methods for detection are limited. Currently, Tethered Aerostat Radar System (TARS) balloons, deployed to the southwest border shortly after WWII, are still used for detecting aerial incursions into U.S. airspace along the border today. Customs and Border Protection began relying on the U.S. Air Force's radar balloons 30 years ago as a cost-effective way to detect low flying smuggling aircraft. The TARS balloons have had an impact dwindling unidentified aircraft crossing the border. However, the small drones being used by cartels today have the radar cross-section of a small bird making them much more difficult for the balloon radars to detect while filtering out the small radar returns from birds or weather. Also, small drones can circumvent the radar balloons by flying outside of radar coverage or by flying low behind mountains or in valleys.

Multiple federal agencies with some jurisdiction administer the airspace above the border. The Federal Aviation Administration (FAA), Department of Defense (DoD), and Customs and Border Protection (CBP) are a few of the government entities with a mandate for monitoring aircraft entering U.S. airspace. Each has different missions that contribute to homeland security ranging from regulating airspace use to law enforcement in the airspace, to the defense of the airspace. The performance of each mission contributes to the security apparatus for constraining illegal drone flights across the border, but no one border security entity has put forth a counter-drone policy as of yet.

Finally, the problem implicit in the research question is DHS needs a strategy to control the use of criminal drones in the airspace along the border. DoD support for DHS border security agencies in drone defense against a well-funded, innovative, agile adversary—Mexican drug cartels—is an opportunity to consider as part of the secure

[15] Robert J. Bunker, "Mexican Cartel Tactical Note #21: Cartel Unmanned Aerial Vehicles (UAVs)," *Small Wars Journal* (blog), accessed May 10, 2017, http://smallwarsjournal.com/blog/mexican-cartel-tactical-note-21.

border strategy. In order to leverage DoD capacity and experience, this thesis explores the gamut including strategic; military-to-military cooperation between the United States and Mexico, operational use of DoD assets along the border in support of improved operational control, and tactical; what drone countermeasure systems and tactics are DoD personnel using on the ground in the war zones of Afghanistan and Iraq to mitigate the emerging threat of nefarious drone attacks.

Mexican drug cartel smuggling operations are widespread, particularly in the border region where they have expanded their areas of control and influence. Current policies by the Mexican government have had little effect on degrading the cartel's command and control structure funded primarily by smuggling operations. Mexican drug cartels operating in the U.S. may want to maintain a low profile, which could mean avoiding violent confrontations with U.S. law enforcement or rival cartels. The negative attention would perhaps elicit a government response that would be counterproductive to their operations there.[16] However, instances of cartel violence in Mexico demonstrate that circumspection with respect to drone use may not be replicated south of the border.

In Mexico, weak law enforcement and judicial institutions have left Mexico vulnerable to dealing with cartel-related violence.[17] Some have labeled the cartels in Mexico as an insurgency.[18] Others label them merely parasites feeding off the host state.[19] Whatever their intention, the violence associated with these groups is having a destabilizing effect on Mexico which threatens to spill over into the United States. The potential spillover may be fueling a sense of urgency for DHS to put forth an aggressive plan to curb drug

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16 Drug Enforcement Administration, *2015 National Drug Threat Assessment Summary* (Washington, DC: U.S. Department of Justice, 2015), 3, https://www.dea.gov/docs/2015%20NDTA%20Report.pdf.

17 Max Fisher and Amanda Taub, "Mexico's Record Violence Is a Crisis 20 Years in the Making," *New York Times*, October 28, 2017, https://www.nytimes.com/2017/10/28/world/americas/mexico-violence.html.

18 Max Fisher, "Why Drug Cartels Are Mexico's Insurgency," *Atlantic*, March 16, 2010, http://www.theatlantic.com/international/archive/2010/03/why-drug-cartels-are-mexicos-insurgency/37573/; "Mexican Cartel War: Profiling an Unorthodox Insurgency | Geopolitical Monitor," Geopolitical Monitor, February 4, 2013, https://www.geopoliticalmonitor.com/mexican-cartel-war-profiling-an-unorthodox-insurgency-4777/.

19 Todd Staples, "Foreword: Texas in the Crosshairs—Armed Cartels Spread Fear at the Border," in *Mexican Cartel Essays and Notes: Strategic, Operational, and Tactical*, (Bloominton, IN: iUniverse, 2013), xxx.

cartel operations along the U.S.–Mexico border. If anything, cartel violence is feeding into the conversation about how the cartels can use commercial drones for smuggling as well as for attacks against rival cartels or law enforcement agencies in both the United States and Mexico.

Just this year, the U.S. Customs and Border Protection started soliciting ideas from Silicon Valley for employing commercial drones for law enforcement, at the same time DHS Science and Technology Directorate is seeking technology solutions from federal, state, and local organizations to detect, identify, and track criminal drones.[20] Silicon Valley is more than ready to provide innovative ideas to improve drone sensors and controllers as DHS became overwhelmed with proposals causing them to close the proposal window three months early.[21]

Unfortunately, the cartels have been implementing drone technology for their purposes for many years, at least since 2010. The relatively quick development and implementation of new technology for smuggling seems to be a hallmark of the drug cartel's horizontal organizational structure and competitive nature. To adapt to the hardened border security, cartels adopt technology faster. What border security expert Rodrigo Nieto-Gomez refers to as "systemic changes" in the war on drugs, is the need for innovation in tactics which are trending towards unmanned vehicles, e.g., drones, submersibles.[22] Border security agencies seem to be slow adopters of new technology. The Department of Defense could provide fast-tracked testing and approval processes for new border security technology based on proven drone detection and interdiction technology, tactics, and procedures that are being tested and fielded in conflict zones like Afghanistan and Iraq.

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[20] Department of Homeland Security, "*Emerging Technology Solutions to Detect, Identify, and Track Small Unmanned Aerial Systems*," Solicitation Number PEO UAS2017_1 (Washington, DC: Office of the Chief Procurement Officer, 2017), https://www.fbo.gov/index?s=opportunity&mode=form&id=bfe96f4f0da57378b7eddd5362fc0f28&tab=core&_cview=1.

[21] Nikita Biryukov, "Department of Homeland Security Flooded with Bids to Build Border Drones," NBC News, May 11, 2017, http://www.nbcnews.com/news/us-news/department-homeland-security-flooded-bids-build-border-drones-n754071.

[22] Rodrigo Nieto-Gomez, "A Director of the Present? Nowcasting Homeland Security's Challenges," *Homeland Security Affairs* XIV (September 2016), https://www.hsaj.org/articles/11952.

D. LITERATURE REVIEW

The purpose of this literature review is to develop a conceptual framework for countering criminal drones operating in the airspace over the U.S.–Mexico border, in particular, how can the Department of Defense, with its existing airspace defense responsibilities, provide support for DHS border security agencies against an emerging threat in the low-altitude airspace. The literature review begins with the 2014 Quadrennial Homeland Security Review on the current threats to border security. Then reviews news media and government reports on drone innovation trends by transnational criminal organizations to understand the discourse on the new border security problem. Finally, it surveys possible solutions for addressing the problem of criminal drones in the airspace of the border zone.[23]

1. Narco-Drone Defined

The Science and Technology Directorate at DHS is the DHS-designated leader of the interagency community for addressing menacing drone use.[24] The Directorate researches criminal activity involving small commercial drones. They use terms like nefarious or illicit to describe drone behavior to add emphasis to the unlawful employment of commercial drone technology. To be clear, drones are merely a tool that can be employed for illicit or criminal activity and drones are not inherently criminal in design or purpose. For convenience, and to differentiate between lawful and unlawful commercial drone usage in the border zone, I refer to the commercial type of drones being employed by the Mexican drug cartels as *narco-drones*. I do this to convey the Mexican drug cartels employ the drones in support of illegal narcotics trafficking operations. The intent is to qualify narco-drones as drones that operate outside of the regulatory system, having criminal or unlawful implications, and add emphasis to the fact that these drones are not constrained by legality or caution.

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[23] The border zone is defined as the area of land that is 62.5 miles or 100 kilometers North and South of the international boundary. See United States-Mexico Border Health Commission, "The United States-Mexico Border Region at a Glance," http://www.borderhealth.org/files/res_55.pdf.

[24] Robert Griffen, "Benefits and Risks of Unmanned Aerial Systems," *Department of Homeland Security Science and Technology* (blog), May 10, 2017, https://www.dhs.gov/science-and-technology/blog/2017/05/10/benefits-and-risks-unmanned-aerial-systems.

Brenda Fiegel contends the Mexican drug cartels were the first to use drones to transport drugs. She claims the cartels began using drones as a method for transporting narcotics over the border in 2010.[25] Further, she writes the tactic of using drones for drug smuggling is becoming more prevalent in Mexico. Which is evidenced by the estimated two metric tons of narcotics carried by commercial drones that were intercepted by U.S. authorities along the border in 2012, just two years after narco-drones were first discovered to be a tactic the drug cartels were beginning to exploit.[26] She notes that the tactic is gaining interest as a viable trafficking method in Colombian narco-trafficking operations as well, evidenced by the discovery by Colombian police of a narco-drone and 130 kilograms of cocaine in the Bahia Solana sector of Choco.[27] The narco-drone was suspected to be employed by the Clan del Golfo drug cartel.

Narco-drone, as the word implies, has origins in narcotics trafficking. However, the future definition of narco-drones could be drones built for, or acquired by drug-trafficking criminal organizations for purposes that go beyond just drug smuggling to more sinister cartel operations involving counter-surveillance or targeted killings of rivals, government officials, or border security officers.

2. Game Changer?

Criminal drones in the domestic airspace of the United States launched a surge of threat analysis reports that use terms like "game changer," and "force multiplier" to describe the effect that criminal drones are having on the homeland security apparatus.[28]

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[25] Brenda Fiegel, "Narco-Drones: A New Way to Transport Drugs," *Small Wars Journal*, accessed August 18, 2017, http://smallwarsjournal.com/jrnl/art/narco-drones-a-new-way-to-transport-drugs.

[26] "Narcotraficantes envian cocaina a Panama con drones: Policia de Colombia [Colombian Drug Traffickers Send Cocaine to Panama with Drones]," La Prensa, November 16, 2016. http://www.prensa.com/mundo/Narcotraficantes-enviando-Panama-Policia-Colombia_0_4622537754.html

[27] Ibid.

[28] Sandra Erwin, "Technology Leaps and Tighter Budgets Reshaping Drone Market," National Defense, June 2, 2016, http://www.nationaldefensemagazine.org/articles/2016/6/2/technology-leaps-and-tighter-budgets-reshaping-drone-market; '*Using Unmanned Aerial Systems Within the Homeland: Security Game Changer?' before Subcommittee on Oversight, Investigations, and Management*, (statement of Michael McCaul (R-TX), Chairman) (July 19, 2012), https://homeland.house.gov/files/07-19-12%20McCaul%20Open.pdf; Associated Press, "AP Interview: Drones 'A Huge Game Changer' for Aviation," US News & World Report, June 20, 2017, https://www.usnews.com/news/business/articles/2017-06-20/ap-interview-drones-a-huge-game-changer-for-aviation.

Drones used for drug smuggling may not be the most concerning employment of the new technology along the border. As Sullivan and Bunker point out, the more pressing concern for border security are drones used for spying, surveillance, and targeted killings.[29] Sullivan and Bunker are surely right because recent reports coming out of Iraq and Afghanistan have shown small drones are becoming practical tools for all three of the mentioned threat categories.

According to recent reports, Mexican drug cartels are acquiring and developing high tech systems to traffic narcotics from Mexico to the United States.[30] The technologies observed that are engaged in drug trafficking activities according to *Business Insider* are submersibles, able to transit under the ocean waves, ultralight aircraft, with extremely quiet engines, encrypted communication networks, and the focus of this thesis—small commercial drones.[31]

Border security onlookers have learned over the course of decades by observing the game of transnational drug-smuggling at the U.S. border that there are two players or agents: the State and the smuggler. The change in tactics or technology referred to here as innovation is what Dr. Rodrigo Nieto-Gomez calls adversarial stigmergic coordination between the two agents.[32] He writes, the coordination between these two adversarial agents results not from direct interaction but through indirect coordination.[33]

When U.S. border security around South Florida deployed "down looking" radar balloons in the 1980s, cartel use of single-engine smuggling aircraft to ferry drugs through Caribbean routes decreased. The actual amount of interdiction success of the smuggling

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[29] John P. Sullivan and Robert J. Bunker, "Mexican Cartel Strategic Note No. 18: Narcodrones on the Border and Beyond," *Small Wars Journal*, accessed April 25, 2017, http://smallwarsjournal.com/jrnl/art/mexican-cartel-strategic-note-no-18-narcodrones-on-the-border-and-beyond.

[30] Ibid.; Danielle Muoio, "Here's All the High-Tech Gear Cartels Use to Sneak Drugs into the US," *Business Insider*, July 20, 2016, http://www.businessinsider.com/cartels-use-tech-to-sneak-drugs-into-the-us-2016-7.

[31] Muoio, "Here's All the High-Tech Gear Cartels Use to Sneak Drugs into the US."

[32] Rodrigo Nieto-Gomez, "Stigmergy at the Edge: Adversarial Stigmergy in the War on Drugs," *Cognitive Systems Research* 38, no. Supplement C (June 1, 2016): 38, https://doi.org/10.1016/j.cogsys.2015.12.005.

[33] Ibid.

aircraft resulting from the new radar platforms is said to be minor.[34] However, the deployment of the radar balloons influenced the cartels to change their routes and smuggling tactics. Air routes through the Caribbean shifted to ground routes through the heart of Mexico and new innovative smuggling tactics to cross the contiguous U.S.—Mexico border began to develop.[35]

The innovation influencers for the cartels may also come from environmental stimuli i.e., arrests, press releases rather than organically within the organization. Narco-drones may be a result of "deviant innovation," in response to the limitations in narco-drone detection and interdiction capability in the border security airspace environment. The drug smuggling game may have the same goals, but the status quo security environment can be disrupted from time to time with deviant innovation and tactics by cartels. The capabilities and limitations of each agent's respective smuggling and interdiction tactics and technology, whether perceived or real, indirectly influence the innovation in both agents seemingly in turn.

3. Drone Threat Scenarios DHS Should Consider

The drone threat scenarios described below are a mix of possible and present threats to border security. Dan Gettinger of the Bard College Center for the Study of the Drone has written about current instances of illicit commercial drone use as well as some possible drone attack scenarios.[36] He briefly describes five scenarios of illicit drone use including surveillance, smuggling, kinetic attack, electronic attack, weapons of mass destruction (WMD) attack. In the U.S.–Mexico border zone, the present-day threats that are most evident and from a Homeland Security risk perspective most probable, are narco-drones used for surveillance, smuggling, and targeted or kinetic attacks. Gettinger's insight on the drone threat scenarios relevant to border security described as follows:

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[34] Federation of American Scientists, "*Tethered Aerostat Radar System,*" accessed December 17, 2017, https://fas.org/nuke/guide/usa/airdef/tars.htm.

[35] Ibid.

[36] Dan Gettinger, "Domestic Drone Threats," Center for the Study of the Drone, March 20, 2015, http://dronecenter.bard.edu/what-you-need-to-know-about-domestic-drone-threats/.

a. Reconnaissance and Surveillance

In this scenario, an actor could use a drone to reconnoiter targets for attack or monitor the actions of individuals or law enforcement. The utility of off-the-shelf drones for reconnaissance and surveillance has already been proven in battle spaces like the civil war in Ukraine. The rapid spread of hobbyist drones makes this scenario both the most likely threat involving drones and the most difficult to identify. Just in the past few years, there have been many cases in which it was difficult to determine whether the drone was being used for recreational use, newsgathering, activism, or for an activity that could result in harming public safety.[37]

b. Smuggling

There have been multiple cases where criminal organizations or individuals have used drones to smuggle illicit material, usually across borders or into prisons. In November 2013, a drone was spotted flying over the walls of a prison in Quebec, and in March 2014, a similar event occurred in Australia. Earlier this year, a drone carrying drugs was discovered crashed just south of the U.S.—Mexico border.[38]

c. Kinetic Attack

In this scenario, an attacker might strap guns or explosives to a drone and fly it into people or structures to inflict physical damage or loss of life. The targets of these attacks may be individuals, buildings, or transportation infrastructure such as commercial airliners.[39]

4. Department of Homeland Security and Department of Defense Overlap

In 2014, DHS and DoD both published their legislatively-mandated Quadrennial Homeland Security and Defense Review respectively. The Homeland Security and Defense reviews are considered to be a thorough and inclusive report describing the vision, goals, and objectives of each department for future operational planning. Both security reviews emphasize the importance of a more collaborative departmental strategy which

[37] Ibid.

[38] Ibid.

[39] Ibid.

includes interagency cooperation and cooperation with our international partners for countering the expanding influence and capabilities of transnational criminal organizations in Latin America.[40]

The Quadrennial Homeland Security Review states that one of the Department of Homeland Security's primary security missions is to "secure and manage the border."[41] The mission fits nicely into the Department of Defense updated strategic framework for protecting the homeland and building regional security.[42] The homeland security review acknowledges that "we must continue to improve upon border security, to exclude terrorist threats, drug traffickers, and other threats to national security, economic security, and public safety."[43]

Worst case scenarios for border security planners might include the possible exploitation of gaps in border security by terrorist organizations using drones as weapons. Sanchez highlights the possible scenario of a drone attack in "sensitive locations."[44] When a small drone crashed on the lawn of the White House unchallenged, it demonstrated how easily small drones could penetrate what should be secure airspace. The incident highlights the fact that small drones can fly undetected into highly restricted areas. In the isolated regions along the 2,000-mile southwest border, the task is even more daunting. Perhaps DHS needs to rethink how to fill the security gaps in operational control of the airspace in the region.

5. Policing the Borderland Airspace

Policing the airspace on the border entails two tools of policing which fall explicitly into the mandate of the state in a free market society; regulation, and defense.

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[40] Department of Homeland Security, "*The 2014 Quadrennial Homeland Security Review*," June 18, 2014, https://www.dhs.gov/sites/default/files/publications/qhsr/the-2014-quadrennial-homeland-security-review-overview.pdf

[41] Department of Homeland Security, "*The 2014 Quadrennial Homeland Security Review*," June 18, 2014, 6, https://www.dhs.gov/sites/default/files/publications/2014-qhsr-final-508.pdf.

[42] "U.S. Department of Defense Fact Sheet," Department of Defense, 2014, https://www.defense.gov/Portals/1/Documents/pubs/20140302_FINAL_QDR_Fact_Sheet_v13_CLEAN.pdf.

[43] Department of Homeland Security, *The 2014 Quadrennial Homeland Security Review*, 6.

[44] Sanchez, "Worst Case Scenario: The Criminal Use of Drones."

Peter Andreas writes, the new border security environment is "more difficult to manage, with more players, played out on a bigger stage, and with higher stakes and greater collateral damage."[45] The airspace over the southwest border is a space of jurisdiction convergence for multiple government organizations. The security stakeholders are numerous: Northern Command (NORTHCOM), Federal Aviation Administration (FAA), Immigration and Customs Enforcement (ICE), Customs and Border Protection (CBP), Federal Bureau of Investigations (FBI), Drug Enforcement Agency (DEA), local police departments, and their Mexican government counterparts. There is overlap and redundancy, making it difficult to discern a lead agency. Some lines of demarcation exist in regulation, law enforcement, and national security responsibility which requires further explanation.

U.S. code 40103 states "the United States government has exclusive sovereignty of airspace of the United States."[46] It also delineates that "the FAA shall develop plans and policy" for airspace controls. Snead and Seibler write the FAA has recently made an exclusive claim to regulating drones in the National Airspace System (NAS).[47] While regulation is one part of constraining the proliferation of criminal drones, the organization better positioned to streamline and coordinate surveillance operations and defense against rogue drones beyond sovereign U.S. airspace may be the Department of Defense.

One possible catalyst for more military involvement in policing U.S. border airspace has come from the massive ramp up of illegal aerial narcotics smuggling due to the insatiable drug market that has plagued the United States. The FY 1989 Defense Authorization Act and associated fiscal appropriations put the Department of Defense front and center as the lead agency for detection and monitoring of aircraft smuggling illegal

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[45] Andreas, *Border Games: Policing the U.S.-Mexico Divide*, 153.

[46] Sovereignty and Use of Airspace, 49 U.S. Code § 40103 (1994), Legal Information Institute, https://www.law.cornell.edu/uscode/text/49/40103.

[47] Jason Snead and John-Michael Seibler, "Seizing the Sky: Federal Regulators Use Drones to Justify Controlling the Airspace Over Your Backyard," *The Heritage Foundation*, no. 4565 (May 19, 2016), https://www.heritage.org/crime-and-justice/report/seizing-the-sky-federal-regulators-use-drones-justify-controlling-the.

drugs into the United States.[48] The use of the word policing may be inaccurate to describe what the military role was, the 1989 Act was written to be narrow in scope regarding the militaries' role in aerial drug trafficking interdiction specifically because military drug interdiction support was not to involve law enforcement activities. However, the military's role goes beyond mere passive detection of aircraft, but also encompasses a more active mission of interception of unidentified aircraft before entry into U.S. airspace. The designation of a buffer zone known as an Air Defense Identification Zone (ADIZ) to assist in early identification of aircraft entering the United States has its origins during World War 2 as a way for the U.S. to assert control of coastal airspace. The problem of identification and interception are core issues when it comes to small drones entering the low-altitude airspace.

A review of past air defense security challenges has brought up instances of emerging threats in U.S. airspace that coincide with the challenges associated with drone defense.[49] Christopher Bolkcom, a specialist in national defense, writes that the threat of Soviet cruise missiles and bombers attacking the U.S. homeland during the Cold War era spawned the creation of a networked air defense system, under the umbrella of the DoD's North American Air Defense Command (NORAD). The network consisted of coastal radars, interception aircraft, and surface-to-air missile systems (SAMS).[50] NORAD has developed a robust air defense infrastructure that is bolstered by a bi-national regional defense agreement with Canada. However, NORAD's current infrastructure for air defense is costly to maintain, and its effectiveness is still in question according to Bolkcom. Challenges with detection, tracking and intercepting aircraft continue to be an issue despite the refocus on U.S. air defenses following the September 11th terrorist attacks.

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[48] National Defense Authorization Act for Fiscal Year 1991, S.2884, 101st Cong. (1990), https://www.congress.gov/bill/101st-congress/senate-bill/2884.

[49] For a more in-depth discussion on the novel threat of unmanned aerial vehicles and the implications for defense, see Brian A. Jackson, David R. Frelinger Michael J. Lostumbo, Robert W. Button, *Evaluating Novel Threats to the Homeland Unmanned Aerial Vehicles and Cruise Missiles*, (Santa Monica, CA: RAND, 2008), https://www.rand.org/pubs/monographs/MG626.html.

[50] Christopher Bolkom, Homeland Security: Defending U.S. Airspace, CRS Report No. RS21394 (Washington, DC: Congressional Research Service, 2006), https://fas.org/sgp/crs/homesec/RS21394.pdf.

The Border Patrol has said they see a growing number of drones used as narcotics smuggling delivery systems. According to the Department of Homeland Security, the small UAVs can be used for "weapon or smuggling payloads," as well as "prohibited surveillance and reconnaissance."[51] Sullivan and Bunker assert that:

> Drones are becoming more common along the US-Mexico border as Mexican cartel assets. While typically considered a tool for smuggling, they are increasingly seen as having application for other purposes including espionage, surveillance, and as weapons.

In 2015, Congress directed the Secretary of Homeland Security to research how small and medium drones could be used in an attack. The threat posed by small drones is not entirely understood. Representative Bonnie Coleman D-NJ introduced the Homeland Security Drone Assessment and Analysis Act which directs DHS to:

> (1) Research how commercially available small and medium-sized unmanned aircraft, excluding aircraft over 1,300 pounds, could be used to perpetuate an attack; and (2) develop policies, guidance, and protocols for DHS to prevent, or mitigate the risks of, such an attack. Authorizes DHS to provide the Departments of Defense, Transportation, and Energy and the Nuclear Regulatory Commission information regarding how to best prevent and mitigate the risk of such an attack.[52]

In February of 2017, Matthew Allen Assistant Director of Homeland Security Investigative Programs testified for the border and maritime security congressional committee that the cartels are using counter-surveillance drones as scouts or spotters around and between border points of entry (POE).[53] The counter-intelligence observation platform that narco-drones provide may be more concerning to drug enforcement agents who are being tracked or targeted.

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[51] Sullivan and Bunker, "Mexican Cartel Strategic Note No. 18: Narcodrones on the Border and Beyond."

[52] Homeland Security Drone Assessment and Analysis Act, H.R.1646 114th Cong. (2015), https://www.congress.gov/bill/114th-congress/house-bill/1646.

[53] *Dangerous and Sophisticated Adversary: The Threat to the Homeland Posed by Cartel Operations before the House Committee on Homeland Security Border and Maritime Security Subcommittee*, (2017) (statement of Matt Allen, ICE Homeland Security Investigations Assistant Director for Investigative Programs).

In the airspace on the southwest border, there is no clear current policy for what to do about criminal drones beyond the status quo procedures for identifying, tracking, and intercepting of manned aircraft entering and exiting the United States contiguous southwest border.

6. Evolution and Innovation of Drone Smuggling

Testimony from Paul Beeson, Director Joint Task Force West, Customs and Border Protection provides further insight into the new threat CBP is facing on the border. She explains that smuggling by manned general aircraft has not been significant since the late 1990s. In the last decade, cartels have been experimenting with multiple types of unmanned aircraft for smuggling from small drones carrying a couple of pounds of narcotics to ultralight aircraft, which can carry up to 100 kilos, in addition to traditional manned aircraft.[54] She asserts that as CBP interdiction and enforcement efforts go up, TCO's will continue to use drones as a viable smuggling platform because of their low-cost to own and operate. The high payoff in U.S. dollars for every drone smuggling incursion across the border signals that the problem of funding and sustaining border security capabilities vs. narco-drones will continue to be an issue.[55]

Peter Andreas reminds us that the innovative drug smuggling methods seen at U.S.–Mexico border today are perhaps due to the unintended consequences of former U.S. government border security actions.[56] As an example he writes, the "successful" crackdown on Colombian cocaine traffickers in the 1980s in the Caribbean into South Florida created an unintended consequence of pushing the cocaine trafficking smuggling routes southwest into Mexico.[57] Moreover, he says by pushing the drug smuggling routes into the heart of Mexico, Mexico's drug cartels increased their power and wealth resulting

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[54] *Dangerous and Sophisticated Adversary: The Threat to the Homeland Posed by Cartel Operations before the House Committee on Homeland Security Border and Maritime Security Subcommittee*, (2017) (statement of Paul Beeson, Director Joint Task Force West).

[55] Ibid., 3.

[56] Peter Andreas, "Myths and Realities of Transnational Organized Crime," Brink – The Edge of Risk, accessed December 10, 2017, http://www.brinknews.com/myths-and-realities-of-transnational-organized-crime/.

[57] Ibid.

from greater control over the drug trade, which he says had a devastating effect on Mexican civilians that lived in the regions where the cartels operated.[58]

The literature indicates Mexican cartels, being motivated by profit, demonstrate a capacity for innovation of new technology, and a willingness to adopt new tactics quickly to maximize profits and minimize risks. Evolution of some of the most infamous smuggling tactics are trending towards instances of technological sophistication. From rudimentary small underground tunnels in the 1990s that allowed one man to fit through with a backpack to the more recent "super tunnel" equipped with a railway system, lighting, and ventilation that could move large amounts of narcotics quicker and more efficiently across the border. The cartel's semi-submersible submarines were at one-time hot death traps barely floating from shore to shore with a crew of one or two men. They are now being equipped with air conditioning and even kitchens for crew comfort.[59]

Today, small recreational drones in the place of traditional manned aircraft are being employed to traffic narcotics. Drone technology is becoming more prevalent and sophisticated and is now used as a cost-effective method for smuggling narcotics across the border. Due to the small carrying capacity of recreational drones, cartels have been investing in home-grown drone suppliers in Mexico that can deliver custom narco-drones designed specifically for smuggling larger payloads.[60]

Mexican drug cartels are not the only criminal organizations adding drones to their arsenals. Drug traffickers in Northern Colombia are using drones to move illicit contraband across borders. Police in the Colombian town of Bahia recently uncovered parts to another drone aircraft buried on a beach along with 286 pounds of cocaine.[61] The drone had a carrying capacity of 10 kilos and was suspected of transporting drugs into Panama while on its journey North. Terrorist groups like the Islamic State in Iraq, Hamas in Palestine,

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[58] Ibid.

[59] Giraldo, "Mexico's Cartels Building Custom-Made Narco Drones: DEA."

[60] Ibid.

[61] Christopher Woody, "Colombian Traffickers Have Added Drones to Their Smuggling Arsenal," Business Insider, November 18, 2016, http://www.businessinsider.com/colombian-cocaine-drug-smuggler-using-drones-2016-11.

and the Taliban in Afghanistan are all observed using drone technology in propaganda and recruiting videos. Although, terrorist organizations are shown to be using drones for surveillance and targeted attacks and not necessarily for smuggling. This is significant because if terrorist groups exploit commercial drones and challenge the asymmetric air power of coalition forces overseas, then drug cartels can use drones for surveillance and attacks on their government security adversaries.

The Department of Homeland Security and the Department of Defense have both taken an interest in the innovation of drone and counter-drone technology developing in the private sector. The homeland security interest is in drone technology that can support law enforcement, however, both government entities are looking to acquire counter-drone technology that can defeat hostile drones.[62] In 2015, DHS sent out an intelligence bulletin warning police organizations across the United States about the emerging nefarious use of drones and forewarned law enforcement agencies about the "disruption and detection challenges" faced.[63] Both the DoD and DHS may recognize the need for innovation of new technology to counter the drone threat, especially with the push to integrate commercial drones into the U.S. National Airspace System.

The need for drone countermeasures led both the DoD and DHS to open offices in Silicon Valley to offer investment grants to technology start-ups to develop new ideas to solve technology shortfalls related to drone detection and interdiction.[64] The DoD has sponsored drone countermeasure exercises. It is agreed upon that drone innovation, and the

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62 "News Release: CBP Partners with ST & Columbus Start Up," Department of Homeland Security Science and Technology, April 27, 2017, https://www.dhs.gov/science-and-technology/news/2017/04/27/news-release-cbp-partners-st-columbus-start; "News Release: CBP DHS ST Award San Diego Start Up $152K," Department of Homeland Security Science and Technology, April 27, 2017, https://www.dhs.gov/science-and-technology/news/2017/04/27/news-release-cbp-dhs-st-award-san-diego-start-152k; "News Release: CBP and S&T Award $200K to San Mateo Start-up," Department of Homeland Security Science and Technology, March 29, 2017, https://www.dhs.gov/science-and-technology/news/2017/03/29/news-release-cbp-and-st-award-200k-san-mateo-start; Heather Kelly, "The Department of Defense to Silicon Valley: Let's Be Friends," CNN Money, September 13, 2016, http://money.cnn.com/2016/09/13/technology/ash-carter-dod-silicon-valley/index.html.

63 "DHS Warns Local Law Enforcement to Watch for Drones Used by Terrorists, Criminals," Homeland Security News Wire," August 3, 2015, http://www.homelandsecuritynewswire.com/dr20150803-dhs-warns-local-law-enforcement-to-watch-for-drones-used-by-terrorists-criminals

64 Sean D. Carberry, "DOD, DHS Chart Paths to Acquisition Innovation," FCW, November 2, 2016, https://fcw.com/articles/2016/11/02/acquisition-innovation-dod-dhs.aspx.

widespread availability of drones, has brought with it changes to the security system on the border in ways that Dr. Nieto-Gomez has called "disruptive" to the border security ecosystem, introducing new vulnerabilities and risks that need to be addressed.[65] This thesis will analyze the known capabilities of small drones and how criminal organizations are currently using them, and for what purposes, to draw conclusions on the future use of this technology primarily looking at ways the DoD can support a cohesive defensive strategy on the border where one is lacking.

The initial assessment of the literature discussing the current and future threat of criminal drones on the border is threefold. First, drones are being utilized by cartels for drug smuggling and pre-operational surveillance, and DHS has limited policies in place to counter them. Second, the propensity of the drug cartels to adopt new technology—drones—is changing the dynamic of border security and DHS border security organizations, whose core mission is primarily law enforcement, is not having a measurable effect on degrading or destroying criminal drones in the airspace over the border. Lastly, DHS is not giving enough consideration to policing the airspace above the border, most of the attention and investment is going to ground level policing, and the security gap is growing with the innovation of drone technology by TCOs in Mexico.

E. METHODS AND SOURCES

This thesis intends to accomplish three goals: (1) it is to assess the current and future threat of narco-drones operating over the U.S.–Mexico border and the current technology utilized for monitoring the low altitude airspace over the border including their respective cost, capabilities, and limitations; (2) it is to assess technology innovation behavior of transnational criminal organizations, specifically Mexican drug cartels, by looking at the innovation behavior of terrorist groups like Hamas, Al-Qaeda, Hezbollah, Hamas and ISIS and how they are changing the dynamic of border security, specifically in the low-altitude airspace; and (3) it is to determine if Department of Defense entities, i.e., NORTHCOM,

[65] Rodrigo Nieto-Gómez, "The Power of 'the Few': A Key Strategic Challenge for the Permanently Disrupted HighTech Homeland Security Environment," *Cytometry. Part A: The Journal of the International Society for Analytical Cytology* 91, no. 1 (January 2017): 11, https://doi.org/10.1002/cyto.a.23051.

NORAD, can support a long term strategy for operational control of the low-altitude airspace by leveraging technology capabilities, and battlefield experience.

A first step for assessing an emerging threat is conducting a threat analysis. In light of evidence that commercial drones are being adopted by criminals, terrorists, and drug smugglers as tools for their operations, it is imperative that the Department of Homeland Security has a strategic vision for countering them. The threat assessment in this thesis is guided by an analysis of the current capabilities and limitations of narco-drones, and the implications for future narco-drone innovation. Open source news reports from U.S. and Mexico and expert analysis from relevant U.S. National Security Journals will be used as primary sources for supporting the thesis argument.

Government-produced reports and homeland security academic articles will be the primary sources used to examine the current discourse regarding airspace controls, operational control, and legal considerations for deploying drone countermeasures to the US—Mexico Border.

By framing the counter-drone strategy on the border as a convergence of homeland *defense* and homeland *security* missions, I will frame the level of engagement necessary to combat narco-drones operating in the region of the U.S.–Mexico border and reveal some alternative ways of constraining narco-drone use. Sources will be research centers like the Center for the Study of the Drone at Bard College, as well as expert analysis from Anthony Kimery.

To assess drone innovation behavior by transnational criminal organizations, this thesis analyzes documentation on cartel manned aerial smuggling operations during the 1980s, the government's security response, and the effects on smuggling behavior. The Brookings Institute issues on technology innovation and specific terrorist group studies of innovation behavior may provide insight into what motivates innovation in criminal and terrorist organizations.

Finally, the primary focus of this thesis is the question of how the Department of Defense can support a long-term strategy to counter the drone threat on the U.S.–Mexico border. Three areas of empirical analysis will be examined to investigate the idea of an

expanded DoD role in detecting, deterring, and interdicting drones in the airspace over the border as part of a long-term strategy. One area of study will be of how the United States defends against cross-border smuggling aircraft today in comparison to the 1980s and 1990s noting the security challenges between manned and unmanned aircraft.

I argue that the Department of Defense is a crucial player in aerial defense in the Homeland Security apparatus, and doctrine developed from experience with terrorist drones overseas can be applied to the U.S. border zone. This thesis is forward-looking and relevant to the security challenges we face now and in the near future in the national security interest of increasing operational control of the low-altitude airspace where small drones operate. The role of the U.S. military in border security should be shaped using existing core competencies in air defense that can be applied to the new problem of criminal drones in the border zone.

F. BACKGROUND

The proliferation of consumer drones and drone technology is growing steadily worldwide, but considerably in North America. Personal drones sold in the United States alone have more than doubled in one year, increasing "from 1.1 million sold in 2015 to 2.4 million in 2016."[66] By 2021, drone sales are expected to surpass $12 billion in sales up from $8.5 billion in 2016, and by the FAA's estimation, the number of drones sold in the United States is expected to reach 7 million.[67] The proliferation of drones is notable in the private sector, but also in the Homeland Security Enterprise at the federal and local law enforcement level despite pushback from civil rights groups with concerns for citizen privacy. Federal Aviation Administrator Michael Huerta, speaking at the second annual FAA Unmanned Aircraft Systems Symposium declared "we're ushering in a new age of

66 Andrew Meola, "Drone Industry Analysis: Market Trends & Growth Forecasts," *Business Insider*, July 13, 2017, http://www.businessinsider.com/drone-industry-analysis-market-trends-growth-forecasts-2017-7.

67 Ibid.; Griffen, "Benefits and Risks of Unmanned Aerial Systems."

American aviation: the unmanned aircraft era. And it's moving at a quicker pace than anything we've seen before."[68]

The trend is remarkable, and the emergence of drones in the skies raises understandable concerns. The main concerns with drones flying overhead fall into two general categories: safety and security. Safety issues are easier to identify because the requirements for safe flight in the National Airspace System can be extrapolated from the lessons learned through the history of manned aviation. Understanding security needs, on the other hand, is the process of identifying threats and mitigating the risk of those threats which can be much more cumbersome of an exercise, especially when the threat centers around technology which is dynamic and ever-changing.

The United States and Israel have been the biggest players in producing military-grade drones for the global market over the past decade. However, China currently dominates the small drone market. It was estimated in 2015, Chinese tech company Dajiang Innovation (DJI) accounted for 70 percent of the global recreational and commercial drone market.[69] DJI produces drones in many price categories; the most popular are used for aerial photography. In North America, DJI controls the most market share of any drone tech company primarily because of the speed that China can bring new technology to market, and what seem to be recent aggressive price drops, making it difficult for other companies to compete. According to Colin Snow of Skylogic Research, a company that tracks the drone industry, in the last year DJI accounted for 36 percent of the units sold in North America, its closest competitor is 3D Robotics accounting for 19 percent of market share.[70]

In the current political climate, border security continues to be a priority as evidenced by the fact that Customs and Border Protection account for 23.2% of DHS's

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[68] Kaya Yurieff, "U.S. Drone Registrations Skyrocket to 770,000," CNN Money, March 28, 2017, http://money.cnn.com/2017/03/28/technology/us-drone-registrations/index.html.

[69] Yue Wang, "As China's Drone Market Takes Off, Leader DJI Still Flies Far Above The Competition," Forbes, May 11, 2016, https://www.forbes.com/sites/ywang/2016/05/12/chinas-flood-of-cheap-flying-cameras-is-little-threat-to-dajiang/.

[70] Ibid.

total budget authority, more than any other DHS organization.[71] The budget priorities as stated in the DHS 2018 budget in-brief shows that security of inflows at U.S. borders is ostensibly the number one priority for the Department of Homeland Security.

[71] Department of Homeland Security, *Budget In-Brief Fiscal Year 2018*, 10, https://www.dhs.gov/sites/default/files/publications/DHS%20FY18%20BIB%20Final.pdf.

II. DRONE THREAT: PREPARING FOR THE INEVITABLE

In this chapter, I address three questions about the emerging threat: 1) what types of drones are the drug cartels using in the border zone, 2) what are the respective capabilities and limitations of the drones, and 3) what are the implications for the future threat of narco-drones on the U.S.–Mexico border?

This chapter analyzes the current state of drone technologies and the risk to border security posed by criminal drones in the airspace over the southwest border. Understanding the utility of small drones used by Mexican drug cartels at the U.S.–Mexico border will inform the strategy to counter them.

In addition to smuggling, security experts are expressing concern the commercial-type drones, like the ones the drug cartels are using, are proven surveillance platforms and capable of remote targeted attacks, and therefore pose a significant threat to border security officers and infrastructure who have maintained the monopoly on drone employment in the border zone up until recent years.

Whether drones used for drug-trafficking, surveillance, or targeted attack, the threat is a new means to an end. Small drones are a disruptive technology along the border as well as around the world. Many believe the threat posed by small drones requires new threat mitigation tactics and technology. The author analyzes the emerging threat posed by narco-drones by first describing the capabilities and limitations of the few instances of narco-drones interdicted by CBP, as well as possible scenarios for future narco-drone use in the context of border security. An objective analysis considering the capabilities and limitations of the narco-drones will help to frame the threat at the border and expose vulnerabilities in status quo security apparatus.

A. WHAT IS A NARCO-DRONE?

First, there is no one standard when it comes to the classification of drones. The military has its standard, and civilians have ever-changing categories and classifications. Drones can be classified by their size, range, and endurance or their performance

capabilities.[72] The FAA has a simplistic approach to drone classification that derives from the drone operator's intent of use for the drone. They demark drones along the lines of whether they are utilized for recreation (fun) or commercial (work) use.[73] The FAA recently proposed some performance regulations with limits on commercial drone size and speed which help to define the drones further. As it stands now, drones used for recreation or business shall have a max takeoff weight less than 55 pounds and a max airspeed of less than 100 mph subject to waiver granted on a case by case basis.[74] The DoD's drone classifications offer more clarity on the performance characteristics of small drones like narco-drones. What is characterized as a small drone shown in Figure 1 are drones that fly at a speed of less than 100 knots, have a max takeoff weight of less than 20 lbs., and typically fly below 1200' Above Ground Level (AGL).

Category	Size	Maximum Gross Takeoff Weight (MGTW) (lbs)	Normal Operating Altitude (ft)	Airspeed (knots)
Group 1	Small	0-20	<1,200 AGL*	<100
Group 2	Medium	21-55	<3,500	<250
Group 3	Large	<1320	<18,000 MSL**	<250
Group 4	Larger	>1320	<18,000 MSL	Any airspeed
Group 5	Largest	>1320	>18,000	Any airspeed

*AGL = Above Ground Level
**MSL = Mean Sea Level

Figure 1. Drone classification according to the U.S. Department of Defense[75]

[72] Qassim A. Abdullah, "1.4 Classification of the Unmanned Aerial Systems," accessed December 20, 2017, https://www.e-education.psu.edu/geog892/node/5.

[73] Drone Registration, "FAA Drone Registration," accessed December 20, 2017, https://drone-registration.net/faa-drone-registration/.

[74] Ibid.

[75] U.S. Army, *Eyes of the Army' U.S. Army Unmanned Aircraft Systems Roadmap 2010-2035* (Fort Rucker, AL: U.S. Army UAS Center of Excellence, 2010), http://www.rucker.army.mil/usaace/uas/US%20Army%20UAS%20RoadMap%202010%202035.pdf.

B. DRONE CATEGORY (ARMY)

The U.S. Army classifies drone threat types by "groups," dividing the drone types into five groups based on the drone's performance (max speed, max altitude) and size, for simplicity large or small.[76] Groups 1–3 are the smaller types of drones similar to the DJI series commercial drones observed being used by the Mexican drug cartels for smuggling. These drones present challenges to the U.S. militaries' detection systems as they do border security radar systems because they fly low and slow, and are difficult to detect, identify, and defeat.[77] These types of drones can be "proprietary, state-sponsored, or commercial-off-the-shelf (COTS)," and in many cases are customizable. The U.S. Army believes the tactical role for these types of drones is limited to mostly surveillance and reconnaissance. Although, in my view the impetus for future security countermeasures is probably due to the small drones potential as weapons delivery systems.[78] Further, the Army's rationale that is repeated in this thesis is, due to commercial drones becoming cheaper, widely available, and simple to use, the use of them by our adversaries will continue to diffuse to worldwide.[79]

It is the small and medium type drones that are smaller than light aircraft, commercially available, can be carried by one person, and fly low and slow that the Mexican drug cartels are adopting. According to Army doctrine, the drones in groups 1–3 are smaller platforms that are slower and have shorter-range than the larger drones but can be purchased on the open market. These types of drones and their parts are commercial-off-the-shelf and widely available in Mexico to both legitimate business organizations and criminal organizations alike. The U.S. Army mirrors much of the expert's consensus when they write that because drones have become smaller, slower and fly lower, "they have become more challenging to detect, identify, and defeat."[80] Technological advances in

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[76] U.S. Army, *Counter - Unmanned Aircraft System (C-UAS) Strategy Extract*, October 5, 2016, http://www.arcic.army.mil/App_Documents/Army-CUAS-Strategy.pdf.

[77] Ibid., 5.

[78] Ibid.

[79] Ibid.

[80] Ibid.

drone autonomy may be exacerbating the challenges of detection and interdiction of these small aircraft at the border. The documented instances of cartel drone use show they are experimenting with what can be classified as professional or commercial-grade drones, so-called "heavy lifters" that can carry a payload of narcotics, cameras, or weapons.

C. TACTICAL TO PRACTICAL OR THE OTHER WAY

Stewart Smith writes as technology develops for military applications there is often a transition into the civilian business markets where similar technology is used but for a completely different range of uses.[81] Depending on the market, the biggest drivers for drone innovation can come from the business community, from companies like Amazon.[82] Commercial drones are a special case because innovation is being driven by both the business community and the military and to some extent criminal organizations like the drug cartels.

The U.S. military developed Unmanned Aircraft (UA) in the 1950s.[83] The aircraft's ability to return successfully after a mission became a defining characteristic of unmanned drones. Today, drone applications are not only military, but more so for civilian purposes that could include taking pictures, delivering packages, conservation, and providing wireless internet.[84] There seems to be a technology convergence in drone use, combining both tactical and practical applications. The drug cartels are using drones for both tactical and practical operations.

The tactical practicality of drones to conduct illicit activities like smuggling as well as terrorist-style attacks combined with the mass proliferation of cheap drone technology in the United States and Mexico produces an aggregate threat. The current limitations of

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[81] Stewart Smith, "Military and Civilian Drone Use (UAV, UAS) The Future of Unmanned Aerial Vehicles," The Balance, last modified January 10, 2017, https://www.thebalance.com/military-and-civilian-drone-use-4121099.

[82] Ibid.

[83] Jimmy Stamp, "Unmanned Drones Have Been Around Since World War I," Smithsonian, February 12, 2013, http://www.smithsonianmag.com/arts-culture/unmanned-drones-have-been-around-since-world-war-i-16055939/.

[84] Jeff Desjardins, "Here's How Commercial Drones Grew out of the Battlefield," Business Insider, December 15, 2016, http://www.businessinsider.com/a-history-of-commercial-drones-2016-12.

commercial drones regarding payload limits, the range of flight, and frequency encryption are hurdles that can be overcome by research and development, experimentation, and investment.

Drug cartels in Latin America are beginning to develop a homegrown drone manufacturing industry by commissioning custom-made drones built to fit their needs.[85] El Universal reports that the DEA is tracking the recent trend. They report the cartels are drawing from companies in Mexico that have the professional knowledge needed to innovate and produce narco-drones.[86]

One terrorist drone may not be a considerable threat to border security that would require a change in strategy or installation of countermeasure systems along the border, but a few hundred drones deployed in unison could disrupt the economic and security apparatus on the level of the September 11th terrorist attacks. The 9/11 Commission Report stresses as part of why intelligence agencies failed to identify the possibility that aircraft could be used as missiles was due to a lack of imagination and dismissed possibilities.[87] The threat from weaponized drones should be no less apparent to the observant security professional. To avoid the pitfalls of a lack of imagination and dismissed possibilities, a survey of threat scenarios, even if improbable, is useful for understanding the threats from drones.

D. THE QUINTESSENTIAL DRUG MULE

The most evident purpose of cartel drones is narcotics trafficking. The drones captured by U.S. border security to date have been drones used for transporting narcotics. There are three reported-on drug-smuggling interdiction cases since 2015 where drones were used to transport marijuana, cocaine, or methamphetamine across the border; the three cases indicate smugglers are experimenting with remotely operated drones, as well as

85 Giraldo, "Mexico's Cartels Building Custom-Made Narco Drones: DEA."

86 Compañia Periodística Nacional México El Universal, "Fabrican Narcos Sus Propios Drones, Alerta La DEA [They Manufacture Narcos Their Own drones, Alert the DEA]," El Universal, July 31, 2015, http://archivo.eluniversal.com.mx/nacion-mexico/2014/carteles-fabrican-narcodrones-trasiego-eu-1022274.html.

87 National Commission on Terrorist Attacks upon the United States. The 9/11 Commission Report: Final Report of the National Commission on Terrorist Attacks upon the United States, 2004, https://www.9-11commission.gov/report/911Report.pdf.

autonomous drones for narcotics trafficking in urban and sparsely populated regions along the border. This chapter will devote a section to the types of drones that were used in those cases to understand their capabilities and limitations.

Experimentation by the Mexican drug cartels with drone narco-trafficking is believed to have started in 2010.[88] The evolution of drones since as a viable narco-trafficking tool continues to progress despite the current payload capacity limitations of small drones. In 2015, two high-profile drug seizures by U.S. law enforcement put to rest the theory of drones as potential drug mules and demonstrated the practical application of the new technology. That year, two men pleaded guilty to drug trafficking charges after using a drone to airdrop 28 pounds of heroin over the course of multiple flights ending in the California border town of Calexico.[89] The same year Border Patrol agents in San Luis, Arizona using night vision goggles tracked a drone overhead to a drop point in the Arizona desert where 31 pounds of marijuana packaged into ten-pound bundles were discovered.[90] Fast forward to 2017, Border Patrol agents in San Diego heard the buzzing of a drone overhead and tracked it to a landing zone about 2,000 yards from the Mexican border where they arrested the drone operator with 13 pounds of smuggled methamphetamine.[91] All three cases of cross-border drone smuggling were interdicted by seemingly vigilant border patrol agents using cameras and night vision goggles to track the drones to their drop zones, although it may have had more to do with luck of being in the right place at the right time and less to do with the agencies anti-drone training or tactics.

Each case points to a vulnerability in border security on a macro level. The narco-drone flights are originating on the Mexican side of the border and presumably were not detected or tracked by any security agency before entering U.S. airspace. While the

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88 Fiegel, "Narco-Drones: A New Way to Transport Drugs."

89 Kristina Davis, "Two Plead Guilty in Border Drug Smuggling by Drone," *Los Angeles Times*, August 12, 2015, http://www.latimes.com/local/california/la-me-drone-drugs-20150813-story.html.

90 Susan Jones, "A First: U.S. Border Patrol Confiscates Drugs Dropped by Drone in Arizona," CNS News, January 13, 2016, http://www.cnsnews.com/news/article/susan-jones/first-us-border-patrol-confiscates-drugs-dropped-drone-arizona.

91 "A Drone Was Used to Smuggle Meth from Mexico. Officials Say This Could Become More Common," NBC News, August 19, 2017, http://www.nbcnews.com/news/us-news/man-smuggled-13-pounds-meth-mexico-using-drone-n794146.

incidents are examples of interdiction success stories for Customs and Border Protection, the number of narco-drone flights that successfully cross the border is not known. The DEA estimates there were approximately 150 narco-drone incursions into U.S. airspace between the years 2012 and 2014, although it is unclear what data the DEA is using as a basis for estimating the number of narco-drone flights into U.S. airspace.[92] The three drone incidents described above are not an all-inclusive portrayal of the problem drones pose to border security, nor do they offer insight into the amount of narco-drone flights into U.S. airspace. They merely imply narco-drones are becoming more attractive to smugglers likely because of their low-cost, ease of use, and capability to avoid detection in the low-altitude airspace.

The amount of successful narco-drone flight incursions through the low-altitude airspace probably exceeds what we might think. The radar systems in place to detect low-flying drug-trafficking aircraft in the low altitude approaches along the southwest border—six Tethered Aerostat Radar balloons—have been in service since the 1980s when single engine Cessna's were the typical smuggling aircraft used by drug cartels throughout South America and Latin America.[93] The drug cartels have adapted to avoid detection by using smaller aircraft such as ultralight craft, which are simplistic in design and typically built with aluminum tubes and fabric, a single seat for the pilot, and a lawn mower size engine for propulsion.[94] Narco-drones could be an evolutionary technology step in low-altitude smuggling aircraft for the same reasons ultralight craft evolved from single-engine Cessna's. Although, drones in contrast to single-engine Cessna aircraft remove the need for an onboard pilot and runway, making them convenient for quick trips across the border in areas of rugged terrain.

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92 Giraldo, "Mexico's Cartels Building Custom-Made Narco Drones: DEA."

93 "Tethered Aerostat Radar System," Air Combat Command, March 28, 2007, http://www.acc.af.mil/About-Us/Fact-Sheets/Display/Article/199137/tethered-aerostat-radar-system/; *Border Security Gadgets, Gizmos, and Information: Using Technology to Increase Situational Awareness and Operational Control: Testimony before the House Homeland Security Subcommittee on Border and Maritime Security*, (2016) (statement of Randolph Alles, CBP Air and Marine Operations Executive Assistant Commissioner).

94 Marisa Mendoza and Robert J. Bunker, "Mexican Cartel Tactical Note #32: Ultralight Aircraft and Border Drug Smuggling, *Small Wars Journal*," accessed November 3, 2017, http://smallwarsjournal.com/jrnl/art/mexican-cartel-tactical-note-32-ultralight-aircraft-and-border-drug-smuggling.

Drones give their human operators advantages that make them ideal smuggling vehicles that can transport contraband over security boundaries. One advantage for criminal drone operators is a lower risk of being arrested by authorities because they can pilot drones from remote locations increasing the distance between themselves and law enforcement, decreasing the probability of capture. Since 2012, the U.S. prison system is seeing an uptick in remotely operated drones by the family or friends of prison inmates who are attempting to use small drones to drop everything from cigarettes and pornography to drugs and weapons inside prison yards.[95] What should be secure airspace, the low-altitude airspace over maximum security prisons, is still vulnerable to small drone intrusions. On the U.S.–Mexico border, the advantages of lower-risk narcotics smuggling for the operator and the cartel organization as a whole using drones is even more apparent. If Border Patrol captures a narco-drone, it cannot divulge information about the cartel's techniques, tactics, and procedures (TTP), shipment amounts, routes, or timetables like a human who can be coerced to give up information on sensitive cartel operations.[96]

Moreover, the monetary cost of a drone is negligible compared to other transportation methods like narco-tunnels or narco-submersibles. The cost to buy or build multiple commercial-type drones pales in comparison to the cost of recruiting and developing human drug mule syndicates. Human drug mules can cost up to 10,000 dollars for delivery of a single shipment, where drone drug mules are much more cost-effective.[97] The types of drones the Mexican drug cartels are using vary in cost from 200 to 5,000 dollars depending on the level of technology, cost practically nothing to operate, and best of all they are reusable.

The critical limiting factor of drones as drug mules is payload capacity. To put it in perspective, drug kingpin El Chapo's fleet of smuggling aircraft included a multi-engine

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95 Jake Swearingen, "6 Drones Turned Drug Mules," *Popular Mechanics*, August 25, 2015, http://www.popularmechanics.com/flight/drones/a17061/6-drones-turned-drug-mules-drone-drug-smuggling/.

96 Fiegel, "Narco-Drones: A New Way to Transport Drugs."

97 Ibid.

Gulfstream aircraft which can transport 1,000 pounds(+) in a single flight.[98] Ultra-light aircraft typically carry 150 to 250-pound loads.[99] The drones the drug cartels are using are categorized as "heavy lift" drones but can only carry up to 40-pound loads by some estimates.[100] The trade-off for drones that can carry a bigger payload is reduced battery life, i.e., flight time, which is inversely affected by total drone takeoff weight. Nonetheless, the critical capability drones provide is their ability to subvert border security detection and interdiction assets, not necessarily the payload capacity which may be negligible with increased drone flights and the price increases of narcotics in the order of magnitude that seems to occur at each line latitude of travel north.

E. EYE IN THE SKY

Second, drones used for surveillance and intelligence gathering. The concern is that narco-drones are used for pre-operational planning of smuggling routes in both remote and urban regions along the border where they can provide intelligence, surveillance, and reconnaissance (ISR) of border security agents and infrastructure in real-time. In February of 2017, Matthew Allen Assistant Director of Homeland Security Investigative Programs testified for the border and maritime security congressional committee that the cartels are using counter-surveillance drones as scouts or spotters around and between border points of entry (POE).[101] The counter-intelligence observation platform that narco-drones provide may be more concerning to drug enforcement agents who are being tracked or targeted.

Bunker agrees, drug-enforcement officials are less concerned with drones used for narcotics smuggling because of the limited payload capacity. In other words, drones

98 Christopher Woody, "'El Chapo' Guzmán Had More Airplanes than the Biggest Airline in Mexico," Business Insider, May 4, 2016, http://www.businessinsider.com/el-chapo-guzman-mexico-drug-trafficking-airplanes-2016-5.

99 Mendoza and Bunker, "Mexican Cartel Tactical Note #32: Ultralight Aircraft and Border Drug Smuggling."

100 Drone Enthusiast, "5 Best Heavy Lift Drones [2018]-Large Drones That Have High Lift Capacity," January 18, 2017, https://www.dronethusiast.com/heavy-lift-drones/.

101 Allen, testimony on *the Threat to the Homeland Posed by Cartel Operations*.

transport negligible amounts of narcotics across the border per flight relative to the high-volume smuggling conveyances, i.e., tunnels, trucks, boats.

Of greater concern, according to Bunker is intelligence collecting narco-drones because they can be used to survey Border Patrol movements and smuggling routes in preparation for high volume shipments.[102] The notion that drug-cartels would use drones outfitted with cameras for surveillance operations is likely because a look at today's commercial drone usage shows the primary utility of drones across hobbyist, commercial, and government industries is often related to the drone's camera. The FAA reports that aerial photography currently accounts for thirty-four percent of the major applications for commercial drones.[103] The cameras are used for remote observation and video monitoring, a capability the drug cartels could utilize in the border zone.

The U.S. military recognized early on that intelligence, surveillance, and reconnaissance is a mission set drones excel in. The first practical application of drones used for surveillance operations dates back to the 1898 Spanish-American War when the U.S. military used kites fitted with cameras to monitor enemy troop movements.[104] Bunker asserts that drug cartels now realize the benefit of small drones as a means to provide tactical intelligence to smugglers.[105] Border Security analyst Nelson Balido asserts drones are replacing *halcones* or lookouts along the border, traditionally human intelligence gatherers.[106] Although there is no direct evidence that cartels are widely using drones for surveillance missions along the border, the concern for border security officials who prefer to maintain a monopoly in aerial surveillance is still prevalent. The concern of

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[102] Sullivan and Bunker, "Mexican Cartel Strategic Note No. 18: Narcodrones on the Border and Beyond."

[103] Federal Aviation Administration, *FAA Aerospace Forecast Fiscal Years 2017-2037* (Washington DC: Office of Policy and Plans, 2016), https://www.faa.gov/data_research/aviation/aerospace_forecasts/media/FY2017-37_FAA_Aerospace_Forecast.pdf

[104] Ian G. R. Shaw, "The Rise of the Predator Empire: Tracing the History of U.S. Drones," Understanding Empire, accessed December 18, 2017, https://understandingempire.wordpress.com/2-0-a-brief-history-of-u-s-drones/

[105] Sullivan and Bunker, "Mexican Cartel Strategic Note No. 18: Narcodrones on the Border and Beyond."

[106] Ibid.

drug cartel surveillance drones increasing in frequency along the border is shared by security expert Nelson Balido who insists "there are legions of [drones] patrolling the U.S.—Mexico border, and they do not belong to the United States."[107]

Before the September 11th terrorist attacks, drones used for surveillance and reconnaissance would be considered the exclusive capability of state militaries. Over the past decade, that has changed commensurate with the proliferation of cheap, easy-to-use commercial drones. Hezbollah is credited with being the first terror group to employ drones, albeit Iranian state-sponsored military-grade drones.[108] The Lebanese based pro-Iran terrorist group used a drone for a successful reconnaissance flight over Israel in 2004. More well-known is the Islamic State's adoption of commercially available drones observed on the battlefields in Iraq and Syria as a new platform to conduct aerial attacks in close quarters urban warfare.[109] Beginning in 2014, Islamic State fighters started using Chinese produced DJI Phantom drones in Fallujah, Iraq to collect intelligence on coalition forces defensive positions.[110] Also, video recordings taken from drones began showing up in ISIS propaganda and recruitment media publications during that time.[111]

Whatever the size of commercially available drones today, cameras usually come standard. The utility of small drones for most commercial or recreational drone operators is the ability to put a camera in the sky that can surveil from a bird's eye view, territory

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[107] Ibid.

[108] Steven Stalinsky and R. Sosnow, "A Decade Of Jihadi Organizations' Use Of Drones – From Early Experiments By Hizbullah, Hamas, And Al-Qaeda To Emerging National Security Crisis For The West As ISIS Launches First Attack Drones," MEMRI - The Middle East Media Research Institute, February 21, 2017, https://www.memri.org/reports/decade-jihadi-organizations-use-drones-%E2%80%93-early-experiments-hizbullah-hamas-and-al-qaeda.; Scott Stewart, "Beyond the Buzz: Assessing the Terrorist Drone Threat," Stratfor, February 9, 2017, https://worldview.stratfor.com/article/beyond-buzz-assessing-terrorist-drone-threat#/entry/jsconnect?client_id=644347316&target=%2Fdiscussion%2Fembed%3Fp%3D%252Fdiscussion%252Fembed%252F%26vanilla_identifier%3D236656%26vanilla_url%3Dhttps%253A%252F%252Fworldview.stratfor.com%252Farticle%252Fbeyond-buzz-assessing-terrorist-drone-threat%26vanilla_category_id%3D1%26title%3DBeyond%2Bthe%2BBuzz%253A%2BAssessing%2Bthe%2BTerrorist%2BDrone%2BThreat.

[109] Stewart, "Beyond the Buzz: Assessing the Terrorist Drone Threat."

[110] Chris Abbott et al., "Hostile Drones: The Hostile Use of Drones by Non-State Actors against British Targets," Open Briefing, January 11, 2016, 12, https://www.openbriefing.org/publications/report-and-articles/hostile-drones-the-hostile-use-of-drones-by-non-state-actors-against-british-targets/.

[111] Stewart, "Beyond the Buzz: Assessing the Terrorist Drone Threat."

that would otherwise be inaccessible or inconvenient for human observation. Once a camera is in flight, there is no shortage of applications. For industries that use drones for overhead inspections in agriculture, construction, and public works, drones are a boon. For security agents who want to keep their movements covert, unbridled drones' overhead are not only a nuisance but a grave threat.

Drones equipped with cameras provide real-time tactical intelligence, a capability the U.S. military exceedingly uses to hunt terrorist leaders as well as provide overwatch for friendly forces in Afghanistan and Iraq. Terrorist groups have been using drones for surveillance since 2004 in Iraq and Afghanistan, and over the last few years moving from surveillance operations to drones used for targeted attacks on coalition forces.

F. TARGETED ATTACK

A targeted attack using a drone is feasible using available commercial drone technology. Drones are proven to be customizable machines that can deliver lethal munitions like gunfire, grenades, or deadly chemical or biological substances on target with precision accuracy. The amount of professional knowledge needed to modify a drone is minimal. For instance, an 18-year-old man in Connecticut demonstrated that with some imagination and ingenuity, you could transform a toy drone into a "flying gun." He modified a quadcopter in his father's garage with a semi-automatic pistol and a remote firing mechanism, then flaunted his invention on Youtube triggering an FAA investigation.[112]

Drug cartels like private citizens have no shortage of imagination and creativity in modifying drones, and generally speaking the drug cartels have the capital to invest and experiment with drone technology. Don Rassler from the Combating Terrorism Center at West Point writes the private citizen is extending the realm of possibility with a drone

[112] Alex Lockie, "An 18-Year-Old Mounted a Gun to a Drone and Fired Shots in the Middle of the Woods," Business Insider, July 22, 2015, http://www.businessinsider.com/an-18-year-old-mounted-a-gun-to-a-drone-and-fired-shots-in-the-middle-of-the-woods-2015-7.

attack, "driven by their own creativity and a do-it-yourself ethic."[113] He asserts that these innovations in drone attack capability demonstrate to terrorist groups that drones can be easily repurposed.[114] The same logic extends to the Mexican drug cartels who wish to repurpose drones for their illicit operations whether for smuggling or as killing machines.

Terrorist groups like Islamic State (ISIS), shown in Figure 2, are modifying widely available recreational drones similar to the Chinese DJI Phantom series, available on Amazon for 500 dollars, with a mechanism to release small bombs in flight over targets. ISIS has demonstrated their drones can deliver what are essentially airborne improvised explosive devices (IEDs) with reliable accuracy on a variety of soft and hard targets.[115] A video cited in the *Washington Times* shows aerial footage of an ISIS Chinese Skywalker X8 drone striking Iraqi soldiers, buildings, and tanks.[116] In 2016, a video that appeared to be authentic surfaced showing a Taliban operated drone recording a suicide bomber attack on an Afghan government building.[117] Simple to use, and cheaper to acquire than other means for aerial attack, small drone surveillance and attack capabilities will continue to be developed by groups that want to challenge state security and asymmetric air superiority.

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[113] Don Rassler, "Remotely Piloted Innovation Terrorism, Drones and Supportive Technology," *Combating Terrorism Center at West Point*, October 2016, https://ctc.usma.edu/v2/wp-content/uploads/2016/10/Drones-Report.pdf.

[114] Ibid.

[115] Nick Waters, "Types of Islamic State Drone Bombs and Where to Find Them," Bellingcat, May 24, 2017, https://www.bellingcat.com/news/mena/2017/05/24/types-islamic-state-drone-bombs-find/.

[116] Rowan Scarborough, "ISIS Drone Dropping Precision Bombs Alarms U.S. Military," *Washington Times*, January 24, 2017, http://www.washingtontimes.com/news/2017/jan/24/isis-drone-dropping-precision-bombs-alarms-us-mili/.

[117] Zainullah Stanekzai, "Taliban Release Drone Footage of Suicide Attack," Reuters, October 22, 2016, https://www.reuters.com/article/us-afghanistan-taliban/taliban-release-drone-footage-of-suicide-attack-idUSKCN12M0LD.

Figure 2. Video showing fighters learning how to weaponize drones in class[118]

Weaponized drones are now being found in Mexico. In October 2017, Mexico's Federal Police arrested four men in the Guanajuato state of Mexico driving a stolen vehicle carrying a 3DR Solo Quadcopter, depicted in Figure 3, equipped with an Improvised Explosive Device (IED) commonly referred to as a "potato bomb."[119] Police did not definitively say whether the four men had ties to the drug cartels. However, the Guanajuato territory where the men were apprehended is contested by the powerful Jalisco New Generation, Los Zetas and Sinaloa cartels making a connection to drug cartel activity in the area likely.[120]

[118] Stalinsky and Sosnow, "A Decade Of Jihadi Organizations' Use Of Drones – From Early Experiments By Hizbullah, Hamas, And Al-Qaeda To Emerging National Security Crisis For The West As ISIS Launches First Attack Drones."

[119] Kathleen Joyce, "IED Attached to Drone in Mexico Could Show Evolution of Drug Cartel Tactics," Fox News, October 25, 2017, http://www.foxnews.com/world/2017/10/25/ied-attached-to-drone-in-mexico-could-show-evolution-drug-cartel-tactics.html.

[120] David Axe, "Great, Mexican Drug Cartels Now Have Weaponized Drones," Motherboard, October 25, 2017, https://motherboard.vice.com/en_us/article/j5jmb4/mexican-drug-cartels-have-weaponized-drones; Joyce, "IED Attached to Drone in Mexico Could Show Evolution of Drug Cartel Tactics."

Figure 3. 3DR Solo Quadcopter with IED and Remote Detonation Switch (side view)[121]

The weaponized drone is suspected to be the first of its kind that was found in the hands of organized crime groups in Mexico. Of note, the drone contained a large explosive charge according to Attorney General of State Carlos Zamarripa Aguirre and is fully capable of radio frequency remote detonation.[122]

The design of the drone and the shrapnel-filled IED demonstrates the drug cartels can adapt the drone payload easily from narcotics to explosives, and more importantly, it shows a willingness by the drug cartels to adopt tactics for targeted attack first observed being used by terrorist organizations like ISIS in the Middle East. Further examination of the drone in Mexico revealed it did not have a release mechanism for the IED, indicating the drone would be destroyed when the payload exploded. Although, with a sticker price of 299 dollars for the Solo Quadcopter, the drug cartels can afford to lose a few narco-

[121] REDACCIÓN, "¡Dron Bomba! [Drone Bomb!]," Periódico am, October 20, 2017, https://www.am.com.mx/2017/10/20/leon/sucesos/interceptan-dron-bomba-385781.

[122] Axe, "Mexican Cartel Tactical Note #35."

drones in an attack.[123] Jeremy Kryt writes, the design of the weaponized drone found in Mexico represents a hybrid of techniques. Marrying weaponized drone Techniques, Tactics, and Procedures (TTPs) from ISIS with "potato bomb" IED design originally developed by the Revolutionary Forces of Colombia (FARC) terrorist organization.[124]

Bunker et al. expound on the significance of the discovery by saying the IED drone recovered by Mexican authorities saying the incident crossed a "firebreak" that previously existed between Mexican drug cartel narco-drone technology and drone weaponization.[125] It is not clear if the drug cartels would use a weaponized drone against a U.S. border security agent. However, the development adds urgency to the need to close the gap in drone countermeasure capability in the border security environment.

The extent of the weaponized narco-drone threat will depend on the drug cartels own risk analysis. On the one hand, weaponized drones could be used for attacks on rival cartel members operating in Mexico which would likely garner a limited government response. On the other hand, the tactic could be used target U.S. Border Patrol agents in the more remote regions along the border which would likely evoke a much larger response from the American security apparatus. Cartel members have killed Border Patrol officers in the past, CBP officer Brian Terry was killed in a shootout with cartel members near Arizona's border with Mexico.[126] Presumably, the cartels could use drones for attacks on CBP officers in certain circumstances. We cannot discount the fact that the tactic could be used to target with some precision Border Security personnel or critical infrastructure that monitor prized drug smuggling routes that run over land in the U.S.–Mexico border zone.

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123 "3DR Solo Quadcopter (No Gimbal)," Amazon, accessed March 12, 2018, https://www.amazon.com/3DR-Solo-Quadcopter-No-Gimbal/dp/B00ZPM7BOG/ref=sr_1_3?ie=UTF8&qid=1512685881&sr=8-3&keywords=3DR+Solo+Quadcopter.https://www.amazon.com/3DR-Solo-Quadcopter-No-Gimbal/dp/B00ZPM7BOG/ref=sr_1_3?ie=UTF8&qid=1512685881&sr=8-3&keywords=3DR+Solo+Quadcopter; Jeremy Kryt, "Game of Drones: Mexico's Cartels Have a Deadly New Weapon," The Daily Beast, November 12, 2017, https://www.thedailybeast.com/game-of-drones-mexicos-cartels-have-a-deadly-new-weapon.

124 Kryt, "Game of Drones: Mexico's Cartels Have a Deadly New Weapon."

125 Axe, "Mexican Cartel Tactical Note #35."

126 Nicole Chavez, "Man Arrested in 2010 Killing of Border Patrol Agent," CNN, October 18, 2017, http://www.cnn.com/2017/10/18/us/arrest-border-patrol-agent-killing/index.html.

G. DRONE CAPABILITIES AND LIMITATIONS

The drones used by the cartels in two of the incidents pictured in Figure 4 and Figure 5 are built by the Chinese drone manufacturing company Dà-Jiāng Innovations Science and Technology (DJI). Equipped with a prototype GPS unit, these six propeller drones are capable of autonomous flight programming which allows the drone to follow a predetermined flight path of GPS waypoints. The GPS navigation capability is similar to the autopilot function of a manned aircraft. The GPS unit is an aftermarket upgrade that provides the capability in-flight navigation that does not need a remote human operator to guide the drone to its desired landing or drop zone.

Drone used to smuggle 13 pounds of crystal meth spread out over six cross-border flights. Flown either by the remote operator or autonomously via GPS waypoints to a pre-planned drop zone with a waiting accomplice. Border Patrol agents reportedly heard the drone propeller buzz overhead before tracking it to the planned drop point, about 2,000 yards from the U.S.–Mexico border.

Figure 4. DJI Matrice 600 Pro[127]

[127] "Man Smuggled 13 Pounds of Meth from Mexico Using a Drone," NBC News, August 19, 2017, https://www.nbcnews.com/news/us-news/man-smuggled-13-pounds-meth-mexico-using-drone-n794146.

The drone crashed carrying approximately seven pounds of crystal meth in Tijuana, Mexico. Suspected to be overloaded which led to the crash. Packets of narcotics attached using tape.

Figure 5. DJI Spreading Wings S900[128]

1. DJI Spreading Wings S900

a. Capabilities

- Price USD $1,199
- Max takeoff weight 8.2kg (18 lbs.)
- Hover time 15–18 min w/ 6.8kg payload (15 lbs.)
- Max Speed 35 mph
- Folding propeller, portable[129]

[128] Joel Christie, "Drone Carrying Six Packets of Crystal Meth across the Border Crashes," Mail Online, January 22, 2015, http://www.dailymail.co.uk/news/article-2921217/Drug-smuggling-drone-attempting-carry-six-packets-crystal-meth-border-crashes-Tijuana.html.

[129] "Spreading Wings S900 - Highly Portable, Powerful Aerial System for the Demanding Filmmaker," DJI Official, accessed March 12, 2018, https://www.dji.com/spreading-wings-s900/info.

b. Limitations

- Short battery life, takeoff weight increases-max battery life decreases.
- Transport small payloads per shipment compared to trucks, cars, tunnels, submersibles
- Unable to fly in high winds or rain (bad weather)
- Unencrypted radio frequency controller[130]

2. DJI Matrice 600 Pro

a. Capabilities

- Price USD 4,999
- Max recommended takeoff weight 15.5 kg (~34 lbs.)
- Hover time 16 min w/ 6 kg payload (13 lbs.)
- Max Speed 40 mph/65 mph no wind
- Folding propeller, portable[131]

b. Limitations

- Short battery life, as payloads increase in weight-max battery life decreases
- Carry small payloads
- Controller transmission max range 5 km (3.1 miles) *tested in unobstructed line of sight areas; *controller range, not a factor if the drone

130 Ibid.

131 "Matrice 600 Pro Specs," DJI Official, accessed March 12, 2018, https://www.dji.com/matrice600-pro/info.

is capable of satellite or GPS communication (autonomous flight), limiting range factor becomes fuel or battery capacity in this case.[132]

H. NARCO-DRONE INNOVATION FACTORS

Research findings conducted by Open Briefing and published by The Remote Control Project assert the capabilities most relevant to drone operations are: payload, range, weatherproofing, and imaging.[133] These are capabilities that are likely to be included in customization requests by cartel drone operators.

1. Payload

Most commercial-off-the-shelf drones have a limited payload capacity. The max payload of a drone decreases as its gross weight increases. To carry heavier payloads or fly for longer over further distances requires an increase in drone engine power output.

Hybrid drones are one answer to the power problem by converting gas to battery power. Hybrid drones are an example of what could be the next generation of commercial drones. The technology is said to provide "an order-of-magnitude increase in range, payload size, and power over battery-powered counterparts."[134] TCOs who use drones along the U.S.–Mexico border may purchase or build these types of drones very soon. Long Phan, CEO of Top Flight Technologies is the entrepreneur credited as being the first to commercialize gas-to-electric hybrid drones which are expected to enter the market in 2017.[135] A quick Google search finds hybrid drones have arrived. Drone company Quaternium is marketing a drone named the Hybrix.20; they claim it is the first commercially available gas-electric hybrid drone and it serves as an example of the innovation trajectory of drone technology.[136] They claim their drone has a 2–4 hour flight

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[132] Ibid.

[133] Abbott et al., "Hostile Drones: The Hostile Use of Drones by Non-State Actors against British Targets," 5–6.

[134] Rob Matheson, "Hybrid Drones Carry Heavier Payloads for Greater Distances," MIT News, August 4, 2017, http://news.mit.edu/2017/hybrid-drones-carry-heavier-payloads-greater-distances-0804.

[135] Ibid.

[136] "Quaternium Company," Quaternium, accessed December 14, 2017, http://www.quaternium.com/quaternium-company/.

time at max payload, even in adverse weather conditions. In the span of a few years, the maximum flight time of 30 minutes has increased to a max flight time of 4 hours and more payload capacity using engines that convert gas to electricity. An increase in flight time equates to an increase in flight range, possibly up to 100 miles.[137] The implication is, drug cartels may adopt hybrid drones that can carry bigger payloads and transit over greater distances.

2. Range

Currently, commercial drones are limited by the range of the controller signal, data link transmission distance, and battery power or flight time. The remote operator must be within a limited range of the drone to maintain positive control of it. Cartel drones operating near the border will need to have a remote operator within transmission range, by my estimates approximately 1 to 4 miles. Battery changes at landing zones on either side of the border can help to manage shorter battery life due to heavy loads but may be time-consuming and cumbersome for operators who value speed and efficiency.

3. Weatherproofing

Low-end or mid-level drones can operate in limited weather conditions. Mainly they cannot operate efficiently in high winds, rain, or extreme heat. On the U.S.–Mexico border, high winds, rain, or high heat is typical depending on the time of day or time of year. The CBP does not fly it is military-grade drones to patrol the border in severe weather conditions; smaller drones are even more susceptible to damage or loss due to bad weather.[138] Commercial drones could be customized with weather-hardened components to fly in harsh weather conditions. However, the extra weight would reduce maximum flight time and payload capacity unless offset with an increase in power available.[139]

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[137] Matheson, "Hybrid Drones Carry Heavier Payloads for Greater Distances."

[138] Arthur H. Mitchel, "Customs and Border Protection Drones," Center for the Study of the Drone, January 7, 2015, http://dronecenter.bard.edu/customs-and-border-protection-drones/.

[139] Naveed, "Keep Your Drone Business Afloat with Weatherproofing," DroneFutures, June 27, 2015, http://dronefutures.org/keep-drone-business-afloat-weatherproofing/.

4. Imaging

Most recreational or commercial drones come standard with medium to high-resolution cameras able to capture still pictures or record video. At the higher end, drones come with high-resolution cameras attached to 3-axis gimbals, greater camera rotation can provide better situational awareness. Customized drones can be equipped with infrared cameras as well, much like the ones reported as being installed by cartel members on telephone poles in the border town of Reynosa, Mexico. According to El Universal, the cartels installed internet operated cameras around town for counter-surveillance of government security forces.[140] Counter-surveillance of security forces and civilian life along trafficking routes provides valuable intelligence to these groups for planning future operations.

5. Assumptions Going Forward

1. Commercial drones will continue to become cheaper, smaller, and more capable with time and innovation.

2. The proliferation of small drones will increase in the U.S. and Mexico as drones become less expensive and more mainstream in commercial markets.

3. New technologies will emerge allowing for further range, faster speed, and more autonomy.

4. Future government regulation will not provide adequate safeguards against the small drone threat which will lead to more development by the private industry of Counter Unmanned Aerial System technology (C-UAS).

5. Current and future Integrated Air and Missile Defense Systems, including surface-to-air systems, air-to-air systems, command and control systems,

[140] Compañia Periodística Nacional México El Universal, "Crimen Organizado Tenía Su Propio 'Big Brother' En Reynosa [Organized Crime had his own 'Big Brother' In Reynosa]," El Universal, May 22, 2015, http://archivo.eluniversal.com.mx/estados/2015/crimen-reynosa-big-brother-1101979.html.

are not adequate or feasible solutions in countering small drones in the low-altitude airspace.

6. The low-altitude airspace will continue to be contested in the future by non-state actors and transnational criminal organizations who operate across international borders.

6. Conclusions

While I agree that commercial drones are change agents for aviation because unmanned aerial systems will undoubtedly influence the future of aviation and airspace design, the cross-border smuggling game remains a cat and mouse game that isn't likely to change anytime soon.

Transnational criminal organizations are adopting commercial drones because they are capable of crossing protected boundaries and entering restricted airspace with impunity. The U.S.–Mexico land border, which has been a proving ground for the U.S. Border Patrols own fleet of drones to monitor illegal immigration may be fixated on ground monitoring and ignoring a vulnerability in the airspace. The low-altitude airspace over the border zone is being challenged by drug cartel narco-drones, disrupting the security apparatus that so long enjoyed air supremacy. Considered a civil authority matter for the FAA and their Mexican counterpart in their respective national airspace, the cartels use of narco-drones on the border calls into question whether the security of the airspace against low-flying drones should be considered a homeland security problem or a new threat to homeland defense.

The current performance limitations of drones make them less likely to become the preferred drug mule in the near future. Acting U.S. attorney for the Southern District of California Alana Robinson thinks the drug cartels desire to use drones in mass to smuggle narcotics over the border is not there because the distinct noise of drones attracts attention and the battery life is too short.[141] The drone's battery life and its inverse relationship to

[141] Elliot Spagat, "Border Agents Track Drone From Sky to Drugs on the Ground," US News & World Report, August 19, 2017, https://www.usnews.com/news/best-states/california/articles/2017-08-18/authorities-say-drone-used-to-fly-drugs-over-mexican-border.

payload capacity are what I believe is restricting further growth of commercial drones as drug smuggling vehicles.

Drone payload capacity pales in comparison to other transportation methods, like cars, trucks, boats, or tunnels which are far more profitable per trip. However, the use of narco-drones to deliver narcotics across the border could evolve into a favored tactic among drug cartels because they are risk are a risk adverse solution for traversing the border zone and the success rate will remain high despite hardened security measures at ports-of-entry. If the narco-drone tactic is successful, meaning drones continue to subvert aircraft detection infrastructure and interdiction efforts by Border Patrol, then the tactic will likely diffuse among competing drug cartels as is often the case. Drone payload capacity limitations can be overcome with innovation and investment.

Drug cartels interested in investing in new innovative technology like narco-drones to remain competitive and agile in their smuggling operations have an advantage over the average law-abiding technology startup investor in Mexico. Government regulation and taxation do not handicap drug cartel investors in Mexico. Innovation development for drone customization is funded, developed, and tested against the border security apparatus when a security obstacle presents itself.[142] Even with the occasional loss of a drone and its payload like the ones shown in figures 1 and 2, the drug cartel stands to make a healthy profit from the drone narcotics payloads delivered successfully. One kilo of cocaine worth 2,200 USD in Colombia spikes to 16,000 USD when it makes it to the U.S.–Mexico border, and fetches up to 27,000 USD per kilo as it makes its way to U.S. streets.[143] Dr. Rodrigo Nieto-Gomez asserts the extremely high profit-margins produced by the risky business of transnational drug smuggling guarantees there will be enough investment capital to

[142] Nieto-Gomez, "Stigmergy at the Edge: Adversarial Stigmergy in the War on Drugs," 38.

[143] Scott Stewart, "Mexico's Cartels and the Economics of Cocaine," Stratfor, January 3, 2013, https://worldview.stratfor.com/article/mexicos-cartels-and-economics-cocaine#/entry/jsconnect?client_id=644347316&target=%2Fdiscussion%2Fembed%3Fp%3D%252Fdiscussion%252Fembed%252F%26vanilla_identifier%3D236007%26vanilla_url%3Dhttps%253A%252F%252Fworldview.stratfor.com%252Farticle%252Fmexicos-cartels-and-economics-cocaine%26vanilla_category_id%3D1%26title%3DMexico%2527s%2BCartels%2Band%2Bthe%2BEconomics%2Bof%2BCocaine.

continue to test new ideas.[144] Moreover, in his view the advent of narco-drones may stimulate subsequent innovation, improving the viability of narco-drones, or a counter innovation from border security agencies which may be small drone countermeasures deployed along the border.[145]

Drones may become more prevalent as instruments for surveillance of law enforcement activity around high-value smuggling routes in both urban and remote areas of the border between points-of-entry. Due to commercial drones being small and portable, they can be staged and employed quickly to provide real-time surveillance video of law enforcement movements and checkpoints. More nimble drone technology can assist human sources of surveillance information, and the implications are that law enforcement officers can be tracked and possibly targeted from above.

In addition to surveillance and reconnaissance, drones are being developed by terrorist organizations to be killing machines in places like Iraq and Afghanistan and Syria.[146] Given this present trend, it is plausible that drug cartels, with state enemies and fierce drug market competitors, will adopt these tactics using similar drones available in Mexico.

As small drone capabilities improve and the current limitations are overcome with innovation, the criminal or terrorist organizations who adopt drone technology into their modus operandi will want to customize their drones with the performance capabilities that are most critical for meeting their objectives.

The use of drones to smuggle narcotics across the border is an example of drug cartel organizational innovation. With the innovation of narco-drones comes the ability to customize the drone with specific plug and play features that are specific to the criminal organization's needs. A feature of small commercial type drones is they are highly customizable in areas affecting engine performance, and remote navigation. We have

144 Nieto-Gomez, "Stigmergy at the Edge: Adversarial Stigmergy in the War on Drugs," 38.

145 Ibid.

146 Waters, "Types of Islamic State Drone Bombs and Where to Find Them,"; Stalinsky and Sosnow, "A Decade Of Jihadi Organizations' Use Of Drones – From Early Experiments By Hizbullah, Hamas, And Al-Qaeda To Emerging National Security Crisis For The West As ISIS Launches First Attack Drones."

already seen customization in the drone interdictions described earlier with the addition of GPS receivers to the drones.

Drug smugglers are adding GPS receivers to their narco-drones to pre-program flight waypoints across the border, lessening the need for human interaction and constant radio frequency control. The drug smuggler may seek higher payload capacity; the more narcotics a drone can transport translates into increased profit per flight. To do this drug smuggler will need to customize drones with components built to specification, and we may be seeing that in their homegrown drone development programs. John Davidson first reported back in 2013 that drug traffickers in Mexico are using drones built by factory workers that are employed by Mexico's aviation manufacturing industry.[147]

[147] Meghan Neal, "Cartels Are Reportedly Building DIY Drones to Fly Drugs Over the Border," Motherboard, June 2, 2014, https://motherboard.vice.com/en_us/article/gvyybx/cartels-are-reportedly-building-diy-drones-to-fly-drugs-over-the-border.

III. UNDERSTANDING AIRSPACE CONTROL AND CONTROLLED AIRSPACE

According to the FAA, three government entities are responsible for operational control and security of the airspace adjacent to the contiguous United States: the Federal Aviation Administration (FAA), the Department of Homeland Security (DHS), and the Department of Defense (DoD).[148] When Congress passed the Aviation Drug Trafficking Control Act in1984 and the Federal Aviation Administration Drug Enforcement Assistance Act in 1988, the FAA broadened its mandate to include aerial drug trafficking.[149] Congress enlisted the assistance of the FAA in combating aerial drug smuggling into the United States during the so-called 'War on Drugs' by granting them greater authority to enforce aircraft registration and certification of pilots.[150]

Even with expanded authorities granted by Congress, the FAA's cardinal responsibility is aviation safety and not law enforcement. When it comes to law enforcement including drug smuggling interdiction in border zones such as the US/Mexico border, the burden lies mainly on DHS. Within the Department of Homeland Security, the U.S. Coast Guard shares lead agency responsibility with U.S. Customs and Border Protection in drug interdiction including aerial drug smuggling interdiction, although the Coast Guard's primary drug interdiction focus is in the maritime environment.[151] The 1989 Defense Authorization Bill assigned the DoD as the lead agency for detection and tracking of drug smuggling aircraft transiting through the airspace and maritime approaches into

148 "Entering, Exiting and Flying in United States Airspace," Federal Aviation Administration, accessed April 23, 2017, https://www.faa.gov/air_traffic/publications/us_restrictions/airspace/.

149 Karen M. Hanchett, "The Role of the Federal Aviation Administration in the Control of Aviation Drug-Trafficking," *Journal of Air Law and Commerce*, no. 56 (1991): 1000, https://scholar.smu.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1934&context=jalc.

150 Ibid., 999–1000.

151 Don Philpott, *Understanding the Department of Homeland Security* (Lanham: Bernan Press, 2015), 181, https://market.android.com/details?id=book-v4mUCwAAQBAJ.

U.S. territorial borders.[152] The FAA, DHS, and the DoD all play a role in some aspect of aerial drug trafficking interdiction.

A survey of the literature discussing the security stakeholders on the border suggests federal agencies have jurisdiction over state and local law enforcement when implementing and enforcing regulations related to airspace security. Unmanned drones are just another aircraft that are subject to the same rules and regulations as manned aircraft. While the federal government may have the ultimate authority in enforcing drone regulations, the FAA recognizes that state and local law enforcement "are often in the best position to deter, detect, immediately investigate, and, as appropriate, pursue enforcement actions to stop unauthorized or unsafe [drone] operations."[153] This makes U.S. states adjacent to the U.S.–Mexico border and their local law enforcement agencies in the border towns' likely partners in any Homeland Security strategy to degrade the drug cartels narco-drone operations in the region.

In the vast U.S.–Mexico border zone, the U.S. federal government is confronted with a spectrum of threats that can be assessed within the context of both Homeland Security and Homeland Defense. At one end of the border airspace threat spectrum there is drug smuggling, considered a law enforcement threat in the U.S., and on the other end ballistic missiles, considered a national security threat.[154] This chapter will discuss airspace sovereignty, the FAA's regulating powers, and the legal considerations for deploying active and passive drone countermeasures in the U.S.–Mexico border zone. The strategy for countering the emerging threat of narco-drones should consider federal laws that may inhibit the use of new and innovative anti-drone capabilities that are being tested by the U.S. military in Iraq and Afghanistan.

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[152] Ltc Joseph F. Hunt, "DoD Involvement in Drug Interdiction: Success or Failure?" (U.S. Army War College, 1991), 1, http://www.dtic.mil/dtic/tr/fulltext/u2/a238240.pdf.

[153] Amanda Essex, "Taking Off State Unmanned Aircraft Systems Policies," *NCSL Partnership Project on Unmanned Aircraft Systems*, (Washington DC: National Conference of State Legislatures, 2016) 10, http://www.ncsl.org/Portals/1/Documents/transportation/TAKING_OFF-STATE_%20UNMANNED_%20AIRCRAFT_SYSTEMS_%20POLICIES_%20%28004%29.pdf.

[154] Thomas Goss, '"Who's in Charge?' New Challenges in Homeland Defense and Homeland Security," *Homeland Security Affairs XIV*, (2006), 2, https://www.hsaj.org/articles/173.

A. INTERNATIONAL LAW AND AIRSPACE SOVEREIGNTY

Early multinational agreements addressing the geopolitical intricacies of international air travel emerged from the Paris Convention of 1919. One principle proposed and agreed upon during the Paris Convention was "the recognition that every State has complete and exclusive sovereignty over the airspace above its territory."[155] The 1944 Chicago Convention on International Civil Aviation expanded on the Paris agreement. The Chicago Convention established the International Civil Aviation Organization (ICAO), an agency that became part of the United Nations. ICAO's purpose is to develop the internationally accepted rules for airspace, and to define the rights of signatories which include the United States and Mexico. Article 1 of the 1944 Chicago Convention reaffirms the state's exclusive sovereignty of the airspace over its territory.[156]

B. AIRSPACE SOVEREIGNTY

The airspace adjacent to a country's territory is the sovereign of the state from a Weberian perspective. Author Thomas Biersteker writes that the "Weberian state is legitimated by its ability to protect its citizens from attacks from outside its boundaries and to provide security and order within the territorial space defined by its borders."[157] A sovereign state's territorial space, in part due to technological advances, now includes three planes of controlled space that extend into the depths of the Earth and the sky above the territory.

According to Straus, sovereign authority in the sky did not become a concern until the early 1900s, with the advent of motor driven aircraft.[158] Motorized propulsion did for aircraft what steam power did for seagoing ships, allowing transit between two points

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155 Michael J. Strauss, "Boundaries in the Sky and a Theory of Three-Dimensional States," *Journal of Borderlands Studies* 28, no. 3 (December 2013): 370, https://doi.org/10.1080/08865655.2013.862761.

156 "Convention on International Civil Aviation," Chicago, December 7, 1944, https://www.icao.int/publications/Documents/7300_orig.pdf.

157 Peter Andreas and Thomas J. Biersteker, *The Rebordering of North America: Integration and Exclusion in a New Security Context* (New York: Psychology Press, 2003), 153, https://market.android.com/details?id=book-o1jySnbVzJcC.

158 Strauss, "Boundaries in the Sky and a Theory of Three-Dimensional States," 369.

without the requirement of favorable winds.[159] Major advances in air travel and air commerce came after WWII, with the introduction of airplanes that had "longer ranges, faster speeds, enhanced lift, and the increasingly ability [sic] to cope with adverse weather conditions."[160] Technological advances often stemming from military capability offshoots increased the speed of transportation of people and goods between states. As a matter of necessity, modern states had to expand their regulatory powers into the airspace to accommodate airplanes and airships.[161]

U.S. law clearly defines who has sovereignty in the airspace. Title 49 of U.S. code 40103 states that the federal government has exclusive sovereignty in U.S. airspace. The federal government asserted control over airspace early on in response to aviation industry leaders requests for federal action to establish standards for aviation safety. Early aviation industry leaders believed that without government regulation the aviation industry could not reach its full commercial potential.[162] After some urging, Congress passed the Air Commerce Act in 1926. This legislation assigned exclusive sovereignty of U.S. airspace to the federal government. From then on airspace control took on a new shape with the issuing of air traffic rules, pilot licensing requirements, aircraft certifications, and charting of airways across U.S. territory.[163]

C. UNCONTROLLED AIRSPACE

The commercial drones the cartels are using typically fly in what the International Civil Aviation Organization (ICAO) classifies as Class G airspace. Class G airspace exits below 1200 feet Above Ground Level (AGL), or in some areas below 700 feet when near

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159 Ibid.

160 Ken Button, "The Impacts of Globalisation on International Air Transport Activity Past Trends and Future Perspectives," Global Forum on Transport and Environment in a Globalising World, November 2008, 7, http://www.oecd.org/greengrowth/greening-transport/41373470.pdf.

161 Strauss, "Boundaries in the Sky and a Theory of Three-Dimensional States," 369.

162 "A Brief History of the FAA," Federal Aviation Administration, accessed September 24, 2017, https://www.faa.gov/about/history/brief_history/.

163 Ibid.

an airfield. Class G airspace is 'uncontrolled' by Air Traffic Control (ATC), meaning you can fly an aircraft in the airspace without coordinating with air traffic controllers.

Similar to U.S. drone regulations, drones in Mexico may not be operated in areas that are designated as prohibited or restricted, and can only be flown during the daytime hours.[164] Drones cannot drop objects or material that could cause injury to people or damage to property.[165] Any drone operator that wants to fly outside the requirements and limitations described above must request approval from Mexico's aeronautical authority.[166]

The United States and Mexico both adhere to ICAO standards, both countries currently limit drone flights to Class G airspace, unless waived by proper authority. According to the FAA, commercial drone flights are restricted to altitudes below 400 feet AGL, day-time flight only, and the pilot must maintain visual line of sight (VLOS) with the drone at all times.[167] Mexico adopted similar measures, specifically the restrictions of daytime flight only, and the requirement for pilots to maintain visual sight with their drone in flight while adhering to visual flight rules.[168]

The restriction that pilots maintain visual line of sight with their drone and fly during daytime only is an effective way to control drones on the border. If a drone is flying at night in the border zone, which the narco-drones highlighted in chapter 2 were, then drones detected flying at night in the border zone can be assumed to be hostile or possibly engaged in illicit activities.

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164 Secretaría de Comunicaciones y Transportes, "Vigente La Regulación Sobre Uso de Aeronaves No Tripuladas (drones), Para Su Operación Segura [The Regulation on the Use of Unmanned Aircraft (drones), for its Safe Operation is in Force]," Gob.mx, accessed September 26, 2017, http://www.gob.mx/sct/prensa/vigente-la-regulacion-sobre-uso-de-aeronaves-no-tripuladas-drones-para-su-operacion-segura.

165 Ibid.

166 Ibid.

167 "Getting Started," Federal Aviation Administration, accessed September 30, 2017, https://www.faa.gov/uas/getting_started/.

168 "The Mexican Civil Aviation Authority Has Issued a New Mandatory Circular for All Remotely Piloted Aircraft Systems (RPAS) Operations," Global Media and Communications Watch, May 27, 2015, http://www.hlmediacomms.com/2015/05/27/the-mexican-civil-aviation-authority-has-issued-a-new-mandatory-circular-for-all-remotely-piloted-aircraft-systems-rpas-operations/.

However convenient the night flying restriction is for identifying rogue drones in the border zone airspace, the FAA's restrictions and Mexico's restrictions on night flying and the requirement that pilots maintain visual line of sight with their drone will be short-lived. Once safety issues like a drones ability to see and avoid other aircraft in flight and autonomous flight standards are perfected, and commercial drones are capable of adhering to the International standards for aviation safety, drone laws will inevitably become more permissive.[169]

D. INTERNATIONAL COMMERCIAL DRONE REGULATION

Regulation of commercial drones, like the one the drug cartels are using, is an international problem because countries are struggling to incorporate drones into their aviation regulatory frameworks despite having a mature model of safety regulation standards developed for manned aircraft to model after. A RAND study found that some countries continue to have outright bans on commercial drones. In most cases these countries may be in a 'wait and see' period where they can observe the effectiveness of other countries drone policies before implementing their own.[170]

The United States and Mexico are ahead of most countries because they are evaluating permissive legislation that will allow Beyond Visual Line of Sight (BVLOS) drone flights, needed to incorporate autonomous delivery drones fully. However, the U.S. and Mexico aeronautical authorities are still woefully behind in accounting for drone technology trends that have security and safety implications. Currently, the regulations in both the U.S. and Mexico require the drone pilot to remain in visual line of sight of their drone in-flight, considered the primary obstacle for businesses who wish to use delivery drones.[171] In addressing the security and safety concerns of unmanned drones, governments should not discard what has been learned over years of mishaps and lessons learned in manned aviation.

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169 Colin Snow, "Sense and Avoid for Drones Is No Easy Feat," Skylogic Research - Drone Analyst, September 22, 2016, http://droneanalyst.com/2016/09/22/sense-and-avoid-for-drones-is-no-easy-feat/'.

170 Therese Jones, *International Commercial Drone Regulation and Drone Delivery Services*, (Santa Monica, CA: RAND, 2017), https://www.rand.org/pubs/research_reports/RR1718z3.html.

171 Ibid.

Safety and security standards resulting from general aviation lessons learned undoubtedly made manned aviation one the safest modes of transportation today. In 2017, commercial aviation had a banner year. Four billion passengers on thirty-eight million flights without a single fatality.[172] Internationally, regulation has contributed to increased safety and security. Regulation stipulating licensing requirements, aircraft registration, restricted airspace zones, and insurance requirements are a few regulation requirements that help make aircraft safer.[173] I argue standardized aircraft required equipment like transponders and anti-collision lighting contribute to airspace safety and security.

E. FAA REGULATORY FRAMEWORK FOR DRONES

The FAA argues that "it has authority to regulate aircraft in U.S. airspace," and drones are, by definition aircraft, albeit unmanned.[174] Title 49 of U.S. Code section 40102(a)(6) defines "aircraft" as "any contrivance invented, used, or designed to navigate or fly in the air."[175] FAA regulation 14 CFR section 1.1 defines an aircraft simply as "a device that is used or intended to be used for flight in the air."[176] Title 49 U.S. Code section 40103 stipulates the administrator of the FAA "shall develop plans and policy for the use of navigable airspace and assign by regulation or order the use of the airspace necessary to ensure the safety of aircraft and the efficient use of airspace."[177] Although plans for integrating drones into the airspace are trickling out of the FAA, the FAA is often criticized for being too slow when implementing rules and regulations.

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172 John Cox, "Ask the Captain: Why Aviation Was so Safe in 2017," USA Today, January 7, 2018, https://www.usatoday.com/story/travel/columnist/cox/2018/01/07/ask-captain-why-aviation-so-safe-2017/1005183001/.

173 Therese Jones, *International Commercial Drone Regulation and Drone Delivery Services.*

174 "Unmanned Aircraft Systems," Federal Aviation Administration, accessed September 24, 2017, https://www.faa.gov/uas/.

175 Federal Aviation Administration, *Law Enforcement Guidance for Suspected Unauthorized UAS Operations,* Version 4, (Washington, DC: Department of Transportation, 2017), 2, https://www.faa.gov/uas/resources/law_enforcement/media/FAA_UAS-PO_LEA_Guidance.pdf.

176 "Busting Myths about the FAA and Unmanned Aircraft–Update," Federal Aviation Administration, accessed September 25, 2017, https://www.faa.gov/news/updates/?newsId=76381&omniRss=news_updatesAoc&cid=101_N_U.

177 Sovereignty and Use of Airspace, 49 U.S. Code § 40103 (1994), https://www.law.cornell.edu/uscode/text/49/40103.

The FAA has provided a framework for incorporating drones into the National Airspace System due to industry pressures in areas like land surveillance, disaster response, wildlife tracking, search and rescue, photography, and law enforcement.[178] Similar to manned aircraft, the FAA regulates drones by requiring mandatory registration of aircraft and pilot certifications.

The number of people purchasing drones for work or recreation is rising, and the trend of drones entering the airspace does not seem to be slowing down. Over 770,000 drone operators registered their drones ever since the FAA began requiring registration in 2015.[179] That is over double the number of manned aircraft registrations in the U.S. and the gap continues to grow.

The statutory authority of the FAA to regulate drones in the airspace has its limits, and those limits are codified in law, namely the FAA Modernization and Reform Act. A U.S. Court of Appeals for the District of Columbia recently ruled that the FAA's registration requirement for small drones, which until included drones operated as "model aircraft," directly violates the FAA's statutory authority. The FAA Modernization and Reform Act states the FAA "may not promulgate any rule or regulation regarding a model aircraft."[180]

Congress has directed the FAA to "promote safe flight of civil aircraft" and to standardize the operation of aircraft in the United States, as directed by 49 U.S.C. § 44701(a). In response, the FAA has taken on a regulatory role, requiring drone operators to register their drones, take a knowledge exam, and be vetted by the Transportation

[178] The National Airspace System is defined as "The common network of U.S. airspace; air navigation facilities, equipment and services, airports or landing areas; aeronautical charts, information and services; rules, regulations and procedures, technical information, and manpower and material. Included are system components shared jointly with the military." See "Pilot Controller Glossary (effective 4/03/2014)," PCG N−1, https://www.faa.gov/air_traffic/publications/media/pcg_4-03-14.pdf.

[179] Steve Dent, "There Are over 770,000 Registered Drone Owners in the US," Engadget, March 28, 2017, https://www.engadget.com/2017/03/28/there-are-over-770-000-registered-drone-owners-in-the-us/.

[180] FAA Modernization and Reform Act of 2012, H.R. 658 (2012), Sec. 336. (a), https://www.congress.gov/bill/112th-congress/house-bill/658/text.

Security Administration (TSA).[181] The FAA's attempt to control drone use in the U.S. by implementing a drone registration requirement for all drones seems like a good approach for getting accountability for drone pilots that may perpetrate airspace violations. However, drone owners who say that they fly drones for recreation or as a hobby took issue with the registration requirement.

In March of 2017, hobbyist drone owner John Taylor filed a lawsuit challenging the FAA's authority to require registration of all categories of drones. After examination, the U.S. Court of Appeals for the District of Columbia invalidated the registration requirement for drones considered 'model aircraft' because the court found the registration requirement conflicted with guidance set forth in the Congressional FAA Modernization and Reform Act. The Act states drones "capable of sustained flight in the atmosphere, flown within visual line-of-sight of the person operating it, and flown for hobby or recreational purposes in the category of 'model aircraft.'"[182] If a drone is purchased in the US, and weighs less than 55 pounds—which by all accounts the narco-drones and respective payloads found to be used by the drug cartels have all weighed less than 55 pounds—then the operator does not need to register the drone with the FAA as it would meet the requirements to be considered a model aircraft.

Henceforth, the FAA encourages voluntary registration of drones flown as model aircraft. Drone operators have an avenue to avoid the drone registration requirement if they claim their drone meets the "model aircraft" requirements. The number of drones registered with the FAA prior to the court's decision as of 2016 is 466,931, which includes both hobbyist and non-hobbyist drones.[183] It may be harder to track the type of drones or the amount of drones in the U.S. if all drones are not registered with the FAA. The real number of drones flown in U.S. airspace is presumably much higher than what we know.

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181 "Fly Under the Small UAS Rule," Federal Aviation Administration, accessed October 10, 2017, https://www.faa.gov/uas/getting_started/fly_for_work_business/.

182 FAA Modernization and Reform Act of 2012.

183 "FAA Releases Drone Registration Location Data," Federal Aviation Administration, accessed October 15, 2017, https://www.faa.gov/news/updates/?newsId=85548.

The Federal Aviation Administration Modernization and Reform Act of 2012 is a starting point for understanding the trajectory of federal airspace regulation for drone operations in the United States. Transnational criminal organizations operating on the Mexico side of the border have no impetus for adhering to U.S. federal regulation, which begs the question what is needed to protect against drones coming from Mexico.

A 2015 GAO report on the progress made by the FAA towards drone integration into the National Airspace System finds that countries around the world and specifically western countries like Australia, Canada, France, and the United Kingdom are leading the U.S. in drone regulations.[184] Although, the challenges for these countries in realizing drone integration into a well-established airspace system, is both the drones see and avoid capability and the methods for positive identification. The GAO highlights the capability to *detect and avoid* other aircraft in flight as an example of a technology shortfall that should be addressed prior to full drone integration into U.S. airspace.

The FAA's primary concern integrating drones into the airspace system is the safe integration of bona fide commercial use. The FAA has expertise in formulating and enforcing aircraft safety regulations, but other governmental entities in the Department of Homeland Security and Department of Defense may be better suited for law enforcement and defense measures that are needed to mitigate the threat of drones used for illicit smuggling, surveillance and targeted attacks.

The FAA is often criticized for being too slow in rolling out the rules and regulations that are desperately needed to integrate drones into the National Airspace System. Congress gave the agency until September 30, 2015 to put forth a plan to regulate drone usage in the national airspace.[185] October 1st came and went, and industry leaders who were waiting on the sidelines for a regulatory framework from which to operate were left with a hodgepodge of proposals with no rules finalized. The FAA initially made some

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[184] *Unmanned Aerial Systems: FAA Continues Progress toward Integration into the National Airspace*, GAO-15-610 Highlights (Washington DC: Government Accountability Office, 2015), https://www.gao.gov/assets/680/671468.pdf.

[185] Jason Koebler, "The FAA Has Missed Its Congressionally Mandated Deadline to Regulate Drones," Motherboard, October 1, 2015, https://motherboard.vice.com/en_us/article/ae35dz/the-faa-has-missed-its-congressionally-mandated-deadline-to-regulate-drones.

progress towards the goal of drone integration in 2013 by publishing a UAS Comprehensive Plan and UAS Integration Roadmap as well as a Notice of Proposed Rulemaking specific to small drones, but implementation of the plan has been slow and incremental, leaving many commercial and recreational drone users perpetually frustrated with the perceived lack of urgency in the FAA.

F. FAA CALLING ON INNOVATORS

The FAA is calling on the private industry and government think tanks for ideas on how to monitor restricted airspace and enforce drone regulations that could help enforce airspace controls at the US/Mexico border. For instance, the MITRE Corporation, a non-profit federally funded research organization is assisting the FAA by researching methods beyond kinetic countermeasures (e.g., shotguns or missiles) that are considered unsafe or too costly a means of interdicting rogue drones. Instead, the FAA is looking at lower cost and lower risk of collateral damage non-kinetic counter drone technology (e.g., radio frequency or GPS jamming).

The FAA is working with think tank organizations like the MITRE corporation which specializes in advanced aviation systems development to find counter-drone solutions because of the rise in incidents like passenger jet near misses around airfields, drones in the air over sporting events, drones flying over military installations, and drone drug smuggling into prisons and over U.S. borders. Just recently, the first confirmed collision occurred between an aircraft and a small drone. A military UH-60 Blackhawk helicopter struck a civilian drone flying at an altitude of 500 feet over Staten Island, New York. A violation by the drone pilot, as current regulation stipulates that recreational drones shall not fly above 400 feet AGL.[186] The Army helicopter was providing security for the United Nations general assembly. Luckily, the Blackhawk sustained only minor damage to

186 "Small Unmanned Aircraft Regulations (Part 107)," Federal Aviation Administration, 2016, https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=20516.

a window and a rotor blade, but the incident could have been much worse for the aircrew and the people on the ground.[187]

One approach MITRE is taking is soliciting "solutions from a wide range of innovators from industry" and academia around the world by issuing a "challenge" to innovators to bring ideas that can be tested in a drone countermeasure competition. The most recent competition held on September 8, 2016, asked innovators to find solutions that could: "1) detect small drones (under 5 lbs.) during flight and determine which ones were threats based on a geographic location and flight trajectory, and 2) interdict small drones that were perceived as threats by forcing them to be recovered intact in a safe area."[188] Detection, interdiction, and accountability of operators is as much a problem in the U.S.–Mexico border airspace as it is in the airspace over Los Angeles International Airport or in the restricted airspace over Washington, DC, The problem on the border is further complicated by international boundaries where technology gaps make policing drones in shared airspace much harder, although border zones can be excellent testing grounds for new security and surveillance technology.

The demand signal seems to be coming from the federal government, and increasingly, law enforcement agencies that want an early detection capability. Law enforcement agencies may want a capability for interdiction that allows for safe capture of rogue drones. The safe capture of a drone, as opposed to the destruction of a drone in flight, would presumably be a capability that would help trace a drone back to its owner, therefore increasing the accountability of the drone operators that violate restricted airspace.[189]

The DoD's approach to countering drones may not be the best fit for those in law enforcement who may want to capture and not destroy criminal drones in order to prosecute the respective drone operator. Defense officials may be more concerned with destroying

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187 Kyle Rempfer, "For the First Time, a Civilian Drone Has Crashed into a Military Aircraft," *Military Times*, September 25, 2017, https://www.militarytimes.com/news/2017/09/25/for-the-first-time-a-civilian-drone-has-crashed-into-a-military-aircraft/.

188 "MITRE Names C-UAS Challenge Winners," MITRE, September 8, 2016, https://www.mitre.org/news/press-releases/mitre-names-c-uas-challenge-winners.

189 Jonathan Vanian, "Take Down a Drone Safely and Win $100,000," *Fortune*, December 3, 2015, http://fortune.com/2015/12/02/mitre-drone-competition/.

drones that threaten troops on the ground. Whether destroy or capture, any anti-drone innovation should help achieve a tactical advantage in the airspace.

The tactical advantage of air superiority supported by air power found its place as an indispensable weapon during WWII, and the objective of air superiority has carried forward as an operational necessity that allows for safe movement of troops and equipment.[190]

G. LEGALITY OF DRONE COUNTERMEASURES

U.S Customs and Border Protection do not have the legal authority they need to counter narco-drones on the border. Acting DHS Secretary Elaine Duke recently spoke about the need to keep up with our enemies and pointed to counter drone technology as an area where DHS lacks authority to engage and mitigate the threats the way they should.[191]

According to a senior official at DHS, federal agencies are calling on Congress to change laws that inhibit law enforcement agencies from downing small drones perceived to be a threat.[192] Recently, Congress took a significant step by authorizing the DoD to take necessary action to mitigate drones that pose a threat to the safety and security of military assets at 133 military installations.[193] The legislation authorizes "reasonable force" to detect, identify, track, and seize or destroy unauthorized drones flying over military base infrastructure.[194]

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190 "Modern Military Aviation," National Air and Space Museum, July 13, 2006, https://airandspace.si.edu/exhibitions/modern-military-aviation.

191 *Threats to the Homeland testimony before a Senate Committee on Homeland Security*, (2017) (statement of Elaine Duke, DHS Acting Secretary), https://www.dhs.gov/news/2017/09/27/written-testimony-dhs-acting-secretary-elaine-duke-senate-committee-homeland.

192 Bill Carey, "DHS, Other Agencies Seek Law Changes To Intercept Drones," Aviation International News, September 7, 2017, https://www.ainonline.com/aviation-news/defense/2017-09-07/dhs-other-agencies-seek-law-changes-intercept-drones.

193 National Defense Authorization Act for Fiscal Year 2017, S.2943, Sec. 1697 (2016), https://www.congress.gov/bill/114th-congress/senate-bill/2943/text; Tara Copp, "New Policy: Military Bases Can Shoot down Trespassing Drones," *Military Times*, August 7, 2017, http://www.militarytimes.com/breaking-news/2017/08/07/dod-can-now-shoot-down-trespassing-uavs/.

194 Ben Lerner, "NDAA and the Counter-Drone Challenge," Defense News, December 22, 2016, https://www.defensenews.com/opinion/commentary/2016/12/22/ndaa-and-the-counter-drone-challenge/.

Officials at the Pentagon acknowledge the threat that private and commercial drones pose to the safety and security of military installations. The Congressional authorization allows the DoD to be proactive in defending the airspace from small drones and is a momentous step towards challenging antiquated federal statutes. Penned in the 2017 National Defense Authorization Act, the legal authority given to the military to seize or destroy small drones in the airspace over critical infrastructure is decisive for policing them. Can civilian law enforcement and border security agencies be granted the same authority? I believe they can because the U.S.–Mexico border region, already notorious for what some may consider watered down Constitutional protections, could be granted sweeping authority to bring down narco-drones that may fly close to border security infrastructure or personnel.

In June 2017, DHS communicated some considerations for taking action against drones to state and local law enforcement agencies in a memorandum. The letter reminds law-enforcement to consider the multiple legal hurdles for employing various active and passive countermeasures against drones that are considered personal property.[195] The memo suggests local/state law enforcement policies are continuing to evolve. Federal law prohibits many of the active and passive countermeasures that are being developed for the military. Below is a non-exhaustive list of Federal statutes composed by DHS for law enforcement agencies to consider that we may need to rethink in the US/Mexico border zone:[196]

- Sovereignty and Use of Airspace[197]
- Aircraft Piracy[198]

195 "Unmanned Aircraft Systems Considerations for Law Enforcement Action" (official memorandum, Washington DC: Department of Homeland Security, 2017), https://www.dhs.gov/sites/default/files/publications/uas-law-enforcement-considerations-508.pdf.

196 Ibid.

197 49 U.S.C. > Subtitle VII > Part A > Subpart I > Chapter 401 > § 40103

198 49 U.S.C. > Subtitle VII > Part A > Subpart iv > Chapter 465 > § 46502 (a)(1)(A)

- Destruction of Aircraft or Aircraft Facilities[199]
- Aiming a Laser Pointer at an Aircraft[200]
- Interception and Disclosure of Wire, Oral, or Electronic Communications Prohibited[201]
- General Prohibition on Pen Register and Trap and Trace Device Use[202]
- Emergency Pen Register and Trap and Trace Device Installation[203]

Such a request is particularly challenging to grant because any authorities given to law enforcement need to respect the privacy and the civil liberties of private citizens. An expansion of law enforcement agency authority to seize and destroy personal property without due process will undoubtedly be a point of contention for civil rights activists concerned with government overreach in the name of national security. It appears Congressional authority needed for law enforcement to effectively police drones on U.S. domestic soil will require a revision of multiple federal statutes.

According to the *New York Times*, President Trump wants Congress to give the federal government more extensive powers to detect, identify, and if needed, to destroy commercial drones over U.S. soil.[204] A proposal for new rules regarding drone countermeasures is drafted and will be a part of the 2018 National Defense Authorization Act barring any changes.[205] The draft bill is said to contain language that will "enable the

199 18 U.S.C. > Part I > Chapter 2 > § 32 (a)(1), (2), (4), (5)

200 18 U.S.C. > Part I > Chapter 2 > § 39A (a)

201 18 U.S.C. > Part I > Chapter 119 > § 2511 (1)(a), (b)

202 18 U.S.C. > Part II > Chapter 206 > § 3121 (a)

203 18 U.S.C. > Part II > Chapter 206 > § 3125 (a)(1)(A), (a)(2)

204 Charlie Savage, "Proposed Rules Would Allow U.S. to Track and Destroy Drones," *New York Times*, May 23, 2017, https://www.nytimes.com/2017/05/23/us/politics/drone-surveillance-policy.html.

205 Ibid.

government to develop and use 'countermeasures that can address the unique public safety and homeland security threats' posed by drones."[206]

H. DRONE-THREAT COUNTERMEASURE APPROACH

A sensical approach to the hostile drone problem is suggested in a report composed by The Remote Control Project. Their group is an international collaboration of intelligence, law enforcement, military and government professionals that conduct extensive research on non-state actor's hostile drones. They suggest the best defense against malicious drone use is to apply a hierarchy of security measures that include a combination of regulatory, passive, and active countermeasures (see Figure 6).[207] A layered defense approach encompassing the three countermeasure components suggested by *Open Briefing* is presumably the most effective framework for constraining and countering the use of narco-drones by the cartels. The layered defense fits the tested military strategy of defense in depth. In their report they outline three drone countermeasure lines of effort, with regulatory countermeasures, presumably ranked biggest and at the top because new regulation will have the biggest impact in constraining hostile drones, and active Countermeasures at the bottom. As with any security problem, a layered approach like this is most likely the most effective way to counter a disruptive technology threat like narco-drones.

206 Ibid.

207 Abbott et al., "Hostile Drones: The Hostile Use of Drones by Non-State Actors against British Targets," 1.

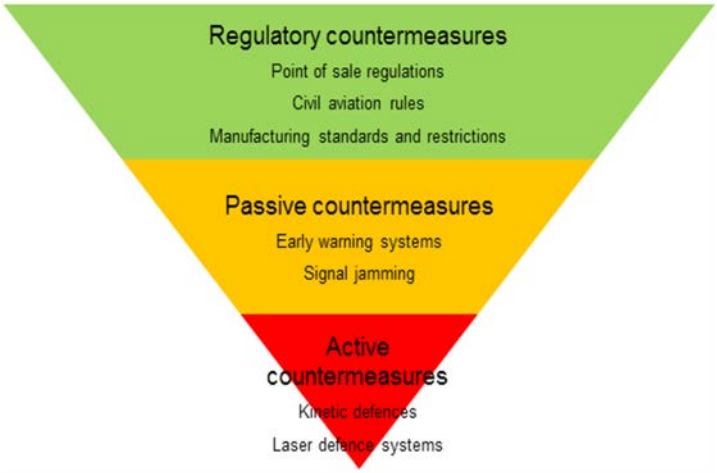

Figure 6. The Remote Control Project hierarchy of hostile drone countermeasures[208]

I. LAYERED DEFENSE AND DEFENSE IN DEPTH

The Department of Homeland Security (DHS) uses the multi-layered defense approach to essentially expand border controls, adding more time to interdicting illicit material being smuggled into the U.S.[209] By applying a layered approach, DHS wants to create greater system flexibility to protect against a range of traditional and asymmetric threats.[210] The expected results of the DHS's layered defense approach can be garnered from their strategy on how to protect the United States' global supply chain. The goal of layered defense in the supply chain is to "identify high-risk cargo and conveyances as early as possible and simultaneously facilitate the swift movement of legitimate trade across our borders."[211] Inspection and screening of 'high-risk' shipping containers begin in the country of origin, usually far from U.S. borders and ports-of-entry.

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208 Abbott et al., "Hostile Drones: The Hostile Use of Drones by Non-State Actors against British Targets," 14.

209 "Multi-Layered Defense," Department of Homeland Security, last modified February 11, 2016, https://www.dhs.gov/multi-layered-defense.

210 U.S. Customs and Border Protection, *Vision and Strategy 2020 U.S. Customs and Border Protection Strategic Plan: Delivering Safety, Security, and Prosperity through Collaboration, Innovation, and Integration*, 15-16.

211 Ibid., 16.

Barnum et al. (2005) refer to a layered defense approach as "defense in depth" in the context of digital network security against computer hackers. This approach assumes that redundant security mechanisms will require an attacker to circumvent multiple security mechanisms to gain access to the system.[212] Defense-in-depth is an approach the DoD and DHS have both embraced in their operational planning.

J. MILITARY PERSPECTIVE ON DEFENSE IN DEPTH

As a military defense strategy, defense in depth seeks to delay and not prevent an enemy attack by trading time for space.[213] Instead of hardening a single defensive position along a line, where if breached by an attacker would expose defensive units to flanking maneuvers, defensive depth is constructed by deploying resources and fortifications well-behind the front line in an effort to sap the attacker's momentum and cohesion and ultimately deter further aggression.[214]

Early detection of narco-drones is a problem because small drones can evade fixed aircraft detection radars. To smuggle narcotics via drone, you would not have to transit deep into U.S. territory. In most cases, less than a mile flight distance is needed to drop a payload to a waiting cartel member in U.S. territory. International border enforcement coordination between the U.S. and Mexico, should in include sharing drone detection and interdiction technology. DHS reiterated in its most recent strategic plan that situational awareness about what is coming into the country illegally comes from a combination of surface, aviation, and infrastructure, and in no small part international partnerships.[215] Further technology sharing with Mexico's border security agencies could add depth to the border zone and support interdiction efforts.

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212 Sean Barnum and Michael Gegick, "Defense in Depth," Department of Homeland Security, accessed January 12, 2018, https://www.us-cert.gov/bsi/articles/knowledge/principles/defense-in-depth.

213 Eric J. Wittenberg, "The Defense in Depth as a Revolutionary Battlefield Tactic," *Emerging Revolutionary War Era* (blog), June 2, 2016, https://emergingrevolutionarywar.org/2016/06/02/the-defense-in-depth-as-a-revolutionary-battlefield-tactic/.

214 Ibid.

215 Department of Homeland Security, *Fiscal Years 2014-2018 Strategic Plan* (Washington DC: Department of Homeland Security), 21, https://www.dhs.gov/sites/default/files/publications/FY14-18%20Strategic%20Plan.PDF.

K. OPERATIONAL CONTROL

Prevention of unlawful entries into the United States by criminal organizations is directly related to what Congress and Customs and Border Protection call operational control of the border. While definitions vary as to what operational control of the border is, Chief of Border Patrol Paul Beeson expands on the definition of operational control beyond obscure prevention standards by saying it is the "the ability to detect, identify, classify, respond and resolve any border incursion in your area of responsibility."[216]

The 2014 QHSR recognizes that absolute security, meaning 100% operational control of the border against all threats is not fiscally or operationally possible.[217] This logic holds true for the security of the airspace over the border. DHS has a history of throwing technology and money at border security to solve the problem. Tom Barry, a contributor to the Center for International Policy, points to the Secure Borders Initiative (SBI) as an example of wasteful technology spending on an unfocused strategy for border security. Perhaps DHS should leverage existing capabilities, experience, and organizational structure of the DoD to improve operational control of the U.S.–Mexico border.

The 2014 QHSR highlights two of the principal threats that pose the most significant risk to U.S. national security; the terrorist threat, and the transnational criminal organization (TCO) threat. The report refers to the terrorist groups evolving tactics to exploit vulnerabilities in the United States' security apparatus.[218] It also points out that "transnational criminal organizations are increasing in strength and capability."[219] The porous nature of the border is a "primary concern" to homeland security because extremists and criminals can operate undetected in certain areas, highlighting a deficiency in sensor coverage and interdiction assets in the border region.[220]

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216 Glenn Spencer, "Defining Operational Control of the Border," accessed June 1, 2017, http://www.americanpatrol.com/SPENCER-GLENN/OperationalControlGS_100505.html.

217 "The 2014 Quadrennial Homeland Security Review," 32.

218 "The 2014 Quadrennial Homeland Security Review." 6.

219 Ibid.

220 Ibid, 34.

Homeland Security officials and members of Congress may recognize after years of ambiguity that border control needs to be defined, measured, and evaluated to allocate limited resources effectively. The 2006 Secure Fence Act is the first congressional attempt at clarifying the goal of a secure border using the metric of "operational control." The Secure Fence Act defines operational control as "the prevention of all unlawful entries into the United States, including entries by terrorists, other unlawful aliens, instruments of terrorism, narcotics, and other contraband."[221] In passing the Act, Congress ordered DHS to gain and maintain complete control of U.S. land and maritime borders, and prevent all unlawful entries in a time span of eighteen months. This goal proved to be unrealistic because it is now 2017 and operational control has yet to be achieved, nor does appear it ever will be when we are reminded there are limits of Congressional support and funding for ballooning border security measures. Mr. Richard Stana of the Government Accountability Office asserted in 2011 that the cost of preventing *all* unlawful entries into the U.S. by land, air, and sea is surely prohibitive.[222]

1. Border Patrol and Operational Control

Meanwhile, the CBP's understanding of operational control of the border in contrast with Congress's unrealistic definition provides a practical element to what is meant by "operational control" of the border. CBP's thinking about operational control stresses "the ability to detect, respond, and interdict border penetrations in areas deemed as high priority for threat potential or other national security objectives."[223] The emphasis is a goal of achieving a certain level of *capability* to mitigate current and/or emerging threats at the border. Former Chief of CBP Michael Fisher explained in a Congressional

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221 Secure Fence Act of 2006, H.R. 6061 (2006). https://www.govtrack.us/congress/bills/109/hr6061/text.

222 *Securing our Borders—Operational Control and the Path Forward, House of Representatives,* 112th Cong. (2011), https://www.gpo.gov/fdsys/pkg/CHRG-112hhrg72215/html/CHRG-112hhrg72215.htm.

223 Chad C. Haddal, *Border Security: The Role of the US Border Patrol*, CRS Report No. RL32562 (Washington, DC: Congresstional Research Service, 2010), 6, http://www.dtic.mil/docs/citations/ADA530562.

hearing that operational control is a measurement based on the assessments of the Chief agents in the field and "is not, in and of itself, an assessment of border security."[224]

The purpose of defining operational control also called "effective control" of the border is building capacity and capability relative to specific threats. Building capabilities relative to specific threats enables CBP to mitigate risk while avoiding wasteful security measures that may do nothing to make the border more secure. In stopping drones used by the drug cartels, a rapid response by law enforcement while necessary, may not be the most critical capability that would hope to deter narco-drone use. A response is only effective if it is based on accurate intelligence. I argue a critical step in achieving operational control in the shared airspace of the US/Mexico border is deploying the type of aerial surveillance technology the U.S. military is using in Iraq and Afghanistan to counter ISIS drones to the border zone.

A few sections of the southwest border could be examples of 100 percent operational control. A result of the Secure Fence Act, a nine-mile section of the San Diego border sector could be an example what would is required for operational control. This span of border territory consists of a primary fence on the actual border; a band of land directly adjacent to the primary fence lined with an all-weather road that is lighted and patrolled day and night by Border Patrol; a secondary fence; and an unknown number of sensors, radars, and infrared cameras. But even in the most secure or technologically equipped sectors of the border narco-drones are able to get through. Border Patrol Supervising Agent Mark Endicott said there had been seven known nacro-drone incursions in the San Diego sector, five in 2016, and two in 2017.[225] In six of the incidents, Border Patrol agents lost sight of the drone, and they either completed their payload drops in the US, or they could have returned to Mexico.[226]

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224 H.R., *Securing our Borders.*

225 Pauline Repard, "Buzz Overhead Leads Border Patrol to Make San Diego's First Drone Drug-Smuggling Arrest," *San Diego Tribune*, August 18, 2017, http://www.sandiegouniontribune.com/news/public-safety/sd-me-drone-smuggling-20170818-story.html.

226 Ibid.

2. Operational Control Definition Remains Illusive

Total operational control of the southwest border is a concept that House Homeland Security Committee Chairman Michael McCaul R-Texas struggles to define. During a Council of Foreign Relations press conference, a questioner inquired as to what criteria will indicate that we have a secure border. In response, Rep. McCaul explained somewhat ambiguously that "it's when we gain operational control."[227] He went on to say that operational control can be defined in multiple ways, but currently, "we are catching less than half of what's coming in."[228] For him, the problem of achieving operational control is the lack of situational awareness and perhaps the lack of capabilities to monitor the entirety of the border zone.

[227] Terence P. Jeffrey, "Homeland Security Chair Says U.S. Far from Having Operational Control of Border," CNS News, June 9, 2016, https://www.cnsnews.com/news/article/terence-p-jeffrey/homeland-security-chair-says-us-far-having-operational-control-border.

[228] Ibid.

IV. DRUG CARTEL INNOVATION BEHAVIOR

The adversarial relationship between U.S. Border Patrol and the Mexican drug cartels makes for an interesting dynamic of action and reaction. Retired Immigration and Customs Enforcement agent Mike Unzueta comments, as fences went up in the San Diego sector of the border, drug smugglers turned to oceanic routes, underground tunnels, and designated ports-of-entry to funnel drugs into the United States.[229] Like a river breaking around a rock, smugglers find ways to keep the drugs flowing North despite hardened borders in the post 9/11 period. Vital to understanding the innovation capacity of Mexico's drug cartels is the observation that criminal agents, like the cartels, continue to challenge the U.S. border security apparatus with smuggling methods that, when discovered, seem surprising and unexpected. Moreover, at times some of these tactics can "shock" the status quo that is the existing state of border security controls, requiring border security officials to adapt their tactics, adopt risk-mitigating technology, or accept the new normal. In any case, the action/reaction adversarial relationship on the US/Mexico border, according to Dr. Nieto-Gomez, has created a system of interdependent government and criminal agencies.[230] And, in his view, the system is maintained through the process of innovation. That innovation system has presented security planners with the threat of narco-drones.[231] This chapter looks at what could be driving the Mexican drug cartel's technology innovation using a survey of scholarly analysis regarding organizational behavior to find indicators of why narco-drones are being used. The chapter ends with a comparative analysis of terrorist drone innovation and cartel narco-drone innovation which I believe will provide insight into what DHS could expect from future drug cartel drone innovation.

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229 Gustavo Solis, "Drug Smuggling, and the Endless Battle to Stop It," *USA Today*, accessed November 27, 2017, https://www.usatoday.com/border-wall/story/drug-trafficking-smuggling-cartels/559814001/.

230 Nieto-Gomez, "Stigmergy at the Edge: Adversarial Stigmergy in the War on Drugs," 32.

231 Ibid.

A. DRUG CARTELS CARE ABOUT SUPPLY CHAINS

Drug cartels are competitive and independent organizations that want to build a business empire funded by diversified revenue streams. In addition to the drug trade, Evelyn Morris says the cartel business portfolio now includes pirated intellectual property, counterfeiting, and the increasingly lucrative human-trafficking service.[232] In her view, narcotics are just one product among many that drug cartels traffic through various distribution hubs. It is the *logistics* that matter most to the cartels. From a business perspective, if logistics or the transportation of products to customers is critical to the survivability of the drug cartel, then like business organizations, drug cartels are incentivized to innovate new ways for transporting contraband to their customers faster and cheaper. To that end, narco-drones similar to legitimate commercial drones are evolving to be positioned in supply chains to do just that.

B. DRUG CARTELS ARE SIMILAR TO BUSINESS CORPORATIONS

The observation that drug cartels behave like business corporations in that they need to be profitable to survive is significant in predicting future narco-drone employment. Paul Kan compares the Mexican drug cartels to legitimate businesses but accounts for their inherently violent nature by labeling them "vicious firms" made up of "violent entrepreneurs."[233] Further, the drug cartel's violent acts may be an effective means of public relations and marketing if the goal is more political influence and recruitment through intimidation. Although, Kan believes too much focus on the violent nature of the drug cartels may be a distractor in understanding their organizational behavior.[234]

Kan asserts acts of violence are bad for the drug cartel's business because they impede the organization's profit-making activities, driving up member security costs and the possibility of state intervention. I agree that high visibility acts of violence may be

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[232] Evelyn K. Morris, "Think Again: Mexican Drug Cartels," *Foreign Policy*, December 4, 2013, https://foreignpolicy.com/2013/12/04/think-again-mexican-drug-cartels/.

[233] Paul R. Kan, "Mexican Cartels as Vicious Firms," *Small Wars Journal*, accessed November 17, 2017, http://smallwarsjournal.com/jrnl/art/mexican-cartels-as-vicious-firms.

[234] Ibid.

counterproductive to the drug cartels principal profit-making goal but the violent behaviors should not be discounted when assessing how they might use technology to violent ends.

Drug Cartels Violent Tendencies

Mexico's drug cartels are unlikely to use narco-drones in large scale against U.S. border security targets because it would provoke an unwanted security response. Sylvia Longmire believes the drug cartels understand that the types of violent acts they are committing in Mexico, would not be tolerated if committed against innocent men, women, and children on the U.S. side of the border. She asserts they would elicit an unprecedented U.S. government response.[235] What that response would be is unknown. It could be temporary law enforcement crackdown, or it could result in a permanent ramp-up of U.S. military assistance in the form of more security personnel and infrastructure, and perhaps a change in the rules of engagement (ROE) to degrade drug cartel networks in the border zone. In no instance would the sort of cartel violence seen in Mexico benefit the drug smuggling money stream coming from the United States, which is crucial for cartels survival.

Drug cartel violence in Mexico cannot be easily uncoupled with its profit-driven business acumen. Los Zetas cartel, organized initially by former commandos in Mexico's army, are known to be the most gruesome and violent of the drug cartels. The Zetas made a name for themselves by conducting gruesome beheadings among other acts of sensational killing of rival cartel members and Mexican government officials which would then be posted to websites or spread through social media as a warning to anyone who would interfere with their smuggling operations.[236] Pew Research Center data gathered in 2017

[235] Sylvia Longmire, "Homeland Security Today: Los Zetas Employ Terror Tactics Near US Border," Homeland Security Today, April 30, 2011, http://www.hstoday.us/briefings/correspondents-watch/single-article/los-zetas-employ-terror-tactics-near-us-border/14b27c3775ab3d3ba60d414468c584bf.html.

[236] Brianna Lee and Danielle Renwick, "Mexico's Drug War," Council on Foreign Relations, last modified May 25, 2017, https://www.cfr.org/backgrounder/mexicos-drug-war.

puts cartel-related violence as one of the top concerns for Mexican citizens, ranking just behind crime and political corruption.[237]

Los Zetas brought militaristic discipline and tactics to the cartel business model. The U.S. government has characterized the Zetas cartel as "the most technologically advanced, sophisticated and dangerous cartel operating in Mexico"[238] because of their extensive weaponry and military expertise. The weaponized commercial drone would be a fierce and terrifying capability that the Zetas cartel could use to kill an enemy just as a U.S. Special forces unit might. The first weaponized drone seized in Guanajuato, Mexico, a territory plagued by cartel violence and contested by the Sinaloa, Cártel Jalisco Nueva Generación, and Los Zetas drug cartels, is an indicator that weaponized narco-drones could be seen more in Mexico in violent attacks.[239]

C. THE DEMOCRATIZATION OF AIRSPACE

Commercial drones may be challenging the assumption that U.S. military air power is overwhelming, and air dominance in the battlespace is assured. Jonathan Gillis argues American air dominance has remained a foregone conclusion over the past few decades. American military forces on the ground have assumed freedom of movement with assumed air superiority coming out of WWII, and certainly during the post 9–11 wars in Afghanistan and Iraq.[240] Dan Gettinger, of the Bard College Center for the Study of the Drone, asserts that "in Syria and Iraq today, there are more drones, made in more countries, and flown by more groups, than in any previous conflict."[241] He points out less technologically equipped non-state actors, increasingly are adopting drones and adapting them to a range

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[237] Margaret Vice and Hanyu Chwe, "2. Mexicans Are Downbeat about Their Country's Direction," Pew Research Center's Global Attitudes Project, September 14, 2017, http://www.pewglobal.org/2017/09/14/mexicans-are-downbeat-about-their-countrys-direction/.

[238] Michael Ware, "Los Zetas Called Mexico's Most Dangerous Drug Cartel," CNN, last modified August 6, 2009, http://www.cnn.com/2009/WORLD/americas/08/06/mexico.drug.cartels/index.html.

[239] Axe, "Great, Mexican Drug Cartels Now Have Weaponized Drones."

[240] Jonathan Gillis, "In Over Their Heads: U.S. Ground Forces Are Dangerously Unprepared for Enemy Drones," War on the Rocks, May 30, 2017, https://warontherocks.com/2017/05/in-over-their-heads-u-s-ground-forces-are-dangerously-unprepared-for-enemy-drones/.

[241] Dan Gettinger, "Drones Operating in Syria and Iraq," Center for the Study of the Drone, December 13, 2016, 1, http://dronecenter.bard.edu/drones-operating-in-syria-and-iraq/.

of operations.[242] The increase in the use of commercial type drones by non-state actors like ISIS and now the Mexican drug cartels have contributed to what T.X Hammes calls the "democratization of airpower" which is challenging state controls in the airspace.[243] Widely available commercial drones that can be customized with payloads of narcotics, cameras, or bombs are making airspace accessible to everyone.

D. LOW-COST, EASY TO USE, WIDELY AVAILABLE

The use of low-cost, readily available vehicles for carrying out attacks i.e., cars, trucks, knives, machetes and now commercial drones have proven to be one of the more successful tactics in current day terrorist attacks. Even though there is no direct evidence that the Mexican drug cartels are adopting drone tactics from terrorist organizations like ISIS, one can assume that the drug cartels are paying attention to how drones may benefit them in pursuit of their goals. Although it is difficult to predict with certainty the rate, scale, or influence of technology innovation like narco-drones, industry trends suggest commercial drones and the by-product of criminal drones will become a new normal very soon.

E. MEXICO'S DRUG CARTELS COULD BE LEARNING FROM TERRORIST DRONE SUCCESSES

The Mexican cartels are capable of learning from terrorist groups without having direct contact with terrorist organizations. Brian Jackson theorizes that terrorist groups learn new tactics and adopt new technology through a process of research, or incidentally as a result of the group's activities.[244] The same processes apply to the drug cartels. Commercial drone use by terrorist organizations in the conflict zones of the Middle East

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[242] Ibid.

[243] T. X. Hammes, "The Democratization of Airpower: The Insurgent and the Drone," War on the Rocks, October 18, 2016, https://warontherocks.com/2016/10/the-democratization-of-airpower-the-insurgent-and-the-drone/.

[244] Brian A. Jackson. "Organizational Learning and Terrorist Groups" (working paper, RAND Public Safety and Justice, 2004), https://www.rand.org/content/dam/rand/pubs/working_papers/2004/RAND_WR133.pdf.

are well documented going back a decade.[245] Weaponized drones and surveillance drones have flourished in the war zone environment (see Figure 7). Iraq and Syria, ironically, seem to be a testing ground for innovative ideas about how to use commercial drones versus a larger and more powerful adversary like state militaries.

Grenade launchers, suicide bomber drones, flying decoys, flying surveillance platforms, ISIS is adapting small quadcopter and fixed-wing drones with deadly effect.

Figure 7. Islamic State fighters use an assortment of drones for surveillance or targeted attacks[246]

Mexico's drug cartels are believed to have adopted a number of tactics from terrorist organizations. Jason Howerton asks the question, are Mexico's drug cartels taking note of terrorist tactics overseas? He offers some compelling examples in support of the claim.[247]

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[245] Associated Press, "Hezbollah Says it has Capability to Bomb Israel from the Air," Haaretz, Nov 12, 2004; Eugene Miasnikov, "Terrorists Develop Unmanned Aerial Vehicles," Center for Arms Control, Energy and Environment Studies at MIPT, December 8, 2004, http://www.armscontrol.ru/uav/mirsad1.htm; Defense Industry Daily Staff, "Hezbollah Mirsad-1 UAV Penetrates Israeli Air Defenses," Defense Industry Daily, April 20, 2005, https://www.defenseindustrydaily.com/hezbollah-mirsad1-uav-penetrates-israeli-air-defenses-0386/.

[246] Ben Watson, "The Drones of ISIS," Defense One, January 12, 2017, http://www.defenseone.com/technology/2017/01/drones-isis/134542/.

[247] Jason Howerton, "Are Drug Cartels Learning From Islamic Terrorist Groups?," TheBlaze, May 29, 2012, http://www.theblaze.com/news/2012/05/29/are-drug-cartels-learning-from-islamic-terrorist-groups/.

A few of the tactics the drug cartels may have learned from terrorist organizations include impersonating Mexico's military by wearing military organizational clothing during attacks in an attempt to undermine the state, a tactic used by Islamic terrorist groups in Iraq and Afghanistan. Gruesome beheadings and body mutilations characteristic of the Zetas drug cartel are now a staple of drug cartel violence. Beheadings are historically a customary method of execution carried out in accordance with Islamic Sharia law and an infamous tactic made famous by ISIS propaganda videos created in Iraq and Syria. Car bombs and IEDs, at one time associated exclusively with terrorist activities, is now a tactic used by the Juarez cartel to instill fear among law enforcement, rival gang members, and the general public.[248]

[248] Richard Esposito, "Mexican Drug Cartels' New Weapon in Border War—the Car Bomb," ABC News, August 12, 2010, http://abcnews.go.com/Blotter/mexican-drug-cartels-weapon-border-war-car-bomb/story?id=11383665.

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V. DRONE DETECTION AND COUNTERMEASURES

A. AIR INTERDICTION OF NARCO-PLANES

The U.S. drug interdiction crackdown in the 1980s in response to the explosion of cocaine demand in the U.S. disrupted many of the Mexican cartels traditional smuggling routes that crisscrossed through the Caribbean and into South Florida.[249] During that time the preferred method of smuggling vehicle was small aircraft.[250] The crackdown included a steady improvement in U.S. Customs radar air picture with the innovation of 'down looking' radars attached to blimps that were especially good for detecting and tracking small, low, slow flying aircraft like the ones to transport cocaine from Colombia to the Caribbean.[251] According to Peter Andreas, expanding the U.S. radar net pushed a lot of the drug trafficking out of the air, reducing air smuggling by 75 percent of 1982 trafficking levels.[252]

Between 1986 and 1992, in the process of developing a robust system of radars to surveil the border and Gulf of Mexico, the U.S. Customs Service increased its air interdiction infrastructure significantly.[253] According to Andreas, U.S. Customs tripled the size of its air fleet and swelled its air program personnel six fold.[254] The increase in assets and manpower in U.S. Customs combined with the redirecting of DoD assets from strategic missile defense to counter-drug operations may have been decisive in the successful interdiction of cartel smuggling aircraft. Although Andreas says, the result of the combined drug interdiction effort only shifted the drug smuggling to land routes through Mexico to

249 Andreas, *Border Games: Policing the U.S.-Mexico Divide*, 52.

250 Ibid.

251 Dave Long, "CBP's Eye in the Sky," U.S. Customs and Border Protection, accessed December 15, 2017, https://www.cbp.gov/frontline/frontline-november-aerostats.

252 Andreas, *Border Games: Policing the U.S.-Mexico Divide*, 52.

253 Ibid.

254 Ibid.

the U.S. contiguous border and did little to reduce the overall amount of drugs flowing north.[255]

B. DOD DRUG INTERDICTION

By the 1990s, the U.S. military was deeply involved in drug interdiction on the U.S.–Mexico border. Air Force AWACS aircraft and NORAD's early warning radar, once dedicated to detecting Soviet launched missiles entering the U.S. Air Defense Identification Zones (ADIZ) were now assisting U.S. Customs in counter-drug air interdiction mission.[256]

The DoD provided U.S. Customs with the air surveillance capability they wanted, and the relationship seemed to be a cost-effective means of utilizing homeland defense assets for homeland security missions prior to the official establishment of the homeland security enterprise (HSE). That relationship continues today; a 2011 DHS press secretary release affirmed the "critical" partnership between DHS and the DoD highlighting "unprecedented levels of personnel, technology, and infrastructure along the southwest border… [and the] ongoing commitment to secure the border and facilitate legitimate trade and travel."[257]

Weaponized ISIS drones have forced the U.S. military to think about anti-drone capabilities that will protect troop movements and infrastructure from drones. In October 2016, Kurdish Peshmerga fighters downed a hobby type drone in Erbil, Iraq. When they went to investigate the small drone, it exploded killing the Peshmerga fighters and injuring two French paratroopers.[258] Army Colonel Brett Sylvia says ISIS drones have evolved, initially developed for reconnaissance and now they are equipped with munitions to be

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255 Ibid., 52–53.

256 Ibid., 53.

257 "DHS and DOD Announce Continued Partnership in Strengthening Southwest Border Security," Department of Homeland Security, December 20, 2011, https://www.dhs.gov/news/2011/12/20/dhs-and-dod-announce-continued-partnership-strengthening-southwest-border-security.

258 Patrick Tucker, "Pentagon Urgently Pushing Anti-Drone Tech to ISIS Fight," Defense One, October 13, 2016, http://www.defenseone.com/technology/2016/10/pentagon-urgently-pushing-anti-drone-tech-isis-fight/132308/.

dropped on Iraqi troops.[259] LT General Michael Shields, the director of Joint Improvised Threat-Defeat Organization (JIDO) has said the U.S. military has been pushing new anti-drone technology, some already operational, others that are in stages of development.[260] The growing use of armed drones in the battle for Mosul is said to have allowed the U.S. Army to put some of the early anti-drone proposals to the test on the battlefield with some success.

C. DETECT AND TRACK AIRCRAFT

The low altitude airspace of U.S.–Mexico border is monitored by six fixed radar balloons like the one pictured in Figure 8, while the 'high altitude' airspace is monitored by air traffic control radars. The standard practice for air traffic management internationally is to use radar to detect and track air contacts. In addition to ground-based radar is the aircraft's transponder that reports the aircraft's position automatically when queried.[261] A 'transponder' is short-hand for 'transmitter-responder,' which is a piece of aircraft required equipment that automatically transmits an assigned four-digit code when it receives a radio-signal from air-traffic control radar.[262] Currently, because commercial drones are reserved to fly in Class G airspace only, a transponder is not required. Unless future aviation regulations require drones flying in the border zone to be equipped with a transponder in class G airspace, then ground-based radar will continue to have primacy in drone detection. First, a look at the current state of low-altitude aircraft detecting radar.

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[259] George Leopold, "Mosul Battle Fuels Anti-Drone Development," Defense Systems, accessed May 14, 2017, https://defensesystems.com/articles/2017/02/23/leopoldisisdrone.aspx.

[260] Tucker, "Pentagon Urgently Pushing Anti-Drone Tech to ISIS Fight."

[261] BBC, "How Do You Track a Plane?," BBC News, March 17, 2014, http://www.bbc.com/news/world-asia-pacific-26544554.

[262] Ibid.

Figure 8. TARS blimps carry a radar payload used to monitor the low-altitude approaches to the U.S. border[263]

D. TETHERED AEROSTAT RADAR SYSTEM (TARS)

TARS developed originally during the 1980s as part of a surge in U.S. counter-drug programs. A capability was needed for persistent surveillance that could detect and track low flying smuggling aircraft, hence the birth of the innovation of radar balloons. The U.S. Air Force, U.S. Customs, and U.S. Coast Guard shared the management of the TARS network up until 1992 when sole management was transferred to the Air Force.[264] The Coast Guard and U.S. Customs Service struggled prior to the introduction of TARS with inadequate capabilities to control the air approaches coming through the Caribbean and South Florida.[265] The U.S. military's system of radars at the time was focused on tracking high altitude threats, i.e., Soviet bombers and ballistic missiles. The drug traffickers subverted the militaries' radar net by flying low and slow.

[263] Long, "CBP's Eyes in the Sky,"

[264] Federation of American Scientists, "*Tethered Aerostat Radar System*."

[265] Ibid.

The Tethered Aerostat Radar System (TARS) is a series of lighter-than-air blimps that are tethered by a cable to ground stations strategically positioned along the U.S.–Mexico border in the cities shown in Figure 9.[266] The TARS balloons are unmanned, unarmed, and networked radar platforms that provide persistent surveillance out to 200 nautical miles depending on their height above ground. Figure 9 depicts the current TARS stations along the border.

Figure 9. TARS balloon stations along the southern border[267]

By the late 1980s and into the early 1990s, the U.S. began taking back control of the airspace over the Caribbean when the radar attached down looking balloons went up around Florida.[268] Intelligence reports note the "dramatic decreases in the amount of airborne drug traffic" after the first U.S. Southern border radar balloon deployed above

266 Defense Industry Daily Staff, "Time for TARS Along USAs Southern Borders," Defense Industry Daily, September 5, 2011, https://www.defenseindustrydaily.com/Time-for-TARS-Along-USAs-Southern-Borders-04973/.

267 Long, "CBP's Eyes in the Sky."

268 Ibid.

Fort Huachuca, Arizona in 1987.[269] Although holes in radar coverage persisted, use of military radar aircraft, i.e., P-3C, AWACS, helped to fill the radar gaps but are much more costly in their operation than radar balloons. The most critical factor TARS provided to border security is persistent "around-the-clock" surveillance.

The Department of Homeland Security has taken over the management and operation of the TARS program at the urging of Arizona Congressional delegation.[270] In 2011, the DoD ended its sponsorship of the TARS balloons said to be due to budgetary constraints.[271]

For all intents and purposes, the TARS program with the support of DoD aircraft has been effective in deterring low-flying drug trafficking aircraft along the border even if only to push the cartels back to land smuggling routes. Cartel narco-drones are challenging the capabilities of legacy TARS detection sensors because they are much smaller than the manned aircraft traffickers used in the 1980s and 1990s making detection and identification difficult when they are similar in size to birds. Although, the flight patterns of birds and drones are discernibly different which could help radar operators to identify narco-drone's flights in the border zone.

The TARS balloon's effectiveness at detecting aircraft degrades with bad weather and mountainous terrain.[272] In high winds the balloons must be brought down. The fact that commercial drones are not reliable in high winds either may cancel out the issue. However, balloon downtime due to weather or maintenance seems to be a problem in providing consistent radar coverage. In 1992, the balloons were only operational 59 percent of the time due to maintenance or defective parts and today the standard operational time for the TARS balloons is about 60 percent.[273]

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[269] Ibid.

[270] "DHS Takes Control of Arizona Border Blimp, Grounding it for Repairs," Homeland Security News Wire, August 20, 2013, http://www.homelandsecuritynewswire.com/dr20130820-dhs-takes-control-of-arizona-border-blimp-grounding-it-for-repairs.

[271] Ibid.

[272] Federation of American Scientists, "*Tethered Aerostat Radar System*."

[273] Ibid.; "Tethered Aerostat Radar System," Air Combat Command.

E. U.S. ASSISTANCE TO MEXICO'S RADAR CAPABILITY

The U.S. presumably is leading Mexico in developing radar technology for use along the border that can detect and track small aircraft that can fly low and slow. In a joint venture, the U.S. is assisting Mexico in upgrading its radar capabilities with three-dimensional long range (3DLR) and GM400 radars capable of real-time tracking of up to 2,000 targets. This technology transfer will undoubtedly require a level of cooperation between U.S. and Mexico border security agencies in detecting and tracking suspected drug smuggling aircraft in the border zone.[274] It is unclear if these new radars are capable of tracking relatively small targets like narco-drones. However, bilateral cooperation in the form of technology transfer between the U.S. and Mexico is a positive step for expanding detection *capability* in the border zone airspace. The detection capability could act as a deterrent to cartel narco-drones, even if the radars are unproven drone sensors.

Consistent, mobile and extensive radar coverage may be needed to detect drones because of the short detection and interdiction time window when a narco-drone. One hundred percent radar coverage on the border may not be economically feasible even if management of the radars is shared between DoD and DHS. On the U.S.–Mexico border, perhaps we need smaller, portable radar balloons that are not fixed to a ground station and well known to the drug cartels. CBP is testing the feasibility of smaller tactical aerostats that can be used for border security missions that were once DoD assets deployed around forward operating bases in Afghanistan.[275] There are three models of aerostats that could be considered the next generation of the existing TARS technology using automated. They are the Persistent Threat Detection System; the Persistent Ground Surveillance System; and the Rapid Aerostat Initial Deployment system.

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274 "Looking North: Enhancing Mexico's Radar Capabilities," Security Assistance Monitor, September 15, 2015, https://securityassistance.org/content/looking-north-enhancing-mexico%E2%80%99s-radar-capabilities.

275 Long, "CBP's Eyes in the Sky."

F. DRONE DETECTION IN URBAN AREAS

The airspace around critical infrastructures like airports is space where the government is trying to assert controls to mitigate hazards from rogue commercial drones that wander into restricted airspace, but not without challenges. The FAA's drone detection program is finding it difficult to ensure that drone detection and drone defense systems around airports do not interfere with or adversely affect air traffic services. For instance, drone jammers are designed to direct electromagnetic noise at radio frequencies drones use to disrupt radio communication between the rogue drone and the operator.[276] Moreover, any government instituted countermeasures deployed around airports must not violate statutes.

In 2016, Congress authorized funding towards "airspace hazard mitigation." Congress directed the FAA in consultation with the DoD and DHS to conduct a pilot program to ensure any new drone detection systems are developed and tested to not "interfere with safe airport operations, navigation, air traffic services, or the safe and efficient operation of the national airspace system."[277] The FAA began it is testing and detection research around large international airports, meanwhile the DoD conducted counter-drone testing as part of the annual "Black Dart" exercise at Eglin Air Force base in Florida.

Many of the drone detection issues that occur around airports are similar to problems the U.S. military observed during its testing exercises. Recently, the Army and DHS conducted a counter-drone exercise in New Orleans to test new drone detection systems. Mark Gibson, the FAA's senior advisor on drone integration, says "most of the Army systems encountered a lot of the same issues that we witnessed in our venues in and around airports, including radio frequency detection systems that were inhibited by line of

276 "Drone Defence: Jammers 101," DroneShield, January 14, 2017, https://www.droneshield.com/blog-content/2017/1/14/drone-defence-jammers-101.

277 FAA Extension, Safety, and Security Act of 2016, Pub. L. No. 114-190 Sec. 2206 (2016). https://www.congress.gov/bill/114th-congress/house-bill/636/text.

sight and also by interference in a highly dense [radio frequency] environment."[278] The U.S.–Mexico border has 14 major cross-border cities and towns that can be characterized as urban areas.[279] Infrastructure will be the most significant inhibitors to line of sight detection systems and radio frequency congestion. In the remote areas of the border zone, the most significant inhibitors to line of sight radio wave detection are natural barriers like mountains or valleys in the border zone landscape.

G. PASSIVE COUNTERMEASURES

The recent military sponsored counter-drone exercise known as 'Black Dart' is now publicized taking place annually, although the testing of counter-drone technology aimed at small drones is said to have started in 2002 under a veil of secrecy.[280] The indifferent defensive approach of shooting a drone out of the sky with a sniper rifle or machine gun, while somewhat effective, are taking a back seat to non-kinetic methods of defeating drones. We learned recently that a 3 million dollar Patriot missile could destroy a 200 dollar drone.[281] To restate the obvious, missiles are a cost-prohibitive solution for interdicting hostile commercial drones. Non-kinetic passive solutions for defeating narco-drones may be more affordable and safe options for defeating the drones used by the drug cartels. Non-kinetic is military vernacular for destroying or disabling drones by using other methods than bullets, missiles, or lasers.

The military has been testing counter-drone technology developed by an array of public-private companies since 2015 at their annual invitation-only drone countermeasure exercise. The purpose of the exercise is to test the latest drone countermeasure technologies for defense against hostile drones. A multitude of countermeasures are being vetted that

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[278] Bill Carey, "U.S. Military, Federal Agencies Join on Counter-Drone Efforts," Aviation International News, May 4, 2017, https://www.ainonline.com/aviation-news/defense/2017-05-04/us-military-federal-agencies-join-counter-drone-efforts.

[279] Sasha Trubetskoy, "Mexico's Urban Pileups," Sashat.me, December 14, 2016, http://sashat.me/2016/12/14/mexicos-urban-pileups/.

[280] Richard Wittle, "Military Exercise Black Dart to Tackle Nightmare Drone Scenario," New York Post, July 25, 2015, https://nypost.com/2015/07/25/military-operation-black-dart-to-tackle-nightmare-drone-scenario/.

[281] Chris Baraniuk, "Small Drone 'Shot with Patriot Missile,'" BBC News, March 15, 2017, http://www.bbc.com/news/technology-39277940.

step into the realm of science fiction, ranging from lasers and rockets aimed at destroying hostile drones to nets or jamming devices aimed to capture it.[282]

Many possible solutions are being presented at the most recent exercises using electronic jamming, radar, and control signals with the potential to detect, track, identify, destroy, or even take control of hostile drones.[283] Dave Bessey of SRC Inc., one of Black Darts most active participants, says his company believes in a layered approach to drone countermeasures. For Bessey, a layered approach first means a drone is detected by radar.[284] Then using electronic or jamming sensors, you differentiate a drone from other noise in the environment like birds. Next he says would be deciding if the drone is hostile. In a civilian environment in contrast to a war zone, determining hostile intent may be ambiguous among those in security professions. A drone that is smuggling narcotics may not meet the threshold for hostile intent. However, in controlled airspace or designated 'no drone zones,' intent may not matter when deciding to take down a drone or disrupt the controller signal.

Passive drone countermeasures seem to be more acceptable for law enforcement even though many types are still legally problematic.[285] New sensor technology like Spynel, a rotating mid-wave infrared camera that can be fitted to a tall tower, or drone-borne radars capable of detecting enemy drones are the next wave of drone detecting technology.[286] Drone detection systems like radars, radio wave sensors, and audio and optical sensors have less legal considerations than jammers and spoofers which may be a liability for law enforcement and border security. The problem is, defensive drone signal jamming and GPS spoofing can affect more than the target narco-drone.

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[282] R. Colin Johnson, "'Black Dart' Counters Drones," EE Times, August 11, 2015, https://www.eetimes.com/document.asp?doc_id=1327384.

[283] Ibid.

[284] Ibid.

[285] For discussion on legal considerations see "7 Big Problems with Counter Drone Technology (Drone Jammer, Anti Drone Gun, Etc.)," Rupprecht Law, last modified August 7, 2017, https://jrupprechtlaw.com/drone-jammer-gun-defender-legal-problems.

[286] Tucker, "Pentagon Urgently Pushing Anti-Drone Tech to ISIS Fight."

There is interest coming from border security officials as well as police departments throughout the United States in drone early warning systems, radio frequency jammers also known as geo-fencing, and GPS jammers; all of which can be classified as non-kinetic or passive drone countermeasures.

H. ACTIVE COUNTERMEASURES

Directed energy weapons built for radio frequency jamming and GPS jamming that can disrupt or destroy drones are already operational. Anti-drone companies like Battelle have developed and sold the Drone Defender, a handheld portable drone remote control and GPS jammer, to customers in both the Pentagon and Department of Homeland Security.[287] Defense contractor Rafael is introducing drone-killing lasers into their counter-drone defense platforms.[288] Although, some countries have found there may be no need to purchase costly high technology to stop criminal drones. Police in the Netherlands are using eagles to hunt and catch rogue drones that fly into restricted airspace.[289] Whether it be jammers, lasers, or eagles, the limiting factor for using active countermeasures like these will be the legality of the methods and the unlimited liability.

I. AERIAL DRUG INTERDICTION CAPABILITIES MAY BE DOOMED TO FAIL

In the 1980s, U.S. Customs and the Coast Guard would interdict aerial drug smugglers by using radar to detect suspicious aircraft and would then dispatch an intercepting aircraft to assess if the suspicious aircraft may be a drug smuggler.[290] Then a tracking aircraft would follow the suspect aircraft to its destination, after which a law

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287 Ibid.; Batelle, "Counter-UAS Technologies," accessed January 7, 2018, https://www.battelle.org/government-offerings/national-security/aerospace-systems/counter-UAS-technologies.

288 Rafael Advanced Defense Systems, "Rafael Offers South Korea Laser for C-UAV System," UAS VISION, October 20, 2017, https://www.uasvision.com/2017/10/20/rafael-offers-south-korea-laser-for-c-uav-system/.

289 "Dutch Police Use Eagles to Hunt Illegal Drones," PBS NewsHour, September 18, 2016, https://www.pbs.org/newshour/show/dutch-police-use-eagles-hunt-illegal-drones.

290 *Drug Smuggling Capabilities for Interdicting Private Aircraft Are Limited and Costly*, GAO GGD 89-83 (Washington, DC: Government Accountability Office, 1989), 4, https://www.gao.gov/assets/150/147877.pdf.

enforcement staffed helicopter would stop the suspect aircraft when it lands, detain the crew, and seize the drugs. Often Customs officers relied on intelligence from informants and prior investigations to plan these operations. This process is not feasible for narco-drones due to what could be prohibitive capability costs associated with traditional air interdiction procedures. Further, in the early days of private plane narcotics smuggling, the GAO found that while additional detection radars at the border may improve the detection capabilities, coverage will likely be inconsistent due to maintenance and weather.[291]

Today, just as in the 1980s, there are radar coverage gaps that drug smugglers exploit. Military assets like air surveillance aircraft have been a part of the solution to aerial drug smuggling for some time, at least since Congress passed the National Defense Authorization Act of 1989. Tactical aerostats that are mobile and operationally unpredictable to the drug cartels may help to deter cartel narco-drone use. CBP operates tactical aerostats similar to the one pictured in Figure 10 that vary in size in the border zone of South Texas and Arizona.[292] The limiting factor for deploying these tactical aerostats according to a GAO report is access to airspace, bad weather, and access to private property.[293]

[291] Ibid., 5.

[292] *Border Security: DHS Surveillance Technology, Unmanned Aerial Systems and Other Assets*, GAO-16-671T (Washington, DC: Government Accountability Office, 2016), 1, https://www.gao.gov/assets/680/677408.pdf.

[293] Ibid.

Figure 10. Persistent Threat Detection System (PTDS) balloons[294]

These systems carry a variety of sensors that evolved from balloon aerostats. RAID uses EO/IR sensors, radars, acoustic sensors that can detect specific sounds like gunshots. The purpose of RAID is to enable persistent and wide area surveillance, providing early warning of possible airborne threats among other intelligence-gathering purposes.

Figure 11. These sensor towers are part of the Rapid Aerostat Initial Deployment (RAID)[295]

294 "Persistent Threat Detection System (74K Aerostat)," Army Technology, accessed December 18, 2017, http://www.army-technology.com/projects/persistent-threat-detection-system-us/.

295 "Army Deploys 300th RAID Tower, Supporting Forward Base Protection by Persistent Surveillance and Dissemination System PSDS2," Defense Update, accessed December 18, 2017, http://defense-update.com/features/2008/november/231108_psds2_raid_sensors.html.

Small aerostats operate at altitudes ranging from 500 to 5,000 feet as opposed to the 10,000 to 14,000 feet operating altitude of the current TARS balloons in place.[296] Towers and lower altitude tactical radar balloons are presumably safer because they are not hazardous for larger passenger aircraft transiting through the airspace because they will typically fly higher than 5,000 feet. Radar balloons can be dangerous for general aircraft flying in the border zone because they communicate to ground stations over thick metal cables, and if a passenger aircraft hit one of these cables, the result can be tragic.[297]

Each tactical aerostat can fix to a geographical position or be a relocatable mast.[298] They are also equipped with radio repeaters that re-transmit radio communications from high altitude can boot Border Patrol's communication ranges in mountainous terrain or regions with poor reception.[299] In addition to a standard radar suite, the small aerostats and sensor towers host infrared as well as high-resolution cameras that can send immediate real-time imagery and video.[300]

296 Long, "CBP's Eyes in the Sky."

297 "Airship Tether Severs Cessna Wing, Killing Three," AOPA, accessed January 19, 2018, https://www.aopa.org/training-and-safety/air-safety-institute/accident-analysis/featured-accidents/airship-tether-severs-cessna-wing-killing-three.

298 Long, "CBP's Eyes in the Sky."

299 Ibid.

300 Ibid.

VI. CONCLUSIONS

The answer to the research question of what strategy can the Department of Homeland Security adopt to police the airspace of narco-drones requires a multidisciplinary approach because the hostile drone problem is complex and there are many unknowns regarding the trajectory of drone innovation. Hostile drones are a global, national, and municipal airspace security problem, and many State governments are beginning to take the threat of small hostile drones more seriously. Without narco-drone detection or interdiction data at the U.S.–Mexico border, it is difficult to say with certainty the scope of the narco-drone problem, however, instances of criminal drones and terrorist drones are becoming more common. Anti-drone countermeasures are now being tested around airports, military bases, and near federal prisons in light of criminal drone threats. Commercial drones are set to enter the National Airspace System of the United States very soon with many positive implications for a wide variety of industries. It is important to acknowledge that commercial drone technology and inherent threats continue to evolve, and like any new technology the utility is dependent on how the actors choose to employ them, but nevertheless government security agencies should be prepared for small hostile drones in the airspace.

A. THE THREAT

The threat of weaponized narco-drones is by all accounts concerning and probably the most compelling reason to aggressively develop and deploy drone countermeasures to the border zone. I looked at drones as smuggling tools, surveillance platforms, and as killing machines and found that the most evident narco-drone mission is narcotics smuggling, but the most significant threat DHS should plan for is weaponized narco-drones. The threat from weaponized commercial drones in the airspace has transitioned from being a novel threat to one of grave concern for both the DoD and DHS. The DoD's concern stems from intelligence assessments and encounters with Taliban and ISIS drones in the battle zones of Syria, Iraq, and Afghanistan.

Border security experts contend that narco-drones are more than drug mules, they are surveillance platforms. I found little hard evidence to support the claim that narco-drone counter surveillance is happening on a grand scale, but their assertions are logical given how drones are being used by terrorist organizations for reconnaissance against coalition forces. The suggestion that narco-drones are taking over traditionally human surveillance missions like that of the "lookout" makes sense given the tactical advantages drones provide. The trend is an indication that drones are capable of providing the same information as human lookouts, employing multi-axis high definition cameras that can surveil from a bird's-eye perspective which is advantageous for collecting tactical information on troop movements and border security personnel. It is sensible that the drug cartels, who have a history of adopting technology to perform surveillance in Mexico's border towns, would use commercial drones to gather intelligence on the border security officers that threaten cartel influence and operations. The trend is not surprising; U.S. drones have performed surveillance in the border zone for some time now. To suggest the drug cartels would use drones for surveillance is not as alarming as some might suggest. Drones are very capable surveillance platforms, in fact they are overwhelmingly manufactured for it, with cameras coming standard on many commercial models.

While 'narco-drone' has a narcotics smuggling connotation, future narco-drones encountered at the border may be not only smuggling vehicles, but also drones conducting counter-surveillance operations, and perhaps even targeted attacks on rival cartel members or U.S and Mexican border security personnel and infrastructure. I looked at open source news reporting and found evidence that commercially available "heavy lift" drones are the preferred narco-drones due to their payload capacity which is the highest in the small drone category. More payload capacity equals higher profits. Mexico's drug cartels are using heavy lift drones similar to the ones Amazon would use to deliver products to customers, although in this case they are used to smuggle narcotics over international borders. Initial reports of narco-drone interdiction cases on the border have shown that drones are capable drug mules that can yield healthy profits even with limited payloads. I argue narco-drone payload capacity is limiting the growth of narco-drone drug mules, although drone

technology innovation will lead to drones with greater engine power, which translates to more payload capacity, longer flight time, and greater flight range.

The high profit margins and relatively low weight of packaged cocaine and methamphetamine make them the most likely narcotics that narco-drones transport. Narco-drone use will continue as long as they are successful at delivering their payloads, even if they successfully deliver only most of the time. Moreover, narco-drones are virtually anonymous, making them ideal smugglers with low risk and high payoff potential. For these reasons, I argue narco-drone smuggling will increase in frequency, however, narco-drone smuggling is not the biggest threat to border security officers.

B. AIRSPACE CONTROLS

Since 2001, the U.S government has hardened border security by doubling Border Patrol personnel from 9,000 to 17,000, and doubling border security task forces charged with dismantling cartel operations on the border and defending against border incursions. Over 650 miles of fencing has been built, inspection and mobile surveillance units deployed, remote video surveillance systems put up, thermal imaging sensors and license plate readers implemented, yet airspace controls seem underdeveloped. The U.S—Mexico border is nowhere near 100 percent operational control. In fact, the metrics of operational control are so obscure that Congressional leaders have trouble articulating what operational control looks like. The oversimplified objective of controlling everything that comes in or out of the border zone is not feasible. Therefore, I argue that new border security measures should support building passive airspace detection systems on the U.S.–Mexico border to improve situational awareness regarding aerial drug smuggling as a means of operational control.

Tactical aerostats that are smaller and more mobile than legacy TARS balloons may be the preferred drone detection platform. Tactical aerostats deployment can be unpredictable to the drug cartels who often adapt their tactics to circumvent fixed border security infrastructure. Deploying mobile detections systems in mass will break the action/reaction cycle of aerial smuggling innovation that seems to happen in response to static border security measures. Further, the first step in gaining and maintaining operational

control, especially in the airspace, is having situational awareness. More passive detection systems on the border that promote airspace security are the most legally feasible countermeasures in the near term, that is until Congressional action allows for more active countermeasures to be deployed.

C. CARTEL INNOVATION

Cartel drone innovation will overcome many of the current limits of narco-drones, and drone tactics may change with advances drone engine performance, weatherproofing, and autonomy. Hybrid gas-to-electric drones provide a measurable improvement in drone engine performance, contributing to improved range, power, and payload capacity. Hybrid drones are an example of drone innovation that overcomes the current limits of battery powered narco-drones. Drone innovation is trending towards more examples of autonomous flight capabilities. Future narco-drones may not have human pilots in the control loop at all. GPS enabled drones that can navigate over long distances may become more prevalent in narco-drone tactics.

Drones are a rapidly growing industry in the United States and notably in Mexico where drug cartels may be benefiting from the influx of drone technology and drone manufacturing basing resulting from the rising market of consumption and a robust drone industry that is taking root in Mexico. Government regulation for constraining drone use is trailing domestic security needs in both countries, and current regulations and registration requirements are not enough to curtail criminal drone use. Commercial drone and counter-drone technology are growing industries in three primary segments of the market: consumer, enterprise, and government. The consequence of the proliferation of drone technology is prices are going down, and availability is going up. Business Insider's research center expects sales of drones in the United States alone to surpass 12 billion in 2021, up from 8.6 billion in 2016. Narco-drone incidents on the border are not going away anytime soon.

I looked at non-state actors like terrorist organizations in Iraq, Syria, and Afghanistan and their recent commercial drone innovations to understand what the implications are for asymmetric hostile commercial drone use. Some may balk at the notion

of comparing cartel organizational behavior with terrorist organizational behavior. There are clear lines of demarcation between the two groups, mainly what motivates the organization's actions, and how their values help to predict their use of drones. However, I argue these groups do share innovative ideas, albeit indirectly, and their behavior is similar in that they use violent acts at times to expand their group's influence and relative power. Moreover, these groups can learn from each other's successful drone tactics even if their goals are different. The weaponized drone found in Mexico is compelling as a data point highlighting the fact that drones as killing machines is not beyond the scope of what the cartels will do with their narco-drones to expand their influence and defend their supply chains.

As for the strategy to counter narco-drones, an observant student of the history of drug smuggling along the U.S.–Mexico border might conclude that government security measures and infrastructure investments are too reactive and often lag in the action/reaction cycle, perhaps making their efforts doomed to fail. The fact that the flow of drugs has not subsided but merely adapted in routing despite the incremental build-up over the years of radar capabilities, DoD drug interdiction assets, and border security personnel is eye-opening as to the real successes of these costly security measures. DHS is playing a cat and mouse game against a well-funded, motivated adversary in the drug cartels that isn't likely to be deterred or defeated by security measures alone. However, I argue doing nothing is not an option. Predicting what will follow narco-drone innovation is problematic for any security analyst. That is why I argue DHS should build a defense capability at the border that can do both homeland security and homeland defense missions in airspace monitoring, and the DoD should play a more prominent role to be cost effective.

D. COUNTER-DRONE STRATEGIES

In monitored areas of the southwest border, low-flying drug smuggling aircraft are tracked by legacy TARS balloons. However, those are now incapable of detecting small drones which have a similar radar cross section to that of a large bird. Past generations of radar detection systems do not have the fidelity to identify drones, classified as Low, Slow,

Small (LSS) targets. Higher fidelity radars that can detect, track and queue interdiction agencies are needed in the border zone.

A strategy for countering hostile drones discussed in this thesis is the layered defense approach. The layered defense approach is often implemented by security planners when thinking about ways to deter or defeat a dynamic technology threat. The layered approach is not necessarily the best approach for defeating narco-drones. However, it is a useful method to leverage multiple arms of government controls to counter hostile drones. The layered approach may be an efficient way to manage the narco-drone problem, with a combination of FAA drone regulations, as well as active and passive countermeasures. A layered approach could also mean pushing out border controls, adding time and space to the problem of detection and interdiction that is needed to deter or defeat narco-drones. The layered approach that seems to be the most prudent on the U.S.–Mexico border encompasses a combination of regulatory, passive, and active countermeasures coupled with cooperation among U.S. and Mexico border security agencies whose shared strategic interest is degrading the drug cartels who operate in the border zone.

In my view, drone regulations which limit drone engine performance, designate no drone zones, and mandate that small drones meet specific identification requirements to operate in the airspace, similar to manned aircraft, will have a positive influence for constraining future narco-drone proliferation. Identifiers like transponders, paint schemes, and anti-collision lighting are a few examples of aircraft identifiers that could help with the drone detection and identification problem.

Airspace security in the U.S.–Mexico border zone is a government responsibility. Government agencies like the FAA continue to explore as options to constrain hostile drone use. A few other approaches to develop defense in depth stand out in this thesis. First, is expanding the border zone by cooperating with Mexico's security agencies and sharing drone detection technology, whether coming from Silicon Valley or the military research enterprise and whereby building effective anti-drone tactics that benefit both countries. Narco-drones are a shared security problem and cooperating on this issue serves both the U.S. and Mexico's interests. Second, leveraging DoD aerial surveillance assets, i.e., tactical aerostats, to supplement Border Patrol's aerial surveillance radar infrastructure. The 2,000-

mile border is too vast for Border Patrol to perform the duties of airspace monitoring while at the same time carrying out interdiction operations. The unmonitored regions of the border zone are areas with minimal or no border security manning and limited surveillance technology, usually consisting of desert or mountainous terrain divided by the occasional service road. In these remote regions of the border, CBP does not have the equipment or officers to detect and interdict drones that operate below the radar and out of reach of law enforcement. According to a report by the Government Accountability Office, CBP relies on alert citizens in remote areas to fill the security gap which is not ideal or practical.[301]

The Department of Homeland Security may need assistance to cover the space. The DoD has a successful history starting in the 1980s in countering cartel narco-aircraft. I argue DoD's drone detection assets can be managed by U.S. Northern Command or perhaps NORAD whose missions include defense of U.S. airspace. DoD aerial surveillance aircraft influenced cartel smuggling operations in the 1980s by deterring the drug cartels use of smuggling aircraft. DoD aerial surveillance assets also provided greater situational awareness in the Caribbean which may have indirectly influenced cartel smuggling behavior. The final approach is leveraging counter-drone innovation from Silicon Valley, Defense research groups, and the militaries' research enterprise because multiple industries are driving anti-drone innovation and the government certainly does not have the monopoly on good ideas. I argue a strategy that leverages DoD detection assets, experience, and frankly opportunities to test anti-drone technology in real-world threat environments will help DHS to be more efficient at filling the security gaps in airspace monitoring in the border zone.

In looking at active and passive countermeasures, I found there are many promising options, ranging from high-technology solutions, i.e., lasers and jammers, to low-tech solutions of nets and drone hunting eagles. Passive countermeasures seem to be the most socially acceptable and legally feasible line of effort in the current state. Active countermeasure may not be necessary for the near term because the risk of attack by narco-

301 *Border Security: Security Vulnerabilities at Unmanned and Unmonitored U.S. Border Locations*, GAO-07-884T (Washington, DC: Government Accountability Office, 2007), https://law.utexas.edu/humanrights/borderwall/maps/gao-border-security-vulnerabilities-testimony.pdf.

drones to U.S persons or infrastructure is relatively low. Although, I suggest that the pace of drone innovation and the current threat of weaponized narco-drones is evidence enough to suggest anti-drone active countermeasure deployed to the border zone will be necessary in the future.

E. FUTURE RESEARCH

In my research findings, I present the narco-drone threat and implications, as well as few approaches to countering them. I described different types of passive and active drone countermeasures. I concluded that a layered defense approach that includes both active and passive countermeasures might be the most effective. Deploying a drone detection capability that includes mobile tactical radar aerostats that can improve situational awareness in the border zone airspace should be the first step. My conclusions raise questions about exactly how cartel narco-drones subvert border security infrastructure or how they could target security personnel. I suggest future researchers conduct a red team analysis of narco-drones vs. border security targets and test the countermeasures suggested here.

My research also found that Mexico is probably a necessary partner for building defense in depth in the border zone. Further exploration of regional security agreements with Mexico and the implications for future airspace defense cooperation is needed to answer the following questions: What regional security agreements have improved airspace controls; has security cooperation between the U.S. and Mexico degraded cartel technology innovation; What avenues of cooperation, either military-to-military or otherwise would be socially and politically acceptable to Mexicans and the Mexican government?

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