

## PEER-REVIEWED ARTICLE

# WHO OWNS THE SKY?

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### ABSTRACT

The Federal Aviation Administration's 2016 release of 14 CFR parts 107 and 101 has led to substantial growth in the UAS industry. While the regulations provide stringent requirements for airspace, altitude, and other operational restrictions, they fail to address several key issues associated with property rights. The authors use a blend of doctrinal research, reform-oriented research, and theoretical research methods to assess the convergence of common law concepts, statute law, binding administrative regulations and existing case law. The purpose of this paper is to formulate a doctrinal foundation to delineate the boundary between navigable airspace and vertical real property rights.

*Keywords:* Drones, Navigable Airspace, Property, Privacy, Surveillance, Transportation Security, Unmanned Aerial Systems (UAS), Small UAS (sUAS)

## **Problem**

The lack of foundational statute and case law creates a legal vacuum for determining where real property rights end and public, navigable airspace begins.

## **Purpose**

The purpose of this study was to assess common law concepts, statute law, administrative regulations and case law to formulate a doctrinal foundation to delineate a boundary between navigable airspace and vertical real property rights. The study sought to discover answers to the following research questions:

1. What legal rights/concepts, and laws, exist to aid in determining an appropriate boundary between private property and navigable airspace?
2. What aviation regulations are applicable to defining the boundary between private property and navigable airspace?
3. What factors should be considered in defining private property and navigable airspace boundaries?

## **Method**

This study utilized a qualitative approach. The authors employed doctrinal research, reform-oriented research, and theoretical research methods considering U.S. Congressional intent for UAS integration, the concept of ‘navigable airspace’, both legally and from a professional pilot’s perspective and the discussion of 18 distinct legal rights/concepts that could be contributory in establishing a legal boundary between private and publicly navigable airspace. As shown in Figure 1, these legal rights are grouped and discussed sequentially in five areas with the unique number of rights/concepts in the respective area shown in [brackets], as Rights of: a) Possession [3], b) Control [4], c) Exclusion [4], d) Enjoyment [5], and e) Disposition [2]. The authors assessed the potential implications of various transportation security, real property concepts and doctrines on the National Airspace System framework to assess common law concepts, statute law, aviation regulations and case law relevant to UAS law, property rights, and navigable airspace. The overall intent of the research is to catalog relevant issues for discussion and postulate a possible solution space.

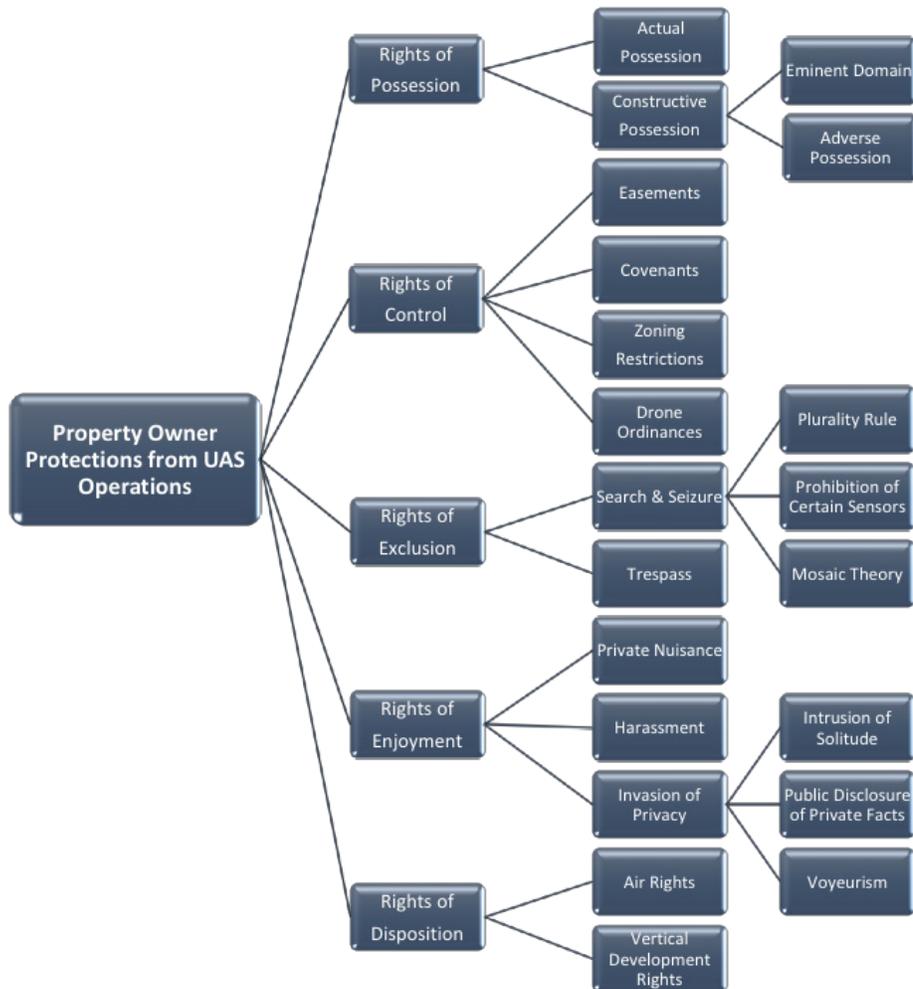


Figure 1. Concept diagram of property owner legal protections from unmanned aircraft operations.

It is worth acknowledging that some of the “common law” concepts with respect to various legal elements and caveats may vary from state to state, depending on how each State’s court has interpreted and worked these various concepts out; however, this manuscript reflects a more generalized/Federal review of some of the concepts (i.e. with respect to trespass, invasion of privacy, etc).

### Findings & Discussion

There are many recent and authoritative writings on the general subject of UAS/sUAS privacy, and the evolving nature of case law with respect to the UAS platform’s integration into the NAS and legal framework to include Carr (2013), Cash (2016), Kapnik (2012), LeighFisher (2017), Rule (2015, 2016), and Thompson (2015); however, none offer a summary recommendation or propose a structural solution to the issue(s) – that is the potential value of this research. Prior to discussing in detail the 18 assembled legal rights/concepts associated with privacy, three background perspectives are offered to set context.

## Congressional Intent for Unmanned Aircraft Integration

In 2012, Congress passed the Federal Aviation Administration Modernization and Reform Act (FMRA). Within the safety provisions contained under Title III, Congress articulated its intent for civil unmanned aircraft integration into the National Airspace System. Sections 331 through 336 charge the Secretary of Transportation with developing “a comprehensive plan to safely accelerate the *integration* [emphasis added] of civil unmanned aircraft systems into the National Airspace System” (FMRA, 2012, p. 64).

Recognizing the potential benefits of unmanned aircraft, Congress provided a provision under Section 333 to hasten approval for certain unmanned systems, contingent upon a satisfactory risk assessment executed by the Secretary of Transportation: “If the Secretary determines under this section [333] that certain unmanned aircraft systems may operate safely in the national airspace system, the Secretary shall establish requirements for the safe operation of such aircraft in the national airspace system” (FMRA, 2012, p. 67).

Congress also made under Section 333 a specific provision to protect model aircraft operations, strictly limiting curtailment of such operations. The FAA Modernization and Reform Act of 2012 clearly establishes Congressional commitment to *safely* and fully *integrate* unmanned aircraft systems into the existing national airspace system structure.

## Airspace: A Public Highway Through the Sky

The sky is the domain of aircraft, balloons, rockets, kites, and all sorts of other fantastical flying machines that mankind has yet to invent. The size and scope of domestic aircraft operations in the United States is staggering. According to the FAA (2016b), at least 7,000 aircraft are airborne throughout the National Airspace System at any given time. The NAS spans 5 million square miles and includes 19,299 airports. The NAS supports an average of 23,911 commercial flights transporting nearly 2.25 million passengers every single day. General aviation accounts for a further estimated 50,000 flight hours per day. A 2016 forecast by the FAA suggests that unmanned aircraft will become a substantially larger user of the NAS in the coming years; the administration expects the 1.9 million existing unmanned aircraft will top 7 million aircraft by 2020 (FAA, 2016a).

All of these aircraft operate in a domain of the sky commonly referred to as *navigable airspace*. The Air Commerce Act (1926) identified navigable airspace in loosely defined terms as “airspace above minimum safe altitudes of flight prescribed by the Secretary of Commerce under section 3, and such navigable airspace shall be subject to a public right of freedom of interstate and foreign air navigation...” (p. 574). Today, that definition is little changed; 49 USC 40102(a)(32) defines “Navigable Airspace” as “airspace above the minimum altitudes of flight prescribed under this subpart of subpart III of this part, including airspace needed to ensure safety in the takeoff and landing of aircraft.”

Codified in 49 USC 40103, the U.S. government determined that navigable airspace falls within the public domain as a medium for airborne transportation and commerce. The first criterion of navigable airspace is for aircraft to operate at a “minimal altitude to allow emergency landing in the event of an engine failure” (14 CFR 91.119(a)). With the previous (91.119(a)) caveat in mind, however, pragmatically the navigable airspace *highway* terminates at a floor of 500 or 1,000 feet AGL (Above Ground Level), depending upon the surface location congestion (14 CFR 91.119(b), (c)). Interestingly, the regulation fails to distinguish between a congested vs. uncongested area. A specific exception allows operations all the way to the surface if separated by at least 500’ (laterally) from any, “person, vessel, vehicle or structure” (14 CFR 91.119(c)). One might think of airports and other aerodromes comparable to *onramps* to this public transit system, thus, by definition navigable airspace also includes the protected areas defined by 14 CFR Part 77 as dictated by 49 USC 40103. It is logical that UAS operations around airports are restricted by 14 CFR 107 and 14 CFR 101.

These definitions of navigable airspace are nuanced with unique restrictions, as defined by the specific class of airspace in which an aircraft is operating. The FAA defines these airspace classes, using the designations A-G, excluding F. Until now, manned aircraft have enjoyed unchallenged dominance in low-level airspace.

## **Navigable Airspace Problem: A Professional Pilot's Perspective**

Beyond the definition of *Navigable Airspace* defined in 14 CFR 1.1 and the minimum altitudes prescribed in 14 CFR 91.119, the subject of who owns the sky and the corresponding floors of navigable airspace has historically not been a predominant discussion of concern in professional, commercial aviation; at least it has not been until the advent of UAS and in particular sUAS. The sanctity of the airspace surrounding air carrier airports to be free of UAS and sUAS is now of significant concern.

While possibly casually aware of 14 CFR 77, professional pilots do not need to be and are not concerned with the specificity of obstruction regulation contained there within. These regulations govern how high and how close to an airport an obstruction may be erected, thus protecting the approach corridors to airports and guaranteeing obstacle clearance. The regulations however, cannot guarantee that other aircraft including UAS or sUAS are not present in the approach corridor airspace.

Professional transport category aircraft pilots or corporate pilots do not operate low to the ground, other than that required for take-off and landing. The take-off and climb performance of jet aircraft and most turbo-prop aircraft is such that less than a minute is required to climb above 3,000 ft AGL. This altitude would be sufficient to clear almost any conceivable current civil UAS and sUAS operation. The amount of time professional transport category aircraft pilots or corporate pilots spend below 3,000 ft AGL during the landing sequence is also short, approximately 5-7 minutes depending on approach speed and associated rates of descent. All instrument approaches start at a defined point in space known as an Initial Approach Fix (IAF). IAFs are typically located at multiple points surrounding the airport of intended landing, approximately 15 NM away and at 3,000 ft AGL. From the IAF, the approaching aircraft proceeds on a prescribed descent profile to the beginning of the final glide path to the runway which formally starts at the Final Approach Fix (FAF). FAFs will consistently place an aircraft 5 NM from the airport at 1,500 ft AGL or higher and aligned with the runway.

The standard glide path in the U.S. is a 3° slope measured above the surface of the earth that starts at the FAF, from there a linear slope is followed so that 1 NM from the runway the aircraft is reliably at 300 ft AGL and in a stable position to land. Assuming a nominal approach speed of 120-140 KTAS (Knots True Airspeed), the total time spent below 3,000 ft AGL to reach the final descent slope at 1,500 ft AGL, typically does not exceed 3-5 min, with the final 2 min on the 3° glide path spent on approach to touchdown. Deviating below the prescribe descent profile or the glide path on approach is operationally unsound, judged as unprofessional, and if the aircraft's airspeed is also slow, simply unsafe. No professional pilot would consider purposefully placing their aircraft in jeopardy by taking such action.

The minimum safe altitudes prescribed in FAR 91.119 are operationally and essentially non-applicable to professional aviation. Given the objective of professional aviation is to transport passengers and goods efficiently, to do this requires the minimum time spent at low altitudes where fuel efficiency is dramatically reduced to that compared with higher, cruising altitudes. FAR 91.119 does have material, operational applicability to the General Aviation (GA) fleet, particularly the day-to-day operation of recreational, light, piston-powered aircraft that do not possess the climb/cruise performance of transport category or corporate jet aircraft.

Furthermore, virtually all scheduled commercial, for-profit passenger operations (FAR Part 121) operate in the Instrument Flight Rules (IFR) regime simply because to do so is predictable, dependable, safer and allows operations in restricted to no-visibility conditions. Every movement of the aircraft when operating IFR is charted, prescribed with a 3-D tolerance, and under the positive control of FAA Air Traffic Controllers (ATC). Additionally, the IFR system guarantees obstacle clearance and provides safe separation from other known air traffic. None of these assurances are guaranteed when operating outside of the IFR regime.

Operating IFR does not itself guarantee absolute safety; but it is significant to acknowledge the transport category fleet, which by in large operates exclusively IFR, enjoys an accident record in the developed regions of the world to include North America, Europe, and the Middle East which is exemplary. In the U.S. there has not been a loss-of-life accident from a U.S. air carrier in over eight years. There has never been in the history of aviation, in any region of the world, such a lengthy time period with no air carrier loss-of-life accidents (Aviation Safety Network, 2017; International Air Transport Association [IATA], 2016a; IATA 2016b).

Operations other than IFR are codified as Visual Flight Rules (VFR). While flight under the much less restrictive VFR can be accomplished safely, the risks are higher simply because the pilot must be able to see where they are going, their aircraft are typically much closer to the surface of the earth, closer to obstructions, closer to other aircraft, and are operating without the fore-knowledge benefit of who else is in the same airspace, or positive control from ATC. Both GPS precision and Automatic Dependent Surveillance-Broadcast (ADS-B) are significant navigation and situational awareness enhancements available for forward-fit or retro-fit to all aircraft; however, even the combination of these tools does not guarantee safe separation from other aircraft or obstacles. A small, and growing, portion of the GA fleet is equipped with both tools. A pair of ADS-B equipped aircraft can easily see each other in location and altitude but unless all aircraft, including unmanned, are nodes on the ADS-B network, the data presentation will be incomplete, thus raising the risk of in-flight collision.

The advent of UAS and especially sUAS in the airspace is of concern for two major reasons (a) the sheer proliferation potential of UAS and sUAS in the airspace—sUAS are significantly smaller, cheaper and much easier to operate autonomously, and (b) there is not yet a mechanism to formally integrate UAS (or sUAS) safely among piloted aircraft and particularly within the IFR system.

Especially at lower altitudes, below 3,000 ft AGL for UAS, and below 500 ft AGL for sUAS, the potential volume of new air vehicles competing for airspace is daunting. Simply considering the current corporate momentum and plans to commercially operate small parcel delivery with sUAS could greatly complicate safe separation between the parcel delivery sUAS and aircraft taking-off and landing at nearby airports. For these emerging UAS and sUAS reasons it is even more valuable for commercial piloted operations to transit through this lower altitude layer more quickly. The airspace immediately around airports and in the approach corridors to airports remains as the primary de-confliction concern between piloted and unpiloted aircraft.

## **Rights with the Potential to Determine Airspace Privacy Boundaries**

This discussion presents 18 distinct legal rights/concepts that could be contributory in establishing a legal boundary between privacy and publicly navigable airspace grouped in five areas a) Possession, b) Control, c) Exclusion, d) Enjoyment, and e) Disposition.

**Right of Possession.** Possession is a highly ambiguous term that in practicality seems simple but given a legal lens can become enormously complex. The Lectric Law Library suggests that “a person has possession of something if the person knows of its presence and has physical control over it, or has the power and intention to control it” (“Possession,” n.d., p. 1). Right of possession is conferred in title; in other words, the owner of the property has the *right* to possess it. It is important to note that the right of possession binds the owner not only to rights, but also to the obligations of the real property, such as property taxes, liabilities, ordinances, and other applicable legal considerations (“Bundle of rights,” n.d.).

The concept of possession is nuanced among many distinctions.

**Actual Possession.** (Legal right/concept #1) Actual possession is having “physical control or custody of an object” (“Actual possession,” n.d., p. 1). The owner of a house that is *actively living in the house* would be exerting actual possession of the building and its accompanying land. Comparatively, the owner of a second vacation or summer home does not exercise actual possession during the time they are not living there. This situation does not diminish the owner’s *right* to possess the second owned property, as they have knowledge of its presence and ability to physically control it, upon desire.

The concept of actual possession is reasonably clear when it comes to real property. Some examples of owners demonstrating actual possession include the owner’s physical presence upon the property, making property improvements, constructing structures, maintaining foliage, or making other uses out of the property’s surface area. The concept of actual possession becomes much more muddled when it comes to establishing actual possession over the vertical area above the property. How does one take *possession* of the sky above a property? After all, the sky cannot be practically cordoned off with a fence like surface property.

The most obvious methods to demonstrate actual possession of the altitude above a property is to lay claim to the area by the laying of some obstacle, barrier, or structure. In some ways this concept is not unlike early explorers laying claim to territory on the American continents by planting a sovereign flag, establishing colonies, and erecting fences around plots of land. The action provides clear evidence of possession, use, and control. Perhaps more pragmatically, an owner can build a structure upon the surface of a property extending vertically. Suppose a house is built to a vertical height of 30 feet, it would seem reasonable that the most airspace or sky a person could actually possess on the property would be that space within immediate reach of the highest point of the house. To extend the argument, suppose the owner planted a row of giant sequoias trees in his yard after purchasing a plot of property. When the trees reach maturity at 200-275 feet tall, does that then imply that the owner now possesses that altitude of sky? Perhaps an owner decides to place a 50-foot flagpole in their front yard. Does this action then claim the space at that vertical level because of the object's penetration into that area? Further, does the concept of airspace possession apply equally over a horizontal span of property? If a property owner owned 100 acres and the highest structure on the property is 100 feet tall, does the owner's airspace possession apply to the farthest reaches of the property where there are no vertical impediments?

Perhaps one of the most creative methods of actual possession stems from Kansas State University, which built a 60,000-square foot outside drone enclosure, which essentially amounts to netting suspended from a series of 50-foot posts (Mayerowitz, 2015). The university built the netted area to avoid FAA restrictions to drone operations in proximity to airports, since the agency's UAS restrictions do not apply if flown within an enclosure (Mayerowitz, 2015). The creation of this aerial fence, however, seems to be one of many possible mechanisms of taking actual possession of a property's vertical space.

The concept of actual possession of airspace is best defined by the notion of *containment* or *penetration* into the auspices of the vertical space. In some ways, this concept is best represented by a quote from Sitting Bull, "They claim this mother of ours, the Earth, for their own use, and fence their neighbors away from her, and deface her with their buildings and refuse" (as cited in Hammond, Hardwick, & Lubert, 2007, p. 33). After all, a structure or navigation impediment is a certain method of keeping airborne objects clear.

**Constructive Possession.** Constructive possession extends the concept of possession to include lawful possession or ownership. For example, allowing someone to make use of a vacation house while the owner remains in their primary home does not cause the owner to surrender their right to later actually possess the property. Under such an example, the owner is still deemed to have knowledge of the house and the ability to exert control of it, on demand ("Constructive possession," n.d.).

To a limited extent the courts have already addressed the possession question and determined that physically occupying airspace is not necessarily a requirement, thereby establishing *constructive possession* for the surface landowner. In fact, Sen. Dianne Feinstein recently proposed language in the Drone Federalism Act of 2017 that supports this notion. If passed, this bill would grant property the ability to control airspace within 200 feet of property structures (Drone Federalism Act, 2017). Unfortunately, constructive possession of airspace does not establish an impediment to entry, like actual possession. A *keep out* sign, after all, does not necessarily have the same effect as a barrier or fence around a surface property. Nevertheless, the deterrent effects of signage can yield compliance. It is likely that the posting of signage prohibiting, or restricting drone operations around real property would likely deter some operators. Eminent Domain and Adverse Possession are both subdivisions of Constructive Possession worth presenting in more detail.

*Eminent Domain.* (Legal right/concept #2) The U.S. government has established mechanisms for legally seizing control over a private citizen's real property. Known as *eminent domain*, this governmental power allows the taking of private property for public use, provided the property owner receives just compensation. ("Eminent domain", n.d.). Government entities at all levels flex this power regularly, known as a *taking*, to assume legal ownership and control of private real property for all manner of public uses. Eminent domain extends beyond merely land rights, but also includes air and water rights, as well ("Eminent domain", n.d.). In some cases, eminent domain is exercised before governmental use of the property, often to legally force an unwilling owner to sell his property interest. In other cases, a taking is determined after the fact, due to court finding that

the government illegally interfered in private property. In aviation, eminent domain is sometimes used to remove obstacles to safe air navigation, as well as takeoff and landing areas near airports. Additionally, a posteriori taking result near some airports where aircraft noise impinges on proximate property owners.

The precedence established in the *Causby* and *Griggs* cases leads to several fundamental conclusions (U.S. v. *Causby*, 1946; *Griggs v. Allegheny County*, 1962). Foremost, that real property owners are not in fact entitled to an unlimited extension of airspace, as originally envisioned by the Heaven to Hell Doctrine (Abramovitch, 1962). The potential adverse impacts to aviation, commerce, and legal ramifications make the argument not only impractical but outright untenable.

While it is possible for a real property owner to establish actual possession of the airspace above a property through *containment* or *penetration* of the space, the need to physically possess it is largely irrelevant. Both cases establish a firm adherence to the concept of a property owner's inherent right to a "superadjacent space" in so far as to ensure the owner's right to the freedom of enjoyment and use over their real property, in whatever capacity that may entail.

It is possible, but extremely unlikely that the government could use the eminent domain clause to restrict the vertical rights of property owners in deference to unmanned aircraft operators. It is possible, however, that property owners may find legal relief in an a posteriori court determination that a government entity effected a taking by allowing drone operations near or over private property. This is especially true if the operation adversely affected the owner's use or enjoyment of the property.

Alternatively, such a clause *could potentially* be used to restrict a private property owner's right to fly a drone on their own property. Use of eminent domain in this fashion seems unlikely, however, as it would be fiscally impractical in most cases to compensate private property owners for restricting use of their vertical space in this fashion. Governmental entities have far more effective and less expensive legal tools to facilitate such restrictions.

*Adverse Possession.* (Legal right/concept #3) Adverse possession is a form of hostile takeover of real property by an individual exerting actual possession without the right of possession ("Adverse possession", n.d.). Provided that the adverse possessor exhibits exclusive, actual possession of the real property in an open and notorious manner for a duration that exceeds the statute of limitations for legal removal by the owner, the title of the real property is legally—if not unethically—passed on to the adverse possessor ("Adverse possession", n.d.). Using the vacation home example, an individual could break into the owner's vacation home and take up notorious residence there. If the vacation home owner fails to legally eject the squatter within a timeline set by the statute of limitations, and the squatter exerts adverse possession over the property's title, the original owner could lose right of possession. Perhaps a more common example is a neighbor erecting a fence that physically occupies a portion of a landowner's property. This overt action, if not addressed by the landowner could eventually result in the encroaching neighbor assuming legal ownership of the new land.

To apply this example in an aviation context, suppose that the superadjacent space entitled to property owners under the *Causby* and *Griggs* cases, is regularly overflowed at low altitude by a helicopter or drone. Suppose that the landowner fails to make complaint, or take legal recourse against the offending aircraft or drone. In the same manner that surface property is assumed by a trespassing neighbor's fence, is it possible to extend the concept of adverse possession to the sky?

A rational argument can be made that low-altitude unmanned aircraft could engage in exclusive use of a property owner's superadjacent airspace in an open and notorious manner hostile to the owner's wishes for a duration that could exceed a defined statute of limitations.

The courts will likely be required to weigh in on this question, as some might argue that such an intrusion to the superadjacent space is an encroachment rather than adverse possession. Findlaw describes an encroachment as "when another person puts up a structure that intrudes on (or over) your land" ("Encroachment," n.d., p. 1). An example of an encroachment is a tree that extends over a neighbor's property line. Similarly, if a neighbor erects a structure that

impinges on a neighbor's property, like the earlier described fence, that action could also represent an encroachment. Failure to address encroachments *can* lead to adverse possession claims, but not always so. Despite the notorious invasion of the neighbor's property, the courts have found that certain encroachments, such as vegetative overgrowth, do not rise to the level of adverse possession (Jones v. Wagner, 1993).

**Right of Control.** The right of control is the freedom of a property owner to make use of the owned property in any *legal* manner he sees fit ("Bundle of rights," n.d.) and can be exercised through easements, covenants, zoning restrictions, or state/municipal legislation.

**Easements.** (Legal right/concept #4) In certain circumstances, however, use of real property is restricted through the placement of easements. Burton's Legal Thesaurus describes an easement as ("Easement," n.d.):

The right of to use the real property of another for a specific purpose. The easement is itself a real property interest, but legal title to the underlying land is retained by the original owner for all other purposes. Typical easements are for access to another property...for utility or sewer lines both under and above ground, use of spring water, entry to make repairs on a fence or slide area, drive cattle across, and other uses. (p. 1)

One unique type of easement is imposed on properties that adversely affect aviation operations, such as those that could pose an obstruction, navigation hazard, or wildlife issue (Strauss, 2012). Unlike traditional easements that generally restrict the use of property on the surface or subsurface, easements for aviation called *aviation easements*, restrict an owner's use of airspace or limits certain activities that *could* adversely affect nearby airspace. "An aviation easement is a property right acquired from a landowner which protects the use of airspace above a specified height and imposes limitations on the use of the land subject to the easement" (Strauss, 2012).

The establishment of specific aviation easements for unmanned aircraft are impractical considering the decentralized nature of such operations. As a result, the impetus from the Federal Aviation Administration would likely be to push the floor of navigable airspace lower than the existing 500-foot [uncongested]/1,000-foot [congested] levels. While not necessarily an easement in name, such an action would be an easement in deed. Reducing the defined floor of navigable airspace essentially sets a nation-wide easement for the benefit of unmanned aircraft operators and to the potential detriment of property owners.

**Covenants.** (Legal right/concept #5) Covenants are binding agreements that contain restrictive or beneficial stipulations related to land development or use, and are often used in the establishment of certain types of neighborhoods ("Covenant," n.d.). "Courts enforce such covenants provided they benefit and burden all property owners in a neighborhood equally" (Covenant, n.d., p. 1).

It is likely that some managed neighborhoods, such as those governed by a homeowners association, may begin enforcing policies restricting drone use. According to Sleeth (2014), homeowners associations can restrict drones operating in common areas, and establish time or use restrictions. This authority is limited to the property owner, whereon such restrictions are levied. Such restrictions would be largely unenforceable against non-property owners, unless they are agents or acting on behalf of the property owner. Consider the possibility of an insurance adjuster using a drone to survey the roof of a homeowner. It is possible that the homeowner's association may consider the adjuster as an agent, or extension of the homeowner and acting under his authority. It is possible that the association could use such an event to fine or otherwise punish the homeowner for his covenant violation.

**Zoning Restrictions.** (Legal right/concept #6) Zoning restrictions allow municipalities to control property development within their purview. Generally, zoning restrictions are used to separate residential, commercial and industrial areas of a municipality by structural criteria such as size, height, and property use. Zoning regulations apply to both existing structures as well as future developments ("Land Use," n.d.). While a powerful tool to control property development, zoning restrictions can sometimes run afoul of the U.S. Constitution's *Taking Clause*, codified in the Fourteenth Amendment. "Courts have held that a zoning regulation is permissible if it is reasonable and not arbitrary; if it bears a reasonable and substantial relation to the public health, safety, morals, and general welfare, and if the means employed are reasonably necessary for the accomplishment of its purpose ("Land Use," n.d., p. 1).

“Zoning law rests upon the notion that, like a ‘pig in the parlor instead of the barnyard’ certain land uses may be perfectly acceptable in some locations within a city and yet be prohibitively disruptive in others” (Rule, 2016, p. 137). Rule (2016) suggests that “some municipalities might find it beneficial to adopt drone zoning ordinances that specifically restrict where, when, and under what conditions civilian drones may fly within their jurisdictions.” Rule (2016) claims that state and municipal governments are more knowledgeable in the unique qualities of their jurisdictions and could implement local restrictions more effectively than the Federal Aviation Administration. A number of municipalities have implemented such drone ordinances or zoning restrictions.

**State Legislation & Municipal Drone Ordinances.** (Legal right/concept #7) Recognizing the potential threats drones pose to community safety, security, and privacy, some states and municipalities have adopted drone restrictions or ordinances, prohibiting, limiting, licensing, or otherwise curtailing drone and model aircraft flight within their jurisdictions.

According to the Syracuse University Institute for National Security and Counterterrorism’s (n.d.) Domesticating the Drone Project, 47 states and 40 municipalities have proposed or enacted UAS legislation.

**Right of Exclusion.** A property owner’s right of exclusion allows him to make a determination about who may or may not enter his property. With the exception of legal allowances for property entry granted under easements or warrants, property owners enjoy the right to forbid or expel individuals from their owned land (“Bundle of rights,” n.d.). The right to exclusion falls under two basic doctrines, the concept of governmental *search and seizure* under the Fourth Amendment, and tort *trespass*.

**Search and Seizure.** Unmanned aircraft are quickly being added to the arsenals of police departments across the nation as an additional investigative and enforcement tool. According to West’s Encyclopedia of American Law (n.d.), search and seizure are the investigative actions taken by law enforcement to acquire evidence or corroboration of a crime by taking possession of property for examination. Arbitrary intrusions by law enforcement are prohibited under the U.S. Constitution’s Fourth Amendment (1791).

*Plurality Rule.* (Legal right/concept #8) Two cases overview law enforcement’s authority precedent to over-fly property while conducting unwarranted investigations.

In the 1986 case of *California vs. Ciralolo*, police officers received an anonymous tip that defendant Dante Ciralolo was growing marijuana on the backyard of his premises. When officers attempted to investigate the validity of the tip from outside Ciralolo’s property, they were visibly obstructed by two concentric fences surrounding the suspected weed grow (California v. Ciralolo, 1986; Falcone, 1987). To further their investigation, the officers elected to rent a private aircraft to attempt to observe the contents of the backyard enclosure from the air. Their aerial investigation validated the presence of the marijuana grow, which they documented using a camera. The sworn testimony of the officers and accompanying photo was used to secure a search warrant, leading to the arrest of Ciralolo and seizure of 73 marijuana plants. Ciralolo unsuccessfully filed a motion to suppress the evidence used to secure the warrant on the grounds the aerial investigation constituted an illegal, unwarranted search of his property under the Fourth Amendment. The California Appellate Court reversed Ciralolo’s conviction, but was later overruled by the U.S. Supreme Court which reinstated the original court’s conviction. In a closely contested decision, the Supreme Court iterated that the “Fourth Amendment does not require police traveling on public airways at 1,000 feet [the FAA’s floor of navigable airspace over congested areas] to obtain a warrant in order to observe things visible to the naked eye” (California v. Ciralolo, 1986, p. 1365).

In a similar 1989 Florida case, Michael Riley was growing marijuana in an enclosed structure near his Pasco County home. Like in the Ciralolo case, Riley’s home and the structure containing the marijuana grow was enclosed by fencing, obscuring the view of the illegal plants from the ground. A Florida sheriff’s deputy received an anonymous tip of the grow and flew aboard a helicopter to gain an aerial view of Riley’s property (Florida v. Riley, 1989). Flying at 400 feet AGL and using a telephoto lens, the deputy was able to observe the marijuana grow through missing roof panels of the greenhouse. The deputy secured a search warrant for the premises, based on the evidence observed during the aerial investigation. Riley moved to suppress the evidence discovered by the deputy on the notion that the greenhouse was within the curtilage of Riley’s home and therefore, he had a reasonable expectation of privacy. The case elevated through the court system to the U.S. Supreme Court, which reversed the decision of the lower court,

thereby determining that even activities occurring within proximity to an individual's home are subject to aerial observation (Ebsary, 1989).

The Riley case established the *plurality rule*, which in essence permits legal, warrantless law enforcement observations of private property, provided such observations are conducted from a public vantage point (Rule, 2015).

*Prohibition of Certain Sensors.* (Legal right/concept #9) One case which runs contra to the Ciraolo and Riley judgments is the *Kyllo v. United States*. This case examined the legality of law enforcement viewing a home from a public perspective, using specialized Forward Looking Infrared (FLIR) technology. Officers viewed Kyllo's home with a FLIR device to record above normal heat loss from an area of his private home (*Kyllo v. U.S.*, 2001). The FLIR technology revealed areas of heat emitting from Kyllo's house, and the findings were used to justify the arrest and conviction of Kyllo in a marijuana grow operation within his residence. In *Kyllo v. United States*, the Supreme Court ruled the use of FLIR technology to view the exterior of a private home was in fact a warrantless search and violated the Fourth Amendment. In a five-to-four decision, The Supreme Court wrote,

Where, as here, the Government uses a device that is not in general public use, to explore details of the home that would previously have been unknowable without physical intrusion, the surveillance is a search and is presumptively unreasonable without a warrant. (*Kyllo v. United States*, 2001, para. 22)

Most drone operators do not make use of FLIR technology, but it is readily available for the public to install and use onboard sUAS, and is typically used by thousands of manned law enforcement aircraft as well as sUAS owned by law enforcement agencies.

In consideration of the rapid expansion of sUAS technologies a burgeoning dynamic is evolving with regards to the Fourth Amendment to the Constitution. This is particularly applicable to the law enforcement community, but will most likely have implications to the general sUAS community at large.

*Mosaic Theory.* (Legal right/concept #10) In consideration of sUAS and surveillance of the public by individuals or law enforcement an interesting concept of what constitutes a search was decided by the U.S. Supreme Court known as the Mosaic Theory. The Mosaic Theory comes from a Supreme Court's decision on GPS surveillance, *United States v. Jones* when considering if a series of actions by a government entity, as a whole, constitute a search when on an individual basis or in isolated steps they would not constitute a search (Kerr, 2012). Thus, the 'mosaic' in this case is a practical application of the phrase, "the whole exceeds the sum of its parts". A unanimous opinion of the Supreme Court stated a GPS surveillance over an extended period (28 days in this case) was in fact a search under the Fourth Amendment. If one would consider the ruling by the Supreme Court in GPS monitoring it is easy to see how this conclusion may follow sUAS surveillance for extended periods of time and it would be applicable to the reasonable expectation of privacy under the Fourth Amendment.

Law enforcement capabilities have greatly increased with the addition of sUAS in concert with evidence collection and surveillance. Using applications, such as Light Detection and Ranging (LIDAR or LADAR), FLIR, and automated license plate readers have greatly enhanced law enforcement abilities to detect and prevent criminal activities. The mosaic theory may apply to extended surveillance by sUAS in law enforcement investigations and will likely be new case law in the future.

While these cases ultimately determined the legality of Fourth Amendment aerial searches, they indirectly highlight the high court's increasing deference towards public access over private ownership of low-level U.S. airspace. Rule (2015) cites Justice Brennan's dissenting opinion in the Riley case as a warning of the impingement upon property owner's rights:

Imagine a helicopter capable of hovering just above an enclosed courtyard or patio without generating any noise, wind, or dust at all—and for good measure, without posing any threat of injury. Suppose the police employed this

miraculous tool to discover not only what crops people were growing in their greenhouses, but also what books they were reading and who their dinner guests were. Suppose, finally, that the FAA regulations remain unchanged, so that the police were undeniably “where they had a right to be.” Would today’s plurality continue to assert that “the right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures” was not infringed by such surveillance? Yet, that is the logical consequence of the plurality’s rule... (p. 173-174)

It would appear Justice Brennan’s fears have come to fruition. In 2013, Florida WKMG TV released footage of a multirotor UAS that captured nearly 2 hours of footage that included coverage near an apartment window, and hovering over an unaware female sunbather (Watson, 2013). Some encounters are even more invasive. An unsuspecting Seattle apartment dweller called police after recognizing a drone peering through her 26th floor window when she was undressed (Bradwell, 2014). Yet another anecdote comes from New York Times contributor Nick Bilton, who was at first unconcerned about privacy threat posed by drones--until being startled by a buzzing noise outside his home office and coming face-to-face with an intrusive camera-equipped drone staring back. Such reports are not necessarily common, but are widespread across the country (Bilton, 2016).

*Trespass.* (Legal right/concept #11) A violation of an owner’s right to exclusion or expulsion is known as a *trespass*. The seminal drone trespassing case involves the encounter between Kentucky residents John Boggs and William Merideth. During the encounter, Boggs had flown his drone approximately two minutes at an altitude around 200 feet AGL while operating in class G airspace. Merideth then used a shotgun to down the craft, alleging Boggs was digitally recording his daughter while hovering over his property (Boggs v. Merideth, 2016). Merideth was criminally charged with felony wanton endangerment and criminal mischief, which were later dismissed in Kentucky district court. Despite a property owner’s right to exclusion, this dismissal is somewhat surprising, as the courts have generally frowned on reverting to *self-help* strategies—particularly engaging overflying drones with weapons.

In a subsequent filed lawsuit, the attorneys for plaintiff and drone owner John Boggs assert their client was operating his drone in navigable airspace and suggest the key issues arising from the case as (Boggs v. Merideth, 2016):

...the resolution to a substantial question of federal law, to wit, the boundaries of the airspace surrounding real property, the reasonable expectation of privacy as viewed from the air, and the right to damage or destroy an aircraft in-flight, in relation to the exclusive federal regulation and protection of air safety, air navigation, and control over national airspace. (p. 2)

The clear conflict between federal and state law lies at the heart of case. To his credit, Boggs was operating his drone legally within the confines of FAA rules, albeit at low altitude. Unfortunately, state and federal law are decidedly silent on the concept of aerial trespass, leaving a critical legal void in establishing clear precedent moving forward. In early 2017, Judge Thomas Russell dismissed the tort claim against Merideth, citing that federal court was not an appropriate venue for the case (Farivar, 2017).

In a similar November 2014 case, drone pilot Eric Joe was flying his custom-made hexacopter over his parent’s walnut orchard in Modesto, California. The neighbor property owner, Brett McBay, allegedly had his son fire at the drone with a shotgun, causing the craft to crash on McBay’s property (Archambault, 2015; Joe v. McBay, 2015). In his defense, McBay stated in court that “he only wanted peace and quiet in his neighborhood” (Archambault, 2015, p. 1).

Unfortunately, existing trespassing laws do not extend to aerial invasions, however, some relief may be granted under other laws, such as those in place to avert certain intrusive behaviors that could affect an owner’s rights to the peaceful enjoyment and use of their property.

**Right to Enjoyment.** The right to enjoyment entitles a property owner to participate in legal, pleasurable activities while on his property (“Bundle of rights,” n.d.). The right to enjoyment for real property owners is fundamental and foundational to all other property rights; moreover, legal precedent elevates the importance of this right among the bundle of rights. This supremacy was clearly reflected in the seminal *Causby* and *Griggs* cases.

**Private Nuisance.** (Legal right/concept #12) According to West’s Encyclopedia of American Law (n.d.), a *private nuisance* is:

...an interference with a person’s enjoyment and use of his land. The law recognizes that landowners, or those in rightful possession of land, have the right to the unimpaired condition of the property and to reasonable comfort and convenience in its occupation (p. 1).

Nuisances are legally distinctive from trespasses, in that a nuisances are disturbances upon the occupants of property whereas trespasses are invasions upon said property. Property occupants must generally encounter an *unreasonable, substantial interference* benchmarked by measuring the disruption, based upon “ordinary member of the community with normal sensitivity and temperament” (“Private Nuisance, n.d., p. 1).

It would likely be difficult to argue that a drone presents a private nuisance, as many unmanned aircraft platforms are virtually silent and unobtrusive when operating at altitude.

**Harassment.** (Legal right/concept #13) According to U.S. Legal (2016), *harassment* is defined as “a course of conduct which annoys, threatens, intimidates, alarms, or puts a person in fear of their safety” (p. 1). Harassment includes a wide variety of behaviors that causes an individual to fear for their safety or creates a hostile environment (“Harassment,” 2016).

It is likely that harassment laws could be relatively easily adapted to deal with unwanted drone operations. The relatively low violation standard creates an ideal avenue for making this tort complaint.

**Invasion of Privacy.** An *invasion of privacy* is a tort law that protects against an intrusion on an individual’s private life (“Invasion of privacy,” n.d.). Under this element of law, an invasion occurs when a perpetrator infringes on the privacy of another when that individual had a reasonable expectation of privacy.

**Intrusion of Solitude.** (Legal right/concept #14) This subcategory of privacy invasion addresses a physical intrusion upon an individual’s private life. Some examples of this behavior may include: peeping, surveilling an individual, or taking non-consensual photos of video a person (“Invasion of privacy,” n.d.).

In August 2016, 65 year-old Jennifer Youngman engaged a drone flying over her property in northern Virginia. She reportedly saw two men setup a card table in proximity to her property, after which she heard a drone overhead. According to Youngman, she believed the men flying the drone were members of the paparazzi attempting to gain a glimpse of her celebrity neighbor, Robert Duvall. Youngman further admonished the drone pilots, saying, “the man [Robert Duvall] is a national treasure and they should leave him the [expletive] alone” (Farivar, 2016b, p. 1). The county sheriff’s office reportedly had no record of the incident (Farivar, 2016b).

**Public Disclosure of Private Facts.** (Legal right/concept #15) This infraction occurs when an individual distributes offensive personal information about another and such information falls outside of the reasonable scope of public records, public concern, or public interest (“Invasion of privacy,” n.d.). The California legislature passed additional privacy legislation in 2014 to curb such offenses committed by drone operators, after receiving complaints from notable celebrities such as Miley Cyrus and Kanye West (Niland, 2015).

**Voyeurism.** (Legal right/concept #16) Voyeurism involves the capturing of images or video of selected private areas of the human body without the individual’s consent, provided that individual had a reasonable expectation of privacy (“Voyeurism,” n.d.).

A Utah couple was arrested following a December 2016 incident in which a man noticed a quadcopter drone flying outside his bathroom window. The victim tracked the flying drone to a nearby parking lot. The victim was able to review the captured images and video on the device’s memory card, which revealed several people in various areas of their homes (Schladebeck, 2017; Reavy, 2017).

While a number of existing laws protect a property owner's right to peaceful enjoyment, it is likely that this aspect of property rights will most heavily influence future drone policy. The prospect of unwanted aerial surveillance on the private sanctuary of one's home--especially if such intrusions breach the intimate parts of private, daily life--are likely to generate a strong public impetus for further curtailment of non-commercial drone operations.

**Right of Disposition.** The Right of Disposition allows property owners to transfer ownership of property to other parties, so long as the owner fulfills lien obligations ("Bundle of rights," n.d.). In many cases, the value in the transfer of real property is not only in the surface rights, but also in the vertical space those surface rights provide.

**Air Rights.** (Legal right/concept #17) The concept of *air rights* is a unique byproduct of aviation, whereby owners of surface property exert ownership of airspace below public, navigable airspace. In essence, this concept was initially solidified by the ruling in *U.S. v. Causby*, but has since evolved into a unique new stratum of vertical ownership. According to Schwartz (2015), "It is important to note, however, that while one may own the non-navigable airspace above one's property, local zoning and land use regulations may make it impossible or expensive to utilize such airspace in development" (p. 2).

**Vertical Development Rights.** (Legal right/concept #18) *Vertical development rights* refer to the commoditization of air rights, based on the notion that such rights are severable from the surface property and transferable to other parties (Schwartz, 2015). Usually applicable only in large cities, the concept is designed to creatively bypass municipally-established vertical zoning limitations. This allows low-story buildings that have excess air rights or more available space to build vertically, to transfer those rights to other building projects, allowing them to additively build beyond the scope of their own available air rights.

For example, if buildings in a certain area are permitted to be 10 stories, a low level 3-story building can forego adding an additional 7 floors and instead transfer its air rights to a development project allowing it to rise 7 additional floors beyond its inherent zone limits.

Such development rights allow cities to control height zoning in aggregate, while still permitting individual buildings to exceed requirements, based on their acquisition of development rights. Incidentally, allowing this practice also alleviates municipalities from most lawsuits arising from a government taking claim (Schwartz, 2015)

This concept of air rights provides credence that surface property owners do exert a level of authority of airspace above their property, regardless of whether or not it is currently used.

## Conclusions

### Research Question 1

*What laws exist to aid in determining an appropriate boundary between private property and navigable airspace?* – Researchers identified 18 distinct, existing legal rights/concepts that may be contributory in determining an appropriate boundary between private property and navigable airspace. Each of these rights/concepts, grouped in five are as, were discussed and presented in hierarchal form in Figure 1.

### Research Question 2

*What aviation regulations are applicable to defining the boundary between private property and navigable airspace?* – The existing definition and altitude delineation between navigable and non-navigable airspace primarily stems from 14 CFR 91.119, whereas the floor of navigable airspace is pragmatically limited to 500 feet AGL over uncongested areas, and 1,000 feet AGL over congested areas. Additionally, navigable airspace is considered to be defined in proximity to airports, to include airspace needed for safe takeoff and landing of aircraft, as defined by 19 USC 40103, and established by 14 CFR Part 77.

An argument can be made that navigable airspace should also include the environment in which the FAA regulates aircraft, which would then include the space below 400 feet AGL, as identified by 14 CFR 107.51(b). While the hobbyist rules do not specifically address altitude limitations in 14 CFR 101, both 14 CFR 101.41(d) and 14 CFR 101.43 charge model aircraft operators to not interfere with manned aircraft and to not endanger the National Airspace System.

### Research Question 3

*What factors should be considered in defining private property and navigable airspace boundaries?* – A myriad of legal factors must be weighed to determine where the legal vertical boundary between navigable airspace and private property should lie. Some considerations include:

- General usability of airspace beyond the barriers of physical structures of constructions and reasonable vertical extent of property rights.
- Monetary property interests in vertical property development.
- Potential impact to property owner safety and security.
- Property owner freedom from obtrusive private interference or government search and reasonable expectations of privacy
- Reasonability of restrictions levied upon UAS operators to avoid overly-burdensome compliance methods or stifled industry growth.

## Recommendations

### Policy Options

Three approaches exist to adequately address issues associated with property rights and unmanned aircraft operational freedom:

**Redefine Navigable Airspace.** Perhaps the most obvious option to solve the evolving legal conundrum between real property owners and UAS operators is for the Federal Aviation Administration to specifically define navigable airspace in 14 CFR 1.1 to include low-level UAS operating altitudes. A clearly defined boundary would ideally suit all stakeholders.

**Define appropriate operating proximity to people and structures.** In similar parlance to operating limitations codified in 14 CFR 91.119(c), the Federal Aviation Administration could define appropriate UAS operating limitations relative to proximity to persons or structures. Although this method of regulation does not wholly conclude the private property rights conflict addressed in this paper, it would likely mitigate the impetus of the original problem.

**Refine Existing/Establish New Legislation & Regulations.** While not a rapid solution, the application of law often evolves with technology over time. Through ongoing judicial cases, precedent becomes established to adapt the applicability and enforcement of existing laws to new technologies, such as unmanned aircraft.

Generally, it is good practice for communities to enforce existing laws rather than rush to create new ones. The predominant preference of many communities is to immediately establish new legislation and restrictions on unmanned aircraft operations. While responsive, this method may have unforeseen consequences, such as the stifling of industry growth. Communities should carefully weigh the need to protect public safety with the impacts of UAS regulation and restriction.

### A Measured Approach

While it may take years for appropriate regulation, legislation, and case law to catch up with the legal challenges associated with evolving unmanned aircraft technology, several notable themes emerge. Within the scope of this research, three key stakeholders can be identified, as identified in Figure 2: property owners, UAS operators, and governmental regulators. With regard to unmanned aircraft, property owners are concerned with the maintenance of their rights, particularly their rights to private enjoyment, control, and exclusion. Conversely, UAS operators are concerned with maintaining freedom of operation, allowing maximum flexibility in which to perform commercial or recreational activities with their platforms. Finally, government—holistically at the federal, state, and local jurisdictions—has a duty to protect its citizens from harm, resulting from UAS technology, as well as maintaining the rights of both property owners and UAS operators.

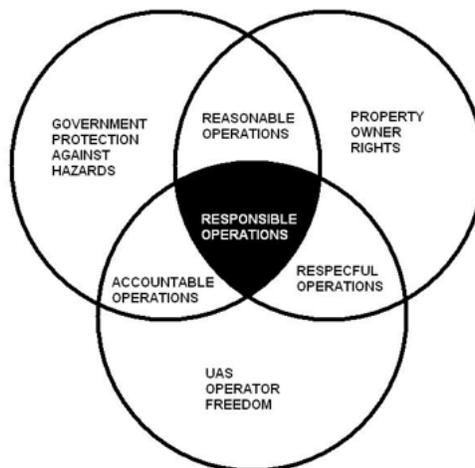


Figure 2. Venn diagram of key stakeholder interests in UAS regulation and legal restriction.

The interaction between each of these respective stakeholders yields an idealistic, philosophical approach to unmanned aircraft operations. Remote pilots have a duty to operate their UAS craft in a manner that respects property owner’s established rights. Similarly, property owners should accept the use of unmanned aircraft in a sensible proximity to their property, in much the same way that owners have come to accept overflying aircraft, street traffic, and other normalized activities. Governmental entities serve as the mediator between the disparate goals of property owners and UAS operators, ensuring that regulation and legislation creates accountability for UAS operators, while preserving their ability to operate in a reasonable fashion proximate to private property. In balance, these philosophical approaches lead to an idealistic goal that merges the needs of all three stakeholders known as *Responsible Operations*.

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