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CIVILIAN DRONES AND INDIA'S REGULATORY RESPONSE

Ananth Padmanabhan

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He has authored India's leading treatise on intellectual property rights, *Intellectual Property Rights: Infringement and Remedies* (LexisNexis, 2012), and a number of book chapters, including chapters in the latest edition of *The Oxford Handbook of the Indian Constitution* (Oxford University Press, 2016). He is a regular contributor to leading Indian newspapers, including the *Indian Express* and *BusinessLine*.

Previously, Padmanabhan practiced law in the Madras High Court, and taught at various institutions, including the National Law University, Jodhpur, and the National Law School of India University, Bangalore. He holds a master's degree in law from the University of Pennsylvania Law School and is currently enrolled in the school's doctoral program on a nonresident basis.

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Summary

Unmanned aerial vehicles, also known as UAVs or drones, have decentralized airspace access, allowing agriculturists, construction workers, and other civilian users to integrate aerial monitoring into their daily work. This technological revolution comes with a set of concerns, impinging as it does upon the proprietary, reputational, and security interests of individuals. An appropriate regulatory response and new policy recommendations must go beyond the current regulatory intervention in India.

Key Insights on Civilian Drones

- Advancements in fields such as automation, robotics, miniaturization, materials science, spectral and thermal imaging, and light detection and ranging have resulted in drone-enabled solutions in areas as diverse as the agriculture, power, infrastructure, and telecom sectors, as well as crowd and disaster management.
- UAV activity will impact proprietary interests because common law has not clearly demarcated the commons from owned airspaces. It will also raise huge privacy concerns, considering the potential deployment of drones for massive data capture and analytics.
- No clear guidance exists on the liability standards for midair collisions and injury to property or persons in the event of untoward incidents.
- In the absence of clear common law rules, Indian states could well step in to regulate UAV activity through a patchwork of rules, resulting in a version of drone federalism as already witnessed in the United States.

Policy Interventions for a Growing Drone Industry

- Despite the promise of UAV technology, Indian regulators have not come up with a framework that unequivocally supports the deployment of drone-enabled solutions. The Directorate General of Civil Aviation (DGCA), which is India's civil aviation regulator, should not be the sole voice on framing such regulations unless it builds sufficient competence internally to appreciate the paradigm shift in aviation brought on by unmanned aircraft.

- Though the present draft guidelines issued by DGCA purportedly safeguard citizen interests, several conflict points have gone unidentified or have been cursorily touched upon by these guidelines. A deeper examination of UAV activity, its real world impacts, and its qualitative difference from manned passenger aircraft operations is immediately required to identify the real loopholes and impingement of proprietary, reputational, and safety interests by such activity. It is not advisable to leave these concerns to courts to adjudicate on a case-by-case basis as regulatory ambiguity can disincentivize innovators.
- India could witness a situation where multiple states regulate UAV activity through a patchwork of rules. To avoid this, the central government must immediately review possible aspects of drone activity that invite inconsistent rule-making and stipulate a consistent policy in line with the interests of innovators.

Unmanned Aerial Vehicles: The Innovation Story and Related Concerns

The recent spurt in automation technology, combined with advanced design, mapping, and visualization techniques, makes possible today something that was unimaginable even a few years ago—a highly accurate and mobile eye in the sky. Add to this the ongoing advances in robotics and deep machine learning and the possible applications of drones suddenly appear limitless. In fact, many unmanned aerial vehicles (UAVs) used by hobbyists today seamlessly incorporate a dazzling variety of technologies—Wi-Fi communications, rechargeable batteries, small high-resolution digital cameras, GPS receiver chips, accelerometer chips, and other miniaturized electronics—in a much better way than the UAVs used for military and intelligence missions, and provide imaging and sensing from a perspective not easily achievable by manned systems.[1]

These technological advances—coupled with innovations in manufacturing, including 3-D printing, autonomous repair systems, and wing coating—have led to a massive expansion in the potential market for UAVs. Together, these changes have turned drones into extremely proactive devices that can support such disparate activities as repair work on high-rises and harvesting operations on farm land, and with significant improvements in efficiency and cost. A comprehensive report on UAVs by the U.S. Department of Transportation identified five key subsystems that will heavily influence market expansion in this space: airframe; propulsion; communications, command, and control; sensors; and information processing.[2]

Barack Obama's use of drones for targeted killings resulted in UAVs coming under a cloud and elicited severe criticism against their military use.

In a recent report, Goldman Sachs estimates the total global spending on drones over the next five years to be around $100 billion, of which $11.2 billion is projected to be generated by the construction industry.[3] By 2020, the market for drone jobs in the United States alone will be $1.3 billion for construction and $1.4 billion in agriculture, according to the report.[4] What cannot be ignored is that UAVs have crucial applications that can enrich such core public sectors as infrastructure, transport, and agriculture.

Widespread use of drones, however, also triggers a number of concerns. The primary concern is over the use of drones as lethal weapons. As pointed out by the human rights activist Medea Benjamin, the September 11 terrorist attacks in the United States played an instrumental role in the perfection of allied technologies that would make drones function better. Unfortunately, the

Barack Obama administration's use of drones for targeted killings resulted in UAVs coming under a cloud and elicited severe criticism against their military use, by Benjamin and others.[5] Additional concerns, especially from a civilian perspective, relate to questions of privacy and property infringement along with a host of other legal issues, including the conditions for drone usage by law enforcement.

This paper first maps the current state of UAV technology and its varied civilian uses in areas as diverse as agriculture, photography, infrastructure, and disaster management. It then examines the extent of drone use in India, and some of the start-up activity in the area of drone-enabled solutions and UAV technology.

The paper then transitions from the descriptive to the analytical, parsing out the proprietary, reputational, and security interests of individuals affected by UAV technology. In the absence of clear-cut judicial guidance or legislative intervention in India to address most of these concerns, the paper examines previous debates in the United States and regulatory responses in other jurisdictions as referential tools. Building on this comparative exercise, the paper offers important recommendations for India's policymakers to ensure safe and dynamic deployment of UAV technology.

The Evolving Space of Civilian UAVs

Unmanned flying operations are more than a century old, and it is useful to trace their path through history, even if briefly. The United States' resort to lighter-than-air balloons during World War I for reconnaissance purposes slowly transitioned to the use of light airplanes in combat during World War II.[6] Manned combat aircraft became more sophisticated during the Korean and the Vietnam Wars,[7] but it was the post-Vietnam experimentation with transmitters capable of sending real-time video back to ground units that truly dictated the future course of unmanned aerial systems.[8] When the U.S. drone program hit a roadblock in the form of resistance and skepticism by pilots of manned aircraft, Israel-backed research and development efforts in UAVs and unmanned aerial systems (UASs)—which are the ecosystem of pilot stations, command-and-control links, and other technical components and support needed for UAVs to fly—became all the more important in the drone development story.[9] The military application of drones found its watershed moment during Operations Desert Shield and Desert Storm when UAVs provided direct support to ground forces in combat for the first time.[10] At about the same time, Japan's early foray into the UAV space started paying returns by the 1990s, when private Japanese entities such as Yamaha began deploying drones for a wide range of commercial applications.[11]

The Teal Group, an American defense consultancy, has been tracking the UAV industry for more than a decade, and its market projections for the

civilian UAV market continue to grow with each annual report.[12] Until 2015, the report projected the total market expansion, that is, it did not separate military and civilian use except to the extent of earmarking percentages for military, consumer, and civil cumulative use. However, 2015–2016 appears to have been an inflection point in the growth of civilian use of drones, as the organization has built on its experience of the past twelve years to prepare separate reports for military and civilian use. The 2016 report on civilian use estimates that nonmilitary UAS production will increase from $2.6 billion worldwide in 2016 to $10.9 billion in 2025, a 15.4 percent compound annual growth rate. Construction is projected to lead the market for commercial use of drones, followed by agriculture.[13]

A 2016 report estimates that nonmilitary UAS production will increase from $2.6 billion worldwide in 2016 to $10.9 billion in 2025.

Several companies and even some individual farmers are now using UAVs to perform precision agriculture. The low-cost combination of a quadcopter fitted with a camera is a powerful tool in the hands of these farmers to conduct effective surveillance of the growth and decay of crops, and thereby target the application of water, fertilizers, and pesticides to specific portions of a farm that need greater attention. This solution offers better resolution than satellite imagery and is far cheaper than crop imaging with a manned aircraft.

Most of the software used in the drone is open-sourced from communities working in this space, and thus avoids hefty licensing fees. The multispectral images taken by airborne cameras can capture data from both the infrared and visual spectrum, thereby highlighting differences between robust and weak plants.[14] Ranchers can use the technology to survey fences and identify diseased cattle, and fishery managers can employ it to combat illegal fishing vessels.[15] In Western Samoa, it has been used to create open-source, location-based visual data on coconut farms.[16] In Nigeria and Bangladesh, these solutions have accelerated the planning, design, and construction of rice irrigation systems and the establishment of irrigation scheduling.[17] A team led by the International Crops Research Institute for the Semi-Arid Tropics is using drone technology in Western Africa to secure land tenure information and thereby guarantee land use rights to small-holder agriculturists.[18]

Similarly, drones are revolutionizing investment monitoring, maintenance, and asset inventory in the infrastructure sector, particularly in energy, roads, railways, and oil and gas. They improve the speed and quality of the design process by providing high-resolution videos and images, as well as site data, to investors and engineers, enabling 3-D modeling that can create digital terrain models for more accurate contract valuation.[19]

They can add considerable value to the monitoring of construction job sites by simply capturing detailed images for daily progress reports, thereby allowing site supervisors to avoid issues such as improper sequencing that may lead to performance delays. With additional knowledge of orthomosaic photography

and photogrammetry, technicians can use drones to create site survey maps that provide a foundation for work plans, including georeferenced cut-and-fill and earthwork hauling operations.[20]

Over time, drones could carry 3-D printers as part of the payload and execute actual repair work, instead of passively transmitting information.[21] The telecommunications industry has started using drones for maintenance enhancement because they are much safer than manned operations in carrying out tower and antenna inspections. In a T-Mobile pilot project, drones took fifteen minutes to test antenna masts at a stadium, compared with the one week needed to achieve the same outcome through traditional methods.[22]

Over time, drones could carry 3-D printers as part of the payload and execute actual repair work, instead of passively transmitting information.

In the mining industry, drones can facilitate digital models of current work progress and detect changes in the mine structure, thereby enhancing safety and bringing down costs of controlling processes. Progress in 3-D scanning technology can improve the mapping efficacy of drones in underground settings.[23]

The transport sector will also be affected by drone technology, as both private companies and the public sector have started experimenting with drones for delivery of e-commerce packages, medical supplies, and industrial spare parts,[24] and during disaster management.[25]

The Growing Potential for Civilian Drones in India

The immense potential of drones has led to their increasing adoption in India, too. Though both the industry and the market in India are at a very nascent stage at the moment, there is immense growth potential for both. A major thrust will be given by the willingness of the present Indian government to use drones for a variety of purposes, including crop mapping and surveillance of infrastructure projects, pushing the projected value of the domestic industry to approximately $421 million by 2021.[26]

The variety of applications is already deeply diverse:

- Indian start-ups are assisting in the 3-D digital mapping of the Raebareli–Allahabad highway, as part of the road-widening project executed by the National Highways Authority of India. The data gathered by UAVs is turning out to be extremely useful in the computation of compensation for those whose property rights are affected by the project.
- Similarly, Indian Railways is planning the bidding process for 3-D video mapping of the entire dedicated freight corridor network of 3,360 kilometers (roughly 2,000 miles) using drone technology.[27]

- The state-owned Power Grid Corporation of India has obtained approval from a committee representing the Ministries of Defense, Home Affairs, and Power to use drones for monitoring project development. The organization believes that this can render the monitoring of projects in hilly terrains particularly cheap and efficient.[28]
- Recently, one of India's leading power transmission companies sealed a deal with a global player to use large-scale, long-distance drone flights for inspection of utility assets.[29] In a country with a power transmission network of more than a million circuit kilometers witnessing annual double-digit growth, drones can potentially help in avoiding grid blackouts.[30]
- The ability of drones to monitor surface integrity, take measurements, and assess wear and damage has prompted the National Thermal Power Corporation to consider their deployment for solar panel inspection, predictive maintenance, and surveillance and intrusion detection in solar power plants.[31] Drone-powered execution of infrared detection in solar photovoltaics can have monumental positive benefits for India,[32] as the country attempts to achieve its stated goal of 100 gigawatts of solar capacity by 2022.[33]
- Coal India has applied for permission from the Ministry of Home Affairs and the Ministry of Civil Aviation to start using drones for aerial surveys of coal blocks that come up for exploration, in order to assess the extent of greenery to be restored after mines are closed.[34]
- The National Disaster Management Authority (NDMA) has already been relying on the delivery and tracking capabilities of drones to handle disaster relief and rescue in India.[35] Similarly, during elections in the State of Chhattisgarh, the Central Reserve Police Force used UAVs for patrolling an area of 40,000 square kilometers and providing round-the-clock surveillance.[36] The Government of Uttar Pradesh has used drones for maintaining law and order at the Kumbh Mela festival in Allahabad, and so have the Mumbai police during the grandiose Ganpati festival.[37] Drones helped the New Delhi police identify seventy bags of bricks stocked for use as projectiles by rioters during the Trilokpuri riots in 2014, and they could take preemptive action.[38]

Equally fascinating is the fact that a lot of these uses have been spearheaded by Indian start-ups:

- Netra, the UAV used by the NDMA during the Uttarakhand floods, was jointly developed by the Defense Research Development Organization (DRDO) and IdeaForge, a start-up created by five graduates of the Indian Institute of Technology, Mumbai.[39]

- Quidich, founded in 2014, has slowly transitioned from an aerial photography services provider to an organization involved in disaster relief operations as it was after the Nepal earthquake in 2015,[40] and it has also helped Indian agriculture through image-processing algorithms that analyze aerial footage.[41]
- NavStik, a Pune-based start-up, has launched an indigenous platform, Flyt, for commercial drone makers, which bundles its operating system (FlytOS) and computer system (FlytPOD) to facilitate the creation of custom drone applications by third-party developers.[42]
- Aarav Unmanned Systems has been providing faster and cheaper land-surveying solutions for the construction industry and utility companies,[43] while Airwood, a Chennai-based start-up, is offering agricultural production management solutions using drone-facilitated data collection and predictive analytics.[44]
- Omnipresent Robot Tech has worked with a major medical college in New Delhi to prototype air ambulances to deliver medical supplies to remote areas,[45] and helped Jabong, a fashion e-retail company, to test drones for product delivery in its warehouse at Manesar, Haryana.[46]

These are just a few of the names in this space.[47] While Indian start-ups are on course to take advantage of the opportunities offered by this industry, the lingering question is whether India itself is ready to take advantage of their vision and enterprise.

The initial response of the Directorate General of Civil Aviation (DGCA), the Indian regulator, to the security concerns posed by UAVs was to issue a public notice forbidding any nongovernment agency, organization, or individual from launching a UAV in Indian civil space for any purpose whatsoever.[48] This knee-jerk reaction, though worded as an interim measure pending full consideration of the issue and the framing of appropriate regulations, disrupted the business operations of several Indian start-ups. Companies such as Airpix, a drone services and consultancy start-up, and users such as housing.com, an online housing portal, had to discontinue aerial photography services and use.[49] A pizzeria's home-delivery service using a drone was immediately locked down by the Mumbai police.[50]

While Indian start-ups are on course to take advantage of the opportunities, the lingering question is whether India itself is ready to take advantage of their vision and enterprise.

Comparisons with drone usage in other countries do not make for a compelling argument in the regulatory space because each society and its needs are so varied. Yet, it is difficult to ignore the reality that SZ DJI Technology Co. Ltd. of Shenzen, China, founded only in 2006, had by 2015 grown big enough to control 70 percent of the global commercial drone market and an even higher percentage of the consumer drone market, with an estimated revenue

of $1 billion.[51] No Indian start-up has gained traction anywhere close to this size in the UAV space. It took the DGCA about sixteen months from its earlier ban to finally come up with draft guidelines for the operation of UAVs, but as discussed below, these guidelines do not reveal much foresight. The fundamental approach of the Indian regulator has been to play catch-up in this space, rather than work with the UAV industry and frame appropriate regulations for a constantly evolving technology and business model.[52]

A decentralized airspace, as brought on by the advent of consumer UAV technology, has implications for three kinds of interests: property, privacy, and life.

Before tweaking the existing civil aviation regulations and force fitting the UAV industry within the older paradigm of the Aircraft Act and Rules and other strictures, it would help to understand the drastic and disruptive shift in use of airspace caused by the technological advances in the UAV industry. Broadly speaking, a decentralized airspace, as brought on by the advent of consumer UAV technology, has implications for three kinds of interests: property, privacy, and life. Nation-states and regulators have to think carefully about all three.

Decentralized Airspaces—Property, Privacy, and Injury Concerns

"The sky has no definite location. . . . There can be no ownership of infinity, nor can equity prevent a supposed violation of an abstract conception."
—Judge Haney, in Hinman v. Pacific Air Transport Corporation[53]

The many types of civilian UAV use outlined above, and some of the recent high-profile incidents involving drones, including the inadvertent incursion and crashing of a hobbyist drone on the White House lawn in Washington, DC,[54] illustrate the decentralization of airspace brought on by UAV technology.

The U.S. Federal Aviation Administration (FAA) has recorded several near-collisions between small drones and manned aircraft in recent years, many of which occurred during takeoffs and landings at busy U.S. airports.[55] To understand these concerns better, it is necessary to appreciate the ambivalent character of airspace in traditional property discourse. The most frequent justification offered for private property—the tragedy of the commons—argues that property goes to waste when left open to unfettered use by all and sundry. To avoid this, the institution of private property is employed to centralize access to property, and then to secure this exclusivity of access through common law tools, such as penalties for trespass and nuisance, as well as regulatory measures, including the registration of property and the recognition of title.[56]

This section of the paper focuses on the American response to these concerns because the United States is one of the few common law jurisdictions in which such issues have been addressed comprehensively by the courts.

Long before the recent surge in UAV activity, the advent of manned aircraft had challenged traditional notions of private property in the context of airspace use and ownership. In a 1936 case, *Hinman v. Pacific Air Transport Corporation*,[57] the appellants sought to use the civil action of trespass to restrain airline companies from flying above their property. Their contention was that as landowners, their rights extended to as much of the airspace as they could reasonably be expected to use and occupy, and that the upper limit of such expectation would certainly not be less than 150 feet above ground level. Because the defendant airlines were flying at altitudes less than 100 feet above the appellants' lands, they were alleged to be committing trespass. Rejecting this contention, the Circuit Court of Appeals held that the air, like the sea, was by its nature incapable of private ownership except in so far as one may actually use it.[58] However, any use of airspace by others that was injurious to the owner's land or *constituted an actual interference* with its possession or beneficial use was considered a trespass. Thus, the court shifted the meaning of trespass—which in the case of land, would require only a showing of factual intrusion—to require *injurious* intrusion in the context of airspace. This view did not, however, fully resolve the complicated question of ownership of superjacent airspace—lying just above the land—as seen from the subsequent U.S. Supreme Court decision in *United States v. Causby*.[59]

In the *Causby* litigation, decided in 1946, the respondent landowner alleged that frequent army flights over his land at low altitudes amounted to a constitutional taking of property, for which he was entitled to compensation. The proximity of the land to the airport, coupled with the sound and fury of the planes, forced the owner to give up his chicken business.[60] The U.S. government countered that the flights were in the navigable airspace, that is, above the minimum safe altitudes as statutorily prescribed, and hence would not amount to a taking. The government also contended that the landowner did not own any superjacent airspace unless he had subjected it to possession by the erection of structures or other modes of occupancy.[61]

In its ruling, the Supreme Court first laid out the general principle that the ancient common law doctrine—*cujus est solum ejus est usque ad coelom* (he who possesses the land possesses also that which is above it)—would not apply in the modern world to extend ownership over land to the periphery of the universe. Otherwise, the court pointed out, every transcontinental flight would subject the airline operator to countless trespass suits and clog the courts.[62] However, it distinguished the case from an easy application of this general principle, on the basis that the owner's residence was rendered uninhabitable and that neither actual physical occupation by the owner nor physical displacement from possession by the intruder were required for the land to be

diminished in its value. The majority opinion also made a technical distinction between the glide path during takeoff and landing and the navigable airspace, and held that the minimum safe altitude stipulated by the Civil Aeronautics Authority would not apply during takeoff and landing operations[63]—a distinction that drew a dissenting opinion.[64] The court concluded that "an intrusion so immediate and direct as to subtract from the owner's full enjoyment of the property and to limit his exploitation of it" would amount to a taking,[65] but did not determine the precise limits "of the public domain."[66] This deliberate omission on the court's part to clarify the extent of the "immediate reaches of the enveloping atmosphere" to which the landowner ought to have exclusive control resulted in leaving open the issue of ownership of the space sandwiched between the ground and 500 feet above ground,[67] the latter being the point from which the navigable airspace would statutorily commence.[68]

Though this decision was rendered in the context of takings law, the principle laid down therein was subsequently incorporated by the Second Restatement of Torts,[69] which said in part that aircraft flight over the land of another would amount to a trespass only when (a) the craft entered into the "immediate reaches of the airspace next to the land," and (b) it caused substantial interference with the owner's use and enjoyment of the land.[70] This principle has specifically been applied in the case of trespass claims involving overhanging encroachments,[71] and could equally apply to drones.[72] In the 2015 case of *Rivera v. Foley*,[73] a U.S. District Court judge endorsed this approach, and held that a journalist who used drones to capture images from a crime scene was "effectively trespassing."[74] Similarly, tort claims grounded on nuisance might also apply against drone users. Despite drones not causing high levels of noise and dust, they could potentially constitute a private nuisance if the million-drones-in-the-sky dream were ever realized.[75] For such a claim to succeed, landowners would have to satisfy the dual test of *substantial* and *unreasonable* interference caused by drones flying over or in close proximity to their property.[76]

The above property-related concerns arise in the context of UAVs as flying machines. In addition, UAVs today represent data in action. The combination of data analytics algorithms, multispectral and thermal imaging, volumetric measurement capabilities, and advanced mapping technologies makes UAVs aerial information-gathering platforms.[77] This capability, however, brings along with it serious privacy concerns, which in the United States has both constitutional and common law dimensions. The constitutional dimension largely arises when drones become a tool for investigative searches and the recording of evidence, since the legality of the search or of the digitally captured evidence could be challenged on the ground of violation of privacy. Though the issue has not come up before the Supreme Court in the specific case of drone use, the court's views on privacy concerns clashing with investigative use of other, possibly related, technologies is instructive.

In *Florida v. Riley* (1989),[78] the issue involved a Fourth Amendment challenge to the legality of a warrantless search conducted by a police helicopter that flew 400 feet above a residential greenhouse for purposes of tracking contraband.[79] The Supreme Court dismissed the challenge, holding that police personnel traveling in the public airways at this altitude need not obtain a warrant to observe what was visible to the naked eye.[80] Similarly, in *California v. Ciraolo* (1986),[81] the Supreme Court held that it was unreasonable to expect marijuana plants to be constitutionally protected from being observed with the naked eye from an altitude of 1,000 feet. On the other hand, in *Kyllo v. United States* (2001),[82] the court held that the use of thermal imaging devices to search a residence was constitutionally improper. Interestingly, the court was influenced considerably by the fact that these devices were "not in general public use" when the surveillance happened.[83] In *United States v. Jones* (2012),[84] the court disallowed unauthorized searches that make use of radio transmitters and receivers, high-resolution digital video cameras, and location-tracking devices. While the jurisprudential basis for these decisions is quite complex and falls outside the scope of discussion here,[85] the court's assessment of "reasonable expectation of privacy" within the Fourth Amendment context could result in potential invalidation of drone-powered investigative solutions that offer enhanced intrusive capabilities.[86]

Drones could run into trouble over privacy infringement as they get increasingly used by the media to gather news and information.

In addition to provoking constitutional issues when deployed by law enforcement, drones could also more generally run into trouble with the civil wrong of privacy infringement as they get increasingly used by the media to gather news and information. The tort of privacy infringement, tracing its origins to a seminal article by Samuel D. Warren and Louis D. Brandeis,[87] has evolved into four separate categories. Drone activity would best fit within the category of "intrusion upon the plaintiff's seclusion or solitude, or into his private affairs."[88] To establish this claim, though, plaintiffs must show intent on the part of drone operators to intrude into their affairs.[89] The tort can, however, apply even to claims against nonphysical intrusions that stay clear of actual trespass into the plaintiff's premises,[90] and to situations where the collected information is not disseminated subsequently to third parties,[91] thereby lending sufficient flexibility to the law to adapt to evolving techniques of drone surveillance and data collection.[92] The "reasonable expectation of privacy" is an important aspect here, too, though it is not entirely clear whether the standard to determine such expectation would be the same as that in the context of the Fourth Amendment issue.[93] Courts will also generally look at whether the intrusive conduct qualifies as "highly offensive to a reasonable person," and whether there are overriding First Amendment guarantees against the regulation of the media that permit the intrusion.[94]

Finally, drones can cause physical injury as a result of midair collisions and crashes. This raises the issue of the optimal trade-off between the negligence

standard and the imposition of strict liability for such unfortunate incidents. In the case of manned aircraft, early legal developments considered the technology hazardous enough to impose strict liability for all ground damage caused by overflying aircraft. However, with time, some courts have rejected the strict liability approach and put onus on the plaintiffs to demonstrate negligence on the part of the aircraft operator, though it is difficult to conclusively say that the present legal standard requires a showing of negligence in all circumstances.[95]

In any case, courts need not necessarily adopt the same approach to UAVs, considering the huge variance in the weight and payload of these devices and the consequential dangers they pose. Similarly, the duty of care owed by aircraft operators to each other may influence courts in adopting a negligence standard for midair collision losses suffered by fellow aircraft operators.[96] However, strict liability imposition is dependent on showing that the activity in question is "not one of common usage," and "creates a foreseeable and highly significant risk of physical harm even when reasonable care is exercised by all actors."[97] UAVs are certainly not as common in usage as manned aircraft, and the very fact that they are not manned could be used to establish the foreseeable and highly significant risk of physical harm.[98] Thus, the eventual choice between negligence and strict liability standards will heavily depend on multiple factors, including the altitude and character of airspace, the manner of operation such as line-of-sight versus beyond-line-of-sight, and the technologies integrated into the UAV to avoid collision. This choice will not only help adjudicate disputes between private parties but also direct the growth of a robust drone insurance industry.[99]

The above mapping of the property, privacy, and injury concerns raised by drones only shows that no conclusive responses are now in sight. But before looking for substantive answers that will largely emerge as the technology evolves, it is key to ask an important procedural question: Who should decide on these issues?

Some commentators have expressed optimism in the ability of courts to respond effectively through common law adjudication,[100] that is, on an evolving case-by-case approach. But others believe in the stipulation of a comprehensive rules-based framework that does not leave much scope for judicial interpretation.[101] Even in the case of the latter, there is considerable divergence of opinion, with some commentators largely trusting the ability of states to address these concerns on a local basis,[102] and others weighing more in favor of a federal policy.[103]

The on-the-ground response in the United States has been a patchwork of state laws to tackle concerns about drones, resulting in constitutional questions regarding the federal preemption of these laws.

The on-the-ground response in the United States has been a patchwork of state laws to tackle these concerns, resulting in constitutional questions regarding the federal preemption of these laws by the Federal Aviation Act, the Airline Deregulation Act, and other federal statutes.[104] Currently, thirty-one states across the country have enacted UAV/UAS laws, regulating or at

least considering regulation of a wide range of issues such as trespass, privacy, insurance, and commercial, governmental, and recreational uses.[105] In fact, privacy counts as one of the most significant areas where state intervention has occurred in the United States. Twenty-two states have passed privacy protection laws, including the requirement that law enforcement obtain a warrant for UAS use, except in exigent circumstances such as destruction of evidence, immediate flight of a suspect, or imminent danger to an individual. The laws also provide for the criminalization of UAV use for "peeping tom" activities by nongovernmental operators and expand the definition of harassment to include certain drone uses near locations enjoying a reasonable expectation of privacy.[106] Nevada and Oregon have provided for trespass claims against UAS operators who continue to fly at less than 250 and 400 feet, respectively, over an owner's property after receiving prior notification from the owner that they are not authorized to do so.[107]

Another interesting trend in many of these state-level attempts is the identification of important public benefit uses of drones and the balancing of privacy and property concerns over these uses. For instance, Florida's legislation, which prohibits the use of drones to capture images, provides for exceptions to this prohibition when the UAV use is for property appraisal in computing property taxes, operating and maintaining utilities, assessing vegetation growth, or monitoring the environment.[108] Even states that restrict the use of UAVs by governmental agencies provide for exceptions such as search and rescue missions, particularly during disaster relief operations, leading to the patchwork approach to drone regulation.[109]

The nuances of these laws notwithstanding, this overall approach, if one could take the liberty to brand it so, represents one way to regulate technology in a federal setting, and poses questions to similarly placed federal nations, such as India, as regards the ideal stance for regulating UAVs. But before detailing the Indian approach, it is important to map the global regulatory response to security concerns posed by UAVs.

The Regulatory Landscape for Airspace Security

The issue of airspace security, in contrast to the concerns discussed above, goes beyond the realm of individual rights to the formation and maintenance of a collective system to prevent collisions and casualties. Globally, the International Civil Aviation Organization (ICAO) has taken the lead in stipulating minimally acceptable standards for UAV operations through the release of Circular 328 and the Remotely Piloted Aircraft Systems (RPAS) Manual. Circular 328 was ICAO's initial attempt to communicate its perspective on the need to integrate UASs in nonsegregated civilian airspace.[110] An integral part of

its thinking has been the presence of a remotely located pilot who takes on the fundamental responsibilities of the pilot-in-command in a manned aircraft.[111] A progressive document, it envisages full integration of RPAS with manned aircraft subject to alternate technological capabilities to recognize aerodrome signs, visual signals, terrain and weather complications, and other aircraft or vehicles.[112] The RPAS Manual provides guidance on the technical and operational issues connected with the integration of RPAS in nonsegregated airspace,[113] including type certification and airworthiness approvals, RPA registration, responsibilities of RPAS operators, RPAS operations, detect and avoid mechanisms, air traffic control communications, and remote pilot stations.[114]

Some commentators have critiqued ICAO's efforts in this area primarily on the basis that they are heavily tilted toward integrating large unmanned aircraft into the manned aircraft space without a clear assessment of whether higher regulatory compliance costs and insurance premiums might dissuade airline companies from making such a transition. They have also added that the ICAO program is ironically quite indifferent to the regulation of small UAVs, which likely pose safety risks for larger manned aircraft.[115]

Regulations Around the World

At the national level, different countries have tried out varying regulatory models. In Singapore, the new UAV guidelines, part of the Unmanned Aircraft (Public Safety and Security) Act, are extremely permit-heavy and have strict restrictions on the movement of drones in mainland Singapore.[116] While hobbyists who use drones weighing less than 7 kilos need not obtain a permit, all users of UAVs above this weight require one of three permits.[117] An Operator Permit is granted by the Civil Aviation Authority of Singapore (CAAS) to an applicant who establishes capability in ensuring safe operation of the UAV. An Activity Permit is granted for a single activity carried out by the UAV at a specific area of operation. Other permits are required for different activities that come under the jurisdiction of various agencies. Additional permits will be required if there is a discharge of objects from the UAV, photographs are taken of a protected area, or if the UAV is flown in Special Event Areas as declared by the Ministry of Home Affairs.[118] While details of a speed limit and training facilities are not mentioned in the act, it criminalizes certain behavior associated with drone use, such as carrying dangerous materials while flying, as mentioned in section 9, and photographing a protected area by using photographic equipment on board the unmanned aircraft, as provided by section 8.

Comparatively, in the United States, the new UAV regulatory framework has given civilians a much faster route for flying UAVs. It substitutes the previous rules, which prescribed a compulsory pilot's license for the UAV operator, with far fewer restrictions.[119] The present FAA rules specify that all civilian UAVs relying on automatic permissions—as opposed to the specific permissions on a

case-by-case basis—must weigh less than 25 kilos, must remain within visual line of sight, cannot be operated at night, and cannot fly more than 400 feet above the ground.[120] Thus, the rules appear to restrict innovative UAV uses, such as Amazon's delivery drones, that would require beyond-line-of-sight operations.[121] However, UAV operations have been permitted within most airspace with air traffic control clearance,[122] and the FAA also appears to be slowly but cautiously permitting the testing of beyond-line-of-sight operations.[123]

Australia's new federal legislation aims to differentiate between low-risk and high-risk RPAS, and uses their weight to classify them.[124] Certain low-risk RPAS can operate without licenses and permissions, thereby providing a business opportunity for commercial enterprises that use drones lighter than 2 kilos.

Drone laws in Poland dispense with registration for drones lighter than 25 kilos but insist on an operator's license when the drone is heavier.[125] The operation of UAVs for commercial purposes requires the pilot to obtain a certificate of competence, which applies to both line-of-sight and beyond-line-of-sight operations.[126] However, the latter is permitted only in segregated airspace.[127]

In Canada, UAV operators require a special authorization except when the UAV is below 35 kilos and used solely for recreational purposes.[128] Safety guidelines include flying only during daylight and in good weather, keeping the UAV within the operator's line of sight, and not flying within 9 kilometers of an airport, higher than 90 meters above the ground, or within 150 meters of people, animals, buildings, or vehicles.[129] For UAVs weighing 25 kilos or less and being used for nonrecreational purposes, applicants are required to take liability insurance and fly only in daylight.[130]

In the United Kingdom, a person in charge of an unmanned aircraft with a mass of more than 7 kilos cannot fly the aircraft without specific permission, or at a height of more than 400 feet except in some very limited instances.[131] In addition, the operator must be reasonably satisfied that the flight can be made and cannot drop an article or an animal from the aircraft so as to endanger people or property.[132]

In Israel, meanwhile, no specific UAV rules are in place, as the country uses its civil aviation law—including its licensing, registration, and operational requirements—to regulate UAVs.[133] However, under rules issued by the Civil Aviation Authority of Israel, UAVs cannot be flown in populated areas below 5,000 feet, except during takeoff and landing or with prior approval.[134] In the absence of prior approval, the rules also disallow the simultaneous remote operation of more than one UAV by the same operator from the same remote pilot station.[135]

China has tried to assimilate the leap in technology into its regulatory framework, as seen from its rules applicable to civil unmanned aircraft that weigh no more than 116 kilos.[136] Apart from a division of the weight range into four subclasses—0 to 1.5 kilos, 1.5 to 4, 4 to 15, and 15 to 116—the rules

have a separate category for plant-protection UASs. Integrating the technological evolution of the Internet of things into the regulatory structure, the rules stipulate an online real-time supervision system that includes a "UAS cloud" and an "electronic fence." The cloud is a dynamic database management system that monitors flight data in real time, and the fence is a software and hardware system that earmarks specific areas as prohibited zones and automatically restrains aircraft from entering. UAVs weighing above 4 kilos must integrate these systems.[137] A chapter in the rules stipulates the qualifications to be a UAS cloud provider. The rules also allow beyond-line-of-sight flying, though they give air route priority to manned aircraft. This is possible primarily because of the integration of the cloud and the fence into UAV flying operations. The UAS cloud system is also expected to provide a level playing field for new UAS operators to access safety instructions and other relevant information.[138] With the parallel proposal to further open up low-altitude airspace for civilian use,[139] China seems to be imbibing the ICAO agenda in full spirit and aiming for complete integration of manned and unmanned aircraft.

Thus, while countries vary in their approaches to drone regulation, there are some common concerns that most of them address: the weight and identification of the craft, the competence of the operator, and altitude or spatial restrictions.

India's Regulations

The Indian draft guidelines, issued in April 2016 by the DGCA, also deal with these issues. As per the guidelines, UAVs have been categorized by weight into four classes: micro, which is up to 2 kilos; mini, exceeding 2 kilos but less than 20; small, exceeding 20 kilos and less than 150; and large, exceeding 150.[140] All UAVs require a Unique Identification Number (UIN) issued by the DGCA.[141] A UIN can be granted only to a citizen of India or to a company that is incorporated and has its principal place of business in India, with substantial control vested in Indian nationals.[142] The UIN is a positive security measure with which any UAV operating in India can be tracked and identified. However, permitting primarily only Indian nationals to obtain a UIN would impede economic growth and technological progress.

The procedure and documentation for granting a UIN is already quite elaborate, requiring address and identity proof; information concerning the purpose of the UAV's operation as well as its specifications, flight manual, and manufacturer's maintenance guidelines; character verification of the operator by the local subdivisional police; and permission from the Department of Telecommunications to use the radio frequencies required for the UAV's operation. Moreover, all civilian UAV operations at or above 200 feet in uncontrolled airspace for any purpose will require an unmanned aircraft operator permit (UAOP) from DGCA, while operation of civilian UAVs in controlled airspace is restricted.[143] UAVs can enter controlled airspace only with the prior

approval of the air navigation service provider, which will be in the form of an airways clearance.[144] In addition, all UAV operators have to ensure that the UAV is flown within a 500-meter visual-line-of-sight during the entire flight.[145] With these precautions in place, it may be redundant and restrictive to exclude foreign players from obtaining a UIN.

The UAOP is valid for two years and is not transferable.[146] A UAOP is not required for civil UAV operations below 200 feet in uncontrolled airspace that is clear of restricted areas, for model aircraft operating below 200 feet in uncontrolled airspace, or for indoor flying for recreational purposes.[147] This is a constructive step to free up civilian use of UAVs, particularly at educational institutions where students could tinker with the technology and innovate further. For all UAV flights above 200 feet, the UAS operator has to inform the local administration, the air traffic service unit, the Bureau of Civil Aviation Security, and any aerodrome operators, if applicable, both prior to and following the operation. The operator also has to file flight plans containing information about the flight, performance characteristics of the UAV, the number and location of remote pilot stations, payload, and insurance coverage for liability.

The guidelines also mandate UAV operators to carry out safety assessments of the launch site and maintain full control over the site of operation. This is integral to airspace security because UAV technology—which relies on a closed loop of radio communications between the remote pilot station and the UAV and is thus less prone to man-in-the-middle type of attacks—is highly prone to attacks at either end of the loop. By infiltrating either the UAV or the command-and-control facilities at the pilot station with malware or bugs, bad actors could gain control over the UAV and play havoc with its operation.

The guidelines also stipulate the training requirements for remote pilots. They should be above eighteen years of age and have a thorough training equivalent to that undertaken by the crew of manned aircraft or by the holder of a private pilot license. The training should also include preparation for a flight radio telephone operator's license. In addition, remote pilots are required to undertake thorough practical training in the control of an unmanned aircraft in flight, including simulated flight training, so that they can build capabilities not only in controlling the UAV throughout its aerial operation but also for its safe recovery in the event of an emergency or system malfunction. These training requirements are not applicable to recreational flying and the flying of micro UAVs.[148]

Gaps in the Indian Approach

In a federal system, three regulatory components are required to ensure that the government promotes the progress of a given industry: (1) identification of all possible concerns, both from an individual rights and collective security standpoint, that can bring the industry under the scrutiny of regulators; (2)

framing of clear rules that optimally balance these concerns with an efficient and competitive functioning of the industry marketplace; (3) unification of the laws applicable to the industry so that there is uniformity in regulatory practice throughout the country.

The first flaw in the Indian approach to UAVs is that all possible concerns have not been identified with care and sagacity. The guidelines take a very airspace-centric view, with little acceptance of the reality that what the present consumer UAV technology does is substantively different from competing with manned aircraft for high-altitude airspace. Ironically, the guidelines overtly restrict UAVs from operating in controlled airspaces but in all other respects regulate them with the primary intent of avoiding collisions. In doing so, the guidelines lose sight of the fact that in low-altitude spaces, the probability of conflict is actually a lot higher between landowners and UAV operators.

These issues could range from trespass and nuisance concerns to privacy infringement and liability for injury. The guidelines make cursory reference, if any at all, to these concerns. Guideline 10.4, for instance, states that the privacy and protection of personnel/property/data shall be given due importance. Guideline 11 provides that the UAOP shall not immunize the UAS operator against any rights or remedies that property owners and residents may have with respect to any personal injury or property damage caused directly or indirectly by the UAV. Guideline 12 mandates all UAOP holders to carry insurance for the liability that they might incur for any damage to third parties. Under Guideline 6, prior written permission from the land/property owner, whose space is used for takeoff/landing operations, is required to obtain a UAOP in case of UAV operations below 200 feet.[149] Apart from these rather indirect references to core individual-level rights and interests, the rules provide no guidance on how to resolve conflicts of the kind outlined above.

In low-altitude spaces, the probability of conflict is actually a lot higher between landowners and UAV operators rather than between high-altitude aircraft.

Unfortunately, Indian courts have not had the opportunity to provide much guidance on these issues either, primarily because the Indian aviation sector has always been highly regulated, with strict limits on the zone of operation of manned aircraft. In addition, aviation technology never went through the legacy phase in India that it did in the United States, where many of these conflicts were addressed by the courts. The few judgments that exist in India seem to point in the direction that ownership of airspace over a surface extends to such a limit as is necessary for the ordinary use and enjoyment of the land and the structures on it.[150] The statutory vesting of streets with the municipal authorities means only that the authorities are vested with so much of the airspace as would be reasonably necessary for them to adequately manage the street as a street.[151]

In *Indrachand Jaju v. The Sub-Divisional Officer*,[152] the Gauhati High Court had to consider whether a structure (*chajja*) built over a government-owned

stream amounted to an encroachment and trespass. The court vaguely observed that "it may be that the law recognizes no right of ownership in the distant airspace at all or at least no right of exclusive use but merely prohibits all acts which by their nature or their proximity interfere with the full enjoyment and use of the surface."[153] However, the court then went on to distinguish intrusion by aircraft from intrusion by other objects. In its view, the former was regulated by statute, and therefore, "the Rule generally is that no action shall lie in respect of trespass or in respect of nuisance, by reason only of flight of an aircraft over any property at a height above the ground, which having regard to wind, weather, and all the circumstances of the case is reasonable, or the ordinary incidents of such flight."[154] It is unlikely that the court envisaged low-altitude airspace, and aircraft presence therein, when considering its ruling. If anything, the court's observations support the view that the scope of individual-level rights challenged by UAV technology should not be left to courts and common law adjudication.[155] In the interests of certainty and clarity, much needed for the organic growth of any new-tech industry, it is imperative that legislative action be directed toward laying down the scope of property rights over low-altitude airspace.

Similar is the case with privacy and injury concerns. In the context of law enforcement, Indian courts have not particularly frowned upon illegally obtained evidence, except in narrow situations where there was "compulsion" placed on the accused to part with the evidence.[156] In *Yusufalli Esmail Nagree v. State of Maharashtra* and *RM Malkani v. State of Maharashtra*,[157] the Indian Supreme Court held as admissible a secretly tape-recorded conversation in which the accused incriminated himself, on the grounds that since the conversation was entirely voluntary, and the accused had not been compelled, tortured, or threatened to make an incriminatory statement, it was not in violation of Article 20(3)—the right against self-incrimination—of the Indian Constitution. Thus, the right of privacy was not enough to eliminate the evidence from the record.[158] This point is affirmed more strongly in *State of Madhya Pradesh v. Paltan Mallah*,[159] where the court ruled that weapons obtained during an illegal search are admissible unless the accused would suffer serious prejudice. The court also created a distinction between offering "personal testimony" and "furnishing evidence" through the production of physical objects, thumb impressions, handwriting samples, and other bodily substances, immunizing the accused only against compulsion to part with testimony and not evidence.[160] In short, if law enforcement were to use UAV technology to surreptitiously gather evidence, Indian courts are unlikely to bar such evidence as the state of law now stands.

The few judgments that exist in India suggest ownership of airspace over a surface extends to a limit as necessary for the ordinary use and enjoyment of the land and the structures on it.

Privacy has fared better in India as an independent right within the context of conflicts between citizens inter se. Two broad conceptual trends can be

discerned from a reading of Indian cases on this point. One is the constitutionalization of privacy as part of the right to life under Article 21, and the other is the evolution of privacy as a separate tort claim in the Indian context. The first trend started not too long after independence, through two seminal decisions by the Supreme Court: *Kharak Singh v. Union of India* and *Govind v. State of M.P.*[161] In the former case, the court, when deciding on the constitutional validity of a police regulation that authorized surveillance of an individual with a criminal past, held that secret surveillance of the individual's residence to maintain a record of his visitors was valid but domiciliary night visits were not. However, the dissenting opinion, which subsequently set the march of the law in motion, held both practices invalid, reasoning that the entire life of the individual was made an open book, with his every activity closely observed and followed, resulting in a violation of the right to privacy—"an essential ingredient of personal liberty."[162] This was followed by *Govind*, holding that constitutional rights and freedoms guaranteed that the individual, his personality, and those things stamped with it shall be free from official interference except where a reasonable basis existed for intrusion.[163]

Privacy has fared better in India as an independent right within the context of conflicts between citizens inter se.

In *R. Rajagopal v. State of Tamil Nadu*,[164] the court carefully distinguished this trend from a separate need to establish violation of privacy as a basis for independent tortious claims, though branding both aspects "two faces of the same coin." In the words of the court:

> A citizen has a right to safeguard the privacy of his own, his family, marriage, procreation, motherhood, child-bearing and education among other matters. None can publish anything concerning the above matters without his consent whether truthful or otherwise and whether laudatory or critical. If he does so, he would be violating the right to privacy of the person concerned and would be liable in an action for damages.[165]

Interestingly, these observations came in the context of the state's attempt to clamp down on the publication of a serial killer's autobiography, relying on his privacy and the potential defamation of state officials as the rationale for its action. It can be reasonably argued that this factual foundation—conflict of free press with privacy and reputation—has led to a heavy focus on the disclosure of private and confidential information as an independent tortious claim,[166] and less of a focus on the intrusiveness of certain practices that may affect privacy though not making the gathered information public.[167] This distinction has great application in the case of UAV technology, because concerns about the intrusiveness of the technology are no less serious than those relating to its ability to illegally gather and publicize private data.

As a final point on this theme of incomplete identification of interests affected by UAV technology, scholars have argued that the heavy influence of public law principles has stunted the growth of private law in India.[168] This is particularly important after acknowledging that the civil justice system is broken and trials take a long time to complete. Therefore, the clarification of principles applicable to the resolution of individual-level disputes has not happened in a consistent and coherent fashion. In matters such as apportionment of liability and award of damages, courts have confused private law concepts such as responsibility and risk with public law ideas of fairness and equity.[169] In their concern to provide immediate, short-term benefits to litigants, Indian courts have ignored the substantive growth of tort law, manipulated tort law principles to suit the adjudicative structure that works faster, and created additional problems such as moral hazard and claim impersonalization.[170] These shortcomings make it all the more important for the legislature to intervene and at least stipulate a coherent substantive legal structure to resolve the property, privacy, and injury concerns raised by UAV technology.

Concerns about the intrusiveness of drone technology are no less serious than those relating to its ability to illegally gather and publicize private data.

This leads us to the issue of unifying the legal norms to address the above concerns. Naturally, one must start with asking whether there is a possibility of disunity in such norms, considering how the Union government and the Indian Parliament have exclusively occupied lawmaking and norm-setting for the aviation industry. On the face of it, Entry 29 of List I, Schedule VII of the Indian Constitution, dealing with airways, aircraft, and air navigation, vests such exclusivity with the central government. However, many of the concerns identified above are claims under the law of tort, and can well fit within Entry 8 of List III, Schedule VII dealing with actionable wrongs. In such a case, till the point when the Union intervenes and occupies the field in question, states can continue to make their own laws and regulations balancing the property, privacy, and injury concerns of citizens with the rights and autonomy of UAV operators. Equally pertinent, but with even more far-reaching regulatory implications, is the fact that rights in or over land are included in Entry 18 of List II, Schedule VII thereby vesting exclusive jurisdiction with the states to make laws regarding the same. A strong argument can be put forth that the issue of ownership over low-altitude airspace falls within this entry and not Entry 29 of List I. This view could in turn result in a patchwork of rules and regulations, with the operation of UAVs falling within the Union's exclusive jurisdiction, the scope of ownership of airspace superjacent to land falling within the states' exclusive jurisdiction, and the design of privacy, trespass, and other civil claims coming within the jurisdiction of both.

Therefore, it is imperative that the government of India begins a serious exploration into the individual-level concerns highlighted in this paper, most of which have been ignored by the current guidelines, and move to occupy

the regulatory field in its entirety, leaving little room for the states to initiate their own collection of rules. At this point, a nascent UAV industry would not be able to bear the huge regulatory compliance costs associated with diverse state-level rules, or even worse, the possibility that a stray incident somewhere would compel one or more states to restrict the technology itself. Such an outcome would be detrimental to the realization of the technology's promise and full potential.

Policy Pathways and Recommendations

Three important exercises are required to be undertaken by the central government when embarking on a more comprehensive regulatory framework.

The first is to take another look at the Aircraft Act and Rules and critically examine how much of this framework is indeed applicable to the current UAV technology. A lot of force-fitting of new technology into an established framework happens simply because the actors involved in creating the regulatory structure are influential in the old order but cannot think beyond its constraints and parameters. To a large extent, the DGCA guidelines suffer from this problem, as seen from the reluctance to provide a road map for beyond-line-of-sight UAV operations, full integration of unmanned aircraft into both controlled and uncontrolled airspace, and the deployment of technological advances that can actually address several security concerns associated with these revolutionary changes. Disruptive technologies cannot grow under the watch of regulators who protect the very industry that is being disrupted.

The second exercise is to be less of a regulator and more of a facilitator. As UAV technology grows exponentially both in market terms and scientifically, regulators necessarily have to work with the new industry and understand the full potential of the solutions they are deploying on the ground.[171] It is only when closely working with the industry that regulators can truly grapple with both the collective security concerns posed by the technology as well as the concerns over individual rights that may come up. It is quite probable that part of the current inability of the DGCA even to flag some of the major concerns highlighted in this paper is a result of not closely understanding the technology, its deployment on the ground, and its potential.

Disruptive technologies cannot grow under the watch of regulators who protect the very industry that is being disrupted.

The third, and related, exercise is to ensure that while UAV use in defense and civilian spaces may be kept separate for regulatory purposes, Indian start-ups and other private players are provided abundant opportunities to deploy drone-enabled solutions and technologies for defense use. The long history of technological innovation speaks to this need to involve private players in defense tech because of the multiplier effects of technology incubated within the defense innovation system. The Internet, the global positioning system,

and autonomous vehicles are more popular examples in this narrative. The Indian Ministry of Defense's procurement strategy should therefore actively promote innovation by competent private players and Indian start-ups through defense contracts awarded for UAV solutions.

What is clear at this stage is that the DGCA is either unwilling or unable to effectively respond to the challenges posed by civilian drones. Its approach to UAVs shows a proclivity to superimpose older technology, such as radio-based communication and control structures, onto a newer, more agile technology that could possibly address airspace security concerns using a wholly different set of inputs and systems. The DGCA should not be the sole voice in framing the necessary regulations until it can demonstrate an appreciation of the paradigm shift in aviation brought on by unmanned aircraft. For that reason, the government of India should create a task force in which the DGCA is just one of the participants.

Though the draft guidelines issued by the DGCA purportedly safeguard citizen interests, several points of conflict have gone unidentified or have been only cursorily touched upon. A deeper examination of UAV activity, its real-world impact, and its qualitative difference from manned aircraft operations is required immediately to identify the loopholes and possible impingement of proprietary, reputational, and safety interests by such activity. Regulatory ambiguity in this regard can disincentivize innovators.

It is also possible that much like the United States, India could witness a situation in which multiple states regulate UAVs through a patchwork of rules. To avoid this scenario, the central government must immediately review aspects of drone activity that could invite checkered rule-making and stipulate a consistent policy in line with the interests of innovators.

Conclusion

UAV technology, primarily directed toward military usage in its infancy, has exploded in the last few years as a powerful tool with consumer and commercial applications. As outlined in this paper, these applications are as diverse as agricultural oversight and power-line monitoring. The miniaturization of hardware required to provide support functions for drones—such as navigational guidance, mapping, and image capture—has resulted in a revolutionary decentralization of the airspace. Today, anyone can fly a drone with a little investment and some basic understanding of technology. This opportunity, however, comes with its share of problems, which can broadly be categorized as individual rights concerns and collective security concerns.

Today, anyone can fly a drone with a little investment and some basic understanding of technology. This opportunity, however, comes with its share of problems.

As this paper shows, regulators around the world have adopted a range of approaches to address these concerns. Worries about individual rights have led

to a patchwork of rules in a federal setting such as the United States, something that India can learn from and possibly avoid. However, the Indian regulatory response in the form of the recent DGCA guidelines leaves a lot to address because of its hopelessly incomplete identification of legal issues. And much remains to be done to weave into the regulatory structure the kind of oversight needed to integrate advanced technologies that can resolve airspace security concerns. These shortcomings raise a basic question: Are industry regulators ever in the best position to oversee industry disruptors?

It therefore becomes necessary for the central government in India to move beyond existing regulatory paradigms. It is also necessary to ensure that the DGCA's role in the deployment of drone technology becomes more facilitative, as opposed to its current obstructive stance. Only if this were to happen would India transition in a smooth and efficient manner to the next wave in UAV technology, involving fully autonomous drones and beyond-line-of-sight operations.

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