Request for proposal

Helping pilots fly drones safely and legally



# Table of contents

1. Introduction
1.1 Background
1.2 Safety concerns
1.3 Privacy concerns
1.4 Request for proposal / Opportunity
2. Stakeholders4
2.1 Primary stakeholders
2.1.1 Drone pilots
2.1.2 City police
2.2 Secondary stakeholders
2.2.1 Homeowners
2.2.2 Airport or airfields staff
2.2.3 People who deal with natural hazards and disaster
2.2.4 Drone law regulators
2.2.5 Drone manufacturers
3. Requirements
3.1 Requirements table
3.2 List of drone related laws
4. Reference designs
4.1 Detecting illegal drones
4.1.1 Human surveillance
4.1.2 Robin system
4.2 Taking down illegal drones
4.2.1 Dronedefender
4.2.2 Net bazooka
4.3 Informing pilots
4.3.1 NATS drone assist
4.3.2 B4UFLY
Appendix15

## 1. Introduction:

#### 1.1 Background

The term "drone" refers to any vehicle that can operate on surfaces or in the air without a person on board to control it; and that can vary in size, shape, form, speed, and a whole host of other attributes [1]. It may sometimes be referred to as UAV (Unmanned Air Vehicle), UAS (Unmanned Air System), RPAS (Remotely Piloted Aircraft Systems) or Model Aircraft [1].

During the past few years, the popularity of drones has begun to soar. Besides domestic drones that are used as, for example, surveillance tools and commercial drones that are used for business research, more and more people own personal drones for recreational purposes or other personal uses [2]. According to staff at Best Buy, the number of drone sales keeps increasing [3]. However, these recreational drones raises new safety and privacy concerns.



# 1.1 Safety Concern

In October 2017, it was reported that a drone hit a commercial airplane approaching Quebec City [4]. In November 2016, 2 crew members on a plane were injured because a drone interfered with the plane's flight [5]. Such incidents caused by drones have become more frequent in the past few years. In 2013, there was only 1 reported drone incident. The number of drone incidents in 2014 rose to 46. The number of drone incidents reported each year has kept going up since then and reached 87 in 2015, 215 in 2016 and 233 in 2017 [6]. As the number of drone sales keeps increasing [3], safety concerns may become even more serious in the future.

Moreover, according to current drone-flying law made by Transport Canada [8], drones cannot be flown within a certain distance from a aerodrome or from a area of accident or natural disaster. Unfortunately, many incidents happened because the pilot did not know these were restricted areas for flying drones [4][7]. Therefore, the police officers do not want to be too harsh on people who break drone-related laws or regulations [9].

#### 1.2 Privacy Concern

Because a camera or a recorder can be mounted to a drone, drone pilots can use the drone to invade other people's privacy from miles away. It is hard to stop drones being used for peeping because it is hard to determine the ownership and purpose of the drone [2].

# 1.3 Various Possible Solutions but No Existing Solution

To solve problems caused by drones, possible solutions range from radar surveillance system to drone-flying assisting app. Unfortunately, no current design satisfactorily meets all requirements in this engineering opportunity. (See later requirements section and reference design section)

#### 1.4 Request for Proposal (RFP)

Although there are current regulations and laws about drone-flying [8], an engineering design solution is requested to enforce the laws and regulations and to protect or prevent drone pilots from breaking the law. The risk of injury or damage would be lowered by helping drone pilots avoid restricted areas and avoid intrusion onto private property. Additionally, if law enforcement has a reliable way of identifying and potentially capturing drones that fly into restricted air space or onto private property, it can become easier to ensure citizen safety and privacy. Therefore, the proposed design should alleviate safety concerns and privacy concerns caused by drone-flying.

## 2. Stakeholders:

#### 2.1 Primary stakeholders:

Primary stakeholders have high influence in the proposed design [14]. Among stakeholders who have high influence in the proposed design, stakeholders who also have high interest in the proposed design are prioritized. Below, stakeholders are arranged in order of prioritization.

2.1.1 **Drone pilots** who wish to know the laws surrounding drone use and would like to fly their drone while fully complying with the law. 2.1.2 **City police** who would like citizens to abide by the law when flying drones. They are responsible for making sure that drones are flying where they are supposed to. If a drone is flying in a restricted area, the police are responsible for finding out who is flying the drone and if needed they need to take down the drone. If a solution is found to help the police with these responsibilities, this would be very interesting for them.

## 2.2 Secondary stakeholders:

Secondary stakeholders have low influence in the proposed design [14]. Among secondary stakeholders, stakeholders who have high interest in the proposed design are prioritized. Secondary stakeholders are arranged in order of prioritization below.

2.2.1 **Homeowners** who would not like their privacy to be invaded by drones and who would not like to be injured or damaged by flying drones.

2.2.2 (equally prioritized as 2.2.1) **Airport or airfields staff** who will not authorize drones to be flown less than 5.5 km away from airport or airfield because it is dangerous and illegal [8].

2.2.3 (equally prioritized as 2.2.1) **People who deal with natural hazards and disasters**. They will not authorize drones to be flown less than 9 km away from natural hazard or disaster site because it is dangerous to people working and illegal.

2.2.4 (equally prioritized as 2.2.1) **Drone law regulators** who would like to see drone-flying related regulations and laws being enforced.

2.2.5 **Drone manufacturers** who would not like the proposed design adding additional cost to drone production.

# 3. Requirements

The table below is organized to show the relationship of stakeholders, high-level and detailed objectives to associated metrics and criteria. The associated metrics have been suggested, however, the list is not exhaustive. It is important to note that a number of approaches may be used to meet the high level objectives, therefore, not all objectives may be relevant to different solutions.

# 3.1 Requirements Table

Stakeholders	High-Level Objectives	Detailed Objectives	Metrics	Criteria	Constraints
Drone Pilots	Provide an engineering	Minimize the number of laws	Number of laws listed in section 3.2 that	For each law	
	design that helps the	that the drone can break.	the solution prevents pilots from	listed in section	
	drone pilot to abide by		breaking.	3.2, design	
	the law (see [8] for law			scored Yes 1s	
	and regulation specified			"NO".	
	by Transport Canada)	Help inform people about	Different laws and regulations listed in	For each law	
		current drone related laws	section 3.3 about which the proposed	listed in section	
		and regulations.	design informs drone pilots.	3.3, design	
				scored "Yes" is	
				"No"	
			Accuracy of representation of restricted	Larger	
			more Measured by persentation of restricted	percentage is	
			areas. Measured by percentage of areas	better.	
			that are correctly marked as		
			unrestricted or restricted relative to		
			total area.		
			Units: %		
			Accuracy of representation of restricted	Less time is	
			areas measured by time taken for solution	better.	
			to inform user about dynamic restricted		
			areas such as areas where an accident has		
			taken place.		
			Units: minutes		
			Cinto. minutes.		

City Police Home Owners Airport and Airfield Staff	Provide an engineering design that helps police enforce drone related laws and regulations. (All stakeholders listed here, besides police, have an interest in the	Help police officers to know who is flying the drone.	Maximum distance for the police to be able to recognize who is flying the drone (either visibly or using a solution that helps them recognize pilots) Units: meters	Higher distance is better.	
People who deal with natural	enforcement of the law because they have an interest in lowering the	Help police officers detect drones that are breaking the law.	Maximum distance between a drone and the police such that the police can identify whether the drone is in the restricted area. Units: meters	higher distance is better.	
hazards and disasters Drone law regulators	risk of injury and/or damage.)	Help police officers take down drones if needed.	Ease of taking down the drones. (see the rubric in section 3.4).	Higher on the rubric the better.	Must score satisfactory in the rubric.
Drone Pilots City Police	Provide an engineering design that is usable for both drone pilots and	Provide an engineering solution that is learnable. [15]	Learnability is measured by time taken for a user to learn to use the solution. [15] Units: minutes	Less time is better.	
police. [15]	police. [15]	Provide an engineering solution that is reliable. [15]	Reliability is measured by rate of errors of the solution, which is number of error occurrence in certain amount time of using. [15] (the exact time of using in this metrics is left to be determined by metric- evaluation team) Units: number	Less number is better.	
		Provide an engineering solution that performs efficiently. [15]	Efficiency of performance is measured by time added if using the solution compare to not using the solution. [15] Units: Minutes 15	Less time is better.	
Drone pilots	Provide an engineering design that is portable	Minimize the weight of the solution.	Weight of the solution. Units: kilograms	Less weight is better.	
Police	for both drone pilots and police.	Minimize the volume of the solution.	Volume of the solution. Units: meter cubes	Less volume is better.	

Drone pilots Police	Minimize the cost to implement the proposed design for both drone pilots and police.	Minimize the cost required from drone pilots to implement the proposed design.	Cost required from drone pilots to implement the proposed design. Units: Canadian dollars, \$	Less cost is better.	
		Minimize the cost from police to implement the proposed design.	Cost required from police to implement the proposed design. Units: Canadian dollars, \$	Less cost is better.	
Drone Manufacturer	Minimize the additional manufacturing difficulties to the drone	Minimize additional drone- manufacturing cost.	Additional cost includes additional material cost, additional research cost and additional labour cost. Units: Canadian dollars, \$.	Less cost is better.	
	itsen.	Minimize additional weight that need to be added to the drone.	Additional weight that need to be added to the drone. Units: kilograms.	Less weight is better.	The weight of the drone and the additional weight caused solution combined cannot exceed 35 kilograms (according to drone weight laws). [8]
Additional con	straint that is not directly li	nk to metrics			Must be usable with all types of recreational drones and control systems (remote control, apps that control the drones.)

3.2 List of drone related laws [8]

The solution technically prevents pilots from violating any of the following laws. [8]:

- 1. flying drones less than 9 km away from natural hazard and disaster area. Yes/No
- 2. flying drones less than 5.5 km away from aerodromes. Yes/No
- 3. flying drones less than 1.8 km away from heliports or aerodromes used by helicopters only. Yes/No
- 4. flying drones 500 m away from themselves. Yes/No
- 5. flying drones 90 m above ground: Yes/No
- 6. flying drones inside controlled or restricted air space. Yes/No

7. flying drones less than 30 m away from vehicles if the drone is less than 1kg weight, else less than 75 m away. Yes/No

- 8. flying drones during nights or cloudy day. Yes/No
- 9. flying drones close to areas where its use could interfere with police or first responders. Yes/No
- 10. flying drones out of their eye-sight. Yes/No
- 11. flying more than one drone at the same time. Yes/No
- 12. fly drones without clearly labelling drone pilots' name, address and phone numbers on the drone

# 3.4 Metrics Rubric

Ease of taking down drones

Unsatisfactory	Satisfactory	Good	Outstanding
Police officers have no way to take down the drone.	Police officers are able to take down the drone but inflict damage to it.	Police officers are able to take down the drone without inflicting damage to it.	As per good + Police officers can take down drones from their office.

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# 4. Reference designs

# 4. 1 Detecting illegal drones

# 4.1.1 Human Surveillance

Surveillance by humans and optical systems, with or without a telescope, has some strengths in detecting drones entering restricted areas such as the capability to distinguish drones from other flying objects, but is also limited by range and visual conditions.[10]

# 4. 1. 2 Robin Radar Systems

Radars can detect multiple targets simultaneously, also under low visibility conditions. However, it comes with the disadvantages of high cost and the inaccuracy in classifying flying objects.[10]



# 4. 2 Taking down illegal drones

# 4. 2. 1 DroneDefender Ray Gun

The DroneDefender disrupts the drone's control signal by bombarding it with even more signal. The problem with "fire so much signal that everything goes electronically deaf" is that it disrupts the communications. [11]



# 4. 2. 2 Skywall 100 Net Bazooka

It's a massive, shoulder-mounted, gas-powered, net-flinging bazooka, blasting a capsule which opens to reveal a net which wraps itself around the target, tangling it in weighted bolas, and then deploys a parachute. It's a good design except for a few safety concerns (capturing other objects) and high requirement of accuracy.[11]



#### 4. 3 Informing drones pilots

# 4. 3. 1 NATS Drone Assist

It is an app developed by the UK's main Air Traffic Control provider in partnership with Altitude Angel, which aims to help drones pilots fly safely and legally in the UK. It contains a map that shows hazards and or restrictions in the air or on the ground, called "zones", and reminds users not to go in the zones. It only shows the airspace information

in the UK, which is the main limitation [12].



# 4. 3. 2 B4UFLY

It is an easy-to-use smartphone app that helps unmanned aircraft operators determine whether there are any restrictions or requirements in effect at the location where they want to fly. Key features of the B4UFLY app include: (a) a clear "status" indicator that immediately informs the operator about the current plan or location, (b) information on the parameters that drive the status indicator, (c) "Planner Mode" for future flights in different locations, (d) informative, interactive maps with filtering options, (e) links to other FAA UAS resources and regulatory information [13].

To use the app you need to pin your location and it will inform you if you are in a restricted zone. It will not inform you if you are in a restricted zone in real time while your are flying the drone. A solution that is integrated into the drone itself or the remote control would fit our requirements better.

# **B4UFLY Mobile App**

B4UFLY is available for free download in the App Store <sup>□</sup> for iOS and Google Play store <sup>□</sup> for Android.

B4UFLY is an easy-to-use smartphone app that helps unmanned aircraft operators determine whether there are any restrictions or requirements in effect at the location where they want to fly.

Key features of the B4UFLY app include:

- A clear "status" indicator that immediately informs the operator about the current or planned location. For example, it shows flying in the Special Flight Rules Area around Washington, D.C. is prohibited.
- · Information on the parameters that drive the status indicator
- A "Planner Mode" for future flights in different locations
- Informative, interactive maps with filtering options
- Links to other FAA UAS resources and regulatory information

For more information, view the B4UFLY Q & A (PDF).

# Appendix

[1] Priv.gc.ca. (2018). Drones in Canada. [online] Available at:

https://www.priv.gc.ca/media/1760/drones\_201303\_e.pdf [Accessed 28 May 2018].

[2] CBC. (2018). Why it's hard to stop a peeping drone / CBC News. [online] Available at:

http://www.cbc.ca/news/technology/why-it-s-hard-to-stop-a-peeping-drone-1.2743927 [Accessed 28 May 2018].

# [3]

Best - Bury Freld Note Q: Current lows regarding where can fly drives A: Not an private property. A few restricted areas. " A part is your best bet . Q: Do a know any existing ways to team people of A: "Not for any of the drives we sell." Q: How long does it take to learn how to fly drones proficienty? A: "Depending on the drone it usually takes a comple sussions to learn " Q: le drone popular right nou? How many paople by them? A: Many of people buy them, the popularity keeps increasing.

[4] thestar.com. (2018). *Drone hit commercial plane approaching Quebec City / The Star*. [online] Available at: https://www.thestar.com/news/canada/2017/10/15/drone-collides-with-commercial-plane-in-quebec-city.html [Accessed 28 May 2018].

[5]Westoll, N. (2018). 2 injured after near 'mid-air collision' involving Toronto Porter flight, possible drone.
[online] Global News. Available at: https://globalnews.ca/news/3065891/2-injured-after-near-mid-air-collision-involving-toronto-porter-flight-possible-drone/ [Accessed 28 May 2018].

[6]National Post. (2018). *The drones among us: Reports of drone-related incidents are going up and up and up.* [online] Available at: http://nationalpost.com/news/canada/the-drones-among-us-reports-of-drone-related-incidentsare-going-up-and-up [Accessed 28 May 2018].

[7]Cbc.ca. (2018). *Calgary man criminally charged for flying drone near airport*. [online] Available at: http://www.cbc.ca/news/canada/calgary/calgary-man-drone-airport-criminal-charge-1.3413818 [Accessed 28 May

2018].

[8]Tc.gc.ca. (2018). *Flying your drone safely and legally - Transport Canada*. [online] Available at: http://www.tc.gc.ca/eng/civilaviation/opssvs/flying-drone-safely-legally.html [Accessed 28 May 2018].

# Fly your drone:

- below 90 m above the ground
- at least 30 m away from vehicles, vessels and the public (if your drone weighs over 250 g and up to 1 kg)
- at least 75 m away from vehicles, vessels and the public (if your drone weighs over 1 kg and up to 35 kg)
- at least 5.5 km away from aerodromes (any airport, seaplane base or area where aircraft take off and land)
- at least 1.8 km away from heliports or aerodromes used by helicopters only
- outside of controlled or restricted airspace
- at least 9 km away from a natural hazard or disaster area
- away from areas where its use could interfere with police or first responders
- during the day and not in clouds
- within your sight at all times
- within 500 m of yourself
- only if clearly marked with your name, address and telephone number

## [9] Drone regulations given by police



outineOrders	Page 2 of 3
Unmanned aircraft systems (UAS), also referred to as unmanned aerial vehicles (UAV), remotely pil (RPAS), or, 'drones', offer tremendous opportunities in the recreational, commercial and public safet represent serious public safety and nuisance concerns. As the number of UAS in Toronto airspace incidence of unlawful flying occurrences reported to the Service. Across Canada, numerous accour interfering with civil aviation and emergency response efforts, as well as causing personal injury and	loted aircraft systems by realms, but can also continues to grow, so too will the its have been reported of UAS committing privacy violations.
Service members are encouraged to visit the Transport Canada website and familiarize themselves to UAS - (https://www.tc.gc.ca/eng/civilaviation/opssvs/flying-drone-safety-legally.html).	with the laws and regulations related
Members should note that there are only two circumstances under which a person may lawfully ope	erate a UAS in the City of Toronto:
1. Commercial operators, including academic research and public safety operators.	
<ul> <li>Must hold a Special Flight Operations Certificate (SFOC) issued by Transport Canada and ha of conditions with which the holder must comply and may be less restrictive than those imposi</li> </ul>	ve it present. The SFOC details a list ed upon recreational operators.
2. Recreational operators are the ones most likely to be encountered by Service members.	
<ul> <li>On 2017 March 16, Transport Canada enacted an Interim Order (in advance of revised regula Canadian Aviation Regulations (CARS) that specifically outlines the requirements that recreat</li> </ul>	ations due in June, 2017) under the tional operators must comply with;
<ul> <li>The Interim Order applies to UAS having a total weight of more than 250 grams (0.55 pounds pounds);</li> </ul>	s) but not more than 35 Kg (77.2
Contravention of the conditions contained within the Order could result in fines of up to \$3000	D.
The Interim Order states that a person must not operate a UAS:	
At an altitude greater than 300 feet above ground level (AGL);	
<ul> <li>At a lateral distance of less than 250 feet (75m) from buildings, structures, vehicles, vessels, spectators, bystanders or any person not associated with the operation of the aircraft;</li> </ul>	animals and the public including
Within 9 km of the centre of an aerodrome;	
Over or within the security perimeter of a police or first responder emergency operation site;	and
Over or within an open-air assembly or persons, at hight, or in cloud.	
In addition:	
<ul> <li>A person must not operate more than one UAS at a time;</li> </ul>	
<ul> <li>The owner's name, address and telephone number must be clearly visible of the original of the original telephone for telepho</li></ul>	operator.
<ul> <li>The UAS must be operated within the of sign and no greater that could be the City of Toronto.</li> <li>Recreational UAS operation is not permitted within the majority of the area in the City of Toronto.</li> </ul>	The Site Selection Tool,
(https://www.nrc-cnrc.gc.ca/eng/solutions/collaborative/dvdas/dav_site_selection_locartain/, edua recreational UAS operation, provided that the remaining conditions contained in the Interim Order	are met.
After consultation with Transport Canada, Emergency Management and Public Order (EMPO) ha and enforcement mechanism undertaken by the Service should be as follows:	is determined that the interim reporting
<ul> <li>Complete a general occurrence "Unmanned Aircraft System" that includes as much informa information, a detailed description of the UAS in question and the altitude and duration of the</li> </ul>	ation as possible, including the operator's ne flight;
<ul> <li>Business Change Management has created a Study Flag in VDX Production called "UA Un the occurrence. EMPO will complete a Transport Canada UAS Incident Report Form;</li> </ul>	manned Aircraft System". Based upon
<ul> <li>Transport Canada will make a determination regarding the type of enforcement action to be</li> </ul>	e taken;
<ul> <li>This mechanism does not preclude a police officer from initiating enforcement action pursu Provincial Offences Act offence if it is in the immediate public interest (e.g., Voyeurism s.16 to Property Act, etc.).</li> </ul>	ant to an obvious Criminal Code or 52 C.C., Mischief s 430 (1) C.C., Trespass
This is an evolving issue and the Service response to UAS incidents will likely also evolve in an Federal Government will establish mechanisms that will facilitate a full spectrum of enforcement agencies. Until that time, education and awareness should resolve most potential recreational exercise reasonableness, proportionality and common sense when dealing with UAS incidents.	iterative manner. In the future, the options available to local police JAS infractions. Service members should
Any questions regarding UAS may be directed to Staff Sergeant Craig YOUNG (6145). Emergen	ncy Management and Public Order at 👂
Per Ememony Management and Public Order	416-508-4910

[10]L. Mckinney, "5 Awesome Ways People Are Defeating Drones", Cracked.com, 2018. [Online]. Available: http://www.cracked.com/blog/5-killer-ways-you-can-take-down-drone/. [Accessed: 29- May- 2018].
[11]"Robin Radar System", Robinradar.com, 2018. [Online]. Available: https://www.robinradar.com/wp-content/uploads/2018/01/RobinRadar\_brchr\_Dronedetectie.pdf. [Accessed: 29- May- 2018].
[12]"NATS Drone Assist: helping you to fly safely on the App Store", App Store, 2018. [Online]. Available: https://itunes.apple.com/ee/app/nats-drone-assist-helping-you-to-fly-safely/id1172916055?mt=8.
[Accessed: 29- May- 2018]. [13]"B4UFLY Mobile App", Faa.gov, 2018. [Online]. Available: https://www.faa.gov/uas/where\_to\_fly/b4ufly/.[Accessed: 29- May- 2018].[14]



	Homeowners	
High interest	Airfields and airport	Drone Pilots
ingn interest	Drone law regulator	Dione i nots
	People who deal with accidents and emergencies	
Low interest	Drone manufacturer	Police
	Low influence	High influence