Commercial Drones Are Coming - Sooner Than You Think?

Abstract

Drones have arrived and have quickly become a part of everyday life. However, given the relative nascency of commercial drones, there remains to be an established set of players providing the underlying infrastructure and marketplace for supporting them. This paper builds upon the hypothesis that drones will continue to expand their role in our lives, providing an exploration and analysis surrounding several opportunities to build a profitable underlying ecosystem for drones. In addition, we examine existing markets that may be potentially disrupted by the increased ubiquity of drones, as well as potential challenges for drones as they become more commonplace.

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Main Hypothesis and Topic

Drones are quickly becoming omnipresent in our lives. There are already a variety of use cases for them, such as: military, agriculture, law enforcement, natural resources, entertainment, commerce/delivery and hobby usage. Drone usage will continue to evolve and infiltrate other parts of our lives. Along the way, existing markets and economies will evolve and shift as they begin to adapt to public acceptance and government regulation that will help accelerate the ubiquity of drones. In this paper we first describe and survey the current drone market. We then explore commercial drone opportunities and fiscal outcomes due to drone growth. This paper then outlines several challenges and risks that drone expansion in our lives will face, including government and geopolitical hurdles.
Introduction

A Brief History of Drones

The origin of drones can be traced back to middle of the 19th century when the Austrian military attacked the enemy Italian city of Venice using balloons laden with explosives, but being entirely at the whim of the wind, a dangerously unpredictable flight-path saw many explode over Austrian territory. In 1898, inventor Nikola Tesla displayed a small unmanned boat that appears to change direction on verbal command. He used RF to change the course of the boat. In 1915, he gave a dissertation on using armed pilotless aircraft capable of defending US.

Drones similar to the one’s used today started showing during the WW II. Image below captures a brief history of drones.

In 2005, drones started entering the consumer market space and the FAA came up with a memorandum of interim policy, which approved the use of domestic drones and helped drone operators fly at the same standard as pilots.

In the following years the FAA restricted that policy and made it a requirement to have a certificate of authorization by FAA to fly drones. This applied to companies, government agencies and universities. This slowed down the commercial applications as very few authorizations were issued. In 2012, Congress enacted FMRA (FAA Modernization and Reform
Insights in Engineering Leadership White Paper

Act), which requires FAA to devise a plan to accelerate and successfully integrate drone usage in the airspace by Fall 2015.

Drones/UAV Classification

The table below covers the varying segments of drones and their characteristics:

<table>
<thead>
<tr>
<th></th>
<th>Close Range (UAV - CR)</th>
<th>Short Range (UAV - SR)</th>
<th>Long/Endurance Range (UAV-E)</th>
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<tr>
<td>Range</td>
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<td>&lt; 125 miles</td>
<td>&gt; 125 miles</td>
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<tr>
<td>Endurance</td>
<td>30 min - 2 hrs</td>
<td>8 -10 hrs</td>
<td>&gt; 24 hrs</td>
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<td>Weight</td>
<td>2 - 10 lbs</td>
<td>&lt; 10,000 lbs</td>
<td>&lt; 200,000</td>
</tr>
<tr>
<td>Speed</td>
<td>&lt;50 mph</td>
<td>&lt; 300 mph</td>
<td>&lt; 450 mph</td>
</tr>
<tr>
<td>Altitude</td>
<td>&lt; 1000 ft</td>
<td>&lt; 50,000 ft</td>
<td>&lt; 65,000 ft</td>
</tr>
<tr>
<td>Pay Load</td>
<td></td>
<td>&lt; 3800 lbs</td>
<td>&lt; 1900 lbs</td>
</tr>
<tr>
<td>Cost</td>
<td>$500 - $1500</td>
<td>&lt; $8 Million</td>
<td>~ $100 Million</td>
</tr>
</tbody>
</table>

What’s in a name?

Industry proponents prefer to use the term UAV (Unmanned Aerial Vehicles) or UAS (Unmanned Aerial Systems) instead of drones. There are two main factors driving the shift in terminology:

- Degree of autonomy: Drones being used today are far more autonomous and hence the drone industry wants to create a distinction between sophisticated and unsophisticated drones.
- Connotation: The term drones invokes a negative connotation because it has been used heavily in context of wars. As the industry for commercial application they are seeking to the term UAV/UAS.

For the purpose of this paper we have used the term interchangeably.

Applications and opportunities

Current Applications for Drones

Commercial Drones Are Coming - Sooner Than You Think?
Although drones have been around for sometime, due to FAA regulations and technology limitations, adoption of drones for commercial applications has been a slow. In the following sections we describe the most visible and profitable market segments for drones.

**Military**

![Trend & Forecast of World](http://www.lucintel.com/LucintelBrief/UAVMarketOpportunity.pdf)

![Trend & Forecast of US](http://www.lucintel.com/LucintelBrief/UAVMarketOpportunity.pdf)


FAA regulations will ease out and drones will see wider adoptions in other market, but as can be seen in the graph military will continue to account for the bulk of UAV/Drone demand as it becomes a vital component of national security.
Hobbyists UAV
Hobby drones can be easily purchased today and they range in cost from several hundred to several thousand dollars. Their adoption in the market has seen a steady increase in the last few years. Hobbyists represent the early adopters of the technology, and as the technology matures this market will see further growth, but it will be outpaced by other upcoming applications which are discussed in the following sections.

New opportunities for Commercial Drones

From construction site surveys to Hollywood films, drones are becoming more and more of a ubiquitous part of everyday life. Currently, many businesses operate drones behind the scenes to provide non-consumer facing services. But Drones are being utilized at a fraction of their potential. There are various additional opportunities for businesses to provide drone based services both for other businesses and directly to the consumer. Drone based services will not only replace current practices with lower cost alternatives that provide better results, but will also create new sectors around services that were previously not possible. This shift will create winners and losers as businesses and the regulatory framework they operate within adapt to the new dynamic realities brought forth by cheaper and better drone technology.

- Delivery Drones - One of the most widely talked about commercial drones is for freight transport or package deliveries. Amazon made a big splash when they announced Amazon Prime Air in December 2013 with the stated goal of reducing shipment times to 30 minutes from nearby distribution centers. DHL initiated a pilot program in Sept 2014 to perform parcel deliveries in Germany to reach remote locations near the North Sea. Google’s “Project Wing” has been testing delivery drones in Australia. UPS is also researching delivery drones, and according to articles, they are considering using drones to move packages between distribution centers and airports to distribution center.

- Agriculture monitoring - This is a prime industry that can greatly benefit by using drones to monitor irrigation, planning harvests, monitor crop health, livestock and so on. Additional usage of drones in agriculture is a low-risk application since farms are sparsely populated with scant air-traffic over vast amounts of private property.
• Oil and gas - This is another industry where pipelines must be monitored in remote areas. Ordinarily, this monitoring is labor intensive and requires many resources if it has to be done manually. Furthermore, there are risks involved in manual monitoring since aircraft need to fly low in order to survey. In June 2014, the FAA approved BP and AeroVironment (a drone manufacturer) to use drones to conduct aerial survey of pipeline, roads and equipment in Prudhoe Bay, Alaska.

• Law Enforcement - Usage of drones by law enforcement agencies has been a controversial topic - 35 law enforcement agencies have been received a certificate of authorization from FAA. There have been cases where drones were used by the FBI during a hostage standoff for surveillance during the night. Drones have also been used for surveillance of public places. Recently the Governor of California, Jerry Brown, shot down the warrant requirement for law enforcement drones.

• Disaster management - This is an area which can greatly benefit from usage of drones, especially when an area becomes unreachable due to an earthquake, tsunami or hurricane. When these occur, drones can be used to deliver medical supplies or use heat sensors to locate buried or trapped humans. Drones can also be used to detect hidden heat or fire sources not easily visible from the ground. The FAA recently approved Equsearch to use drone for a search and rescue operation in Texas to locate a missing woman.

• Entertainment, Media, and Mapping - Drone mounted video cameras have already been used in movies shot mostly outside of the US. Disney has applied for patents to use drones for aerial light shows instead of fireworks. Last year three members of a film crew were killed in a helicopter accident during the making of a reality TV show. Recently, the FAA has given exemptions to Hollywood production firms to use drones.

• Networking for remote areas - Google’s “Project Loon” has the goal to provide internet access to remote parts of the world. They acquired Titan Aerospace which makes solar powered high altitude drones. Facebook has setup a connectivity lab which is aligned with the internet.org initiative with the goal to provide internet connectivity.
across the globe using technologies which include high altitude long endurance aircrafts (HALE).

- Service sector - performing manual service inspections on bridges can be risky, require a lot of resources, and can take a lot of time. There are many other similar applications such as EasyJet, which is partnering with Bristol Robotics Lab to build drones fitted with visual sensors that can scan aircrafts between flights faster and more efficiently. The drones can move around the plane easily without the need for ladders or cranes, and the inspection flight path can even be autonomous.

**Summary and overview of commercial drone opportunities**

Over the next decade, the global drone market is projected to be around $98 billion, out of this the commercial drone market is estimated to be around 12% as shown in the chart below. It appears that the FAA will miss the 2015 deadline set by Congress, it is expected that the regulations will be in place by 2016. The current projections are that by 2020 the commercial aerial drone market will quickly ramp up.

![Global Aerial Drone Market Chart](chart.png)

*Sources: Teal Group, Michael Toscano, BI Intelligence Estimates*
We expect that the following applications will be where we will see an rapid adoption of drones -

- **Agriculture** - We believe that precision agriculture will be the largest of growth. The expectation is that sales will hit about 130K unit in the next decade. Drones will be used to monitor irrigation, plan harvests, monitor crop health as well as livestock. One of the factors that will facilitate this growth is that farms are sparsely populated, have little air-traffic and span vast amount of private property. The risks of operating drones in farms for these reasons is much lower.

- **Parcel Delivery** - This is a large market - $220B and many players are already experimenting with Drones. UPS, FedEx, DHL, Google and Amazon have publicly announced programs to pilot drones for delivering packages. They also have formed a lobby in US to push their agenda and outside US there are pilots in progress.

- **Law Enforcement** - The private security market is about $350B and is expected to grow 21% through 2020. There are 2M full-time security workers (source: ASIS and Institute of Finance Mgmt). This sector will use drones for preventive measures as well as monitoring private property. In the public sector cities are cutting back on law enforcement personnel, in order to maintain the same level of law and order.

- **Technology** - There are various startups which are building hardware, software and cloud services for Drones. These companies are building end-to-end solutions which can be deployed easily and provide mechanisms to use data collected by drones. MIT, DARPA, USAF have research projects to build high endurance UAV charging solution.

### Challenges and Risks

This disruptive shift towards a world with drones will have some negative consequences. As productivity increases, fewer employees will be needed in the short term as drones slowly replace their current functions. Certain service jobs, delivery jobs, pilots, surveyors, and others will see demand for their skills decrease sharply. When commercial or personal drones become ubiquitous there are legitimate concerns around privacy especially if drones are permitted to fly over private property.

**Privacy/Drone Defence**

Drones with high resolution imaging systems could also be used by businesses to gather data about customers daily habits much in the same way instrumentation is used within websites to track dimensions and attributes describing users. Use of drones by paparazzi, law enforcement, and for corporate espionage would add further to privacy concerns.

It is very easy to buy a Drone and fit it with a camera - anyone can do this with as little as $200-300.
The U.S. Federal Aviation Administration (FAA) currently does not have proper regulations for usage of small drones. Criminals could (and have already) used drones for smuggling or to aid in thefts. This will create new kinds of illicit activities that authorities are not equipped to respond to. Integrating drones into the current regulatory framework will be a challenge.

Currently there are a few small companies that plan to build systems that combat with invasion of privacy. DroneShield is one such company and they have products which use acoustic drone signatures to detect drone and send out alerts via alarms, sms, email etc. Another company DDC (Domestic Drone Countermeasure) is building a system that can detect radio frequency (RF) transmitters to identify drones. They have a command and control system that controls detection sensor nodes. DDC had a kickstarter program to fund the effort but it was unsuccessful.

Safety/Insurance
When an unmanned drone crashes one can imagine the risk of personal injuries as well as liability damages. In Australia a drone operator crashed a drone that was taking aerial photographs at a triathlon event and a triathlete had to be hospitalized after she suffered head injuries. There was a similar incident in United States when a drone crashed into spectators at a bull run event in Virginia.

There is a wide awareness of the risks associated with operating drones and a handful of insurance companies provide drone insurance coverage. Transport Risk Management provides insurance coverage for commercial drone operators. There are about 340 operators who have purchased coverage for various uses through transport risk management. There are other companies, such as QuadCopter Insurance, which also provide similar coverage for various sectors that use drones such as film sets, real-estate, sporting events etc.

Another company that provides drone insurance coverage is Overwatch Insurance, which provides coverage for drone operators as well as drone manufacturers. Some other companies such as Nationwide Agribusiness have begun writing policies that provide coverage for drones. The policies are not a separate policy but simply an addendum to their existing policy.

Although there are many companies providing coverage, they are generally niche providers. The expectation is that once the FAA announces regulation for drone operators, there will be an explosion of drone operators and a lot of them will be looking for underwriters. This is also expected to become more important as operators start to grow their fleets and invest large amount of money on drone.

Geopolitical / War
One of the most well-known use cases historically for drones has been that of military use, in particular for targeted assassinations. The General Atomics MQ-1 Predator drone¹ has been

used by the United States Air Force and the CIA to carry out such missions. Squadrons of
drones have operated worldwide across locations including Afghanistan, Pakistan, Iraq, Yemen
and more.
Despite the debatable success or military drone programs, the liberal application (and legality)
of drone warfare has come into question. In perhaps the most notable paper on usages of
drones in interstate warfare, NYU Professor Philip Alston outlined in his 2010 report\(^2\) to the
United Nations Human Rights Council, that a targeted killing is “intentional, premeditated and
deliberate use of lethal force, by States or their agents acting under colour of law, or by an
organized armed group in armed conflict, against a specific individual who is not in the physical
custody of the perpetrator.” Moreover, Alston questioned “Whether or not a specific targeted
killing is legal depends on the context in which it is conducted: whether in armed conflict,
outside armed conflict, or in relation to the inter-state use of force.”
Interestingly, his paper does not draw a conclusion as to whether using drones for targeting
killings is lawful or not. Drone usage for warfare has become commonplace, however, the
debate as to whether or not the usage for killing others for the purpose of political gain is
lawful or not - this seems to be still up for debate.

**Hacking/Security**
Drone hacking is a very real and tangible risk, with hackers interested in the drone as well as
the payload of a delivery drone. The “skyjack” hack created by security analyst Samy Kamkar
takes control of a drone by disconnecting the original controller of the drone using Wi-Fi
network commands. There have been other hacking exploits that involve jamming GPS or GPS
spoofing to confuse the drone’s navigation system.

DARPA has announced that it has developed software that makes drones hack-proof; this is
primarily targeted at the military drones. One could imagine similar solutions could be
developed for commercial drones, however there is not a lot of work actively going on in this
area.

**Govt Regulation**
- ACLU [https://www.aclu.org/blog/tag/domestic-drones](https://www.aclu.org/blog/tag/domestic-drones)

There are several theories on what government regulation may come in the future with respect
to drones. Michael Berry and Nabiha Syed of the Washington Post\(^3\) suggest that the United
States government will seek to regulate drones in the following ways:
1. Regulating operators of drones by mandating government “licenses” to operate
2. Regulating various dimensions in terms of how, where and when drones are operated

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3. Regulating the purpose of drone operation, ie, drones cannot be used for certain uncertified commercial aspects, yet are free for hobby-oriented operation
4. Regulating photography and filming of certain property from the drone
5. Restricting malicious or surreptitious usage of drones. For example, drones should obtain permission to fly over private property and must not be attempted to be masked by camouflage or otherwise hidden from sight.

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Appendix

Drone Adoption Curve

The following chart captures the natural “S” curve growth for number of drones for the public and commercial sectors. This points to the fact that currently it is mostly the innovators that are in the market trying to build products.

Hype Cycle

The following chart shows that drones are in the innovation trigger phase in the technology hype cycle. Technologies in this phase have a lot of media buzz and there are a handful of companies that are experimenting or piloting the technology.

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4 United States Air Force - http://1.usa.gov/1aKtQv8
5 Gartner - http://www.gartner.com/newsroom/id/2819918
National rankings consistently place UC Berkeley’s undergraduate and graduate programs among the world’s best. Berkeley is home to top scholars in every discipline, accomplished writers and musicians, star athletes, and stellar scientists—all drawn to this public university by its rich opportunities for groundbreaking research, innovative thinking and creativity, and service to society.