MS&E 238: LEADING TRENDS IN INFORMATION TECHNOLOGY

Team Droud

José Ruggiero

Pedro Vázquez

Enrique de Muguerza

Index

1. Introduction

When we talk about UAVs, or Drones as commonly known, we are basically referring to an aircraft without a human pilot on board. If we go to the US Department of Defense, we can find a more technical definition of UAVs; “powered aerial vehicles sustained in flight by aerodynamic lift over most of their flight path and guided without an onboard crew”. Overall, this “vehicles” without pilots, were first thought for military purposes only, and for many years it remained as the only use for drones. The first drone ever used was on February 4, 2002, by the CIA with a military purpose, as stated in the article “A Brief History of Drones” by John Sifton. Nevertheless, as technology began to arise and rapidly evolve through time, people started to realize that UAVs had many more uses than only in the military, and that it was foolish not taking advantage of how technology and the use of drones was evolving. It became clear that UAVs could be used for commercial uses as well as for military uses.

Even though one can say that the technology for using drones for many purposes nowadays exists, along with it came a lot of restrictions and barriers that make the “Drone Era” not so clear and around the corner. A lot of these limitations include many law regulations that still need to be sorted out, battery life, among others. In the following pages we will get into the technical aspect of how drones work, what are their limitations nowadays and what can we expect of these limitations in a near future. Also, we will discuss many of the applications of drones in both commercial and military purposes, and also the advantages and disadvantages that they may have.

Drones alone have a lot of uses both military and commercial, but are best taken advantage from when connected to the cloud, as we will discuss in the following pages of this paper. Cloud computing has become a solution nowadays for lowering costs for many companies and also managing data in a more efficient way. We will discuss how connecting drones to the cloud will be a huge advantage for all UAVs applications.

2. How Do Drones Work?

Unmanned Aerial Vehicles (UAVs) are usually deployed for military and special operations, but are used more commonly each time in commercial operations. As the lector may imagine, there exists a huge variety of UAVs ranging from copters to balloons, passing over planes and any other form of flying mechanism. In an attempt to summarize all these differences, we draw the following table:

Category	Acronym	Range (km)	Autonomy (h)	Height of flight (m)	Maximum load (kg)
Micro (<250 gr)	Micro	<10	1	250	<5
Mini (<25 kg)	Mini	<10	<2	150 y 300	<30
Close Range	CR	10 a 30	2 a 4	3000	150
Small Range	SR	30 a 70	3 a 6	3000	200
Medium Range	MR	70 a 200	6 a 10	5000	1250
Low Altitude	LADP	>250	0,5 a 1	50 a 9000	350
Medium Altitude	MRE	>500	10 a 18	8000	1250
Low Altitude Long Endurance	LALE	>500	>24	3000	<30
Medium Altitude Long Endurance	MALE	>500	24 a 48	14000	1500
High Altitude Long Endurance	HALE	>2000	24 a 48	20000	12000
Combat	UCAV	1500	2	10000	10000
Offensive	LETH	300	3 a 4	4000	250
Decoy	DEC	500	4	5000	250
Stratospheric	STRATO	>2000	>48	2000 y 3000	NO

EXO-Stratospheric	EXO	NO	NO	>30000	NO

Table 1: Different categories of UAVs.

Said so, we can imagine the titanic task that consists in evaluating and explaining all the different types of hardware. Nevertheless, when we walking through this project, a careful reader, can notice that it is mainly focused on planes and quadrotors. These forms of UAVs are between the most developed in today's applications and are often heard of.

Quadrotors

A quadrotor is UAV classified in the Mini category, though depending on the size, it can be as well considered as Micro. The name for this type of drone is pretty straight-forward and comes from *quad* (standing for four) and *rotors*. For a non-technological reader, rotors are referred as motors.

The main components of quadrotors are the frame, the control board, the batteries, the electronic speed control (commonly referred as ESC), the rotors and the propellers.

To understand this properly, we proceed to place them in an image:

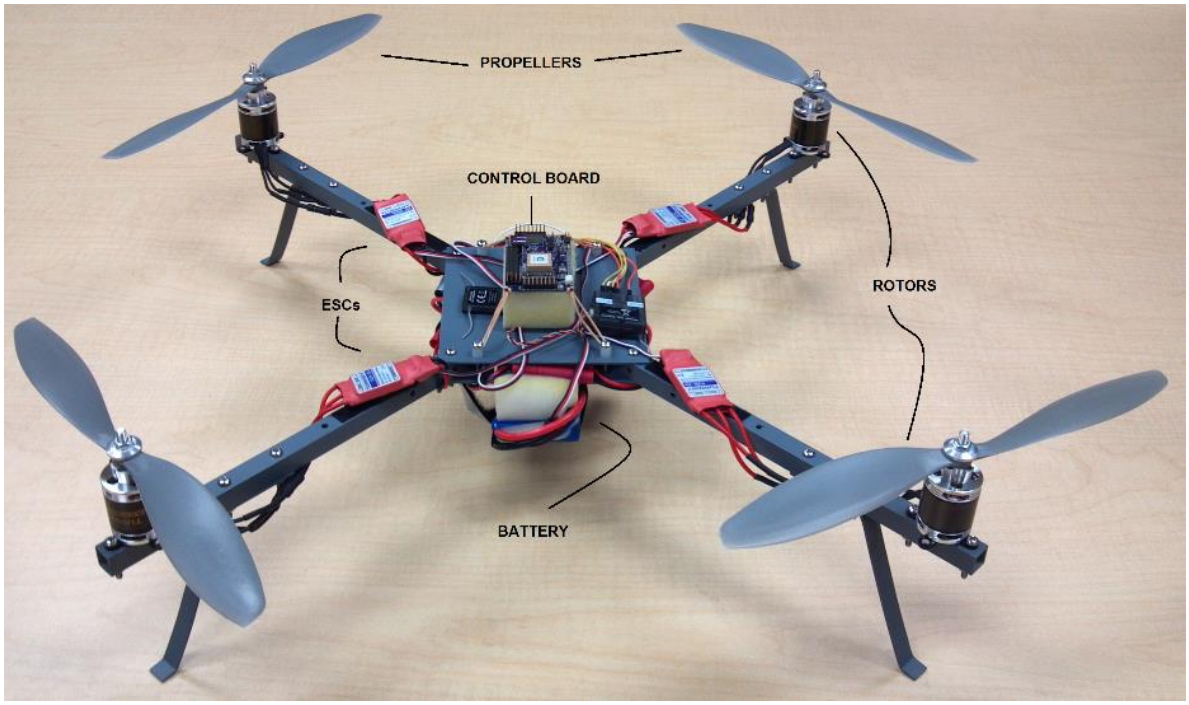

Figure 1: Main components of a quadrotor.

We will as well need a system of control. For this type of devices that are Close Range, we will certainly use Radio Control. The signal is actually codified and modulated as PWM (although it is called PPM by the experts of RC). This type of modulation allows the user to interfere directly in the four parameters of control for a quadrotor. These four parameters are know as *Pitch*, *Roll*, *Yaw*, and *Throttle* and are controlled in the following way:

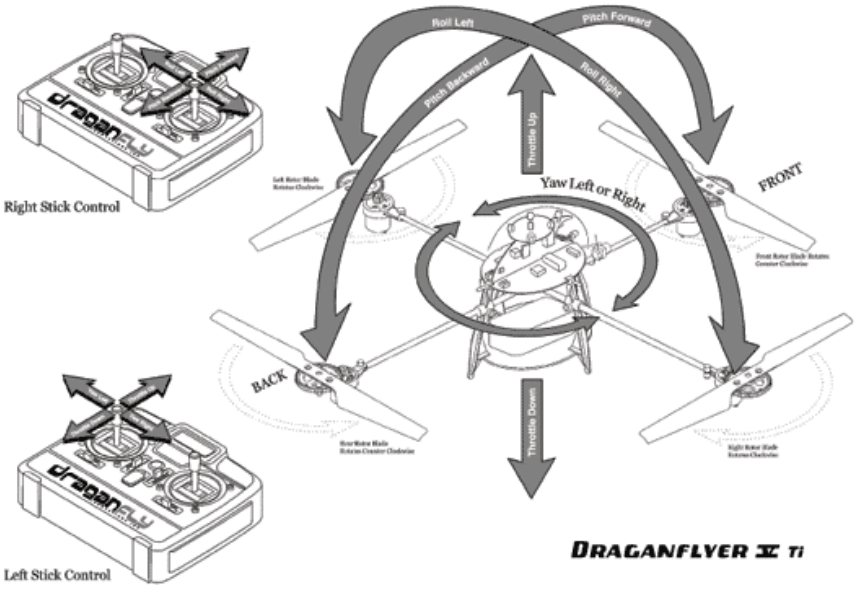

Figure 2: How a quadrotor is controlled.

At this point, software is almost universal for a quadrotor. Any user is able to find hundreds of variations of codes and is able to introduce the little variations he will consider. The most used platform for the control board is Arduino though we can find a lot more platforms.

Planes

As a quadrotor, planes are usually classified as Mini, but they can as well be in a lot of other categories depending on their size and their purpose. Truth is, UAVs as planes have been long used in militaries and are starting its path in commercial use. It is not as easy to identify the different parts of a plane, since it is composed mainly by a frame. In the following image, we can appreciate this fact:

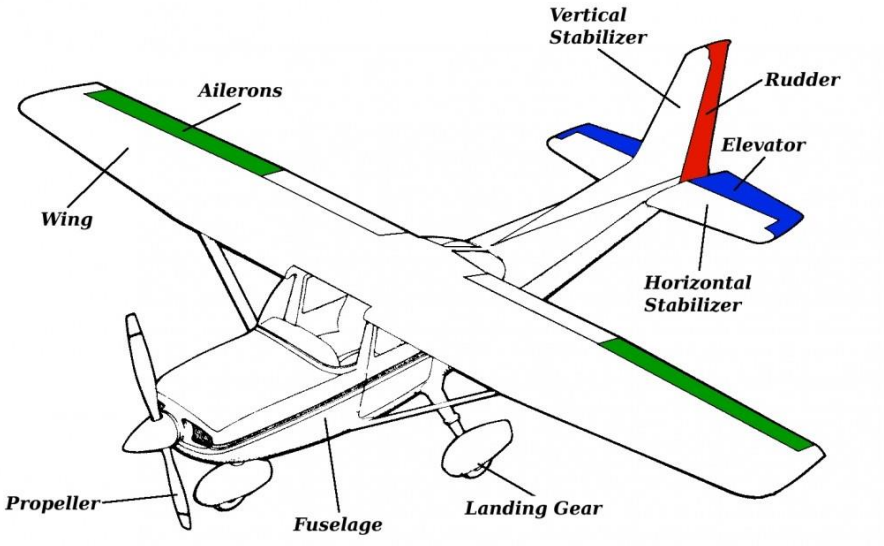

Figure 3: Main components and control of a RC plane.

Usually, a plane has the same type of control input as a quadrotor does, as we can see in the image above. Though the commands are called in a different way (*Throttle*, *Aileron*, *Rudder* and *Elevator*), they are pretty much the same. We can see the influence of the different controls in the following table:

Command	*Plane response*
Throttle	Increase/decrease front propeller's speed.
Elevator	Plane's nose ups or downs.
Aileron	Rolls the plane left or right.
Rudder	Gives direction to the plane.

Table 2: Use of commands and plane response.

As for quadrotors, a ton of variations of software can be found on-line and for different control boards characteristics even though planes are usually bought as a whole and software is commonly included.

3. Limitations

3.1. Batteries

By definition, flight autonomy is the amount of time an UAV can flight without landing due to lack of power. There is a compromise between flight autonomy and load capacity, because the more amount of load the UAV is supporting, the less time it can flight. To calculate the flight autonomy is necessary to considerer different factors also, such as the type of engine, the aerodynamics, the weight, wind, and the kind of shunting the UAV has to do. Hence, the UAV flight autonomy is very limited, getting rarely flight times longer than 60 minutes.

To consider the flight autonomy, it is necessary to considerer the battery. It is possible to differentiate two groups of battery, commercial and military batteries. Depending of the commercial application it is possible to find different types of batteries. One of the most common batteries we can find for commercial UAVs is a Lithium Polymer battery, which provides around 2Ah of service to the UAV. The reasons this battery is one of the best ones for commercial applications is because it is light, 130gr, small, 72x36x27mm, and cheap, around $80, being this measures the standard's. With this battery it is possible to get one hour of autonomy with an engine that needs 2A to work, getting autonomy approximately for 25 minutes if we consider regular conditions, 5mph wind with no load capacity.

Figure 4: Regular Lithium Polymer Battery.

Another kind of battery inside the commercial applications is the Lithium Sulphide battery. The standard battery for this kind of battery has a nominal capacity of 2.2Ah, being lighter, 15gr, and smaller, 55x37x11mm than the Lithium Polymer battery, but being $100 more expensive than the previous one. With this kind of battery it is possible to get a little more amount of time than with the Polymer Battery, between 25min and 30min.

Figure 5: Lithium Sulphide Battery.

On the other hand, one of the challenges in the military field is to reduce the battery weight and size. Investing in a higher density battery, instead of using a regular battery, will allow the UAV to have the same amount of power in a smaller battery, helping the soldier to be more agile and going further in the field. Also, cutting in half the battery pack by increasing the energy density, the soldier will be able to carry other equipment or system that was not possible before. This is the reason the military batteries are different than the commercial batteries. The two types that are most popular in military applications today are Lithium/Sulfur Dioxide (Li/SO2) and Lithium/Manganese Dioxide (Li/MnO2). The life expectancy for this kind of batteries is between 30 minutes and 2 hours, depending of the use of the motor, the control of the UAV, the use of the radio and others equipment. In addition, the military field is studying other kind of materials such as Lithium/Polycarbon Monofluoride (Li/(CF)x) that is a potential next-generation improvement for the battery life time.

To manage the density battery, we have to considerer two factors, the number of watt-hour per kilogram and the number of watt-hour per litter. Here is possible to see a comparison of the materials listed above:

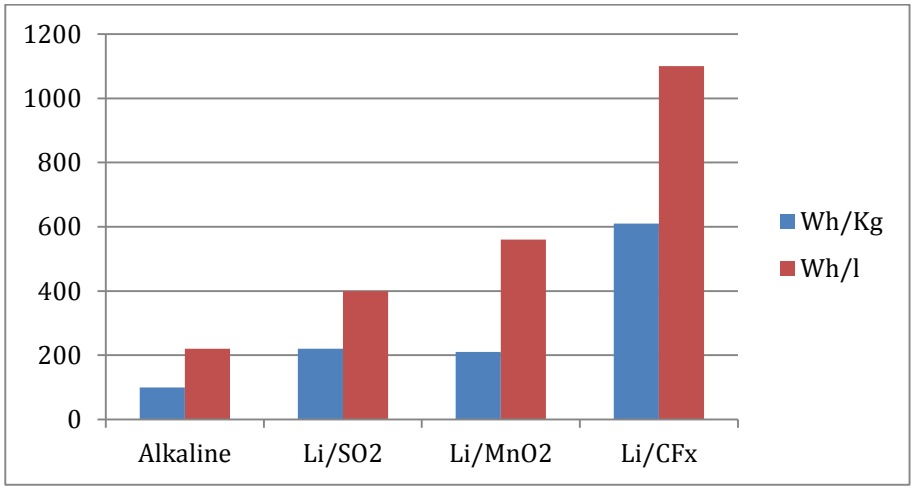

Figure 6: Density comparison in batteries.

The more the density battery, the better the battery life is. Considering this energy density, it is possible to obtain about 11.5Ah of service with a Manganese Dioxide's battery, which is an improvement respect the 7.5Ah of service we can get with a Sulfur Dioxide's battery. As we can see, the Polycarbon Monofluoride is a technology advance to this type of batteries.

In conclusion, it is necessary to research about the battery it is needed for the UAV considering its necessities. As we can see, the high military technology is prepared for specific UAVs, where the money investment can save lives. For the commercial applications it is better to considerer simple batteries, where it is possible to save money.

3.2. Regulation

The UAVs are an element of the Unmanned Aircraft Systems (UAS), which are regulated by the Federal Aviation Administration (FAA). The first time the FAA authorized the use of unmanned aircraft in the National Airspace System (NAS) was in 1990. Today, UAVs are still flying under very controlled conditions.

In order to operate an UAV in the USA it is necessary to acquire a Certificate of Authorization (COA) through the FAA. Currently, these certificates are only granted to federal, state and local government agencies, and restrict flying to specified areas. In the United States, every commercial must satisfy the following basic rules for every application among the requirements of each COA can specify:

1- UAV has to maintain the flight below 400ft.
2- UAV must be operated only during the daytime.
3- UAV must be seen and maintain it inside the visual line of the operator
4- UAV must be further than 5 miles from the closest airport.

According to the FAA, there are different Aircrafts Operations limits that every user has to respect. As a commercial UAV, the aircraft must be flown strictly for hobby or recreational use and must be operated in accordance with a community-based set of safety guidelines and within the programming of a nationwide community-based organization. Also, the aircraft is limited to weight not more than 25kg unless otherwise certified through a design or inspection and in this case must be approved by a community-based organization. Finally the aircraft must be operated in a manner that does not interfere with and gives way to any manned aircraft.

However, the FAA is not even permitted to regulate airworthiness or pilot qualifications. The FAA can only regulate public aircraft insofar as they interact with all other aircraft, whether civil or public. In other words, the FAA can only legally regulate public aircraft to extend that they comply the regulation.

On the other hand, personal UAVs Aircrafts don't require FAA approval to fly an UAV as a hobby, but the user must follow safety guidelines. The first guideline a user must follow is to avoid doing anything hazardous to other airplanes or people and property on the ground. It is convenient for the user to take lessons to learn how to fly safely and to learn what the Aircraft safety rules are.

4. Connecting UAVs to the Cloud

Why connect UAVs to the Cloud?

UAVs can have many applications not only in the military, which was the field where it all started, but also for commercial purposes, such as maintenance and prevention in industries like oil and gas, agriculture and Amazon Prime Air. In industries such as oil and gas drones can be used to detect and prevent leaks, and basically gathering data so that it can be analyzed and then used to make better choices that would help to save money and improve productivity. The same happens with agriculture, and even the aircraft industry where UAVs can also be used to perform inspections. As we can see, all of these purposes for drones have similar characteristics, they all need to store and analyze data in order to achieve the final purpose, which is give and process information that can help companies be more productive and save money. For this reason, the need of connecting UAVs to the cloud is around the corner; by doing so, companies would have better and faster access to data and how to analyze it.

In the agricultural field, there are many companies that are already starting to offer solutions to farmers on how to use drones to better take care of their crops. As the article "MyAgCentral Launches Cloud-based Solution for UAV Imagery" states, the company MyAgCentral has already begun to offer cloud services for drones in the agricultural field. According to MyAgCentral, they now give farmers the tools they need to capture data from their crops, analyze it, and also share it within their entire operations. Using an App developed by the company, farmers can choose to take certain image of their crops and then submit it, and the app will then notify the farmers when there are processed, and all of this can be done from a smartphone, tablet or laptop. With this technology, farmers do not have to worry about owning the technology or how to manage it or how it does work, they just have to worry about their crops and use this information to help them improve. As mentioned before, the UAVs technology for agriculture is moving to basically companies beginning to understand what farmers need and then developing products that suit them, as we see MyAgCentral is doing. This is a win-win situation, because farmers will not have to worry about purchasing expensive specialized equipment, spend money teaching people how to use it; instead, they only rely on the services that companies such as MyAgCentral provide them.

Having access to information drones collect using the cloud, can represent a major advance in military operations, as it is explained in the article "Connecting Unmanned Vehicles to the Cloud". With the system that is being developed at the Space and Naval Warfare Center Sytems Center in San Diego, UAVs would have the capability to be controlled by different users in different locations; for example two different ships. While the information that the drone gathers is stored in the Cloud, any person using this system will be allowed to view and analyze this data in real time. In the same way, users from other ships or at shore will be able to gain control of the UAVs, while the data that it is gathering such as imagery, video, sensor readings, is stored in the cloud and available for everyone using this system. The data available in the cloud will be organized so that you can make a fast and easy query. The system will provide three types of data that all users can have access to; historical, near - real - time, and live. We can see here in this

example how UAVs can work with the cloud and help the military save money and time in its operations.

Another application in military is on the battlefield; being able to know in advance information before adversaries will definitely become a great advantage for the military. As discussed in the article "The Army Brings the Cloud to the Battlefield", data gathered by UAVs such as images and video footage could be stored and analyzed using the cloud and saving time that otherwise would have to be spent in doing it in a different way; and time in the battlefield can "mean the difference between life and death". Using this video footage, images and the cloud; the Army can use cloud-computing systems to quickly understand threats and inform commanders so they can take better decisions. According to Wylie Wong, commanders will have to deal with a large amount of data coming from specialized sensors, data that has to be analyzed, process and then send back; using cloud computing they can save all that time and provide quick answers in the battlefield. Also, using cloud-computing will bring the Army many benefits intrinsic to the technology itself, because as we know cloud-computing is a cost saving and incredibly flexible way of managing data. This is all part of a system called Distributed Common Ground System - Army (DCGS-A) which will "largely be built using cloud-based software", as the US Army states.

Having drones flying and taking pictures or collecting data is the beginning of a process that needs much more than that for it to bring significant value. All of this data needs to be stored somewhere, needs to be available easily, organized, and processed, for it to be efficient and worthwhile. This is why, the only way UAVs can be used for all the purposes mentioned before, is if they are connected to a cloud computing service that allows the users to take advantage of all the data they are able to collect. As Colin Snow states in his article "Drones Revolution Means Big Data Cloud Services", the value of this technology is added when the data collected is managed properly, and this is when companies such as Precision Hawk come to play a big role. We are going to see much more of these companies entering this field of drones and cloud computing, because as Colin mentions in his article this will probably "be a 100 billion dollar industry by the year 2025".

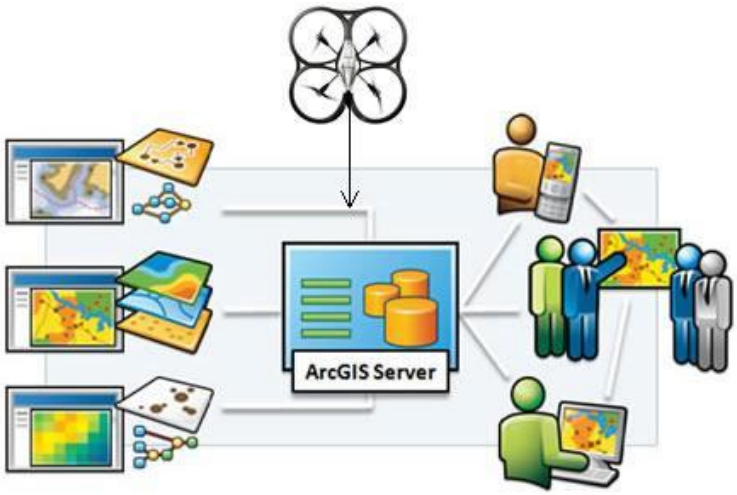

Figure 7: Structure of this concept.

5. Applications

5.1. Commercial uses

5.1.1. Use of UAVs in maintenance and prevention

Another useful application for UAVs is for maintenance and prevention purposes in different industries. One of the reasons for drones being a viable and better solution for inspection and maintenance is that it reduces the risk of humans being exposed to dangerous environments. Another reason is that UAVs can operate in certain environments that humans cannot, or maybe could but under conditions that would require higher costs and also higher risk as mentioned before. Also, drones can be equipped with different sensors and cameras that can make inspections faster and more accurate than human inspections.

One of the industries in which UAVs can be useful for maintenance and inspection is in the aircraft industry. According to the article "*EasyJet* to use unmanned drones to inspect its aircraft" posted in "The Guardian", drones could perform aircraft checks in all of *EasyJet's* fleet, which will reduce a lot of time and effort that they currently spend in doing this checks, not to mention that it could be potentially more accurate. Also, with the use of drones for this type of inspections, these companies will be able to perform more inspections in more places and therefore reduce costs by preventing future breakdowns or problems in their fleet. In the particular case of *EasyJet*, which is an airline that flies to over 138 airports, the data that they could collect from this inspections could be of great help if they could store it and have access to it in any of this locations, preventing failure of parts and reducing maintenance costs dramatically. Despite here we are only discussing the particular case of *EasyJet*, it is only one example of how many if not all airline companies can take advantage of this technology and reduce maintenance costs in their operations.

Figure 8: Logo of the company.

Another industry in which UAVs can bring many advantages and help save money, is in the Oil and Gas industry. In this type of industry, the applications are quite large, since typically a pipeline consists of hundreds of miles and many of those pipelines are located in places and environments that are very hard to reach for humans; and even though they could reach them it still would imply a great risk. Drones can be used in the oil industry to make inspections in pipelines and detect leaks, via cameras and infrared images, this could be a great environmental advance, since major leaks would be prevented; and since you can basically program drones to perform flight routes, which makes it more efficient than having manned aircrafts doing this kind of inspections. Also, using infrared technology UAVs can detect leaks that are undetectable using other technologies, which saves money because companies can act a lot faster to correct this leaks. Another thing that can be achieved by UAVs in detecting gas leaks using specialized sensors, which is another application that could not be possible with normal inspections.

5.1.2. UAVs used in agriculture: from analyzing data corps to use in pesticides

Unmanned Aerial Vehicles, or Drones as commonly known, are beginning to emerge as an incredible solution for many of the challenges we have today in the industry. Despite there are many industries in which drones can be used to make profit, lower cost and improve efficiency; agriculture is one that we have to really take into account and analyze. The Association for Unmanned Vehicle Systems International predicts that the use of drones in agriculture will cover about 80 % of the commercial market of UAVs, as mentioned in the article "Growing use of drones poised to transform agriculture". This prediction is not at all away from reality, since we already see many advances in this area; and also because drones seem like the best solution for collecting a big amount of data that would be much more difficult to achieve using any other method, including manual labor. Also, this technology is perfect for agriculture, because these are mainly vast rural areas, where privacy and safety issues regarding the drones are less of a concern than in many other drone applications.

Figure 9: Example of the usage.

UAVs Equipment and Uses

Drones can be equipped with different tools that can help them obtain useful information about the properties of the land, crops, diseases in plants, wind, moisture levels, among many others. This type of equipment include cameras for taking pictures and videos, infrared cameras, and sensors, that will allow the drones to collect data and then analyze it to give farmers a better understanding of how their crops are doing, so then they can make better decisions that will save them time and money. One of the uses of drones in agriculture is pesticide spraying. Normally farmers spray pesticides to all plants, not taking into account if there are any plants that do not need them; with the use of drones they can detect by aerial survey which of their crops are damaged and need pesticide, saving money and contributing to the environment, as stated in Forbes article "Growing The Use of Drones In Agriculture". Also, if we think of all the data Drones can collect about land, wind, yield, and weather, and then analyze it properly, many farmers across the world would benefit from all the conclusions and information we could get from theses analysis; thus, a lot of money would be saved. Drones could even be able to detect damaged crops in the field, monitor moisture levels, and damage from pests or disease; by collecting all this data over time and analyzing it, farmers could prevent crops from

damaging, getting diseases, and ultimately save millions of dollars. Despite there are some farmers that are taking matters into their own hands and buy and use drones in their land, most farmers are relying on companies that specialize in this kind of technology and working with them, so they can understand their needs and build products that help them solve the problems that they have. This is the best approach for drones and agriculture, because this companies already master the technology, can provide training, data analysis and storage; thus together with farmers will help save costs and improve productivity on crops.

There are many companies that are nowadays entering the field of drones and agriculture, despite the fact that laws in the United States are quite strict about UAVs. Nevertheless, as stated by Christopher Doering in his article "Growing use of drones poised to transform agriculture", there is no point on companies waiting for a response from the government, because it is really clear that this technology is only getting bigger and moving fast, so waiting for a response would mean losing market for any company that decides to do so.

Among the companies that already have been making some progress in this technology we can find: Precision Hawk, which offers Drones that can monitor and process data using their own platform; Lehman Aviation, that has a Drone that can take aerial images with thermal cameras, and can monitor moisture levels and damage from pests; Volt Aerial Robotics, among others.

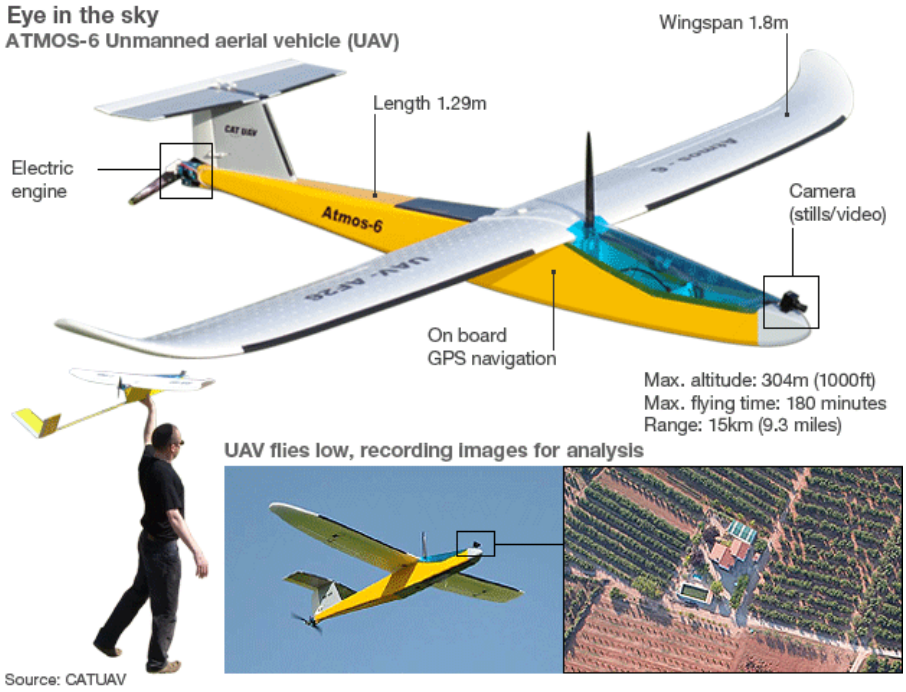

Figure 10: Principle of usage.

It is important to mention that there are many other countries such as Japan and Brazil that are also entering this field, and because they do not have regulations as strict as the US, they are already using many applications of drones to agriculture, so it should not take long before we see more and more of this technology emerging in the US and in other parts of the world.

5.1.3. Amazon Air Prime: 24 hour delivery

On December of last year, the CEO of Amazon, Jeff Bezos, suggested that packages from Amazon could be delivered in a few years by UAVs, along with a commercial where we see a drone flying with a yellow package and delivering it to a customer's front door. With this service, the CEO of Amazon expects that the company might deliver packages of up to 5 pounds through this service. There are many points that we have to take into account and analyze before coming to the conclusion that Amazon Prime Air is not so far away from happening, being the first one the approval from the FAA. As of today, UAVs for commercial use are not legal, and have only been approved for one company that operates in the Alaska; and if we think about it Amazon plans to operate this drones in populated areas and cities. Nevertheless, as stated in Fox News article "Amazon asks FAA permission to test its delivery drones", Amazon has already sent a letter requesting permission to test drones, in which they mentioned that they are working on aerial vehicles for Amazon Prime. Despite the FAA has not yet approved UAVs for commercial uses, it is of great advantage that a company as large as Amazon is already pushing this technology to be available for the commercial industry, and it will certainly help to speed things up.

Figure 11: Logo of Amazon Prime Air

FAA's approval for legalizing commercial use of drones is Amazon's prime, but it is not the only one regarding this idea of drones delivering products at our doors. Another concern regarding drones is how Amazon will manage to protect its drones and the packages that they will be carrying from various hazards. As it is stated in the article by Dave Smith "Amazon Prime Air: 5 Major Weaknesses Of The Proposed Drone Delivery Services", it is a big concern how Amazon plans to protect its drones from, for example, hitting objects in urban areas, such as trees or poles. Other concern mentioned in the article, is how Amazon will protect drones from being shot down by people in the streets. Nevertheless, as stated by Missy Cummings in the article "Amazon's drone delivery: How would it work?", Amazon will probably send UAVs in altitudes of about 300 feet, to avoid any kind of damage that could endanger both the drone and the package that it is carrying. Cummings also states that yes, there are some details that still need a lot of attention but she believes that there is nothing "technologically overwhelming" about it.

Another important issue that Amazon must address before thinking about launching Amazon Primer Air, is the fact that delivery is not always as smooth as we see it in the commercial where the drone simply drops the package in the customer's door. There can be numerous problems with this, beginning by the fact that not everyone who shops online in Amazon lives in a house, some people might want to receive their packages in apartments or their offices, and this would make it really difficult to achieve if the drone cannot enter the building. Hence, there must be away Amazon addresses this issue before launching Amazon Prime Air, because they certainly cannot limit people from using the service just because they do not live in a house.

Figure 12: Photography of the technology in use.

The weather is another issue that might jeopardize the drone's safety and thus, the customer's package. If it is a bit rainy or windy, the drone might not have a problem getting to its destination; but in the other hand, if there is snow or really bad weather, the drone might probably fall or be damaged. Also, with snow, probably the sensors that the drone uses to navigate might be blocked, though, making it impossible for the drone to reach its destination. This is something that Amazon will have to work on if the technology today still does not allow drones to fly in really bad weather, because definitely it would affect all the operations involving drones; and you certainly cannot tell a person not to use the service because of the bad weather.

Amazon will also have to take care of the battery issue in UAVs, which can vary but are no more than 30 minutes long, in that case, will Amazon need to charge the batteries or replace them after every flight? This does not sound very cost efficient, so maybe Amazon will have to think of a solution to this issue before launching this initiative.

Nevertheless, there are other companies that are also trying to implement ideas that look like Amazon Prime Air; for instance, Burrito Bomber has the idea of delivering burritos using UAVs, as mentioned in the article "Amazon's drone delivery: How would it work?". These companies that are trying to deliver food or any other service using UAVs, face the same problems as Amazon does, thus, not everyone must be thinking about doing something that might not be possible to do in a near future.

Despite there are many barriers and issues Amazon must deal with before thinking about launching drones to deliver packages, we have to agree that it certainly seems that it could be possible in a near future. The question is how much time will it take; the FAA approval seems like the main barrier for Amazon, but still they have to somehow have a technology and think of ways of getting past all the issues described before. But certainly, Amazon Prime Air will not be available at least for 5 more years.

5.1.4. The Pirate Bay: Using drones to supply P2P file sharing beyond laws

Figure 13: The Pirate Bay logo.

Whenever talking about piracy and technology, one of the first brand to pop into someone's head is The Pirate Bay. This Sweden website provides torrent files at first, magnet links then to facilitate P2P (peer-to-peer) file sharing using the BitTorrent protocol. For any non-aware reader, this protocol is globally used for P2P communication.

As anyone should notice, the legality of this website is questioned in many places. Indeed, the website is restricted in many countries though it is not hard to find mirrors that link directly to the page and let the user acquiring the magnet.

What's more, The Pirate Bay has gone through several trials and has been even forced to change its directory across its history. Nevertheless, this website has successfully mocked the US Government so far. A quite extended quote from the founders is "American laws [do] not apply [in Sweden]". Anyways, this website got himself involved in a magnifying project worth mentioning in this project to avoid losing its information: have your servers constantly moving.

Figure 14: Technology usage example.

This seems like a colossal task at first. But the way the project is actually designed may blow up anyone's mind. It simply consists of having a number of UAVs flying across the sea, frontiers, or no man's lands that carry the information. Anyone with little technological background will very fastly ask the question that how is it possible for a tiny drone to carry a server or any information since a movie may range from 400 MB to 20 TB and beyond depending on the quality and a couple of other add-ons. The answer is quiet simple again: the drone only hosts the magnet link. As complicated as this may sound at first, it is actually as simple as getting some bytes of information that point directly to a file based on its content or its metadata.

As we can appreciate, this case is a clear example of how drones can be connected to the cloud because it is needed a connection between drones and directly to the Internet. These drones will work as different parts of the server The Pirate Bay has already installed in their facilities.

One major problem arises apparently when talking about costs. But contradictorily to what most people think, each of these drones would cost no more than $60. Anyways number get pretty big easily when multiplying infrastructure and getting an army of drones might be a bit ambitious for a not so big company. We should also add to this price the development of the technology to make this whole infrastructure able to work as well as the necessary maintenance for the drones. As we will see later for Google Loon's

project, this is an essential point for the success of the project since technology has the risk to fail sooner or later and a reputable services company like The Pirate Bay should ensure the perfect flow before putting it into use.

Summing this up, The Pirate Bay goes one step forward in the fight of ethics for their company. As a group, we think that this interesting project is just an anticipatory and cautious move towards future Governments policies that, in case the project succeeds, may leave the company's outlawed but with the only possibility of restraining access to the population if it was to be banned.

5.1.5. Project Loon by Google X: Supplying Internet beyond cables

Project Loon is a project directed by Mike Cassidy in Google X Team. This project consists in providing Internet connection worldwide. For doing so, Mike Cassidy, explained in his lecture that he and his team considered different types of technologies as well as different types of UAVs. The final result was the use of HALE drone (that stand for High Altitude Long Endurance) due to its capacity to avoid commercial flights and other flying obstacles.

Figure 15: Company's logo

Figure 16: Idea summing up the project.

Energetic independence

Precisely, the project involves the use of aerostatic balloons because of their low energy consumption. The fact that this technology is energy-efficient allows to make it long-term. In fact, balloons do not need energy when just flying. They need energy for moving up and down in the stratosphere, what makes them move along through different airflows that push them to different locations. The other consumption of energy the balloons needs is for communication with Google's computers and to provide network connection. With all the optimization running throughout our days, these processes will not take as much energy as one could imagine and make this balloons energetically efficient.

In order to make these balloons energetically independent, they are provided with solar panels that make them able to drain energy in an ecological way. This UAVs have then low impact on the environment.

Basics of the technology

Figure 17: Picture showing the real usage of the technology.

Moving back to the performance of this technology, Mike Cassidy assured us in a lecture he did in Stanford University that he did not want to enter the market of network companies as a competitor. In fact, their will was to be able to offer internet connection in those countries in which it was expensive enough to draw cables all over the lands. Moreover, they were mainly focusing in the south hemisphere since the same airflows travel from South America to Australia, going over Africa.

One of the biggest doubts of the audience during Mike's lecture was the threat companies in the sector should feel. In fact, according to Mike Cassidy, Google Loon is willing to enter as a partner in the market, helping both consumers and providers. One thing that is definitely negative for consumers and that shows Google's support towards providers is the fact that for connecting, a national mobile connection is needed.

Each of these balloons can in fact cover almost 300 connections. In cases that more connections are needed, more balloons will be flying to the exact point. This could happen for example, in a big event such as the World Cup that happened this year in Brazil.

Localization of balloons

The most incredible feature of this technology is that it does not need any human supervision. Everything is automated from Google's computers except for errors that humanly supervised in case any balloon needs to be repaired. To automate this technology, Google use predictive applications for the number of users in the upcoming days. Based on these predictions and on airflows, the software estimates the flying time to move from one place to another (i.e. from South Africa to Australia) and will start inflating or deflating it air balloon inside the helium balloon. The effect this has on the UAV is that it will go up and down in the stratosphere, allowing it to change between airflows. Basing in this estimations, Google plans to cover in an efficient way all the necessities that will be growing in the future.

Last, this project goes beyond the lines of politics. As we already know, not every country allows internet connection to everyone and in every moment (we are currently thinking about civil wars or communist countries). Having these technology in such a big company's hands opens a new debate between governments power over citizens'.

5.2. Military applications

5.2.1. Land recognition: Automation in dangerous tasks

One of the reasons drones are useful for the military service in contrast to satellites is because Unmanned Aerial Vehicles (UAV) offer significantly higher-resolution imagery, are unobstructed by clouds, and are wide cheaper than satellites.

One of the military applications drones can so is the land recognition. A UAV has its itinerary programmed, what means it doesn't need a pilot to drive it, making the military mission safer in case it is necessary to explore and unknown terrain, where you don't know what can you find in the unknown area. For an unknown terrain it is possible to program UAVs that can be sent from a station. For example, sending four drones to a North East position, North West, East and West, from a base that it is located in the South, and sharing all the information they capture with sensors with cloud computing, it is easy to study a terrain it was unknown before. Cloud computing technology is necessary in this case because it is faster to share all the information the drones are collecting to maintain the military service informed to organize the next step in the mission. Also, cloud computing helps the drone to be more effective knowing where the others drones are, helping it to specify the limits of the area the drone has to recognize, without interacting and flying inside another area that it is not supposed to be, saving battery and making the mission faster and more efficient.

Figure 18: Military Drone for Land Recognition.

Military UAVs con be programmed to take-off, fly and land completely autonomously. They include intelligent flight stabilization features that adapt for changing wind speeds and other weather-related conditions. These kinds of drones are built to carry high megapixel cameras to record the terrains they are studying.

In general, this kind of technology can suppose an advance for military technology because they can full recognize a terrain faster than the military service, decreasing to 0% the probabilities of losing lives in case of hostile terrain.

5.2.2. Weather Control: the future in war deployment

This military application for Drones is focused in the possibility of deploying tiny particulates of silver iodide into cloud systems, causing them to either make rain or snow artificially. This process is commonly known as "seeding clouds". If a drone does a successful seeding with silver iodide compound, it increases the number of raindrops that form inside certain clouds. When the silver iodide is burned naturally, produces tiny particles, called ice nuclei that captures water vapor in a cloud and from droplets.

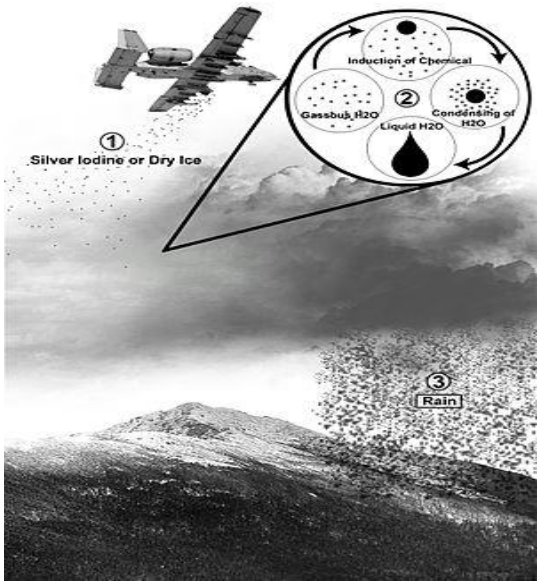

Figure 19: Visual explanation of the process.

One of the countries that are interested the most is China, because with this kind of technology the Chinese government believes that this system can be used to clean pollution from the skies over cities like Beijing.

In the United States, the state of Nevada was one of six selected test sites by the Federal Aviation Administration (FAA) to prove how UAS can make cloud seeding an easier and economical process to change the weather. Nevada is trying to modify the amount of precipitation from clouds, one of the reasons Nevada is using this kind of technology is to alleviate drought by creating precipitation. Presently it is done by launching silver iodide into clouds from the ground or by flying over top of the clouds and dropping the chemicals into the cloud formations. Nevada government is hoping to break into the global weather modification market by working with this new technology.

One of the reasons this kind of technology needs cloud computing to work is to manage all the information about the weather in real time. Pressure variation, wind variation or humidity variation can all be crucial facts to be effective in the area. Cloud computing can manage all this information to allow the drone to do its work efficiently.

6. Conclusion

A conclusion that is easy to face in UAVs is that they are a young technology that needs to evolve to overcome the limitations they have. Limitations such as battery life and regulations can suppose market barriers. These barriers can stop UAVs technology getting inside the society, without making customers lives easier and more comfortable.

On the other hand, it is easy to see that this kind of technology is useful for many applications. UAVs can fly and therefore can arrive faster to a programmed position than a car or than a human body, and this fact can be the difference between to save a life or to lose it. Getting in time with a drone where a patient needs its medication, and where and ambulance cannot arrive in time, can be the difference between life and death.

Hence, researching in new technologies battery in the future and promoting UAVs to society are steps that this technology has to face in the future to evolve allowing its integration in society.

Finally, cheap price for commercial uses can be a good reason to invest in this kind of technology to get nice results. A company or a corporation that implements drones can make the difference, getting an advantage in the market. For military uses, the investment and smart-technology in this kind of technology may be more expensive, but still lower than a human life price.

7. Bibliography

http://www.microdrones.com/products/md4-1000/md4-1000-technical-specification.php

http://www.faa.gov/about/initiatives/uas/

http://dronelawjournal.com

http://www.forbes.com/sites/gregorymcneal/2014/07/01/faa-struggling-to-deal-with-drones-now-going-after-realtors-and-farmers

https://www.aclu.org/blog/technology-and-liberty/status-2014-domestic-drone-legislation-states

http://www.precisionag.com/equipment/myagcentral-launches-cloud-based-solution-for-uav-imagery/

http://futureforce.navylive.dodlive.mil/2014/06/connecting-unmanned-vehicles-to-the-cloud/

http://www.fedtechmagazine.com/article/2013/07/army-brings-cloud-battlefield

http://www.usatoday.com/story/money/business/2014/03/23/drones-agriculture-growth/6665561/

http://en.wikipedia.org/wiki/Lithium_polymer_battery

http://www.barnardmicrosystems.com/UAV/engines/batteries.html

http://mil-embedded.com/articles/advanced-requirements-next-generation-military-applications/

http://www.aeryon.com/applications/regulations.html

http://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=14153

http://www.ictworks.org/2014/06/02/drones-for-development-humanitarian-use-cases/

http://www.intellihub.com/drones-cloud-seed-chemtrail-rain-u-s-year-end/

http://diydrones.com/forum

http://www.rand.org/content/dam/rand/pubs/research_reports/RR300/RR315/RAND_RR315.pdf

http://en.wikipedia.org/wiki/Unmanned_aerial_vehicle

http://www.unr.edu/nevada-today/news/2013/faa-to-select-the-state-of-nevada-as-a-drone-test-site