**Team A - Realistic Issues**

**Intellectual Property (IP) Issues**

In order to understand the Intellectual Property issues or this project, there are a few areas that we must discuss. First is that there exists a binding agreement between team members that must be remedied should someone want to leave but be reimbursed for their contributions. Then there is the issue of the software used in the project. If any of the software requires licensing, it must be purchased accordingly. Then there is the hardware side of the project. All hardware not developed by the team, licensing must be purchased. The idea itself would require a patent to halt infringement. Also, there is the issue of the university and the resources consumed by the team in the development of the project. If required, the university will need to be reimbursed for its contributions.

**Section 1 - Inter-team Intellectual Property**

The intellectual property rights of this project will remain with the six members of the group. This is because the six members of the group are the original developers and account for all contributions for the project. This way, they all hold intellectual rights to the project and the only way to forfeit them is through a contractual means. This contract, in order to be binding, will have to have some sort of monetary backing. This monetary backing is ambiguous however, and the amount can vary. One way for a member to relinquish rights to our project is for the parties to engage in a buyout. This is when the member looking to give up his rights is offered a one time sum to represent his involvement in the overall process. In order for this to be accomplished, there are a few things that must fall into place.

First, there must be a neutral appraisal of the intellectual property. This third party is usually an arbitrator of some kind. Someone unbiased must assess the property and provide a ballpark estimate of the overall worth of the project as it stands now and then a buyout price can be derived from that initial number. This approach is a huge gamble with the person looking to give up their rights if the property is young and untested in the market. In this case, the lump sum does not take into account how big the product might get as there is no telling if it will fizzle out or become a hit. The final buyout price could be much less than the actual product is worth.

The second option is to give up rights to the product via a term agreement. A term agreement is that the party looking to exit will give up all rights to the property and allow the others to use and develop the property to its entirety. However, instead of a one time lump sum, the parties can again look to a third party arbitrator to agree on a percentage over time. To elaborate, the persons whom remain with the property must pay a small percentage, usually 10 to 15 percent depending on the leaving parties initial involvement, for either the life of the property or for a predetermined amount of time. Again, the specifics of the contractual agreement are handled by an independent arbitrator.

**Section 2 - Software Licensing**

In order to make sure that we do not infringe on any existing patents, we would need to do some research on related patents and see if there are any infringements. There are 2 sides of this project that need investigation, hardware and software. Let’s start with the latter. It was a decision of the designers to use only open-source software in the project. That is, all external libraries and tools are free for anyone and provide a universal access via free licensing. The library primarily used to interface with the drone is a Node.js library called node-ar-drone (<https://github.com/felixge/node-ar-drone>). The wireless library used to handle hosting a wifi signal and handling connecting and disconnecting is another java script library called wireless.js (<https://www.npmjs.org/package/wireless>). These libraries are all open source and free to use in their entirety. The third component is the operating system on the Raspberry Pi, Raspbien. This is an open-source Linux ARM operating system (<http://www.raspbian.org/>) that, again follows the free licensing  protocol. The other major software components are Android libraries written in ANdroid Studio which is free to use.

**Section 3 - Hardware Licensing**

The hardware is a different story. Since our project uses hardware developed by other companies, we would have to approach them to work out a business agreement for them to allow us to use their name and likeness as our own. For instance, the drone is manufactured and developed by Parrot (<http://ardrone2.parrot.com/>). They hold the license to exclusively sell their drone as their own. We would either not sell their drone and just market our product as software that is compatible with the drone. Another crucial component to the project is the Raspberry Pi Micro PC that is used as our server. This component is developed and manufactured by the Raspberry Pi Foundation (<https://www.raspberrypi.org/products/model-b-plus/>). Again, we would have to approach them with a business plan to allow us to market their product. This would allow us to sell our servers as a whole. Another approach is that we could sell our server as an image file to install on the SD card of an owners Raspberry Pi along with the application. That way anyone who wants to use it should seek alternative methods of running it. We would not have to explicitly say a Raspberry Pi but just point them in the right direction. The last hardware component of the project is the Edimax wireless adapters (<http://www.edimax.com/>). These adapters allow us to wirelessly interface with the drones and phones. These follow the same pattern as all other hardware. We can either approach Edimax with a business plan or simply point the user in the direction to purchase one if they would like to use our product.

**Section 4 - Patenting**

If we were to pursue the project in the future, I believe that we would have to patent the game idea. We would have to patent the “Drone Wars” game where we would not allow anyone to develop a similar product using drones and video to detect hits. The patent would have to be pursued before we release the product because if we give away our idea before we have a patent on it, we run the risk of another team remaking the product and competing with us. If we can patent the game type, we would be able to release it to the market.

**Section 5 - University Resources**

For this project, the team utilized university resources heavily. We were constantly in the library using the electricity, the tv, the desks, etc. Since all of the members of the team are enrolled at the University of Connecticut, they all have paid tuition. Tuition provides us the right to use resources such resources. You can think of it as purchasing the license to use all these resources for the duration of the semester. We have paid for the right to use these resources to their fullest. The same can be said about the comments from the professors. As we, the team, are current students enrolled in the university and the Senior Design class, we are entitled to use all comments and ideas from all university personnel as our own. However, we did not use any comments from the professor in our design. It is no different for the University for using their resources. The enrollment and tuition payment serves as a binding contract that we are allowed to use their resources for all intents and purposes.

**Funding Issues**

Converting Drone Wars from a preliminary prototype to a fully functioning commercial product will take funding.  The following report plans on detailing the issues related to funding the commercialization of Drone Wars.  Initially, the reason for funding (Section 1) will be covered. Following that, the methods of funding (Section 2) will be evaluated and compared. Finally, the ideal option (Section 3) will be discussed and the hypothetical effects and consequences of this plan will be covered.  For the sake of completeness and to minimize confusion we assume that the Team A, a team of 6 people, will remain together for the duration of the commercialization. We also assume that it will take 6 months to complete the commercialization and have a marketable product. Lastly, we will assume that the team members will forgo an industry job and work on Drone Wars for 40 hours a week.

**Section 1 - Reason for Funding:**

Drone Wars consists of two core components which require funding: the first is the software for the server and the Android smartphones. The second is the actual hardware of the server and the AR.Drone Parrot 2.0 drones. Let us first address the funding related to the software in the project.  Software, in order to be maintained and kept up, requires a version control product. Up until we graduate, we are provided with a free private enterprise Github accounts.  To continue using this version control after we graduate we will need to purchase an enterprise Github license.  According to the Github Enterprise will cost 5,000 a year for 20 people (<https://enterprise.github.com/features>). For 6 people the price would be $1,500.  Furthermore, since these 6 people have forgone a job they will need a source of income to sustain themselves.  If all members agreed to a modest pay of 15 dollars an hour this would result in 600 dollars a person per week or 15,600 dollars per person for 6 months. For all 6 people this would be 93,600 dollars in total.

The second core component which will require funding is the hardware, or physical pieces, of the Drone Wars.  A major part of the hardware would be devices to test on.  In order to make sure that the game was playable and enjoyable for the most amount of people we would need to test on as many devices as possible. If we assume that 90% of the Android market was made up of 20 different phones and the average cost of a phone was 250 dollars we would need 5000 dollars to test these devices.  Additionally, we would like to expand our product to include iOS devices as well as Android ones.  This would mean that we would need to purchase iOS devices to test on as well as an Apple computer to develop on. The cost of an iPad and an iPhone 6 would be, in total, 1,250 dollars.  Including the price of a Mac Mini for each developer , the total would come to 7,250 dollars.  Furthermore, we would need developer licenses for each developer to be able to deploy to the Apple devices. These licenses are 100 dollars each which would mean another 600 dollars total ([www.apple.com](http://www.apple.com)).

The summation of all these costs comes to a total of 107,950 dollars. This cost would cover almost all the needs for the completion of the commercialization of Drone Wars. Not included in this total is any setbacks or mishaps.  Setbacks would be something like a drone not working or a hard drive failing whereas a mishap would be drone propellers replacements or accidental damage to a piece of the Drone Wars setup.  We could assume that setbacks and mishaps would not exceed 5,000 dollars which would mean that our total funding would be 112,950 dollars.  The following section covers the different methods for obtaining the required funding.

**Section 2 - Methods for Funding:**

There are three possible methods to fund the commercialization of Drone Wars.  The first would be to crowdsource the project.  In order to crowdsource the project we would have to demonstrate the uniqueness of Drone Wars enough to have people support our cause. We would use a site like Kickstarter (<https://www.kickstarter.com/>) to show off our prototype and convince people to fund us.  To convince people of our cause we would show them how much fun Drone Wars is and that it is a unique video game unlike any other they have played.

The second method of obtaining funding would be to search out an Angel Investor for Drone Wars. An Angel Investor is a wealthy person or business who will invest in your business or startup for equity in the company (<http://www.entrepreneur.com/article/52742>). We would actively search out an investor or company, like Google or Elon Musk, to support our commercialization.  This method would be similar to crowdsourcing except that the pitch will be geared towards the specific investor. While the crowdsourcing pitch would focus on the entertainment value of Drone Wars and how much fun playing the game with friends would be, the Angel Investor pitch would focus on the profits. The pitch would explain and convince our investor of how many people would want to play Drone Wars. We would need them to see the potential value of the game which would lead to them being justified in their investment towards the finalization of the product.

The third method to fund the commercialization of Drone Wars would be to seek a General Small Business loan 7(a).  This is a loan for small businesses in the United States to get them off their feet. If we filed for a loan and demonstrated that we meet the requirements as a company we could be granted a loan of up to 5 million dollars. However, since the loan we would be taking would be under 150,000 dollars we would have no fees and a relatively low interest rate (<https://www.sba.gov/7a-loan-program>).  This option would mean that Drone Wars must make enough profit to at least pay back the loan to the government but it would also allow us to borrow a greater amount easier if it were needed.

**Section 3 - The Ideal Option:**

If Drone Wars was to be commercialized the best option would be to organize as a company and request a General Small Business loan 7(a).  The issue with crowdsourcing is that it is not reliable. We would leave the funding of our project up to the decision of the public.  If we were to definitely pursue funding for the project this would not be a good way since we may not see any funding at all.

The reason that an Angel Investor isn’t the best option is similar to the reason that crowdsourcing isn’t the best. With an Angel Investor we would leave the funding of our project up to the investor.  If there were no investors that thought that Drone Wars was a great idea then the commercialization of the game would never happen. It is possible that we would waste our time seeking out an Angel Investor.

This leaves a General Small Business loan 7(a).  With this option we are guaranteed a loan to fund our project. We won’t have to wait upon the public or a wealthy figure to fund us.  The only consequence of taking this loan is that we would need to pay it back.  With the other two options, while they are riskier, they do not require the Drone Wars team to repay any money invested or given.  In summation, the realistic issue of funding is that commercialization would cost about 113 hundred thousand dollars and this money would be obtained using a General Small Business loan 7(a).

**Commercialization issue**

Commercializing our product is one of the main issues we have to face before making our project profitable. To begin commercializing our project, the first step we have to take is to contact to the company that owns the components of our project. In the process of acquiring the consent from those companies, we will present of our project to the company. Then we can decide whether we want to form our own company, or to become a branch of one of the companies. After we decide what we want to do to begin the process of commercializing our project, there are many details to be considered, for example advertising, promotions,  the time of launching, location of launching, and the target customers. Everything discussed here is under the assumption that the project is proven to be profitable.

**Section 1 - Choosing between forming and joining a company**

Our Product is an Android application that simulates a drone dogfight. The application allows players to control real physical drones which can fire virtual missiles. A server is run on a raspberry pi to govern the connection between the Android smartphones and the drones. The drones we use are Parrot AR Drone 2.0. Therefore, no matter which way we choose to commercialize our product, consent from Raspberry Pi Foundation and Parrot is necessary, who owns raspberry pi and the drone we are using. In the process of presenting our project to the companies mentioned above, we can bring the idea of being one of the branches of the companies. If we join of the companies in the process of acquiring the consent, we still need to present our project to other companies that own one of the components.

Forming our own company and joining other companies both have advantages and disadvantages:

Instead of working for someone and do what we are told to do, we can start our own company, doing the business we passion about. We can manage our own time of work, we don't  have to work from 8 to 5 every day. If we choose to form our own company, first we need a business plan include the executive summary, a company description (what makes the company unique), a market analysis (the competition and target demographics), the company's structure, a description of the service or product line, the marketing and sales strategy, financial projection plus any additional useful information. Then we need to think about how to gather needed resources, including hardware, software and manpower. As of now, all 6 members of the group is all the manpower we have. In the future, we might need to hire people. We also need plans to do that.

This is also one of the disadvantage of forming our own company: we have to do everything by ourselves. The plans are the paper work of showing what the company can and will do in the future. To start a company, we need to register a name, a logo. On the other hand, if we decide to join another company, being a branch of the company, we don't need to register a name for the company or create a logo.

**Section 2 - Advertisement**

After we decide what we want to do to begin commercializing our project, advertising is our next step. Our product is a multi-player game, the target customers of our product are any individual from 10 - 60 years old, and game rooms that provides service to students and committees. The advertisement needs to be targeting the right customers. Then we need to decide the price of our product. Our product have two parts, an Android application and a server. They are both software. As of now, we only have Android version of our application. The application can be downloaded from Google Play free. The server runs on a raspberry pi and the hardware is required to play our game. What we can do is to sell the hardware with the software installed for a price. The exact number is to be discussed. There are several different medias to advertise our product: online advertising, we can create posters and videos then post them in Facebook, Twitter or Youtube, etc; newspaper ads, we can advertising our product through campus newspaper; radio advertising, also campus radio is another good way to advertise our product; television advertising, obviously television is most popular place to do the advertisement.

**Section 3 - Promotions**

Promotion is another way to advertising our product. At the beginning of launching phase, we can make all our product to be free. Also, we can hold events to invite people to come and play our game. One of detail we need to consider is to make all of the promotional efforts clear, quick, and informative without being overly-dense. Prioritize the most important information about the product - namely, there isn't other games like our product so far.

Another important detail that needs to be considered is to make different promotion over time. Because different types of customers would have different response to different promotions. For example, an individual may interest in promotions where the software is discounted or free; on the other hand, the game rooms may interest in promotions where the hardware is discounted or free.

**Security**

Drone Wars the augmented reality dogfighting game is intended to be a very competitive shooting game. The original idea of the game included the creation of a leaderboard to keep track of scores and hit to miss ratios among users online. Although the leader board was not implemented due to timing restraints, if it were to be commercialized, the leader board would need security protocols to keep user information secure and keep the integrity of the leaderboard intact. The Drone Wars application (DWA) also has various forms of security to prevent unauthorized users from taking control of the drones mid game and prevents unauthorized access to application while a game is currently running.

        DWA game server is hosted on a raspberry pi that is disconnected from outside networks. Being disconnected from outside networks prevents any intruders that could compromise the drones mid-flight and endanger the players and bystanders.  The DWA server also has a few security measures to ensure that unauthorized users don’t connect their android devices via WIFI and connect to a drone mid game or try to override a player's connection to the drone before a game has commenced. When a player connected his/her phone to the server, the server assigns him/her android device an IP address. Once the user starts the game by entering the play activity, they are prompted to select are a drone from the list. Once the user selects the drone from a list, they are paired with the selected drone and the connection known as a handshake locks the users id address with the specific drones mac address.

        Once the handshake is completed on the server side, the drone is removed from the list of available drones to be selected; this prevents users from trying to connect to the same drone.  The handshake method prevents unauthorized access to a drone that is ready to play, keeping its user in full control at all times. Another security feature in the DWA is session locking. Once a game has commenced, the server locks users from connecting another drone and entering the game. The session locking method is a simple yet effective method, used to keep unauthorized access to the server while drones are being flown. The session locking method checks to see if there is a host already connected, and there is a current game session in progress. If a game session is already in progress, a new users cannot connect to a drone via the handshake process, an error message appears alerting the new user that a game session is already in progress and directs them back to the DWA’s home screen to wait for the current session to end.

Another area of concern regarding DWA is the implementation of the DWA server itself, the way it works is that the server broadcasts its own wi-fi network and scan for any signal that matches Parrot AR drones ip ranges and forces it to connect to the game server. This is an area of concern, because if others are using drones within 200 ft of a running DWA server, their connection to their drone will be severed since the drone will be forced to connect the DWA game server. When a drone that is in operation and is forced to connect to the DWA server the original operator of the drone will not be able to regain connection to his or her drone unless they connect to the DWA game server or the server is shut down. This is a security issue because unauthorized users such as DWA players can potentially gain access to drones that are not their own and control them.

If DWA were to be commercialized, more enhanced security features would be needed to  prevent, DWA players from accidentally violated local and federal laws and prevent damage or theft of the players drones. The application would need to limit the players drones altitude to under 400 ft and ensure with gps that the drone could not be operated with four miles of a major airport. Since DWA has a limited wifi playing range, gps would also be used when a drones communication with its operator is lost. When an operator loses communication with his/her drone it would land in the gps location it took off from, and if for any reason include emergency landings if the drone lands down in any other location than where it took off from the drone will report its last known gps location back to the player in order to help prevent possible theft of the drone itself.

Another area of security concern if DWA were to be commercialized would be the games leader-board server. In order for the leader board to work, each user would have to create an account. Unlike the DWA server, the leader board server would be hosted online and accessible to any user. In order to maintain accuracy and integrity of the leaderboard results each user would have to create login credentials in order to be able to access and post their scores to the leader board. The DWA leaderboard will have a two step authentication, upon signing up the users will be assigned a pin generated by the server for their username. Once the user is assigned a pin they will be asked to create a unique password that will be hashed by the app and sent to the leader-board server over the internet with an HTTPS connection.

**Software Licensing Issues**

The core idea behind Drone Wars is to expose individuals to the possibilities that multirotors bring with them. Parrot has already developed hardware that has been very well received by the community. Along with releasing the hardware Parrot has also released the SDK to allow developers to create applications that augment the standard experience provided by the Parrot Free Flight application. Parrots SDK allows developers to create many unique applications by having access to many low level APIs such as video and controls. While at first this seems great there is a very important part missing. While the SDK allows developers to create diverse applications they are always limited to controlling one AR.Drone at a time. Given that there is no multiplayer experiences available for the AR.Drone.

**Section 1 - Drone Wars Intentions**

From the start the idea of Drone Wars was to create a fun collaborative multiplayer experience that users of all ages can enjoy. In order to make Drone Wars very user friendly, it has been developed in such a way that it does not require any specialized hardware. This also means that the AR.Drone does not require any modifications to work with Drone Wars. This is done by the server easily capturing AR.Drones available in the area when it is turned on and releasing them into their original state once the server shuts down. In order to make the Drone Wars experience easily available it would be open sourced and released at no cost. Releasing Drone Wars at no cost will allow non technical users to easily enjoy all that it has to offer, while the open source nature would allow the more technical users to augment the in any way they desire. Open sourcing the project also gives it a high probability of receiving ongoing development from community users.

**Section 2 - Library Licenses**

Since the Parrot AR.Drone SDK has a limit of only controlling one AR.Drone at a time we needed to figure out a different way to implement multiplayer functionality. Since there are no multiplayer libraries available for the AR.Drone we needed to implement something from scratch. As one might imagine this is a very large undertaking and make it possible some libraries have been used throughout this project. In order to release Drone Wars we need to carefully examine the licences all libraries that are used. The libraries used on the server side include node-ar-drone, socket.io, node-telnet-client, underscore and node-wireless, while the application side only utilizes socket-io.client. Table 1 lists all the used libraries and their respective software licences. With the exception of the wireless library, all libraries utilize the MIT software license. Software licensed under MIT license allows anyone to use, copy and modify the software in any way. There are no restrictions on where and how the software is used and distributed. This means that the software can be given away for free or sold for a profit. The only restriction that MIT software license imposes is that the respective software is accompanied with its original license produced by the creators. The node-wireless library is on the other hand licensed under both MIT and GPL. In the case when software is licensed under multiple software licenses the project utilizing the given software has the ability to utilize either license. GPL has many of the same freedoms as MIT license but it imposes a few more restrictions. Like MIT it requires that the respective software is accompanied by its license. GPL differs from MIT in that it requires that the original source be explicitly stated as well as describing any software changes that have been done.

**Section 3 - Drone Wars Software License**

Since Drone Wars has been always meant to be easily available and open to the public we have decided that it would be open sourced. One of the most common licences used for open source projects is MIT as can be seen with most of the libraries used in Drone Wars. While MIT seemed like a good candidate at first since it has so few restrictions it soon became clear that it did not fully line up the ideology behind Drone Wars. It could potentially allow some entity to commercialize Drone Wars without letting users know that the source is freely available for anyone to modify. Given that GPL seems like a much better fit for Drone Wars. Also since one of the libraries used is licensed under both MIT and GPL it is safer to use GPL for Drone Wars since it is slightly more restrictive than MIT and will prevent any future issues.

**Legal/Ethical Issue**

Drone War app will not ask for user their personal information. And during the use of Drone War app, it will not store or copy any user information during or after the game. The app will not read or copy any user data on the device not ask for any authentication on the device(except for the basic ones, such as Wi-Fi access and bluetooth access.). All the user data will be deleted when each game ends. The user will not be asked to provide any personal information(include but not restricted to credit card information, password, SSN etc.). During the game time, the player will only be able to see the information belong to him/herself. Multiplayers only share game statistic among each others.

Under the Special Rule for Model Aircraft, recreational unmanned aircraft systems(UAS) must be operated in accordance with several requirements, including a community-based set of safety guidelines and within the programming of a nationwide community-based organization such as the Academy of Model Aeronautics (AMA).

Here are some guidelines for safely and legally using the drone and Drone War APP by user according to Federal Aviation Administration:

1. Fly no higher than 400 feet and remain below any surrounding obstacles when possible.
2. Keep your UAS in eyesight at all times, and use an observer to assist if needed.
3. Remain well clear of and do not interfere with manned aircraft operations, and you must see and avoid other aircraft and obstacles at all times.
4. Do not intentionally fly over unprotected persons or moving vehicles, and remain at least 25 feet away from individuals and vulnerable property.
5. Do not fly in adverse weather conditions such as in high winds or reduced visibility.
6. Do not fly under the influence of alcohol or drugs.
7. Ensure the operating environment is safe and that the operator is competent and proficient in the operation of the UAS.
8. Do not fly near or over sensitive infrastructure or property such as power stations, water treatment facilities, correctional facilities, heavily traveled roadways, government facilities, etc.
9. Check and follow all local laws and ordinances before flying over private property.
10. Do not conduct surveillance or photograph persons in areas where there is an expectation of privacy without the individual’s permission.

At the same time, although our Drone War APP does not allow user to record the video from drone's camera, we do not suggest the user to use any third-party app or software to record the video from the device screen because the video may contain other people's privacy information or other confidential stuff that shall not be stored or spreaded. According to Federal Aviation Administration(FAA), you can not post onto youtube any of your video recorded by your drone. Certain activities that against the regulation issued by FAA may incurs fine or sanction.

Moreover, our Drone War app shall be free for download and distribution and shall not be used for any commercial purpose. Any commercial use of the APP will go against our intention of design the app and will also violate the regulation by FAA that people should not fly the drone for any commercial purposes.

Disclaimer：

The Drone War app is designed to be used and distributed abiding by local laws and in a safe way. We will not be responsible for any sanction or charge caused by abuse or illegal use of our app as we have assert the intention of this app. We will also not be responsible for any injury or damage cause by using this app to control any drone.

Reference:

1. Testimony  Before the Subcommittee on Aviation,  Operations, Safety, and Security,  Committee on Commerce, Science, and  Transportation, U.S. Senate

<http://www.gao.gov/assets/670/669316.pdf>