A Location-based File Sharing Application

Team File Lending in Proximity (FLIP)

Team Research Thesis Proposal

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Abstract

Multiple computing devices in close proximity must usually rely on the Internet in order to share information, even though doing so is grossly inefficient and subject to external factors. A method to facilitate this sort of local sharing in a secure manner could help alleviate these issues. This study proposes to demonstrate the substantial demand for a more efficient and interactive means to exchange information among networks of people. We will detail how this project will result in a software protocol capable of linking mobile devices for the purpose of sending and receiving data through manipulation of available technology, pursuit of developing computer systems, and creation of an innovative program. The tasks at hand do not rely on innovation through "brute force" development of new hardware, but rather on manipulation of existing technology through revolutionary software.

Introduction:

If two people need to share a word processing document on their computers, their options for doing so are currently limited. Most often, they will opt to email the document to one another, regardless of how close or distant they are. They could literally be in the same room, and yet sharing via the Internet would require the document to be sent to distant towers, servers, and perhaps satellites. This is inefficient from a technical perspective, and it requires significant infrastructure. In a setting where said infrastructure is unavailable or has never existed, the ability to share a document is extremely limited. A large portion of modern information exchange is not suited to local distribution, and the users must compensate with unsuited methods.

These misrepresented transactions are often localized and between groups of people rather than the traditional one-on-one interaction. It is through the characteristics of proximity, scale, and volume that the true flaws in the current information system are revealed (Yinan, Song, Xueping, & Weiwei, 2008). Personal contact is limited by both proximity and scale. This exchange necessitates the closeness of the members and is not practical for sharing a file. Traditional cell phones can only handle limited volume in the form of speech. All phones are also completely adverse to scale. Conference calls are inconvenient and ineffective when there are too many participants, and it is impossible to send media through a cell phone call.

The Internet by comparison is very capable in terms of proximity and volume, and members can easily communicate across the planet. However, its scale approaches infinity because files stored on the Internet are available to everyone at anytime. Passwords and encryption may be set up to protect certain sites or files, but even then they are susceptible to malicious hacking and interruption. Sharing information via the Internet involves a vast series of transactions that make information and data very vulnerable to interception by a third party (Xiao & Pan, 2005). The Internet thrives off a nebulous construction. Behind the convenience of Internet sharing is a number of exchanges that are often unnecessary.

Because of these problems, Team FLIP has come to question: how can we create a wireless networking system that allows users to connect to each other within a geographical area without central infrastructure? Furthermore, how can the concept of rights revocation, the ability of a file-sharer to revoke rights of access to any shared file, be used to secure such a network? By utilizing advantages of existing means of exchange we will create a way of linking mobile devices that involves the aspects of current telecommunications and the Internet. Ad-hoc networking, or networks without pre-existing infrastructure, is a feature not provided by the bulk of current hardware or software (Su & Hischke, 2003). The earlier advent of Bluetooth and its future successor Wi-Fi Direct prove that this is a significant step in the progression of mobile technology (van de Wijngaert & Bouwman, 2008). Our group will create a software protocol that takes advantage of these technologies to make it easier for people to share content securely and conveniently without the need to connect to an active Internet gateway and without the constraints of current alternatives.

Literature Review

Research for this project is grouped in five different categories: ad-hoc networking, file-sharing, location services, wikis and social networking. It also chronicles the progression of our project from its inception to its current state.

Ad-hoc Networking

When we first began this project, we envisioned a type of sharing that would not require us to go through a central server, like those on the Internet. We wanted to use a wireless connection that could send data directly from one device to another, whether that device was a laptop or a smartphone. We considered a few different technologies that may have helped us. First we researched BlueTooth technology, which is used to wirelessly connect cell phones to headset devices.

The transmission and reception of wireless signals has been a crucial base for many means of communication. One of the options is Bluetooth, which is a viable option when dealing with direct linking of two compatible structures with wireless capabilities under limited circumstances. Xiao and Pan (2005) show that Bluetooth, while it does allow devices to share information with one another within a certain distance, is not an ideal platform upon which to create our file-sharing mechanism. The Bluetooth concept requires one device to assume the role of “master,” while the other is “slave” (Xiao & Pan, 2005), while our sharing system necessitates that all devices must be equal to each other within a given network.

Wi-Fi has several advantages over Bluetooth, which makes it a more suitable candidate for use in the technology we wish to develop. Bluetooth has a very limited range of 10 meters (McDermott-Wells, 2004), while Wi-Fi has a greater and more flexible range. It is also much slower, with a transfer rate of 1 megabit per second whereas Wi-Fi can transfer up to 3 megabits per second (Rashid & Yusoff, 2006).

We then considered the concept of ad-hoc networking, which simply refers to a collection of devices that connect to each other wirelessly but still operate independently from one another. Imagine connecting two devices with a USB cable. Our idea was to create this sort of connection wirelessly and with multiple connections. At the time we were considering this idea, a version of the technology had just been released that incorporated “multi-hop” capabilities, as opposed to the previously available “single-hop.” Single-hop was limited in that one device could only share data with devices it was directly connected with. Multi-hop allows a device to connect with another that it is not directly connected with, but indirectly through other devices.

We looked for a collection of devices that connect to each other wirelessly and form an interconnection that allows these devices to remain independent. This concept has been proven to work with Microsoft Windows with the IEEE 802.11 protocol, which can use "multi-hop" (the ability to connect to a remote machine using an intermediary device that is also part of the network) capabilities even with machines that are only designed to be compatible with single hop (Yinan, Song, Xueping, & Weiwei, 2008). However, the method described in most research is a circumvention of intended functionality; most of the research we have encountered relies on "hacks" rather than technologies that will actually appear in consumer devices. For example, the implementation developed by Yinan et al required the researchers to write their own driver that was specific to the one platform they were working on.

Furthermore, while Sharafeddine and Maddah (2011) proposed a new lightweight form for energy-efficient mobile-to-mobile file sharing applications, the technology is not yet readily available to the public. The proposed scheme is to exploit the difference between sending compressed data and sending small amounts of data. The data would be sent in a lower number of bits if compressed, meaning less energy is transmitted.

The protocol that we originally planned to use was Wi-Fi Direct, an official extension of IEEE 802.11. The Wi-Fi Consortium intends Wi-Fi Direct to be a standard that exists for all platforms and will require only a manufacturer-written driver upgrade. Wi-Fi direct "will be built directly into consumer electronics and automatically scan the vicinity for existing hotspots and the gamut of Wi-Fi equipped devices, including phones, computers, TVs, and gaming consoles" (Kharif, 2009). Wi-Fi Direct is an implementation of the Ad Hoc feature of the 802.11 protocol. It will allow devices to act as both access points and connected devices, requiring no external infrastructure but the devices. However, the release of Wi-Fi Direct was repeatedly delayed, and we couldn’t keep waiting for a technology that our project hinged on. For this reason, we decided to use the Internet and go through a centralized server after all, simulating ad-hoc connections, even though it was not our original intention.

File Sharing

Studies have shown that the most common files searched for on existing file-sharing systems are music files (View of the Data on P2P,” 2009). The same study also demonstrated that people who shared the most files had the most file type searches in common with the others in the survey. These figures are important to note because they show how we should tailor our software to different uses.

Another study about a product idea similar to ours, Push!Music (Hakansson, Rost, & Holmquist, 2008), demonstrates that a peer-to-peer mobile file-sharing system had great success when implemented in a social situation. The researchers defined success as a significant increase in the number of file transactions between users, as well as positive qualitative feedback. This particular method of sharing, peer-to-peer instantaneous music sharing, causes a rapid increase in sharing activity. The exact sharing process happens as follows: a mobile device with Push!Music checks for nearby devices with the program and connects to them wirelessly. Media agents then check the status of media on these devices, matching music amongst them. Based on users' sharing settings, new music will jump from device to device, resulting in a network of shared media. While certainly a source of inspiration for our project, their system only allowed transfer between two users and added few new innovations to the field of software engineering. Push!Music's success within the confines of this study reflects positively upon our team ambitions for peer-to-peer sharing.

A study about the willingness of people to share and what causes people to share files with one another also contributes to our product design. The results show that people will share depending on (a) Emergency, (b) Trust of the initiator, (c) Gender, (d) Individual benefit, and (e) User familiarity with technology (van de Wijngaert & Bouwman, 2008). Using these key points, we can determine the success of our unique application of existing technology. We can infer that the second most important of the file-sharing prerequisites, "trust," can easily be established with our software due to the proximal nature of sharing when using our product (Morvan & Sené, 2006). Gender, for us, will be evident, and individual benefit will be immediately discernible when in close contact with the file sender. People will often literally be able to see the other person they are sharing with, providing both an implicit trust and means to determine the worthiness of this person in keeping with the criteria. According to the van de Wijngaert & Bouwman (2008) study, our project will be successful upon application because the standards by which people judge whether or not to share their files are all met by our product. The study further showed that ad-hoc networking is a viable system to use when dealing with activity of this nature.

Location-based Sharing

It's easy to assume that wireless networks work flawlessly when implemented, but that is far from the truth. Any applications that use these networks are only as good as the networks themselves. While FLIP is focused mainly on creating software for allows connectivity between mobile devices based on proximity, we are also taking into consideration the stability of wireless mesh networks, as it is our hope to one day move our application off the Internet and allow for operation independent of a centralized infrastructure. There have already been advances in technology such as WiFi Direct and the Serval Project that are attempting to pave the way for decentralized communication, but how will they stand up to the tests of network size and large numbers of relay nodes? In "Understanding and Tacking the Root Causes of Instability in Wireless Mesh Networks", Aziz, Starobinsko and Thiran (2010) conclude that stability is not an issue in CSMA-based linear wireless mesh networks with only three-hops. After three-hops, a "stealing effect" overtakes the nodes and creates significant transmission delays. This is potentially a problem with FLIP's ambitions since we hope to have information jumping across several nodes if the application is to be removed from a centralized server.

However, Team FLIP acknowledges the difficulty in creating an application that relies solely on ad hoc networks as the venue for communication. Thus, as a stepping stone, we are developing an application which will use the Internet as infrastructure, and to determine which devices are proximate to each other in location. In "Discovering the architecture of geo-located web services for next generation mobile networks", Linwa and Pierre (2006) discuss what transitions a mobile device must go through when leaving one geo-located web service to another. This is helpful to FLIP in that it presents a system architecture for a device that is in motion. Geo-located web services (GLWS) are services on the web that are only offered to a certain geographical area, and once the user steps outside this area, the service can no longer be reached by that user. FLIP's application is all about being able to access data while one is proximate to the data origin, and these geo-located web services are a good example of location-based access. The paper concludes that synchronous APIs are necessary for a smooth transition from one GLWS to another, and this should not be an issue since users running the FLIP application will be using the same API. This paper also introduces the idea of having a migration manager, a part of the program that specifically helps devices detect and switch to other services.

One prominent concern FLIP has about running a location-based application is the battery life of mobile devices. Any battery drains quicker when using geolocation due to the fact that the device has to constantly check-in with global positioning satellites, or even something as simple as operating on WiFi leads to battery drainage. In "A Quantitative Analysis of Power Consumption for Location-Aware Applications on Smart Phones" (Anand et al, 2007), researchers tested various battery-saving methods and concluded that on average, a smart phone can run at most six hours while continuously using location services. To maximize the running time, they recommend that programmers should try to offload computation to servers whenever possible. This is a good suggestion for FLIP's Internet-based model but since FLIP hopes to move to ad hoc networking as the basis for inter-device communication, the battery life of these devices would most likely be shorter than if they operated FLIP's application that uses central infrastructure and servers. The researchers also suggest incorporating a motion-sensing mechanism where if a user is not moving, the device would check in less frequently than if the user were in motion.

In "An open architecture for developing mobile location-based applications over the Internet", Jose, Moreira, Meneses, and Coulson (2001) discuss the concept of creating an architecture that allows new components to be added or removed without having to change the central infrastructure of the application. This is particularly interesting for FLIP because we hope to create an application that is self-governing and constantly evolving through user-generated wiki data. The authors talk about several models, one of which is a proximity-based model. In it, a client is able to set a specific range and discover other servers within that range. As FLIP also realized, this creates problems of scale and how large users want the range to be. Too small a range could mean that the open architecture is barely modifying itself, while a too-large range would mean constant change. Stability and speed issues also arise from this model.

Team FLIP hopes to improve the social lives of its users by allowing them to connect to each other in new ways. FLIP focuses on proximity and location-based file sharing in a social setting. In a world where connecting to the Internet means connecting to millions of others in unknown locations, it is beneficial to know what information is available and/or generated from the locations close to you in real life. According to Fusco, Michael and Michael (2010), adding a location-based service to a social network builds connectivity amongst users. Not only do we know who a user is online, but also where he is located. Users feel a greater level of relation to others users who are geographically close to them, and the information that these proximate users generate is perceived to be of higher relevancy.

Location-based services have the potential to strengthen connections between users but at the same time, privacy and trust are key components that determine whether relationships are positively or negatively affected. Providing greater security over a social network with location services builds trust among users, but this trust can easily be abused. FLIP is working to find a way to verify a user's identity or limit the application's audience in the beginning stages so that spam and other malware do not become an issue across the layers of file-sharing. Bhuiyan, Yue and Josang (2008) propose that public reputation will be sufficient in a community of users who mind what others think of them. In the FLIP context, this is a good natural source of protection against unwanted actions or users because each file or object that a user uploads is tagged with a location and name, and users on FLIP layers are all proximate to each. This means that they should be more likely to be mindful of their reputation because they are not part of the anonymous web on FLIP, but rather identities who are recognized by members of the community around them.

"A Hybrid Mobile-based Patient Location Tracking System for Personal Healthcare Applications" (Chew et al, 2006) presents one area in which FLIP could potentially be useful: healthcare. While FLIP hopes to use its layered maps for security functions, this paper addresses the matter of emergencies and personal health monitoring. FLIP's intention of secure file-sharing means that when a user goes to a doctor or anywhere that requires him to give out sensitive medical information, others may only see that data when he is proximate. Once the user leaves, the offices no longer have access to this data, making it more secure for the user. Chew, Chong, et al. (2006) discuss how in emergencies, locating services could be life-saving. The importance of this could easily be worked into FLIP's application by having an "emergency" map layer where users could signal distress to those proximate to them.

Another setting that FLIP sees great potential for its file-sharing services is the office setting. Sharing based on proximity creates efficiency through bypassing unnecessary log-ins, typing of email addresses, and other hassles. FLIP creates an online environment that mimics the one in reality, where documents are distributed to users proximate to the owner, only it is in electronic form and physically tangible, thus allowing users to connect instantaneously online in addition to offline. “An Indoor Location-Based Social Network for Managing Office Resource and Connecting People” (Wang et al, 2010) studies how efficiency in an office setting could improve by using WiFi as a means of locating employees. In their study, employees use various mobile devices, laptops and computers running Nokia Find & Connect to manage office resources and connect with each other in a social environment. Their study looked at the increase in efficiency if users knew beforehand which office resources such as meeting rooms and desks were occupied. In the FLIP application, this is easily implemented as when users update their location, it is instantly shown on the map for others to see, i.e. a meeting room populated with dots means it is occupied.

Wikis

Although FLIP is not a straight-forward knowledge management system like a wiki, it can be adapted to be used like one, and as such, the Wiki works as a good previous example of a collaborative tool to look at. Yang, Wu, Lin and Yang (2008) show that collaborative tools like Wikis allow both personal research as well as group research to become quicker through allowing easy accumulation and storage of knowledge. They do “not only help users learn new knowledge much faster, but also make better use of the knowledge. More importantly, new beginners can build up fundamental knowledge in the target field faster” (p. 349).

The Internet in its entirety could be labeled a wiki, for its use and wonder come not from a single source but from an infinite network of contributions. In Internet Law professor Jonathan Zittrain's article, "The Generative Internet," (2006) he praises the collaborative development of the Internet and the technologies surrounding it. Zittrain supposes that had the Internet been closed to amateur tinkerers from the beginning, "many of its unusual and now central uses would never have developed because the software underlying those uses would have lacked a platform for exposure to, and acceptance by, a critical mass of users" (p. 1977). Essentially, the Internet was tailored to the very community forging it, ensuring its continued relevancy and use. Information sharing and cooperation have led to great advancements in the web, and by using a model which allows for collaboration and openness, Team FLIP hopes to create a long-lasting, generative software.

The academic community in particular remains adverse to the introduction of wikis under the pretense that this open idea will lead only to inaccuracies and even lies. Knobel and Lanshear detail the rift between Wikipedia and academia as a general misunderstanding due to cultural and generational gaps. "Wikis, Digital Literacies, and Professional Growth" approached the issue as educating an audience on a new technology (Knobel & Lanshear, 2009). Work with students demonstrated clear advantages wikis brought to the classroom, namely by allowing the teachers themselves to contribute and share their material. The general results found that the overall distrust in the system came from unfamiliarity with the technology. These insights hold true when implementing any unproven technology; FLIP aims to provide easy entry into the system even to those with little technical expertise.

Wiki's are a collaboration medium between peers, inheriting their traits for better or for worse. Just as crowdsourcing accesses a theoretically infinite knowledgebase, so too is it open to an infinite amount of possible misunderstandings. FLIP is not a pure knowledge management system like a wiki, however, it was adapted to act as one when features benefit from user collaboration. Team research groups are one such audience for whom the FLIP system is intended to benefit.

Wikis and Location

User-generated data paired with location tags introduces an entirely new method of sharing. There already exist options for bringing wiki-like geospatial information into a learning environment, albeit most of this is geared toward specialty groups. For example, in "A Geospatal Wiki for m-Learning," Safran and Zaka (2008) describe a specialized Wiki called TUgeoWiki and corresponding mobile Java software which allows users to utilize their current GPS-derived location to create and add to existing Wiki articles. Users could search for Wiki articles associated with their current location and upload photos from their location in order to contribute to these articles. However, the end result described in their article is one that only serves a very specific purpose that FLIP hopes to incorporate among other features into its research. Instead of using specific articles to link files and information to, FLIP will simply be an aggregation of points of specific data.

In their article, Safran and Zaka mention Panaramio, which is a geo-located photo sharing service that overlays photos onto Google Maps and Google Earth pages. As opposed to being just a photo-sharing service, FLIP provides extended functionality, allowing any kind of file to be uploaded, and for location-relevant files to become more obvious to the user.

GeoSpaces, a tool used primarily by United States Department of Defense and National Intelligence Community, is a commercially available geo-spatial "whiteboard" system. The software allows for an enterprise's information to be laid out over a persistent map, with location-specific information placed directly at the location it is associated with. For example, it has been used to "communicate real-time, spatial, spatial-temporal, and non-spatial information including stakeholder inputs, air and surface vehicle tracks, transportation routes, air corridors, global and regional weather, national and commercial imagery, and other data to the stakeholders' community of interest" (Baraghimian et al. 2001, p. 1679). The article argues that such a software allows clients to make informed, rapid decisions based on location data in Disaster Scenarios. FLIP has a similar functionality and makes the source of information a community.

Team FLIP's research could have wide-ranging effects on a number of fields if it is adopted. In their paper, "Location-aware access to hospital information and services," Rodriguez et al. (2004) describe a system which allows physicians and nurses with a wireless-capable PDA to access a variety of information and services based on their location. For example, with this system, a doctor could digitally access a patients records if they were proximate to the patient, easily find a colleague by using the colleague's current location, and find the closest medical devices and equipment. The researchers were able to achieve context-aware services by approximating a PDA's location based on which WiFi access points had the strongest signal. The researchers were able to find a PDA's location within a 4m margin of error, which in their implementation was enough to find the nearest patient. Using campus WiFi to approximate location is something that Team FLIP has explored, and the software could possibly be extended to do so.

Social Networks

In the age of technology, social networks are a common way of information exchange and can be useful in both the social world and more academic environments. A study conducted with 67 students in four classes at two public universities in Taiwan examined the potential usages of online social networking to supplement the traditional classroom experience (Hung, 2010). The study found that social networking is a helpful tool in the classroom, especially in increasing connections and communication between students. Students in the study liked the integration of social networking into their classroom experience. The authors provide recommendations and address concerns regarding the implementation of social networking in the classroom.

Although social networking is generally not associated for use in the educational environment, it is quickly being adapted into classrooms around the world. In an "Educational use of social networking technology in higher education" (Hung, 2010), researchers found that social networking was actually a helpful tool in the classroom as two public universities in Taiwan. They found that social networking increased connections and communication between students. Students found that social networking was a complement to the in-classroom experience. The authors believe that social networking can be integrated into the classroom as long as the focus lies on the connectivity it provides.

Additionally, a case study of the University of Cape Town's use of Web 2.0 in supplementing their educational experience examined how Web 2.0 tools such as Facebook could be used as an educational tool. The study followed 200 students and interviewed them about their usage behaviors of Facebook socially and educationally. The study found that it would be beneficial to include Web 2.0 tools into their educational experience because it would "tap into the distinctive proficiencies of their students while ensuring focused learning and positive outcomes" (Bosch, 2009) while increasing networking among the university community.

They, however, found drawbacks in the lack of access to the resources and possible disconnect between the older generation and the technology.

Brady et al. (2010) study replacing current traditional course management systems such as Blackboard with social networking sites such as Facebook. The authors argue that social networking sites, specifically Ning in Education in their study, are more personable and easy to use for students. Traditional CMS is outdated with limited features in comparison to social networking websites. However, they found that people are generally unwilling to add another social networking website to the ones they already use, a huge argument against using anything but the most popular social networking site. Thus, integration of new sites with existing ones is important for new technology adoption.

Of course social networking has benefits beyond the classroom. Chu and Kim (2011) examine the effect of social networking websites such as Facebook and MySpace on electronic word-of-mouth. The authors believe that advertising in social networking websites will become one of the most important strategies for companies. In the United States, advertising spending by companies on social networking websites is expected to increase to $2.8 billion by 2012. The authors tested the effectiveness of social networking sites in creating electronic word-of-mouth by measuring the tie strength, homophily, trust, normative influence, and informational influence. They also measured user opinion seeking, giving, or passing tendencies. The study concluded that social networking sites can increase the strength and effectiveness of a trend when compared to those that were not influenced by them.

Vladar and Fife (2010) discovered that social networks are the only area of mobile communication that saw growth. They identified three major drivers for that growth. First was the improvement of technology, specifically interfaces and processing speeds that have allowed social networking to run more smoothly on mobile technology. Second is the compatibility with existing practices; this means that the mobile technology is supplementing the traditional technology (computers) and furthering the usages of social networking. Third is the value of social networking that allows people to stay connected in yet another way and mobile technology providing the means for that to happen.

Methodology

For our research project, we will use the product development process described in *Introduction to Engineering Design* (Calabro, Dally, Fourney, Portmer, & Zhang, 2000). This outline is directly applicable to our project as ultimately its success will be determined by the success of our product. Because of our inclusion of product development, the value of our research will inevitably be judged by the consumer. However, we did not incorporate step 1 because we determined our goals through our own experiences and needs. The nine-phase methodology is as follows:

1. Identify customer needs.
2. Establish the product specifications.
3. Define alternative concepts for a design that meets the specifications.
4. Select the most suitable concept.
5. Design the subsystems and integrate them.
6. Build and test a prototype and then improve it with modifications.
7. Design and build the tooling for production.
8. Produce and distribute the product.
9. Track the product after release developing an awareness of its strengths and weaknesses.

Product Development

Product Specifications:

After analyzing existing research on topics related to our project, we used Quality Functional Deployment (Calabro et al., 2000) to determine specific objectives we wish to reach. Our product must allow users to connect to each other without using central infrastructure. This means that the complexity and cost of establishing and transferring material should be measurably reduced, or that there are new ways of sharing that were not originally possible with existing means of connectivity. We are looking to create a new, simple, and secure paradigm for sharing electronic information between geographically co-located parties. This means we must both utilize existing hardware and develop new software components that will allow mobile devices to create the connections that we are looking to establish.

The program should allow users to create their own networks as well as join the networks of those around them with the ability to share and receive information of any form across these connections. Networks can be broken up into several groups. Furthermore, the application should provide users with the option of revoking rights of access to any data that they have shared with other users. Finally, this application should be independent of any existing commercial products and therefore not bound to any existing device or operating system. This demand may seem unrealistic, but that is only if this is taken as a deliverable goal rather than an ideological goal. We plan to open source our software to allow others to modify and redistribute the code according to their needs.

Of course, the use of the term “network” is vague. Our software will be able to recognize and create several different types of networks. The first, and possibly simplest, is the “intercom” network type. This network will allow one user to act as an administrator for the group, with the exclusive ability to post files which can be sent among users. This will be useful for presentations, where the presenter may want to share his slide show and related documents for the audience. Furthermore, audience members may have questions. Under the intercom network, users will be able to send questions and comments to the presenter, these can either be anonymous and viewable by only the sender and receiver, or can be seen by all. The presenter will also have the ability to choose whether or not he wants the presentation files to be able to be carried out of this presentation. If he wants the audience's rights to the files revoked after the presentation is over, he will be able to choose to do this before sending out the file. This idea can be expanded to fully "open" networks, where there are no administrators and all users are equal. In these networks, there are no administrators, and no rules. Files could be shared freely amongst users with no limitations. Of course, some limitations could be added (like rights revocation by specific users).

Alternative Concepts:

To solve the issues stated above, several options can be implemented.

1. To address connection issues, we can create "dongles", such as a USB device or external hardware accessory (Boyle, Huang, Kuijken, Liu, Roedle, Simin, Spits, & Sun, 2007) that attaches to mobile devices, which will allow the devices to connect directly to each other without going through a central infrastructure. However, this is not the best concept since we can use Wi-Fi Direct, which will already be implemented in most Wi-Fi consumer devices by the time our research begins. Secondly, our concept is to develop a software solution to a sharing problem, allowing efficient file transfer between users. A hardware-only solution would not solve the

problem of actual file-sharing. We hope to implement a final solution that is much more streamlined and convenient so that our clients will have more incentive to utilize our product.

2. Developing the software that allows users to connect with each other is another important component of our project. There is the option of developing an application for an existing smartphone system such as the iPhone. This would require that we abide by the distributor's rules of development, which are often very restrictive. Apple has a specific set of guidelines (iPhone OS, 2009) that their developers must follow, and it is uncertain if our project will fall within those parameters.
3. To resolve the aforementioned issue, we could create an entirely new operating system for mobile devices. This requires much more programming than an application, as many routine processes an application must run are coded into the operating system. In addition, very few people would be willing to adopt an entirely new operating system that does not already have an established reputation (such as that of the iPhone or Android) making the entire system virtually useless.
4. Data security can be enhanced through encryption on both client and server sides (Jung, Rhee, & Sur, 2007). However, this has already been achieved by many software companies and is not a new or innovative way of providing secure means of data transfer. Coding processes for this type of encryption are general knowledge and thus can easily be hacked.

Determining the Superior Concept:

From looking at the flaws of each of the above concepts, we came up with a model that addresses all the issues. We will first focus on designing an application that will use established networking technology to allow local users to create as well as join ad-hoc networks within a specific geographic region. We aspire to have a final product designed for any mobile device including but not limited to notebooks, mobile media players, and cell phones. However, few mobile media players and smart phones have open Application Programming Interfaces (APIs) and operating systems. Currently, only Google's Android operating system is completely open-source (Android, 2009). This will prove to be a challenge, which may mean that in the end, our product will only exist as an application for Macs and PCs.

Research for this application will involve examining current technologies for the most efficient and updated systems of ad-hoc networking that can support our needs. Currently the most promising technology is Wi-Fi Direct (Foresman, 2009), which allows direct connectivity between two Wi-Fi capable devices without the use of an intermediary such as a router. Initiating Wi-Fi Direct on an existing device will not require any external hardware, but only a firmware update. This makes incorporating people into our user network much easier as this update could be included in the software package given to our research participants. We will write software that allows these newly capable devices to form networks of two or more members at the will of the users and promote seamless file-sharing. Wi-Fi Direct has the capabilities of connecting multiple users, just like a normal Wi-Fi system, through a series of connections and nodes. The only difference is that no central infrastructure is needed. This project will also create an interface in which users can see all available networks within the local area with the option of starting their own. We must create a formal model of the sharing resources and networks, identifying functional capabilities and properties of which the program will consist. As stated in the product specifications, there are different modes of connectivity for different situations. There are basic operations that we must incorporate such as file transfer, but it becomes more intricate as we move away from data transactions and into data rights management.

Our team will examine means of securing files from the possibility of virality or unapproved sharing. Currently, in a normal file transfer, the original data is copied from the sender device onto the receiving device, making both users owners of separate copies of the same file. We are looking to prevent this replication by sharing a temporary version of the file rather than the true copy. We will research how to "tether" a file to its owner, or allow the owner to share the ability to view the file while keeping rights of access under owner control (Purtilo, J., personal communication, November 25, 2009). An owner would be able to share a file under this tethering feature with the confidence that the receiver would no longer have access to the data if the owner so chooses. This encryption system is analogous to a lock and key. A file owner would be able to "lock" any file and then distribute the keys to other users using our network system. These other users would, through the connection between devices, be able to use the key to access the file and its contents. However, if the user decides to effectively change the lock, the keys are rendered useless. If the connection between the host and any user is dropped, either by manual termination or by exceeding the physical range of the connection, the user would similarly be completely unable to access the file. We will research and develop an encryption method that follows these criteria to provide our users with rights revocation power.

Subsystems:

There are three subsystems to our project: Wi-Fi Direct, the application software, and the rights revocation portion, all of which will be pursued relatively simultaneously. Wi-Fi Direct is currently not yet open to the public. While some form of beta version will be in existence, acquiring access to this technology will do us little good as we do not expect to have a prototype for some time. Until Wi-Fi Direct is released (around mid-2010) we will follow any press releases by the Wi-Fi Alliance in order to best prepare for its inclusion in our design (Foresman, 2009). Wi-Fi Direct currently appears the best means to physically allow mobile devices to directly connect to one another. We do not need to work on this system ourselves since it is a packaged service provided by another company.

The second subsystem is the application software, and the bulk of our project. This will provide users with the ability to share files across local networks behind a streamlined visual interface that is efficient and easy to use. This software will be designed to be cross-platform, meaning it will be able to run on both notebooks and various mobile devices. We will be able to create cross-platform software using tools such as the Java Development Kit, which is supported on a wide range of hardware and operating systems (Schach, 1996). The device may vary based on application, as businesses may prefer the higher processing power of a notebook, while the average user may only need that of a digital music player. We will determine possible applications of our technology in order to create the most efficient interface for customers. Based on these applications, we will design the software to support several different modes of communication among users.

The final subsystem we need to develop is the rights revocation. This will be coded as an attachment to our second subsystem and will allows users the option of setting up a "lock and key" system for any file that they wish to share (Jung et al, 2007). These subsystems will ideally become an integrated system, enabling users to share information over Wi-Fi Direct with the option of enhanced security.

Developing a Prototype:

We will be enlisting the help of Software Engineers at Maryland (SEAM) to help with the programming, relieving some of the burden. Dr. Jim Purtilo, our mentor, is the director of SEAM at the University of Maryland and will be able to guide us through the process.

Dr. Purtilo said to us, “Timing is everything. It is important to have an application goal written out clearly, a little bit upstream of a semester in which we would want a CMSC435 class to build something for us. That application is put into the mix of possibilities and the professor then makes the call on which idea will let him make all the desired teaching goals in terms of the projects. (Not all projects are suitable for this.) The down side is that not everyone teaching 435 does these sorts of 'live' projects. The up side is that I am one of the people who do.” (Purtilo, J., personal communication, November 4, 2009).

Thus, we will formally propose our project to SEAM before the fall semester of 2010. With Dr. Purtilo’s help, we will be able to secure a team that would program the software to our liking. It is then our responsibility to match the design with implementation, an important part of software engineering (Atlee & Pfleeger, 2006). We will provide the SEAM team with Wi-Fi Direct access. In addition to our project proposal, we will have the pseudo code for our software written to help advise SEAM as to our thought process regarding the software design. Pseudo code is an imitation of software code written in shortened prose to illustrate what the programmer wants the program to do. For example, the pseudo code program adding a network to a set of favorites would look like this:

Make new favorite network

Accept user input for network name and description

Assign description to new network

Add new network to set of favorites

While the final code would look dramatically different from this representation, pseudo code is a very helpful tool in software development as it helps connect the goals to the digital mechanisms that will make them possible.

Rights revocation will be entirely researched within our Gemstone Team. Dr. Purtilo described the process we would pursue, saying, "We define precisely what we mean by rights revocation in a suitably mathematical statement, so the intent for some abstract system is clear and unambiguous. We then derive (this is the really hard part) an algorithm we think leaves a system in the desired state. Then (and this is the really, really hard part) we prove that the algorithm does that mathematically. Proof trumps test in that situation. With that algorithm in hand, then we can move on to implement it. Testing is the process of checking that the implementation is actually consistent with the specification." (Purtilo, J., personal communication, November 4, 2009). Team members will be working on this portion simultaneously as SEAM works on the application. Once the algorithms are proven, we will give our proofs to SEAM to incorporate into the programming and coding of our application (Sommerville, 2007).

Production and Distribution:

Dr. Purtilo is in contact with a Microsoft employee who he believes will support our project with Microsoft resources if we present him an established methodology. Microsoft has branched into the field of mobile phones, and can likely provide our team with mobile devices that can support our application. We can then specifically program for these Windows Mobile devices, which would then be distributed for testing purposes. Furthermore, we will seek funding in order to afford the inevitable hardware costs of our project. We will apply for research grants, competitions (e.g. Microsoft's Imagine Cup (Imagine, 2009)) and any other opportunities that arise.

We will select one class whose professor is willing to integrate our new application system into his lessons for a class of about 30 students. Each student would be given our software if their device is Wi-Fi Direct compliant. If their computers are not capable, we will, pending feasibility, provide them with USB dongles that support Wi-Fi direct. Ultimately, once the program is streamlined for production through trial and error testing, we will be able to release the application for free downloading on multiple platforms.

Tracking:

As we develop our new technology, it will be imperative that we make adjustments while testing the different features. We hope to determine public interest in our product when used in some basic situations and will use their experience to improve the program. We will simulate our product's application in the following case scenarios:

- Colleges and co-workers who gather for a meeting or study session should be free to immediately share documents and notes in real time, without email transmission or the overhead of uploading/downloading files to/from a server.
- Friends socializing with one another should be able to collectively listen to or view media entertainment (rather than individually experience multiple copies of the same media, as is now the trend with iPods and other portable media players).
- Restaurants and markets should be able to directly share additional information about products or wares, beyond just the product itself. Customers should also be able to establish serendipitous sharing with one another simply based on being in the store together.
- Consumers should be free to consult with legal or medical professionals with the sharing of private materials (documents, medical histories, accounts), with confidence that their data is secure outside of, and after, the visit.

Ideally, we would select participants that fit each of these groups and then install our program on their existing mobile device. However, due to limited resources and time, we will provide the software to a specifically selected class hopefully by the spring of 2011 and see how the professor and students' interactions change after its introduction using a survey methodology (Graziano & Raulin, 2007). For the other sample groups, we will have to expand our range of participants if we have sufficient time. After a trial period of half a semester, the participants would take a survey on their general feelings and specific thoughts about various aspects of the system, as well as what we can work on to improve the software. We plan on applying for Institutional Review Board approval for these surveys as soon as we have determined precisely which questions we wish to ask and which students to survey.

There will be three types of questions in the survey. Closed-item questions (Graziano & Raulin, 2007), which limit participants to one of multiple choices, will ask users about demographic information (e.g., how they use the program, how often they use it, where they use it). Open-ended questions would ask participants about their thoughts on how they would prefer the program to change, or what they would like in the final iteration of the program. Scale item questions will rank attitudes, preferences, and behaviors of participants pertaining to the program, and its use. The use of these three types of questions would allow for a broad spectrum of information to draw upon for the advancement of our research. We will also be able to gather data from the software application itself, including how often a user shares files, how large the files are, and how many users they connect. In addition, the data that we collect from these surveys will help us improve our software, as we will be able to see what our users want from our application (Atlee & Pfleeger, 2006). We expect that the users will create environments and uses for our product that we had never imagined.

Conclusion

We feel that the internet is inadequate in addressing the specific needs of users within a local area and that it does not allow direct connectivity among users who are relevant to each other because of their physical proximity. Our project will introduce a new way for people to connect to individuals, businesses, and communities around them that cater to their respective needs. Currently, Wi-Fi Direct is developing the technology that supports our system but we are applying it to people on an individual and social level. We are creating an application that uses this new technology to cater to the needs of society. This could be very useful in developing nations that do not have established infrastructure and connection to the internet. Our technology will provide them with a means of connecting to each other without having to rely on a centralized system that may be difficult to implement in turbulent times. In addition, the rights management portion of our research will provide an unprecedented change in the way that people share files. Our implementation of digital rights management will move the power of rights management to the people, rather than the large businesses that use them to restrict peoples' use of their software and media.

Appendix A – Benefits of Our Methodology

One benefit of our proposed research methodology is that it is flexible and can be adapted easily to accommodate the rapid expansion and innovations in technology. Because this field of research develops at an exponential rate, it is crucial that we have an adaptive methodology that can be altered as new developments occur in the technology sector. We already expect several improvements in networking and mobile operating systems within the three years that our project will span. Wi-Fi Direct is scheduled for release in mid-2010 (Foresman, 2009) and Google's Android is extending its reach to incorporate new models of smart phones (Metz, 2009). We will account for possible changes in market hardware by first writing our protocol for computers connecting through traditional Wi-Fi. Another benefit of our product development methodology is that we will be able to learn what consumers will potentially want from our application and then adjust its functions accordingly through the tracking phase. Our product is meant to be adaptive to the needs of its users. While our initial research will tell us how our product's users interact with our technology, actually testing and implementing the application in situations outside of computer simulations will tell us the most about the utility of our research and how it applies to the campus.

Appendix B – Drawbacks of Our Methodology

In order to have a presentable and functioning prototype that can be used in case situations, the program will have to run independently of any hardware other than the mobile devices we choose to use. Our goal is to take this application beyond the computer to develop truly mobile direct connectivity, but we acknowledge that it will take time for our application to realize this potential. Our product will need to be independently functioning before we can release a beta version to groups for testing, and this is the most challenging aspect in moving onto the surveying stage. There are many parts to our research and we may not have sufficient time to address every research question stated above extensively. Therefore, we will decrease the number of groups tested instead of eliminating a research question entirely, as all parts of our research are directly correlated. As we proceed with product development, we will reanalyze our objectives and modify our methodology as needed. Because we are unsure of what exactly the final product will be, it is not possible for us to determine survey questions that we would use to assess performance of the product at this moment.

Appendix C – Data Collection

Most of our research data will come from network testing once the application has been developed. We will test different networking hardware to determine which is the best suited for our pattern of information flow and file-sharing. The data will consist of whether or not individual devices will be able to connect to each other using direct Wi-Fi connectivity.

We will research network connectivity by testing the completed program's competency in allowing direct constant connectivity among individuals. Our data will be measured by the number of successes and failures when a computer attempts to connect to the specified network, in the form of 0 or 1 data. We will also test the number of different connections that each system can support at a given time. Since our final product needs to be able to sustain connections with multiple other devices simultaneously, it is imperative that the technology we use for development can handle as many connections as possible. Our data for this aspect of the research will be in the form of how many connections can be established before the system is slowed significantly. Another important capability of the technology we choose for our file-sharing will be the volume of data it can send and receive at one time. This data will be measured in kilobytes per second. Furthermore, we will look at how our program and its associated file encryption capabilities affect the use of system resources on the various devices we plan to develop for. This will be measured by looking at memory usage, processor usage, and network card usage.

Once we have established the correct parameters for our networking framework, we will develop a detailed application that incorporates a user interface. This interface will allow users to easily create or join existing local networks. We will test ease of use by giving mobile devices with the application installed to group of University of Maryland students and surveying them on how easily they found that they could interact with each other using our application. We will also take quantitative measurements of the frequency of their sharing occurrences (i.e., occurrences per day) and the average file size exchanged. These can be compared to the current average ("View of the Data on P2P," 2009), that of previous file-sharing systems such as Push!Music (Hakansson et al., 2008), and our control group. Our control group will utilize current means to exchange information without the advent of our product. Unfortunately measuring this in an equal fashion would be very difficult, and we will have to resort to simpler methods of daily asking participants the amount of emails they sent, phone calls they made, etc. We can compare our findings to the public information of the current consumers average phone and internet usage ("View of the Data on P2P," 2009) to ensure validity.

To test rights revocation, we will use our system to share a secure file to different mobile devices operating on our software just as an average user would. Then we will, as the host, revoke the other user's access to this file. This process will be repeated many times with different file types and the data will also be measured in the form of a success or failure, for any one failure signifies the complete fallibility of the system. We will have to create tests that simulate the process in normal day-to-day use and through uses that would intentionally attempt to thwart the process (Firesmith, 2003). Any problems we encounter in this testing will have to be analyzed and solved by the team and SEAM students.

Appendix D – Data Analysis

For the first set, data collected from various existing systems (e.g. Bluetooth, ad-hoc networks, Wi-Fi, WLAN) will be graphed and compared. This set of data will be collected primarily through our literature review. Tables and charts will demonstrate the advantages and disadvantages of each method. For example, one table will compare the distances that each of these can project. As such, Bluetooth's range of tens of feet can be compared visually to Wi-Fi's hundreds. No statistical analyses should be necessary beyond calculating means for gathered data. Tables and charts will be assembled for factors including broadcast distance, number of connections possible, signal strength, computational strength required, and so on. Inferences can be made by team members considering the visual data. This analysis will inform the product design aspect of the product, and it will have little application outside the scope of the project. It can also be used as a marketing tool to help recruit test subjects, as these results will clearly display our product's advantages over existing systems.

Analysis of the user-interface testing will be primarily qualitative. User comments and experiences can be recorded and analyzed. The responses will be coded into positive and negative comments and from there categorized into the nature of the comment (Graziano & Raulin, 2007). Quantitative analysis will be conducted from the surveys distributed to users. A participant can rate a feature on a numerical scale, such as rating the ease of locating a specific feature on a scale of one to five. As with the analysis of different network systems, this data can be statistically analyzed and placed into tables and charts. Statistical means of responses should show the general opinion regarding various features (Knoke, Bohrnstedt, & Mee, 2002). Additional analysis can be done using demographic data, such as showing the mean response of all students compared with engineering majors.

In order to facilitate analysis of the classroom testing, the software will be designed to keep track of how often it is used and for what purposes. It will do this by storing a series of counters that can be read when the devices are returned. Counters will be used for items such as number of file transfers, number of networks joined or created, and amount of time that the software is active. Participants will be notified of this logging before the study and assured of their anonymity. We will also give them the option of whether or not they would like to send their data to us, like many other software companies do. Error report and data sending has been an effective way of receiving user feedback and data, without intrusive surveying, for companies such as Microsoft. Barring the device being tampered with, data collected this way should be extremely accurate. This usage data can be coupled with information about the particular user. Thus, we will know, for example, how often a particular second-year computer science major receives files. This data will be culled either periodically through the Internet or when the device is returned at the end of the study, depending on technical viability. We will use descriptive statistical analyses to summarize and chart this usage data, which will reveal how and when the software is most useful.

The group given the software will also be compared to the control group that does not use it. In surveys similar to the user-interface testing surveys, students will record their experiences in the class, particularly related to the ease of receiving and sharing class-related documents. As above, written responses will be coded and compared, and multiple-choice answers can be directly analyzed. If possible, we will compare the grades in each class, although the data would be of limited use with such a small sample and difficult to acquire anyway. From these, we will use the t-test and other applicable inferential statistical methods to compare the experiences of the two groups (Graziano & Raulin, 2007). These results can be represented in charts that should show whether the software is useful, a detriment, or an insignificant difference. If we find, for example, that there is a statistically insignificant difference between the groups and that the test group used the software very little, then we can attempt to draw conclusions of the viability of the software a classroom setting.

Appendix E – Limitations and Extraneous/Confounding Variables

In order to make a simple prototype, we need to base current implementations using traditional Wi-Fi over a centralized server. Although good for modeling purposes and easy to work with, these simulations cannot portray entirely the behaviors of an actual decentralized ad-hoc network (Yinan et al., 2008). When moving from the simulation to a real physical implementation, our group may encounter discrepancies between the real and simulation worlds that may mislead our project. The external validity of these simulations may come into question when generalizing our results from simulated centralized network to a real ad-hoc network (Graziano & Raulin, 2007).

The decentralized nature of ad-hoc networks may present difficulties in security protocols and information storage. We plan on having a userID for users of this application so that they may have an identity when communicating with others. However, without a central verification system, userID's may be theoretically changed at anytime prompting confusion and cases of identity theft. Our group will have to create the necessary security so that users will not have to worry about having their data or identity stolen.

There are a few variables that could skew our research results. For example, not all members of a class will necessarily be on campus as much as the average University of Maryland student. Students who live off campus may use our program less or differently than students who live in dorms. Our research is more beneficial if users are within the same general area for extensive periods. Because of the limited initial distribution of our product, users will not be able to interact with many people around them to the scope that we plan our project to eventually reach. They can only interact with those people in the preliminary study that we conduct, so off-campus students who are not able to use the application with the on-campus students would give us the perception that they are not using the application because they do not like it. Additionally, some students may attend class with greater frequency than others, thus limiting the classroom interactions that we would like to observe.

Students testing our application may also feel obligated to use our product more because they were the ones first approached to test it. These subject effects may end up affecting the data in unintended ways since our test population may behave differently than they would normally for any mobile/desktop application they discover on their own on the internet (Graziano & Raulin, 2007). We will have to divide the population into subgroups based upon these confounding variables in order to limit the extraneous effects of these variables.

Lastly, the type of class we distribute our product to may give us different results based on the type of people that are usually in those majors. For example, distributing our application to a more tech savvy audience, such as a computer science or electrical engineering class may give us data that reflects a high volume of usage. But another class with students who typically do not use gadgets or are not as familiar with electronics may find little to no use for that same application. We will have to make sure to evenly distribute our prototype to all types of students who are an accurate representation of a typical university setting and not just all computer science majors or all Gemstone students. Picking popular University CORE classes, such as ECON200, that many students take may minimize these variables.

Appendix F – Anticipated Results

Through our project, we expect to find certain networking systems more efficient in supporting our needs than the other existing technology we researched and described in our literature review. We hope that one of these systems will be sufficient in handling both multiple user connectivity and high volume of data transfer. When we find a network system with the necessary capabilities, we will adapt our application development to accommodate the structure of the system. We expect the survey data to be useful to the progression of our application to public release, and that it will accurately demonstrate the needs of a wider demographic. We hope to find that our application is useful to students and faculty in increasing productivity and connectivity to their local environment and peers.

As a result of our research, we hope to create a system where users can share information securely and conveniently on a local level without the hassle of physical hardware such as flash drives. Ultimately our goal is to create a completely mobile, location-based network that the user can hold in his or her hand. Realistically, during our time with Gemstone, our product will progress to the stage of connecting student's notebooks to others in their general vicinity. This progression is likely because of the relative strength of connectivity capabilities of computers to those of handheld devices.

Appendix G – Budget

Since our initial prototype will be programmed on conventional computers, we will have few initial costs. We intend to use as much open-source code as possible, given that such code is freely available for our use. We intend on outsourcing at least some labor to University of Maryland's Software Engineers at Maryland (SEAM) program directed by our mentor Dr. Jim Purtilo. Due to our team's limited manpower and experience, SEAM would write the complex parts of our software. Because Dr. Purtilo runs the program as a class, we would not have to pay the people that work on our code any compensation for their work.

Since we will be working with advanced technology, we may need to purchase new products that have the new technology. The average consumer notebook today can be bought for under $500 ("Dell Laptops / Notebooks" 2009). Wi-Fi Direct should become a standard technology in notebooks when it is released so we believe that notebooks with that technology will fall in the average range.

When we begin to distribute our program, we may have to purchase dongles with the new Wi-Fi Direct technology to distribute to our focus group if they have computers that do not already have the technology as part of its hardware. In order to avoid this cost, we will look to work with freshmen since they are the group that is most likely to have the newest technologies.

When we begin the mobile program part of our project, we will need to purchase several smartphones in order to test a mobile prototype of the program with actual pieces of hardware. We intend to work with the Google Android operating system for smartphones. As Google Android has only recently began to spread across the major phone networks, smartphones with Google Android vary in price. Recently, Verizon Wireless released the Motorola Droid and priced the phone at $199.99 with a new two-year contract. Given that we do not intend to spend money on the actual service, we will examine purchasing one to two unlocked Android phones, which cost $559.99 each, according to the Motorola Store ("Droid", 2009). There is also an Android emulator, which is free of charge, and we will be using this to test our program on computers (non-mobile devices). [also ACER - http://us.acer.com/ac/en/US/press/2011/23046]

We also have created a contact within Microsoft through the Imagine Cup Program and the Robert H. Smith School of Business. He is more than willing to provide us with free hardware and development tools through Microsoft. These will allow us to experiment with multiple platforms in the creation of our product.

In addition to the $300 that the Gemstone Program provides to us every year, we will look at outside sources of funding. A potential source of on-campus funding is the Dingman Center for Entrepreneurship at the Robert H. Smith School of Business. At the end of every month, the Dingman Center holds a competition for $2,500 worth of funding to the winning start-up proposal. Since we will be on campus for at least eight months, we will have at least eight attempts at winning the $2,500 competition ("Dingman", 2009). The Dingman Center also awards $17,500 to the winner of their annual Cupid's Cup Business Competition, $7,500 to the second place winner, and $2,500 to the "people's choice" winner.

Product	Cost
New Computer	$600-800
Phone with Android OS (2)	$599.99 x 2
Dongles (100)	$20x100
Total Cost of Expected Purchases	$2000-2200

Appendix H – Timeline

In fall 2009, we thought of the project and narrowed our vague idea into a specific, feasible project. We then brainstormed how to make this project marketable while still fitting the Gemstone requirements. Once our project concept was finalized, we drafted a specific methodology to follow throughout the next three years. After feedback was received for this methodology, we began drafting the final Team Proposal, and periodically presented our progress to Gemstone.

We recently began programming learning exercises that will contribute to the completion of a final application software. One exercise allows us to upload and download files from a server. This is no new technology but it allowed us to learn about the mechanisms behind everyday internet transactions. We used PHP, XML, and JavaScript in producing this functioning program. Furthermore, we are currently working on a Microsoft Visual Basic Application which will act as a graphical front end for this prototype.

During the early months of 2010, we went through the preliminary stages of preparing for entry into the Microsoft's Imagine Cup. This competition is a great opportunity to receive funding, and we have already submitted a business plan for our prototype. We were unable to finish a working prototype for the competition deadline, but it acted as a motivator for our team to produce prototype software. We continued to develop more features for this software and began investigating the feasibility of porting the notebook compatible prototype to mobile devices. We then designed and constructed our team website at http://teams.gemstone.umd.edu/classof2012/flip/Team_FLIP1/Home.html. Throughout the spring and fall semesters of 2010, we polished the prototype and decided which mobile device to work on porting the prototype to. At this point, we plan to begin to start working on an IRB proposal. Throughout these processes, we will be searching and applying for funding opportunities and updating our web site.

This process of finding funding is planned to continue over the summer after sophomore year and into junior year. Just before junior year starts, we will submit our completed IRB proposal. Junior year, we will begin testing our mobile prototype. At the same time, the final thesis will be outlined and a draft will be started. Testing of our prototype should be finished by or during winter break. In the spring of junior year, we will finalize the prototype based on our data, revise our draft of our thesis, and create a presentation for Undergraduate Research Day. Throughout junior year, we will continue to look for funding and update the web site.

If testing is not finished by the summer before senior year, we will definitely finish by the start of senior year. Most of senior year will be dedicated to finishing and finalizing our thesis paper. Early senior year, we will also draft our final presentation and invite five or more experts to attend our thesis presentation, and continue to make sure our web site stays up to date. Through the winter and spring of our senior year, we plan to finish the thesis and presentation, as well as to polish and practice our presentation. Not long before the thesis defense, we will submit our final team information. Our Gemstone experience will end with our successful defense of our thesis, and final updates to the team web site.

Timeline by semesters

Sophomore Year:

Late August 2009- Concept conceived, narrowing it to a feasible project

September 2009- Brainstorming how to make the project marketable as well as fitting Gemstone requirements

October 2009- Project idea finalized, methodology drafted

Late October 2009- Coding begins for the prototype application (notebook)

November 2009- Begin drafting Team Proposal, present progress to Gemstone

Early December 2009- Finalize Team Proposal

December 2009/January 2010- Winter Break, continue coding prototype (notebook), look for grants/scholarship opportunities

February 2010- Submit business plan to Imagine Cup, hopefully finish code for prototype application (notebook)

March 2010- Submit prototype to Imagine Cup, begin investigating the feasibility of porting prototype to mobile devices, and begin creating web site

April 2010- Finalize/polish prototype (notebook), decide what kind of mobile device to attempt adaptation of the prototype, purchase mobile devices for testing, continue searching for and applying for grants and scholarships, begin working on IRB proposal, finish first draft of web site

Junior Year:

Summer 2010- Work on porting the prototype from notebooks to the mobile device, continue searching for and applying for grants and scholarships

August 2010- Submit completed IRB proposal

Fall 2010- Begin testing mobile prototype (let people use it and survey), continue searching for and applying for grants and scholarships, present research and progress at the Fall Colloquia, do outline of thesis, begin drafting thesis

Winter 2010/2011- Continue and finish testing of prototype

Spring 2011- Finalize prototype, obtain feedback on draft of thesis and revise draft, create and present a poster for Undergraduate Research Day

Senior Year:

Summer 2011- Test final product, collect appropriate data

Fall 2011- Finish draft of thesis, continue revising thesis, draft presentation, and invite at least five experts to attend thesis presentation, make sure website continues to be up to date

Winter 2011- Finalize thesis, presentation

Spring 2012- Practice presentation, submit final team information, turn in thesis, defend thesis, and make final updates to the team web site

Glossary:

Android - Google's open-source operating system for mobile devices

API - application programming interface; an interface of a specific software that allows other software (such as third party applications) to interact with it

Dongle - a small piece of hardware that connects to a computer, and may be portable

Driver - A computer program allowing higher-level applications to interact with a hardware device

Emulator – A piece of software designed exactly to simulate another piece of hardware or software (e.g. an operating system)

Encryption - converting data or information into code

Firmware - something in between hardware and software; like software, it is created from source code, but it is closely tied to the hardware it runs on

IEEE 802.11 Protocol – A set of standards for carrying out wireless communications, of which Wi-Fi is an implementation

Node - any computer or server that is hooked up to a network

Open Source - software whose source code is freely available to the public

Packet - a unit of data transmitted over a network

Rights Revocation - the ability of a file-sharer to revoke rights of access to any shared file

Tethering - allowing the owner of a file to share a file while still controlling the rights of ownership and access

Unlocked Phone – A mobile phone that is not tied to a specific carrier, allowing it to be used without pay for a service contract.

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