eVote

An Electronic Voting System

Final Report for the ICOM 5047 Course

Section 031

Javier Torres Santiago ID# 802-03-8529

Sylvia Rodríguez Rodríguez ID# 802-03-7033

Angel Vega Cortés ID# 844-02-9732

Laura Cruz Rodríguez ID# 802-03-1797

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1. Executive Summary

JSAL's goal is to design an electronic voting system that may eventually replace the current voting system being used in Puerto Rico. The eVote system provides additional security measures that prevent voters that have voted from being able to vote again due to computer software that electronically monitors the electoral numbers used to register voters. Once a voter's transaction has been completed with no unexpected problems (printer malfunction or device malfunction) their vote will be processed and their voting status will be updated to prevent further use of that voter's electoral ID. After having the voter's vote processed, a printed receipt will be provided where additional verification can be made by the voter. Once the voter receives the receipt, it will be deposited in the corresponding urn for electronic votes. During the initial release of eVote, both normal and electronic kiosks will be made available to satisfy the preferences of each individual voter.

During the design and implementation of eVote, JSAL's goal was to complete the entire prototype by the final phase deadline of December 1, 2008 while making economic design decisions. Our total hardware costs arrived at a total of $247.53 which is way below the maximum amount money allowed of 500 dollars which was set by our clients (capstone professors). By verifying the deadlines for each phase of the prototype, the JSAL team was able to create a Gantt chart that provided the tasks which led to the eventual completion of Sparrow's eVote. The prototype is completely functional as documented in this report which is to be turned in December 8, 2008, and the final presentation on December 11, 2008 will discuss the project details as well as provide a demonstration to the attendants of the presentation. After giving the final presentation, the JSAL team's contract with the client will have been followed through to its end.

Sparrow's original cost for the project was estimated on $33,364.04. The final expense of the project was $34,264.65. Therefore there was a reduction of $911.11 on the company profit for the project.

JSAL's eVote device was designed for the Capstone Computer Engineering course. Our potential clients would be Puerto Rico's State Election Commission. The team has compared products similar to the eVote, in order to implement the best traits from what is already available

in the market. The eVote provides keypad navigation for a screen interface, voter verified paper audit trail (VVPAT), and permits voters to vote in English or Spanish.

2. Introduction

The Puerto Rico of today currently uses a paper format for the elections, which does not reflect a modern approach to casting votes. As the world advances in terms of technology, it would only make sense that archaic systems be redesigned to reflect the current level of existing technology. Every year new car models come out with improved designs and features, but the voting system has remained the same, if not with unnoticeable changes. JSAL proposed a method of using current technology to develop a modern voting system that will store the votes electronically while still providing a paper trail (a receipt) which is desired in electronic systems in the case of a failure.

The most important problem found in the elections, is the privacy of the voter selections. Sparrow's eVote will provide a simple interface for the voters to cast their votes and upon completing their corresponding selections, a receipt will be provided. This receipt will be smaller in size compared to the large ballots currently being used in Puerto Rico, take the legislative ballot for example. The receipt due to its small size will make it easier to conceal the voter's selections. The possibility exists that the device may not be accepted completely by the public, so it may require some publicity and tutorials as to how the system works. Also by providing computer software to register the voters and corroborate their "already voted" status prevents any voters from working around the current election's exploits. If a voter is not marked as "already voted" on paper physically by an elections employee, then the voter can return and vote again. With eVote this can never occur since a number is required to register a voter and once the transaction is complete and no errors arise, their vote is processed and their "already voted" status is updated electronically. The administrator will not have access to this information in order to maintain a level of protection of the data from unethical actions of elections employees.

JSAL has designed two separate systems called Sparrow and Raven. This final report documents the Sparrow system, but the Raven design document can be found in the Appendix B-3. Note that this Design document also has a reference to the Raven database Design document also presented in the Appendix B-4.

The JSAL team was able to evaluate its progress with the following:

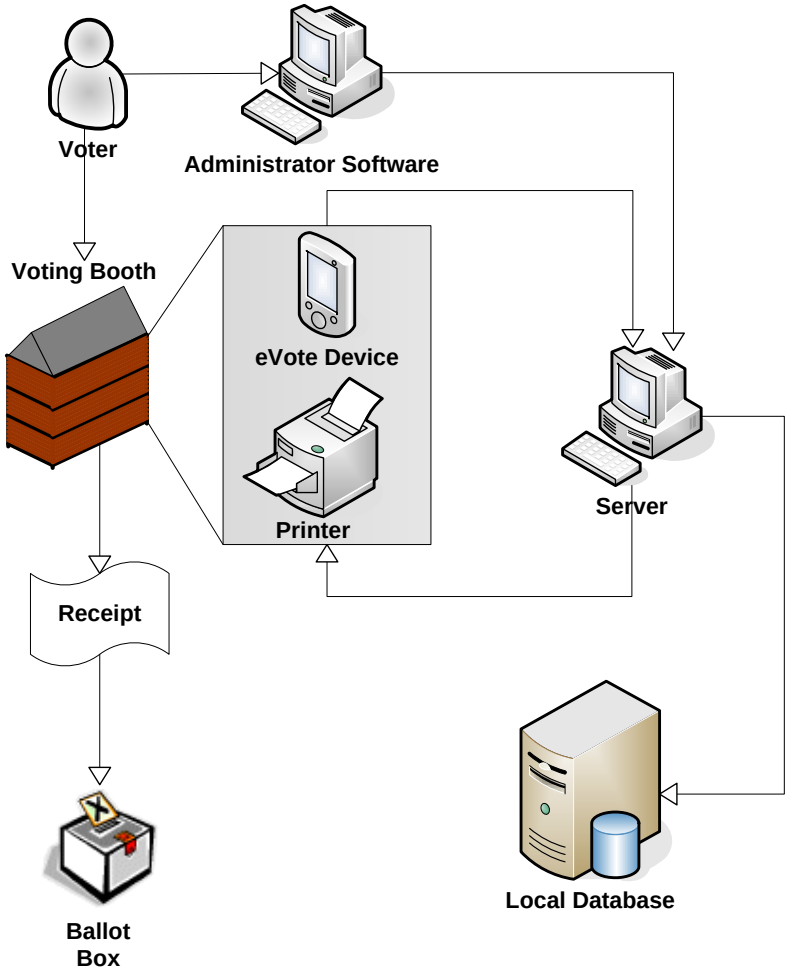
- Provide a proposal document with the design specifications of Sparrow's eVote system
- Complete the entire prototype and the corresponding documentation by December 1, 2008
- Stay within the acceptable budget range of $500.
- Demonstrate periodical progress though out the semester with Oral exams
- Complete Reports for progress

With the previously mentioned items, JSAL has successfully completed the prototype and is ready to provide a demo for the final presentation.

This report contains detailed discussion of all documented activities of the Sparrow eVote system. The system design is described in detail with references to documents found in the Appendix. Also a market analysis comparing our project to that of the available products is provided, along with analysis of environmental, social and legal impacts for the eVote system. Finally the financial considerations are described in detail with comparisons to the originally proposed document.

3. Design Criteria and Specifications

For the design of eVote, three different modules were created for implementation, the database, eVote hardware and software. The eVote architecture can be seen in Figure 1. The architecture is setup in a way that the voter must interact with an elections official to be registered using the computer software. After the voter is registered they can continue to vote in their assigned kiosk which becomes enabled (turned on allowing for a voter to submit their vote). After voting, the voter will receive a receipt which will be deposited in the corresponding ballot box for electronic votes.



Sparrow eVote System Architecture - Figure 1

In each precinct, in order to accommodate voters who have no desire to vote electronically, a separate voting area which still uses the paper ballot methods will be made available to them.

3.1. Hardware Design Specifications

Please refer to the Hardware Design document located in the appendix (section13.7.) for details of the hardware design. The document discusses design decisions made for the eVote system including implementation of the hardware components required and firmware code. The document also includes images pertaining to the overall design of eVote.

3.2. Software Design Specifications

The administrator application design and specifications are included in the Appendix in the Administrator Application Design (section 13.1.). This Appendix describes how the application was implemented, the functionalities provided and the application class diagram. Additional information on the usage of the application can be found in the User Manual Document (section 13.7.) available in the Appendix.

3.3. Database Design Specifications

There are two database design documents in the Appendix that refer to the Database Design. The first is the Database Redundancy and Security design document (section 13.5.) where JSAL presents the database redundancy and security design for the eVote Sparrow and Raven. It explains the different options available for redundancy, and the team's approach on how to implement the security for the system.

The second document in the Appendix is the Sparrow Database Design document (13.6.) which explains in detail the implementation JSAL used for the capstone course prototype.

3.4. System Constraints and Limitations

The eVote system has a few constraints and limitations due to its downscaled design. Since the Sparrow design for eVote was designed in order to comply with the Capstone courses

requirements an alternate design making the product with more functionality was made (Raven), please see the attached Raven Design document for details. Sparrow currently will only work for a specific precinct and one device since the prototype made is just one voting kiosk. Each kiosk has its own printer and device. Obviously the amount of money dedicated to the project was very limited so only one kiosk could be made and so the rest of the Sparrow implementation revolved around one eVote device.

The administrator application has been left in a state that allows for expansion for more devices, but additional testing would be needed to ensure the functionality of a second device. Also the code must be modified to allow a second device to run concurrently, since there is only one device active at the moment, the team was able to demonstrate a higher level of scalability through a simulation which simulated various devices connected at once. The simulation is indeed just a simulation and cannot prove the actual scalability unless more money was made available to make more prototypes.

3.5. Constraints and Limitations during implementations

One of the main limitations during implementation of eVote was the lack of a hardware oriented team member. Much time was dedicated to research but time was a major constraint so quick training sessions by reading online or contacting a hardware consultant was necessary to prevent not meeting the deadlines of the project.

Another constraint was the LCD, when it arrived it was realized that it needed an inverter to provide negative input to one of its ports. The team needed to race against the clock to find a method of providing this voltage to the LCD. Online, a design was found and the creator was contacted to acquire legal permission to use the design for the eVote system. To view the copyright please refer to the Hardware Design Document of the Appendix (section 13.7.).

In terms of the software, one of the limitations JSAL encountered was that of the printing functionality of the administrator application. JSAL acquired various professional consults on how to access the printing job and verify if the task had indeed been completed so that the vote can then be processed in the database. It is very important that the voter's selections remain private so if a printer was to malfunction, the print job would still be within the spooler of the

computer, and at the moment the printer began to function, the voting summary would be printed violating the privacy of the voter if someone else intercepts the receipt. In order to solve this dilemma if the printer does malfunction, then the voter cannot be assigned to that specific kiosk. Currently there is no way JSAL can cancel a print job when there is a malfunction because this requires access to the spooler. JSAL has researched this and has not encountered any methods on how to remove a job from the printing spooler. To this end, only kiosks with printers that are completely functional can be assigned. This removes the need to delete a printing task with if a printer malfunctions.

The most serious limitation that JSAL had come across was that of the UART. The discovery of the malfunctioning UART pins led to a complete overhaul of the firmware code in order to accommodate the migration to a new microprocessor. For details please refer to the Hardware Design Document in the Appendix (13.7.).

3.6. Project Software and Hardware Requirements

The only requirements necessary to be able to use the Sparrow eVote System are:

- A JSAL eVote device
- An outlet that can supply electricity to a 9 volt adapter
- A computer
    - 2.0 USB - to allow UART communication
    - CD-ROM to use installation disc of administrator software
    - Windows XP
    - Minimum of 2 megabytes of hard disk for installation

For modifications to the firmware for future elections:

- A FET-USB Debugger
- Code Composer Software
- An MSP430F149 microprocessor development kit [18]

4. Methods and Approach to Solution

This section discusses all of the activities the JSAL team needed to complete to get to the main project solution proposed.

4.1. Activities

The JSAL team was divided in three sections to accommodate the specialties of each member. Sylvia Rodriguez was in charge of the development of the software administrator application, Javier Torres was in charge of all hardware related items for the project, Laura Cruz and Angel Vega were in charge of the database related items involved with eVote. Although Laura Cruz was in the database section of the team, she was often given tasks to program firmware as well as test it. She also had a hand in the login of the administrator application that Sylvia Rodriguez was working on. Sylvia Rodriguez also had roles in the hardware section of eVote by developing the navigation of the navigation logic for the eVote system. The following sections describe in detail each team member's tasks throughout the development of eVote.

4.1.1. Sylvia Rodriguez

Software:

- Administrator Application Design
- Administrator Software Development
    - Voter verification and registration
    - Kiosk assignment and management
    - Kiosk printer and device status
    - Kiosk history
    - Voting results printing with barcode

Hardware:

- Navigational logic
- Keypad testing with LEDs

Prototype:

- Enclosure aesthetics: repaint navigational buttons and laminate enclosure.
- Overall testing of eVote

4.1.2. Laura Cruz

Software:

- Login Application
- Activation & Deactivation of eVote device
- Structure for sending votes from eVote device to database
- Testing

Webpage:

- Create & Update website

Hardware:

- Write in Screen Design and Logic
- Testing

Database:

- Setup Database environment
- Create & manage tables

4.1.3. Angel Vega

Software:

- Designed the UML Diagrams.
- Developed a database connection test application.
- Implemented information security encryption and decryption.
- Implemented a scalability simulation application.
- Developed a voting summary test application.

Database:

- Database Design and Entity Relationship Diagram.
- Implemented information security encryption and decryption.
- Populated database to simulate a realistic size.

4.1.4. Javier Torres

Team Related Tasks:

- Assigned tasks to team members for each phase
- Monitored individual progress
- Organized team meetings
- Integration of Proposal, Progress Report and Final Report
- Visited the State Elections Committee downtown Mayaguez
- Participated in elections which served as research for the eVote voting process

Hardware:

- Purchased all hardware components
- Designed the port distribution for connections with the Keypad, LCD and UART
- LCD
    - Acquired copyright permissions for LCD inverter
    - Built inverter circuit using copyright design and connected it to the LCD
    - Completed LCD initialization firmware.
    - Completed LCD Screens for eVote in firmware
- Keypad
    - Integrated with the microprocessor
    - Tested functionality with LED lights
    - Removed excess buttons not used in navigation
    - RC circuits, to remove the bouncing effect
- Testing of eVote Firmware Code
- Prototype
    - Used tools to create LCD and keypad openings in the enclosure
    - Placed all hardware components within enclosure
    - Integrated a nine volt dc adapter to power the device
    - Overall Testing of project

4.2. eVote Testing

The eVote system requires that all elements of the project work, or a vote may be counted incorrectly, or not processed. After having a functional database, the team tested the device to ensure the votes made were correctly inserted into the database. A series of scenarios were executed to verify the stability of the system.

Tests were done to verify the functionality of the device if it were to be disconnected from the computer software. Naturally the firmware code recognizes the moment of disconnection between the software and eVote device, and displays an error message indicating that the voter must see an election's official for further instructions.

There were many issues with the printing of the receipt since this is one of the most important elements of the voting process. It allows the voter to receive physical evidence confirming their vote. After already confirming three times on the eVote device (one confirmation for each selection and an additional confirmation to accept the voting summary), the voters are able to once again confirm visually their selections, before depositing the vote into a ballot box for electronic votes.

4.3. Schedule

The eVote system was designed to be completed in three phases. Each phase had its corresponding tasks for the hardware, software and database. Each phase was duly completed on time without passing the Gantt chart deadlines. This is due to the careful planning of the first phase which is the most crucial since it is when the team kicks off into development. Substantial time was given in the first time to mitigate the risk of not receiving any of the hardware components on time. The hardware components did indeed arrive on time, but it was unforeseen that additional hardware components would be needed to work with the LCD. After researching online, the team found an inverter design that allowed the LCD to completely function. The other phases were completed on time as well which is thanks to the careful planning of the first phase and the successful implementation of all the software and hardware tasks.

The only modifications that were made to the original Gantt chart were to include a scalability simulation to verify the stability of the database and if it could handle the weight of many voters accessing it.

Although the team all had specialty in software and not in hardware, the time given in the first phase was sufficient for enough crash courses in microprocessors and the integration of hardware. This was also another reason as to why the first phase was so important and that enough time be allotted for this phase alone. This phase was the longest of the three phases so it gave the time necessary to ramp up on the team's lack of hardware experience. Due to JSAL's precautions, "no biting more than can be chewed" was done in any of the phases.

For Gantt chart specifics please refer to the Appendix section 12.1.

4.4. Changes

Comparing the proposal to the final product, it is noticed that not many changes were made. In terms of hardware, nothing changed physically, but for the firmware small changes have been made and these changes can be seen in detail in the Change Control Document in the Appendix section13.2.

5. Market Overview

JSAL's eVote device was designed for the Capstone Computer Engineering course. Therefore, our current users have been the professors and several students. Throughout the semester, both parties have provided input into what works and what should be improved. The design also took into consideration the success and failures of several companies in the business, some are: Election Systems & Software, Inc. (ES&S), Sequoia Voting Systems, Software Improvements, and lastly Premier Election Solutions Inc, previously known as Diebold [1].

Our potential clients would be Puerto Rico's State Election Commission. Since the Help America Vote Act of 2002 [2] the use of DRE (Direct Recording Electronic) systems have been increasing in the elections (Refer to Figure 2 & 3), this should motivate Puerto Rico to update their current voting system to an electronic voting system.

There are several companies in the market; the following is a brief description of each competitor and a comparison with the eVote system.

ES&S:

Election Systems & Software, Inc. offers the iVotronic. It is a portable, paperless, touch screen voting system that is activated by using a personalized electronic ballot (PEB) cartridge [3].

Sequoia Voting Systems:

Sequoia Voting Systems offers the AVC Edge. A touch screen device that is in a self-contained portable case, and provides a voter verified paper audit trail (VVPAT). It also stores the votes and ballots inside the device [4].

Software Improvements:

Software Improvements offers the Electronic Voting and Counting System (eVACS). It utilizes a client/server system. It is a proven system that has been extensively tested, audited against IEEE Standards and has been transparent with the source code, which is publicly available [5], [6].

Premier Election Solutions, Inc:

Premier Election Solutions, Inc. offers the AccuVOTE-TSX system. It is touch screen device that is in a self-contained portable case. The results and ballots are stored within the device; it utilizes a type of voter card for activation [7].

All the previous mentioned products offer a touch screen interface; the eVote will also have this feature implemented. Out of all the products only the eVACS work as a system and not as a stand-alone product. The iVotronic does not provide a VVPAT which is required by law in the US [8]. The eVote works as part of a system, instead as a stand-alone product and provides a VVPAT. Sequoia Voting Systems and Premier Election Solutions, Inc. have already been hacked [9], [10], [11]. With this said, the eVote does not use any type of smart card in the system. In conclusion, JSAL has studied the best and worst traits of the competition and has come up with a solid and innovative design that will exceed the clients' expectations.

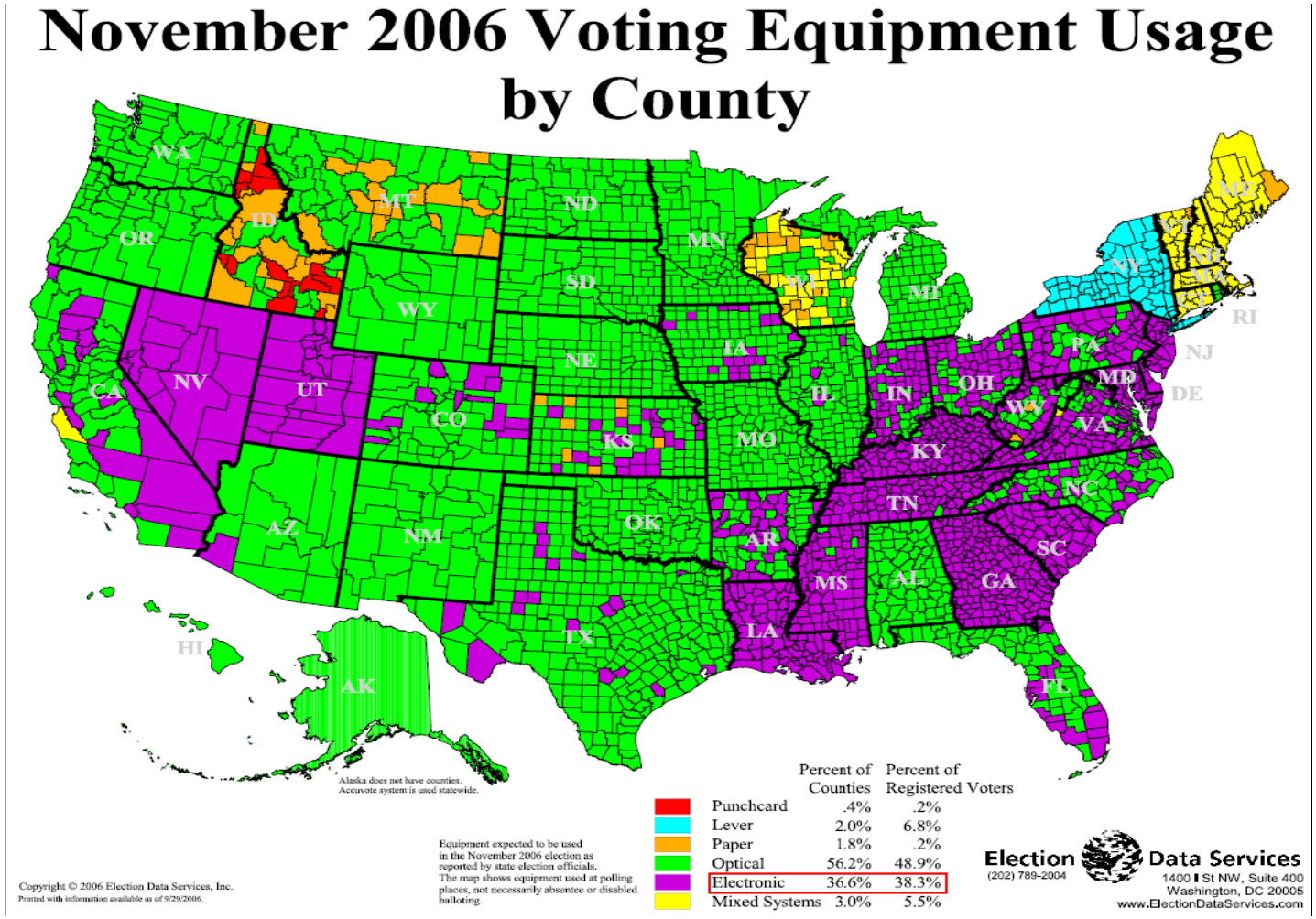


Figure 2: Voting Equipment Usage in the United States.

Taken with permission from Election Data Services, Inc. [12], Appendix Section 12.2

Voting Equipment Changes by Equipment Type — Counties				
Type of Voting Equipment	Number of Counties			
	Nov–2000	Nov–2002	Nov–2004	Nov–2006
Punch Cards	572	459	330	13
Lever Machines	434	288	264	62
Hand-Counted Paper Ballots	370	304	298	57
Optically Scanned Paper Ballots	1,279	1,360	1,443	1,752
Electronic (DRE) Equipment	309	547	631	1,142
Mixed (Multiple Types)	149	156	148	92
TOTAL	3,113	3,114	3,114	3,118

Figure 3: Voting Equipment Changes.

Taken with permission from Election Data Services, Inc. [13], Appendix Section 12.2

6. Results and Discussion

After three phase completion meetings with the client (happy hours), the Team completed all the proposed functionality for eVote. The system is completely functional as a prototype allowing any voter to make their vote using the eVote device. After the vote, the voter will get a printout receipt that has barcode information on it. The barcodes exist for the recounting module present in the Raven design. Although the prototype is a low scale version of a product that would be used on a wide-scale, it still possesses the basics of an electronic voting system. The power dissipation resulted to be very low once the project was integrated, for technical details please refer to the Hardware Design Document in the Appendix in section 13.7.

6.1. Environmental and Social Impact Analysis

The following section identifies the different ways in which the eVote project can impact the citizenship and the environment. The electronic voting system may contain aspects that can have an environmental impact such as the materials used to build the hardware, the printer, and ink and paper used for printing receipts. Since voting is a large scale activity, the slightest impacts can eventually accumulate into something that must be considered.

The impacts have been identified and evaluated following the presentation given by Maria del Rocío Suarez, MSc on Wednesday, September 17, 2008 to the Computer Engineering and Electrical Engineering Capstone students at UPRM. All the criteria and criteria weights have been obtained from her presentation which is available at the UPRM ICOM Capstone website.[19]

6.1.1. Impact Identification and Evaluation

Definitions used for evaluation

LEVEL	DEFINITION	CALIFICATION
Low	Depreciable to low environmental impacts. Mitigation actions taken in consideration or low cost actions involved.	1
Medium	Medium to high environmental impacts. High costs involved to mitigate these impacts.	2
High	Irreversible environmental impact. Legal aspects involved.	3

• Type : Negative (N) = 2 , Positive (P) = 1	10%
• Duration : Long (L) = 3, Medium (M) = 2, Short Term (S) = 1	5%
• Magnitude : High (H) = 3, Medium (M) = 2, Low (L) = 1	25%
• Coverage Area : Local (L) = 2, Regional (R) = 1	5%
• Tendency : Growing (G) = 3, Stable (S) = 2, Decreasing (D) = 1	5%
• Possibility of materialization: High (3) = 3, Medium (M) = 2, Low (L) =1	25%
• Risk Management Options ▪ Prevent (P) = 1 ▪ Mitigation (M) = 2 ▪ Compensable (C) = 3 ▪ Recoverable (R) = 4	25%

Environmental Impact

- Paper trail impacting tree life

  Type: negative, **Duration**: Long, **Magnitude**: medium , **Scope**: Regional ,

  Tendency: Stable , **Possibility of Occurrence**: High

  Management Alternative: Compensational

  Total Impact Score: 2*.10 + 3*.05 + 2*.25 + 1*.05+ 2*.05 + 3*.25+ 3*.25 = 2.5

- Hardware components with hazardous materials such as copper and lead

  Type: negative, **Duration**: Long, **Magnitude**: High, **Scope**: Regional ,

  Tendency: Stable

  Possibility of Occurrence: Medium

  Management Alternative: Compensate

  Total Impact Score: 2*.10 + 3*.05 + 3*.25 + 1*.05+ 2*.05 + 3*.25+ 3*.25 = 2.75

- Less paper wasted on multiple ballots since all is printed on one receipt

  Type: positive, **Duration**: Long, **Magnitude**: low, **Scope**: Regional, **Tendency**: Stable

  Possibility of Occurrence: Sure

  Management Alternative: Recuperation

Total Impact Score: 1*.10 + 3*.05 + 1*.25 + 1*.05+ 2*.05 + 3*.25+ 4*.25 =2.4

- Disposal of non harmful ink toners

Type: Negative, **Duration:** Medium, **Magnitude:** Medium, **Area of coverage:** Regional, **Tendency:** Increasing

Possibility of occurrence: Certain

Management Alternative: Mitigation

Disposal of non harmful ink toners also needs to be regulated by law, so that it is done in the least harmful way possible. If possible, these ink toners should be re-filled and reused.

Impact Score: 2*.10 + 2*.05 + 2*.25 + 1*.05+ 3*.05 + 3*.25+ 2*.25 = 2.25

Social Impact

- People may not respond favorably to the electronic methods of voting and may cause confusion upon transition from normal paper conventions

Type: negative, **Duration**: short , **Magnitude**: medium, **Scope**: Regional,

Tendency: Decreasing

Possibility of Occurrence: medium

Management Alternative: Preventable (orientate voters on system, make code open source)

Total Impact Score: 2*.10 + 1*.05 + 2*.25 + 1*.05+ 1*.05 + 2*.25+ 1*.25 = 1.6

- Faster voting process

Type: Positive , **Duration:** Short Term, **Magnitude:** High, **Area of coverage:** Regional

Tendency: Increasing, **Possibility of Occurrence:** High,**Management Alternative:** Compensate

Impact Score: 1*.10 + 1*.05 + 3*.25 + 1*.05+ 3*.05 + 3*.25+ 3*.25 = 2.6

- Can produce faster methods of recounting of votes

Type: positive, **Duration**: long, **Magnitude**: low, **Scope**: Regional, **Tendency**: Increasing

Possibility of Occurrence: sure

Management Alternative: Mitigate

Total Impact Score: 1*.10 + 3*.05 + 1*.25 + 1*.05+ 3*.05 + 3*.25+ 2*.25 = 1.95

- Allows voter to feel that their vote counted after receiving a printed receipt which is deposited into a ballot box

  Type: positive, **Duration**: Long, **Magnitude**: low, **Scope**: Regional, **Tendency**: Stable

  Possibility of Occurrence: medium

  Management Alternative: Compensate

  Total Impact Score: 1*.10 + 3*.05 + 1*.25 + 1*.05+ 2*.05 + 2*.25+ 3*.25 = 1.9

- Information spreads faster and causes Biased Voting:

  Type: Negative, **Duration:** Short Term, **Magnitude:** High, **Area of coverage:** Regional, **Tendency:** Increasing

  Possibility of Occurrence: High

  Management Alternative: Mitigation

  This impact allows for the vote counting process to be done faster. Therefore the results are known in less time.

  However, with this impact the "Biased Voting" phenomenon may allow for areas to know the results in another area before they have voted. This happens in large countries where the east side votes before the west side due to time zones.

  If biased voting needs to be eliminated, regulations can be made regarding the public reporting of voting results. This kind of regulation is done in Canada, but has received severe criticism from civil rights groups.

  Impact Score: 2*.10 + 1*.05 + 3*.25 + 1*.05+ 3*.05 + 3*.25+ 3*.25 = 2.7

Impact to Public Health

- eVote will make it simpler for voters with writing problems due to the electronic interface

  Type: positive, **Duration**: long, **Magnitude**: low, **Scope**: Regional, **Tendency**: Stable

  Possibility of Occurrence: High

  Management Alternative: Compensate

  Total Impact Score: 1*.10 + 3*.05 + 1*.25 + 1*.05+ 2*.05 + 3*.25+ 3*.25 = 2.15

- Incorrect disposal of LCD screens can contaminate water with lead and copper.

  Type: negative, **Duration**: long, **Magnitude**: High, **Scope**: Regional, **Tendency**: Increasing

  Possibility of Occurrence: medium

  Management Alternative: Compensate

  Total Impact Score: 2*.10 + 3*.05 + 3*.25 + 1*.05+ 3*.05 + 2*.25+ 3*.25 = 2.55

- Wiring process for system installation affects employees and people walking around system

  Type: negative, **Duration**: long, **Magnitude**: High, **Scope**: Regional, **Tendency**: Increasing

  Possibility of Occurrence: medium

  Management Alternative: Compensate

  Total Impact Score: 2*.10 + 3*.05 + 3*.25 + 1*.05+ 2*.05 + 2*.25+ 3*.25 = 2.5

Check List

	Physical Environment	Biotic Environment	Social Environment	Public environment
High Volume of Paper Trail	x			
Disposal of highly contaminant computer parts	x	x		x
Disposal of non toxic ink toner	x	x		x
Rejected by public			x	
Faster Vote counting process			x	
Faster Voting Process			x	
Toxic LCDs disposed of incorrectly	x	x		x
Electronic interface makes voting easier for people with writing problems			x	x
Wiring may impede walking				x

Social-Environmental Interaction Matrix

	New Models offered to Market	Fabrication of new product	Improvements in Technology
Physical Environment	x	x	
Biotic Environment	x	x	
Community			x
Economic	x		x

6.2. Ethical Analysis

This section identifies and evaluates cases regarding the eVote system that may present en ethical conflict. Each case has several proposed solutions and each solution is evaluated with a Solution Evaluation Matrix. [14] The solution that passes the most tests in the matrix is considered the best available alternative for the case. Each case is followed by a recommendation that takes into consideration the best available solution.

6.2.1. Ethical Cases

Case 1: A voting official will not deal a voter appropriately since they have a different political affiliation.

Solution	Reversibility Test	Harm Test	Publicity Test	Code Test	Global Feasibility Test
	Criteria: Fails test if we would not think choice of this option if we were negatively affected by it. Passes otherwise.	**Criteria: Fails test if does not do considerably less harm than option. Passes otherwise.**	**Criteria: Fails test if we would not want option to be published in newspaper. Passes otherwise.**	**Criteria: Fails test if option present code violations. Passes, otherwise.**	**Criteria: Fails if an obstacle prevents the implementation of solution.**
Have officials from different political parties present at all times.	Officials might feel uncomfortable with more than one person present at a registration station, but might prefer this option to spending additional time in training.	Does not harm official or voter, but may create more demand for officials . Passes Test	There is no need to keep this solution from being published in the newspaper. Passes Test	Does not present code violations. Passes Test	No obstacles prevent the implementation of this solution. Passes Test

	Passes Test				
Provide additional education to officials on how to handle voters.	Officials already receive a manual and orientation on procedures during Election Day. Additional time spent in orientation might affect them negatively and they would not consider this option. Fails Test	Does not harm official or voter, but requires additional time for training, and compliance by official is not guaranteed. Fails Test	There is no need to keep this solution from being published in the newspaper. Passes Test	Does not present code violations. Passes Test	No obstacles prevent the implementation of this solution. Passes Test

Recommendation: The recommended solution is having officials from different parties present at all times. This way the officials can keep an eye on each other and prevent another official from mistreating a voter.

Case 2: Official tampers with administrator application by inserting random numbers into Electoral Number field in order to obtain available numbers and save them for someone else from their party so they can vote again.

Solution	**Reversibility Test**	**Harm Test**	**Publicity Test**	**Code Test**	**Global Feasibility Test**
	Criteria: Fails test if we would not think of this option if we were negatively affected by it. Passes otherwise.	**Criteria: Fails test if does not do considerably less harm than option. Passes otherwise.**	**Criteria: Fails test if we would not want option to be published in newspaper. Passes otherwise.**	**Criteria: Fails test if option present code violations. Passes, otherwise.**	**Criteria: Fails if an obstacle prevents the implementation of solution.**
Provide application with	The algorithm to detect excessive failed verification	Incorrect algorithm may	A well built algorithm would	Does not present code	No obstacles prevent the

a way to detect when Electoral Numbers are being verified an excessive amount of times and verification fails.	might be incorrectly design and may result in honest officials being suspected of tampering with application. Fails Test	interrupt flow of elections. Fails Test	benefit the system and it would be beneficial to make public. Passes Test	violations. Passes Test	implementation of this solution. Passes Test
Have two or more officials from different parties present at one registration station.	Officials might feel uncomfortable with more than one person present at a registration station, but might prefer this option to being suspected of tampering by mistake. Passes Test	Does not harm official or voter, but may create more demand for officials . Passes Test	There is no need to keep this solution from being published in the newspaper. Passes Test	Does not present code violations. Passes Test	No obstacles prevent the implementation of this solution. Passes Test

Recommendation: The recommended solution is to have two or more officials from different parties present at each registering station. This way one official can watch that the other official (logged into the application) is not behaving suspiciously when using the application.

Case 3: Since the administrator application may not be visible to voter, the official may tell a voter of an opposing party they appear as "Already Voted" in the record (or create some alleged reason that will not allow them to vote).

Solution	Reversibility Test	Harm Test	Publicity Test	Code Test	Global Feasibility Test
	Criteria: Fails test if we would not think of this option if we were negatively	**Criteria: Fails test if does not do considerably less harm than option. Passes**	**Criteria: Fails test if we would not want option to be published in newspaper.**	**Criteria: Fails test if option present code violations. Passes,**	**Criteria: Fails if an obstacle prevents the implementation of solution.**

	affected by it. Passes otherwise.	**otherwise.**	**Passes otherwise.**	**otherwise.**	
Require administrator to display administrator application to voter and educate voters on their rights.	This solution would only require the official to be sitting in a set up in which the voter can see the verification result, but would not affect anyone negatively. Passes Test	Does not do considerable additional harm. Passes Test	We would want this option to be published in newspapers so voters are aware of their right to se verification result. Passes Test	Does not present code violations. Passes Test	No obstacles prevent the implementation of this solution. Passes Test
Make administrator application only visible to officials but educate them on repercussions of denying right to vote to a person.	Officials already receive a manual and orientation on procedures during Election Day. Additional time spent in orientation might affect them negatively and they would not consider this option. Fails Test	Does not harm official or voter, but requires additional time for training, and compliance by official is not guaranteed. Fails Test	There is no need to keep this solution from being published in the newspaper. Passes Test	Does not present code violations. Passes Test	No obstacles prevent the implementation of this solution. Passes Test

Recommendation: The recommended solution is to keep the administrator application visible to the voter while he or she is being registered to vote. This will also ensure the voter that they are being registered properly and will ensure the official that no one will wrongly accuse him or her from hiding information.

Case 4: Employees working on eVote device might tamper with casing and/or programming to ensure votes for a certain candidate.

Solution	Reversibility Test	Harm Test	Publicity Test	Code Test	Global Feasibility Test
	Criteria: Fails test if we would not think of this option if we were negatively affected by it. Passes otherwise.	**Criteria: Fails test if does not do considerably less harm than option. Passes otherwise.**	**Criteria: Fails test if we would not want option to be published in newspaper. Passes otherwise.**	**Criteria: Fails test if option present code violations. Passes, otherwise.**	**Criteria: Fails if an obstacle prevents the implementation of solution.**
Prepare eVote device with Breach Seal and perform inspection of seal previously, during and after elections.	Officials and Voters would not be negatively affected by this option. Passes Test	Does not harm voter more than option. Passes Test	Breach Seal would benefit eVote image and we would want this to be published in newspapers. Passes Test	Does not present code violations. Passes Test	No obstacles prevent the implementation of this solution. Passes Test
Make eVote device visible at all times during elections.	Voters would think negatively of this option once their privacy is invaded. Fails Test	Harms voters by invading their privacy and violates the right to an anonymous vote. Fails Test	This solution would outrage the public and press. It would not be something that we would want to be published if we were to implement it. Fails Test	This option presents a serious violation to the Puerto Rico Electoral Law since device would have to be visible while a person is voting.[16] Fails Test	The Puerto Rico Electoral Law would prevent this solution from being implemented. Fails Test

Recommendation: The recommended solution is to have each eVote device equipped with a special breach seal and have it inspected at several points throughout the day. This way there is physical proof that the device is protected. This seal should be unique to the eVote device and not readily available to the general public.

Case 5: Employees designing device know of serious fault in system but allow it to be shipped on Election Day.

Solution	Reversibility Test	Harm Test	Publicity Test	Code Test	Global Feasibility Test
	Criteria: Fails test if we would not think of this option if we were negatively affected by it. Passes otherwise.	**Criteria: Fails test if does not do considerably less harm than option. Passes otherwise.**	**Criteria: Fails test if we would not want option to be published in newspaper. Passes otherwise.**	**Criteria: Fails test if option present code violations. Passes, otherwise.**	**Criteria: Fails if an obstacle prevents the implementation of solution.**
Perform routine inspections of code and design by Company, Government and Independent Evaluators.	Persons interested in protecting design and system security might not think choice of this option. Fails Test	This solution does no harm. Passes Test	This is a solution that we would want the press to know about. Passes Test	Does not present code violations. Passes Test	No obstacles prevent the implementation of this solution. Passes Test
Ignore Situation	Anyone affected negatively by an overlooked error in the system would not think choice of this option.	The possible harm of an ignored error does more harm than routine inspections. Fails Test	Should an error occur, we would not want the press to find out we knew about the error and chose to ignore	This solution presents a violation of the IEEE code of ethics. [14] Fails Test	No obstacles prevent ignoring this situation. Passes Test

	Fails Test		it. Fails Test		

Recommendation: The recommended solution is having routine inspections by the Company, the Government and Independent Evaluators. The Independent evaluators are important since they can be completely objective in the process. The Government evaluators can verify compliance with the law.

Case 6: Persons funding project have political interest and wish to affect development of system

Solution	**Reversibility Test**	**Harm Test**	**Publicity Test**	**Code Test**	**Global Feasibility Test**
	Criteria: Fails test if we would not think of this option if we were negatively affected by it. Passes otherwise.	**Criteria: Fails test if does not do considerably less harm than option. Passes otherwise.**	**Criteria: Fails test if we would not want option to be published in newspaper. Passes otherwise.**	**Criteria: Fails test if option present code violations. Passes, otherwise.**	**Criteria: Fails if an obstacle prevents the implementation of solution.**
Involve members of different parties and the public in development of system.	Persons interested in protecting design and system security might not think choice of this option. Fails Test	This solution does no harm. Passes Test	This is a solution that we would want the press to know about. Passes Test	Does not present code violations. Passes Test	No obstacles prevent the implementation of this solution. Passes Test
Accept funding from persons without establishing neutrality in development.	Persons from opposing parties to the persons funding the project may not think choice of	This solution harms the electoral process. Fails Test	This is not a solution that we would want the press to know about.	This solution presents a violation of the IEEE code of ethics.	No obstacles prevent the implementation of this solution. Passes Test

	this option. Fails Test		Fails Test	Fails Test	

Recommendation: It is recommended that different people, like opposing parties and the public be involved in the development of the system. If involved, these persons can detect and prevent unethical funding from occurring.

6.3. Legal Implications

JSAL's analysis of the voting process resulted in designing an electronic voting system that makes sure that no voter's privacy is violated. No vote is ever linked to the voter and the information used for registering at the precinct on the day of elections will also remain private. In order for this system to be implemented in Puerto Rico, it would be necessary to amend the Puerto Rico Electoral Law and create a regulation document for the general elections that provides detailed information on the process regarding electronic voting, since the current Electoral Law and the last regulations for the general elections only take into consideration voting by paper ballot. However, it is important to point out that despite the changes in the voting process, the principles anonymous votes and one vote per person remain the same in the eVote system.[16]

Also, due to resolution CEE-RS-08-89 of the CEE (State Elections Committee) the ballots must be made in both English and Spanish.[15]

7. Budget Analysis

During the development of the project there were some hardware expenses that were not taken in consideration for the original analysis. The total cost for additional hardware is 229 dollars and 3 cents. This amount covers a navigational keypad, casing for the final enclosure, cables and inverter hardware components. Adding this additional cost to the materials total sums the amount of 229 dollars and 3 cents. Comparing the new total for hardware materials we can see that the cost is still below the total that includes the overhead cost, which means that the additional cost were covered but the initial profit was reduced. The profit was reduced from $169.64 to $100.68.

Materials	Total Cost
Microcontroller	$10.08
Development Kit	$149.99
LCD	$18.50
Materials Total	$178.57
Overhead Cost	95%
Total	$348.21

Table 1 - Original Hardware Budget for Sparrow

Additional Materials	Total Cost
Navigational Key Pad, Cables and Inverter Components	$37.00
Casing	$13.46
Additional Materials Total	$68.96
Original Profit	$169.64
Total Profit After Additional Expenses Reduction	$100.68

Table 2 - Additional Expenses

During the development of the software application there were some unexpected problems which cause personnel to work additional hours. An additional feature required by the client also impacted our proposed cost for personnel. A total amount of 25 overtime hours were required to the project manager to solve unexpected problems and changes. One of the computer engineers was required to work 5 additional hours, while other was required to work 8 additional hours as estimated when the new feature was required. The 25 hours of overtime of Javier's work have a total cost of $153.00, while the additional hours for the engineers have a cost of $96.15 and $153.00 respectively. Comparing the new personnel total with the total expected we can see that the personnel expenses are still below the proposed cost but there was a decrease in the profit of $850.15.

Personnel	Annual Income	Hourly Salary	Weeks on schedule	Hours per week	Total Salary	Salary plus benefits (Social Security and Pension Benefits)
3 Computer Engineers						
Laura Cruz	$40,000	$19.23	12	30	$ 6,922.80	$7,490.47
Angel Vega	$40,000	$19.23	12	30	$ 6,922.80	$7,490.47
Sylvia Rodriguez	$40,000	$19.23	12	30	$ 6,922.80	$7,490.47
1 Project Manager						
Javier Torres	$50,000	$24.04	12	30	$8,654.40	$9,364.06
					Personnel Total	$33,185.47
					Overhead Cost	95%
					Total	$64,711.67

Table 3 - Original Personnel Budget for Sparrow

Personnel	Proposed Hours	Hours Worked	Overtime Hours	Total Cost for Overtime
3 Computer Engineers				
Laura Cruz	360	368	8	$153.00
Angel Vega	360	360	0	$0
Sylvia Rodriguez	360	365	5	$96.15
1 Project Manager				
Javier Torres	360	385	25	$601.00
			Overtime Total	$850.15
			Original Profit	$31,526.20
			Total Profit After Overtime Expenses Reduction	$30,676.20

Table 4 – Additional Personnel Expenses

Sparrow's original cost for the project was estimated on $33,364.04. The final expense of the project was $34,264.65. Therefore there was a reduction of $911.11 on the company profit for the project

8. Future Work

Although eVote is a substantial project with many features, there are still items that are desired in its implementation, but due to time constraints they could not be implemented in one semester.

In the future JSAL would like to see implemented additional security measures upon registering a person in a precinct before they exercise their right to vote such as a biometric scanner. This feature would in addition to receiving the ID of the voter would verify if the fingerprint corresponds to the data that is on the voter's electoral number. This security measure would eliminate all doubt that the card has been falsified, or prove otherwise if the prints do not match.

Also due to the unpredictability of printer malfunctions, an additional receipt verification module may be implemented as a means of scanning the receipt upon being printed and corroborating the printed results with the electronic votes. If there is a perfect match with the barcode information found on the receipt then the vote will continue on to be processed, to the contrary an alert can be made to advice the voter what measures should be taken by the voter so that their vote is correctly processed.

As an additional future work item, a tallying module must be implemented. This module will provide application for counting the votes for the case of re-counting for a revision of the results. The counting application will provide an interface so that an official can scan the barcodes printed on a ballot using the barcode scanner. The process of re-counting the votes will be the same process that is being followed today for counting the votes in which there is an authorized representative of each party, the only change will be found in the counting of the votes. Instead of counting the votes manually, the votes will be scanned and the application will count the votes. When all the ballots are counted the application will provide an option to print a document with all the results and a signature space to validate and sign the results. By scanning the votes, instead of counting them manually, there will be a reduction in time of processing the votes as well as precise results.

9. Conclusion

eVote is a system that may or may not be attractive to some demographics only since many prefer to manually mark their selections on paper. As life goes on, modern things are developed while the previous versions of products become obsolete or archaic. It may be a while before all demographics accept electronic voting as a positive way to vote, in the mean time, JSAL has developed eVote which worked as proposed. Without including overhead costs the project cost totals to the amount of $247.53. This is less than half of the recommended amount for the cost of a capstone project.

9.1. Prototype Wrap – up details

- The project is powered with an adapter and does not require an additional power supply
- Encased within an a project box
- Functional PC to eVote communication
- Approximately 5 kilobytes remain within the microprocessor for any future updates in code
- eVote is independent of Code Composer debugging and can run on its own

9.2. Ethical Conclusions

The solutions for possible ethical conflicts that have been discussed in this report rely in part on the fact that voting officials are trained on how to work with voters and informed of repercussions of obstructing the right to vote. It is also necessary that the final product of the eVote system be physically capable to withstand tampering attempts and that the system is setup in a way in hiding information from the voter is not permitted and voter anonymity remains. During development for a system like eVote it is essential to have transparency and involve the public and the government to a certain degree in order to prevent conflicts of interest.

9.3. Legal Conclusions

The eVote system implements bilingual ballots in accordance with the CEE'S resolution 89 of 2008 (CEE-RS-08-89)[15]. In order for this system to be fully implemented, it would be necessary to amend the Puerto Rico Electoral Law[16] and create a completely new Regulation document for the General Elections.[17]

9.4. Environmental and Social Impact Conclusions

At first glance a project like eVote appears to have little impact on the environment, but after this evaluation it can be seen that the disposal of all eVote components are critical to the environment. There are several positive and negative impacts that come along with the eVote system and as seen in the previous analysis they can impact society and the environment in many ways. It is necessary that governments implementing the eVote system create and enforce laws regarding the disposal of these components.

As was expected, the system also has a significant impact in the citizens. Through carefully planned public education, any negative impact regarding the rejection of the system can be minimized. As with the hazardous materials found within the hardware that can cause damage to the environment through lead poisoning or with the copper found in most LCDS, it would be necessary to try and prevent this impact with procedural recycling or disposal of these materials. In most cases materials are just thrown away so it would be necessary to compensate for these impacts at a specific cost.

Hopefully the most positive impact will be seen with the time constraints on the recounting of the votes. The eVote system will reduce this time with its barcode recounting module and also the paper amount would be reduced to just one receipt contrary to current voting methods which use various sheets of paper.

It is with these positive impacts that should outweigh by far the negative impacts that we hope to help move voters all over the country into the next stage of voting.

9.5. Market Conclusions

JSAL has studied the best and worst traits of the competition and has come up with a solid and innovative design that will exceed the clients' expectations. Sparrow's eVote should be an attractive design due to the additional security measures available for identifying voters and with the future work of including biometrics and a tallying module, eVote should be on par with the competition.

10. Glossary

- **UART** – Universal Asynchronical Receiver/Transmitter. Used to establish communication between a microprocessor and a Computer. For eVote we use this to transfer the voting results made on the eVote device to the administrator application.

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12. Appendix A

12.1. Gantt Chart

Task Name	Pred	Duration	Start	Finish	% Complete	Resource Names
eVote Phase 1		**11 days?**	**Mon 8/25/08**	**Mon 9/8/08**	**100%**	
Sparrow Development Phase I	**28**	**24 days?**	**Thu 9/11/08**	**Tue 10/14/08**	**100%**	
Software		**24 days?**	**Thu 9/11/08**	**Tue 10/14/08**	**100%**	
Administrator Application		**24 days?**	**Thu 9/11/08**	**Tue 10/14/08**	**100%**	
Complete User Interface		10 days	Thu 9/11/08	Wed 9/24/08	100%	Sylvia Rodriguez Rodriguez
Printing Format of Receipt		8 days?	Fri 10/3/08	Tue 10/14/08	100%	Sylvia Rodriguez Rodriguez
Login	78	7 days?	Mon 10/6/08	Tue 10/14/08	100%	Laura Cruz Rodriguez
Database		**3 days?**	**Thu 9/11/08**	**Mon 9/15/08**	**100%**	
Create Voting System Tables		3 days?	Thu 9/11/08	Mon 9/15/08	100%	Laura Cruz Rodriguez
Create User/Kiosk Tables		3 days?	Thu 9/11/08	Mon 9/15/08	100%	Angel Vega Cortes
Hardware		**24 days?**	**Thu 9/11/08**	**Tue 10/14/08**	**100%**	
Assemble Hardware		15 days?	Thu 9/11/08	Wed 10/1/08	100%	Javier Torres Santiago
Test Screen Programming	85	9 days?	Thu 10/2/08	Tue 10/14/08	100%	Javier Torres Santiago
Testing		**3 days?**	**Fri 10/10/08**	**Tue 10/14/08**	**100%**	
Software Application		3 days?	Fri 10/10/08	Tue 10/14/08	100%	Javier Torres Santiago
Hardware		**3 days?**	**Fri 10/10/08**	**Tue 10/14/08**	**100%**	
Screen Corroboration		3 days?	Fri 10/10/08	Tue 10/14/08	100%	Sylvia Rodriguez Rodriguez
Database		**3 days?**	**Fri 10/10/08**	**Tue 10/14/08**	**100%**	
Voting System Tables		3 days?	Fri 10/10/08	Tue 10/14/08	100%	Angel Vega Cortes
User/Kiosk Tables		3 days?	Fri 10/10/08	Tue 10/14/08	100%	Laura Cruz Rodriguez
Sparrow Development Phase II		**23 days**	**Thu 10/16/08**	**Mon 11/17/08**	**100%**	
Software		**22 days**	**Thu 10/16/08**	**Fri 11/14/08**	**100%**	
Administrator Application		**22 days**	**Thu 10/16/08**	**Fri 11/14/08**	**100%**	
Create Administrator Voter check in Queries		5 days	Thu 10/16/08	Wed 10/22/08	100%	Sylvia Rodriguez Rodriguez
Check in History	99	3 days	Thu 10/30/08	Mon 11/3/08	100%	Sylvia Rodriguez Rodriguez
Implement Voter Check in with ID #	97	5 days	Thu 10/23/08	Wed 10/29/08	100%	Sylvia Rodriguez Rodriguez
Data Encryption		**22 days**	**Thu 10/16/08**	**Fri 11/14/08**	**100%**	
Encrypt information sent to Database		10 days	Thu 10/16/08	Wed 10/29/08	100%	Angel Vega Cortes
Decrypt information Received from Database	101	12 days	Thu 10/30/08	Fri 11/14/08	100%	Angel Vega Cortes
Hardware		**22 days**	**Thu 10/16/08**	**Fri 11/14/08**	**100%**	
Complete Sparrow Device Screens		9 days	Thu 10/16/08	Tue 10/28/08	100%	Javier Torres Santiago
Write-In		20 days	Mon 10/20/08	Fri 11/14/08	100%	Laura Cruz Rodriguez
Keypad Navigation		10.75 days	Fri 10/24/08	Mon 11/10/08	100%	Sylvia Rodriguez Rodriguez
Testing		**10 days**	**Tue 11/4/08**	**Mon 11/17/08**	**100%**	
Software Application	96	1.5 days	Tue 11/4/08	Mon 11/17/08	100%	Angel Vega Cortes
Encryption Decryption	100	1.5 days	Tue 11/4/08	Mon 11/17/08	100%	Javier Torres Santiago
Hardware	**103**	**5 days**	**Tue 11/11/08**	**Mon 11/17/08**	**100%**	
Screen Corroboration		2 days	Tue 11/11/08	Mon 11/17/08	100%	Sylvia Rodriguez Rodriguez
Navigation		2 days	Tue 11/11/08	Mon 11/17/08	100%	Laura Cruz Rodriguez

Gantt Phases 1 and 2 - Figure 4

Sparrow Development Phase III	**94**	**10 days?**	**Tue 11/18/08**	**Mon 12/1/08**	**100%**	
Software		**10 days**	**Tue 11/18/08**	**Mon 12/1/08**	**100%**	
Administrator Application		**10 days**	**Tue 11/18/08**	**Mon 12/1/08**	**100%**	
Software Hardware Communication		**7 days**	**Tue 11/18/08**	**Wed 11/26/08**	**100%**	
Lock Sparrow Device		4 days	Tue 11/18/08	Fri 11/21/08	100%	Laura Cruz Rodriguez
Activate Sparrow Device		4 days	Tue 11/18/08	Fri 11/21/08	100%	Laura Cruz Rodriguez
Device Status		4 days	Tue 11/18/08	Fri 11/21/08	100%	Sylvia Rodriguez Rodriguez
Printing Complete with Barcode Text Conversion		7 days	Tue 11/18/08	Wed 11/26/08	100%	Sylvia Rodriguez Rodriguez
Database		**2 days**	**Fri 11/28/08**	**Mon 12/1/08**	**100%**	
Store Voting Summary into Database	125	2 days	Fri 11/28/08	Mon 12/1/08	100%	Angel Vega Cortes
Scalability Simulation		7 days	Tue 11/18/08	Wed 11/26/08	100%	Angel Vega Cortes
Hardware		**8 days**	**Tue 11/18/08**	**Thu 11/27/08**	**100%**	
UART Implementation		**8 days**	**Tue 11/18/08**	**Thu 11/27/08**	**100%**	
Receive Activation or Lock	117,	4 days	Mon 11/24/08	Thu 11/27/08	100%	Javier Torres Santiago
Send Voting summary		5 days	Tue 11/18/08	Mon 11/24/08	100%	Javier Torres Santiago
Testing		**3 days?**	**Thu 11/27/08**	**Mon 12/1/08**	**100%**	
Software Application	116	1 day?	Thu 11/27/08	Thu 11/27/08	100%	Angel Vega Cortes
Database Voting Summary Corroboration		1 day	Mon 12/1/08	Mon 12/1/08	100%	Sylvia Rodriguez Rodriguez
Scalability Simulation Test	123	1 day?	Thu 11/27/08	Thu 11/27/08	100%	Javier Torres Santiago
Hardware		**1 day?**	**Fri 11/28/08**	**Fri 11/28/08**	**100%**	
Screen Corroboration	124	1 day?	Fri 11/28/08	Fri 11/28/08	100%	Laura Cruz Rodriguez
Navigation	124	1 day?	Fri 11/28/08	Fri 11/28/08	100%	Laura Cruz Rodriguez

Gant Phase 3 - Figure 5

12.2. Copyright Evidence of

Greetings,

My name is Angel Vega and I'm an undergraduate computer engineering student. I'm currently working on a project involving 'electronic voting systems', and I would like to request permission to use the following research material provided on your website in my project proposal:

- Voting Equipment Studies of 2006
- News Summary
- Report
- Map

The purpose of use is to provide background information and convincing statistics in our proposal. Please reply before Tuesday September 9th, 2008.

Thanks in advanced,
Angel Vega

Angel --

Thanks for your inquiry and permission request. I want to make sure you are citing to the right study. You need to be using the one dated in October of 2006, not our earlier one published in February, 2006. Apparently Goggle keeps linking to the February study, and I have to keep telling people to look at the more up to date one (as well as more accurate about what really happened in the November, 2006 election).

With that understanding, it is ok to use our information, provided you forward to us a copy of your final publication. E-mail is fine.

Thanks again

Kim Brace
Election Data Services, Inc.
6171 Emerywood Ct
Manassas, VA 20112-3078
(202) 789-2004 or (703) 580-7267
Fax: 703-580-6258
Cell: 202-607-5857
Beeper: 1-800-877-6067 (make sure you put in your area code)
KBrace@aol.com or KBrace@electiondataservices.com
www.electiondataservices.com

Kim Brace,

As requested, here is a copy of our project proposal.

Thanks,
Angel Vega

13. Appendix B

The following items are external documents that accompany this report.

13.1. Administrator Application Design

13.2. Change Control

13.3. Raven Full Design

13.4. Raven Database Design

13.5. Database Redundancy and Security Design

13.6. Sparrow Database Design

13.7. Hardware Design

13.8. User Manual

13.9. Administrator Guide

13.10. Administrator Application Code

13.11. Firmware code