Cost Benefits of Thin Client Voting Systems

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Abstract

Thin client computing presents a solution to the largely unanswered problem of cost with electronic voting. After switching to touch screen systems, many states found themselves paying at least three times as much compared to their previous paper-based systems. The thin client model drastically reduces hardware and maintenance expenses, offering the possibility of an electronic voting system that is cheaper than a paper system from day one.

1 Introduction

The 2000 Presidential elections and the many problems brought about by Florida's punch card voting system and recount fiasco put the spotlight on voting technology. A heated debate still remains between the advocates of paper voting systems and those of computerized voting. Critics of electronic voting argue that such systems could never offer the security, accountability, and affordability of paper systems. However, while countless vendors and researchers have made great advancements in the security and accountability of computerized voting, the cost argument remains. Thin client, or dumb terminal, computing systems have regained popularity as processing power has increased and the cost of memory has decreased. Many schools, businesses, and even banks have implemented dumb terminal systems which provide users with a full desktop experience while dramatically reducing hardware and maintenance costs. The thin client model could be implemented into electronic voting systems reducing costs while still providing a secure, accountable system capable of holding fair, accurate, and auditable elections.

The battle rages between the paper voting and computerized voting camps. Opponents of electronic voting argue that the security, accountability and cost effectiveness of paper systems

can never be offered by electronic systems. Those in favor of electronic voting affirm the security and auditability of such systems, and argue that they in fact offer greater security than paper systems. However, there has yet to be a valid response to the cost of electronic systems. According to Jeremy Epstein[1], "acquiring, maintaining, and operating election equipment at a low cost is paramount." In the year 2003 the state of Maryland officially switched from optical scan voting systems to electronic touch screen systems built by Diebold. The state now spends nearly 9 times more than they did in the year 2001[2]. This dramatic increase in spending is due in large part to the extremely high cost for the hardware and maintenance. Statewide, by the end of 2009 over $44,000,000 will have been spent on the hardware and $44,000,000 on maintenance, with another $23,000,000 still owed on the machines and at least $45,000,000 in maintenance costs by the year 2014[2].

2 Thin Client Voting

Thin client, also known as dumb terminal, computing has been around for decades. Early servers built in the 80s were based on the thin client structure, which involves a single central server connected to multiple "dumb terminals" which boot directly off of the server. These terminals are referred to as thin clients because they consist of very simple hardware: small processor, minimal amount of ram, and input-output devices such as keyboards and monitors. The clients have no local hard drive, instead they boot from and store all data directly onto the server. The clients can be machines specifically designed for such a task or outdated computers that are no longer able to easily run current software. Because of this, the cost per terminal is minimal. Since all programs are stored and run on the server, it is the only machine requiring up-to-date components. Additionally, any of the upgrading and almost all of the required maintenance must only be done at the server. Compared to the current machines which cost thousands of dollars each, the terminals are very inexpensive. If a terminal suffers a hardware malfunction, it will be more cost effective to simply replace it with a new one rather than hire a technician to first diagnose and then fix the problem. This will lower the maintenance cost dramatically as service will no longer be done to each individual machine.

Thin client computing offers a solution to the outrageous cost of current voting systems. Current electronic systems such as the Diebold system employed in Maryland use individual, self-contained voting machines in each booth. Each machine must run its own operating system and voting program, requiring powerful processors and large amounts of memory to operate. With the thin client model, all of the programs are run directly on the server. The terminals, therefore, have very little hardware requirements in order to operate. Based on the precinct information for the state of Maryland, and the cost stated by SAVEOurVote for their proposed optical scan system, the hardware for a thin client terminal server system would be cheaper from day one.

3 Cost Analysis

The following section will compare the cost of thin client voting to that of an optical scan system as well as that of a current electronic voting system. The sample comparison is based on the state of Maryland which has an estimated 2,000 voting precincts with an average of ten booths each [2]. This is roughly 10% more than the actual number of precincts in order to allow for the purchase of back-up hardware. The thin client model is compared to the optical scan system proposed by SAVEOurVote, a voting advocay group in Maryland, as well as the ES&S iVotronic touch screen system. In order to accurately compare the systems, it is first important to know what hardware specifications will be required for a thin client system.

3.1 Recommended Hardware Specifications

The Linux Terminal Server Project(LTSP) provides recommended hardware specifications for the server and each terminal. These recommendations are based on day-to-day office use including the use of Firefox, Open Office, e-mail clients, etc. These programs require much more memory and processing power than a voting system requires, thus the requirements are more than applicable. These hardware recommendations will be utilized in section 3.3 and 3.4 when comparing the thin client model to optical scan and current touch screen systems.

Recommended Server Specifications[3]

Ram	256MB + (50MB * number of terminals)
Processor	Multiple CPUs or Dual Core processor, 3GHz good for 30 users
Switch	Gigabit between server and switch, 100mbps between client and server

Recommended Terminal Specifications[3]

Processor	400 to 800 MHz
Ram	32MB minimum

Based on these hardware recommendations, a search of online retailers such as BestBuy.com and Newegg.com provides hardware within the previously stated projected thin client cost while exceeding all hardware recommendations. Sample hardware is listed below, however this is solely used to show that hardware can be found to fit the projected cost and not to infer that off the shelf hardware from a retail store would be used to build a voting system. All products listed below are listed at retail cost and have profit built into the price that would not be present when buying directly from the manufacturer. The sample also does not include software and possible licensing expenses as these are completely at the discretion of the particular vendor and can not be accurately predicted.

Sample Hardware Cost per Precinct

Item	Quantity	Cost	Total
HP Pavilion Server [4]	2	$529.99	$1059.98
DLink 16-Port Gigabit Switch	1	$199.99	$199.99
LTSP 1220 PXE Terminal [5]	10	$285.95	$2859.50
NEC AccuSync 15" Touchscreen [6]	10	$205.69	$2056.90
Total			**$5176.37**

3.2 Thin Client Voting v. Optical Scan Voting

SAVEOurVote proposed an optical scan system in their "Cost Analysis of Maryland's Electronic Voting System." This is a very well made proposition describing, in detail, the cost and budget necessary to replace the state's current Diebold touch screen system with optical scan machines. By the year 2014, Maryland will have spent over $67,000,000 to pay for the Diebold hardware. The article argues that hardware needed for an optical scan system could be purchased $18,300,000. They assume the state has 2,000 voting precincts with 10 booths each, which is approximately 10% more precincts than the state actually has in order to allow for the purchase of spare machines.

Projected Cost of Optical Scan System [1]

Item	Unit Cost	# of Units	Total
Scanner	$4,200	2,000	$8,400,000
Ballot Marking Machine	$4,950	2,000	$9,900,000
Total			**$18,300,000**

This is a dramatic decrease in hardware costs compared to the current Diebold system. Initial hardware costs would decrease by 73% , however this does not take into account the cost of the paper ballots themselves. Maryland has approximately 3.2 million registered voters; with each

[4] AMD Athlon Dual Core with 3GB Ram; Bestbuy.com
[5] 800MHz with 128MB Ram; DisklessWorkStations.com
[6] FirstWorldTech.com
[1] Numbers based on SAVEOurVotes' projected costs

ballot costing roughly $0.25, the state must pay $800,000 per election for ballots alone. While 100% voter turnout is highly unlikely, a ballot must be available for every registered voter. The number of elections varies from year to year, however if three or four elections were held in the same year the state could spend as much as $3,200,000 for ballots.

Projected Cost of Thin Client System [2]

[3]

Item	Unit Cost	# of Units	Total
Server	$1,500	2,000	$3,000,000
LTSP Terminal	$285	20,000	$5,700,000
Touchscreen	$205	20,000	$4,100,000
Total			**$12,800,000**

The chart above shows the projected cost of a thin client voting system based on 2,000 precincts with 10 booths each. Note that the estimated server cost includes a back-up machine, a necessary precaution in the event that the main server suffered a hardware malfunction. The hardware specifications and requirements are based on LTSP recommendations listed in section 3.1. The server costs are estimated to be $1,500 per precinct, which is approximately $200 more than the example server cost listed in the section 3.1. Again, the example cost of section 3.1 are meant only to show that hardware exceeding all recommended specifications can be found for the estimated cost; the example hardware is not meant to represent hardware that could be used in real-world applications. Presumably, vendors would build proprietary hardware that fits their needs rather than using off-the-shelf computers.

3.3 Thin Client Voting v. ES&S iVotronic

ES&S, one of the prominant voting technology vendors today, is currently selling a new touch screen system, the ES&S iVotronic. It is designed to be as usable as possible, requiring voters to verify their ballot before their vote is cast and warning the voter of possible errors such as undervotes, or not selecting a candidate for each race. Each voter is given an electronic ballot, which is essentially

[2] hardware requirements based on Linux Terminal Server Project (LTSP) recommendations[3]
[3] Server + backup server + 16 port gigabit switch

a removable memory card that the voter connects to the voting machine to begin their ballot and returns to a pollworker when they are done voting. However, iVotronic requires a separate, independant machine to be placed in each booth. This design is similar to previous electronic voting machines which have proven to cost drastically more than paper systems both for hardware and maintinance. Each voting machine costs $5,200; each precinct must also have a ballot tally machine, however the cost of these machines are not listed. For this example, I will assume the tally machine costs $3,000 per machine. This is likely to be less than the actual cost as it is a specially designed computer capable of securly reading and tabulating each electronic ballot.

Projected Cost of ES&S iVotronic System [4]

Item	Unit Cost	# of Units	Total
Voting Machine	$5,200	20,000	$104,000,000
Tally Machine	$3,000	2,000	$6,000,000
Total			**$110,000,000**

Compared to the estimated cost of a thin client system from section 3.2, the iVotronic hardware costs more than 8.5 times as much. This is a comparison of upfront hardware costs and does not take into account the additional interest that would be paid. States and counties must take out loans in order to pay for election systems, generally spread over 5 or 7 year periods. The additional interest depends on the type of loan and interest rate, but the interest paid on a $110,000,000 will be drastically higher than the interest paid on a $12,800,000 loan.

4 Future Work

Thus far my research has largely dealt with the theoretical aspect of thin client voting systems. I plan to move forward to the implementation stage and build a terminal server thin client system based on Dr. Juan Gilbert's Prime III voting system. This may require changes to the Prime III software in order to allow separate terminals to run the same program simulatneously. The server

[4] Based on 2,000 precincts with 10 booths each

will be based on Ubuntu Linux 8.04, which allows easy installation and implemenation of a thin client system.

5 Conclusion

While the arguments still rage between the proponents for paper voting systems and those of electronic voting systems, little has been said to refute the high cost of current computerized systems. The state of Maryland switched from an optical scan system to a Diebold touch screen system in the year 2003 and their annual election expenses have increased by as much as 9 times since 2001. Current computerized systems place separate, self-contained computers in each booth which require a large amount of memory and processing power to reliably operate. Also, each machine must be maintained individually. In contrast, if a thin client has some kind of technical difficulty it can simply be replaced to avoid having to spend hundreds or thousands of dollars to have the machine diagnosed and fixed. The state will not have to spend millions of dollars a year on ballots either, as opposed to an optical scan system which could cost Maryland as much as $800,000 per election to print ballots. Thin client computing will be cheaper than paper systems, not ten years down the road, but from the day the system is implemented.

References

[1] J. Epstein, "Electronic Voting," *Computer*, vol. 40, no. 8, 2007, pp. 92-95.

[2] SAVEOurVotes, "Cost Analysis of Maryland's Electronic Voting System," Februrary 2008, pp. 1-15, http://www.saveourvotes.org/legislation/packet/08-costs-mdvotingsystem.pdf.

[3] Linux Terminal Server Project, "LTSP Server Sizing," November 2006, http://wiki.ltsp.org/twiki/bin/view/Ltsp/ServerSizing.