FREEMAN, CRAFT, MCGREGOR GROUP

California Secretary of State Consultant's Report on:

Limited Functional Testing of the Sequoia Voting Systems System 4.0

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Scope of Work and Reporting

The California Secretary of State received an application for approval of the Sequoia Voting Systems' System 4.0 for use in California elections.

The Freeman, Craft and McGregor Group, Inc. (FCMG) was contracted to assist the Secretary of State in conducting the functional test of this system. This report is prepared to present the results of this test that was conducted at the Secretary of State's Office in Sacramento California from August 18, 2008, to August 22, 2008.

We are not attorneys and do not offer legal advice. We assisted the Secretary of State by collecting facts and evidence that she will use to reach a decision regarding Sequoia Voting Systems' application for approval. However, to advise her on the determination of whether the system complies with California's requirements requires an interpretation of law. Accordingly, we do not provide recommendations or any opinion as to whether the system can be approved.

The work we performed and our findings are strictly limited to the specific serial numbered hardware and software elements tested. An inventory of those items may be found in Attachment A of this report. The results described in this report should be reliable and repeatable for those specific items. The decision to extrapolate the results to other pieces of equipment is solely at the discretion and risk of the Secretary of State and any potential purchasers of the system. Although Attachment A can be used as part of a baseline for reaching conclusions about compliance of other items, users of this report who wish to arrive at such conclusions about compliance of purchased systems or the compliance of a system already in use should conduct appropriate acceptance testing or system validation analysis to support those conclusions.

Our tests were focused on the use of the system by the City and County of San Francisco for the elections to be held on November 4, 2008. These tests were designed to determine if the system is capable of handling and accurately tabulating ballots similar to those likely to be used in San Francisco elections. This restricted scope of work was not intended to evaluate the system's compliance with California's overall requirements for voting system approval.

The City and County of San Francisco has hired Sequoia Voting Systems to create the election definition for their election. In light of this fact, Sequoia was allowed to create the test election definition prior to the test. As a result, the election definition function in WinEDS was not exercised under test conditions and therefore we were not able to directly verify the ability of WinEDS to create the test election.

Description of the System

The configuration used in this test is the configuration required by the City and County of San Francisco. The Sequoia System 4.0 is comprised of a precinct optical scan system using the Optech style mark-sense ballots as the primary voting mechanism in the polling places. The system also includes high speed central count scanners for processing provisional and vote-by-mail ballots.

The configuration of this system does not include devices to provide accessibility to voters with disabilities. No audio ballot, sip and puff device or other alternative switch devices were considered during this test.

This version of the Sequoia system is an updated version of the previously California approved version 3.1.012. The Insight Plus and 400-C hardware devices are unchanged but their firmware has been updated. The WinEDS software module has been updated and two new software modules have been added to the system to support Rank Choice Voting (RCV).

The components of Sequoia System 4.0 include:

The Optech Insight Plus (APX firmware version K2.16.080626.1320 and HPX firmware version K1.44.080501.1500) - A mark-sense tabulator used primarily to cast and tabulate ballots at the polling place.

The Memory Pack Reader (model D, firmware version 3.01.080422.0522) **–** This device is used for writing to and reading from the Optech Memory Packs. In preparation for the election, the WinEDS application writes the election and ballot data to the pack through the Memory Pack Reader. When memory packs are returned from polling places the Memory Pack Reader allows WinEDS to read and upload the data captured by the memory pack during voting and tabulation.

The 400-C Central Count Scanner (WinETP version 1.16.6) – This device is a central count mark-sense ballot tabulator which is used for the high speed tabulation of mail-in ballots and any other ballots that are not tabulated in the polling place.

WinEDS (version 4.0.116) – This software is a client/server election management system used to manage election administration data such as voting locations, precincts, political subdivisions, offices, parties, equipment, election definition data and election results data.

WinEDS Server – The server component of WinEDS is used to create the initial WinEDS election administrative database for the election jurisdiction and create the WinEDS administrative user.

WinEDS Workstation – The workstation component of WinEDS is used to perform the normal election management duties including defining elections, importing election specific data, providing election specific data and ballot style information for operation of the 400-C Central Count Scanner and the Insight Plus. It is also used to collect tabulation data and ballot images from the devices, accumulate results and prepare election results reports.

WinEDS Extended Services (version 1.0.47) - This new application provides some new functionality and some enhancements of functions found in previous versions of WinEDS. These functions include database administration, backup and restore functions; system "profile" data management such as precincts, polling places, offices and parties, user account management and maintenance, and election management modules including Ranked Choice Voting tabulation and reporting.

WinEDS Election Reporting (version 4.0.44) – This new application provides enhanced election reporting capability. It includes additional and specialized reporting beyond that provided by WinEDS.

Qualifications

No federal qualification number has been issued by the US Elections Assistance Commission (EAC) for this specific configuration of the system.

The EAC website shows that Sequoia applied for certification testing of WinEDS 4.0.34 with iBeta Laboratories on August 9, 2007 and that testing will be conducted under the 2002 Voting System Standards.

Sequoia states in the "California Application for Approval of a Voting System" that testing for federal qualification is underway at iBeta Laboratories for a similar system consisting of WinEDS 4.0.112; WinEDS Extended Services 1.0.43; WinEDS Election Reporting 4.0.44; Optech Insight Plus, firmware versions: WinETP (400-C) 1.16.6, HPX K1.44.080501.1500, and APX K2.16.080523.1540.

For this application for California approval, iBeta Laboratories conducted functional testing of WinEDS v4.0 according to a test plan approved by the City and County of San Francisco. iBeta's report, "City and County of San Francisco Ranked Choice Voting

(RCV) Test Report" Version 2.0 was issued August 4, 2008. The components listed in their report are the same version numbers we tested.

Tasks Performed

FCMG assisted the Secretary's Office of Voting System Technology Assessment with the following tasks:

Review of the "California Application for Approval of a Voting System" completed by Sequoia Voting Systems for System 4.0

Developing the Test Plan for the system ("Attachment B")

Developing the Ranked Choice Voting Test Cases ("Attachment C")

Developing the Expected Results for the ranked choice contests

Executing the test plan

Developing the findings contained in this report

Findings

The system successfully processed and tabulated all of the test ballots, including the rank choice contests, with no tabulation errors. All tabulated totals matched the expected results.

An anomaly discovered during testing by the State of Washington in an earlier version of the Insight firmware appears to have been resolved in this version of the firmware. During the course of our testing we used a copy of the same firmware tested by Washington and replicated the anomaly on the Insight. Next, we attempted to upload the memory pack to WinEDS. WinEDS detected the error, returned the error message "Inconsistent Data Detected. Please recreate the memory pack" and would not load data from that memory pack. When we used the current version of the firmware, (APX firmware version K2.16.08.626.1320) we were unable to replicate the anomaly.

While attempting to open the WinEDS Extended Services application, the system gave an "Unmanaged Error" message that stated, "An unhandled exception was caught. The application may be in an unsafe state, so it will now close." When we attempted to open the application a second time, it opened with no problem. There did not appear to be any adverse effects beyond the necessity of making two attempts to open the application.

Sequoia Voting Systems attributed this error to the COTS Software Security product that they are using to protect the security of the system. Sequoia's representatives agreed that they would advise their customers of this error in their California Use Procedures document.

We initially set up the machine containing the WinEDS server with the hard disk partitioned into drives C:\ and D:\ with the intention of storing the WinEDS data, logs and backup files on drive D:\. On the WinEDS workstation machine in the Extended Services Database Administration module, we attempted to change the path to those files from a default of C:\ to D:\. The system generated an unhandled exception error and would not allow the change to be made. After discussing this with the Sequoia representatives and OVSTA staff, we abandoned efforts to use the D:\ drive and ran our test with the data, logs and backups on the C:\ drive. Sequoia representatives later acknowledged that this is a bug that needs to be addressed in a future version of the system. They explained that, as a workaround, to select the D:\ drive, the user.config file for the application needs to be changed with a manual edit. We performed the suggested edit of the file and verified that drive setting in the application was changed to D:\. We did not perform a full functional test with the server configured to these specifications, therefore any jurisdiction considering using a drive other than C:\ should conduct functional testing after their system is installed to verify that the Backup, Data, and Log files can be accessed by the application. Sequoia's representatives agreed to add a description of the error message and the workaround to their California Use Procedures.

Security Controls

An analysis of the security controls is outside the scope of functional testing. Source code review is being conducted by atsec Information Security Corporation. We did note that Sequoia has made significant changes to the system with the goal of improving security. Some of these changes include the use of Microsoft SQL Server 2005, the use of a COTS Software Security product and a structured hardening routine for both the server and workstation. While we note this as an improvement, we could not evaluate the effectiveness of these changes.

Attachment A – Test Equipment Inventory

WinEDS Server

Dell PowerEdge SC1430, Service Tag 90L6XC1
- Intel Xeon 2.33 Gigahertz
- Hard Drive 146 Gigabytes - Partitioned into:
  - C: 54 Gigabytes
  - D: 92 Gigabytes
- Installed Memory 2048 Megabytes
- DVD ROM (CD-ROM Drive)
- Broadcom NetXtreme Gigabit Ethernet
- ATI display adapter
- Keyboard and Mouse

Dell Monitor, Service Tag E173FPf

Operating System
- Microsoft Windows Server 2003, Standard Edition, Service Pack 2
- Microsoft Windows component applications including:
  - Microsoft Windows Script Host
  - Microsoft Internet Explorer
  - MS Search
  - Microsoft Office Source Engine
  - Microsoft Windows Installer
  - Microsoft Data Access Components
  - Microsoft Windows Media Player

COTS applications and drivers:
- ATI Display Driver
- HASP SRM Run-Time
- HP Care Pack Core
- HP Laser Jet P3005
- Microsoft .NET Framework 2.0
- Microsoft Visual Studio 2005
- Microsoft SQL Server Agent
- Microsoft SQL Server 2005 Enterprise Edition
- Microsoft SQL Server 2005 Backward compatibility
- Microsoft SQL Server 2005 Books Online (English)
- Microsoft SQL Server Native Client
- Microsoft SQL Server Setup Support Files (English)
- Microsoft SQL Server VSS Writer

MSXML 6.0 Parser
WEP Application 2,0,0,1
Wizards to Adjust .NET Framework security assign trust to assemblies and fix broken .NET applications. Version 1.0.5000.0

Sequoia applications:
WinEDS 4.0.116 (Server)
Sequoia Voting Systems ScriptWiz Application Version 2.0.23.0

WinEDS Work Station

Dell Latitude D620, Service Tag D70CTB1
Intel Core Duo Processor 2.0 Gigahertz
Hard Drive 100 Gigabytes
Installed Memory 2048 Megabytes
CD ROM NEC DVD+-RW
Broadcom NetXtremen 57Gigabit Controller
Conexant v.92 Modem
Accessory Mouse

Operating System:
Microsoft Windows XP Professional SP2
Microsoft Windows component applications including:
Cinematronics 3D Pinball
Microsoft Windows Script Host
Microsoft Internet Explorer
Microsoft Messenger
Microsoft Windows Installer
Microsoft Windows Movie Maker
Microsoft NetMeeting
Microsoft Zone.com
Microsoft Data Access Components
Microsoft Windows Media Player
Microsoft Schedule + for Windows

COTS applications and drivers:
Microsoft Office Professional 2003
Microsoft Visio Professional 2003
Microsoft .NET Framework 2.0
Microsoft Visual Studio .NET Version
Microsoft Report Viewer
Microsoft SQL Server Management Objects Collection

Microsoft SQL Server Native Client
MSXML 6.0 Parser
NVIDIA Drivers
OZ776 SCR CardBus Windows Driver
Shared Add-in support update for Microsoft .NET Framework 2.0
SigmaTel Audio
Windows Installer 3.1
Adobe Acrobat 8 Standard
WinRAR Archiver Version 3.7
Dell Resource CD
HASP SRM Runtime
High Definition Audio Driver Package
HP Care Pack
HP Laser Jet P3005
Intelidev ImageScaler
WEP Application 2,0,0,1

Sequoia applications:
WinEDS Workstation Version 4.0.116
WinEDS Extended Services Version 1.0.47
WinEDS Election Reporting Version 4.0.44

Printer
HP Laser Jet P3005
Serial Number CNJ1F74824

Network Switch
D-Link Model DSS-16+ Desktop Switch
Serial Number F30N161002982
(Connects the WinEDS Server, WinEDS Workstation and the Printer)

400-C Central Count Scanner
Hardware: Version 3.00P
Serial Number: 200209

CPU for the 400-C:

Dell OptiPlex GX520, Service Tag BNFRCB1
Intel Celeron Processor 2.67 Gigahertz
Hard Drive 80 Gigabytes
Installed Memory 504 Megabytes
CD ROM Drive CDRW/DVD
Broadcom NetXtremen 57Gigabit Controller
Keyboard and Track Ball Mouse

Operating System:
- Windows XP Professional SP2
- Windows applications including:
  - Cinematronics 3D Pinball
  - Microsoft Windows Script Host
  - Microsoft Internet Explorer
  - Microsoft Messenger
  - Microsoft Windows Installer
  - Microsoft Windows Movie Maker
  - Microsoft NetMeeting
  - Microsoft Zone.com
  - Microsoft Data Access Components
  - Microsoft Windows Media Player

Sequoia Applications:
- WinETP Version 1.16.6
- 400-C Diagnostics
- Ballot Sorter Version 1.0.0.0

Optech Insight Plus

Serial number 512225
Serial number 502641
Firmware HPX K1.44.080501.1500

Memory Pack Reader

Serial number 506649
Firmware MPR 3.01.080422.0552

Memory Packs

(Several)
Firmware APX K2.16.080626.1320

Attachment B

Test Plan
Sequoia Voting Systems
System 4.0

Definitions used include:

SOS – California Secretary of State Staff
FCMG – Freeman, Craft, McGregor Group Staff with technical support from Sequoia Personnel
SVS – Sequoia Voting Systems Personnel observed by SOS or FCMG personnel

Scope limitation:

This test plan is designed to provide the California Secretary of State with data regarding Sequoia Voting Systems' System 4.0 to assist with her decision as to whether an administrative approval for use of the system by the City and County of San Francisco, California during the November 2008 General Election should be granted. Accordingly, the scope of testing has been limited to those functions needed for the intended use.

Installation of the system environment:

For each server and workstation to be used in the test:

SOS – Format the Hard Disks of the machine. (This may be performed prior to the test)
FCMG – Install the operating system.
FCMG – Take hash values on the system.
FCMG – Install the specified COTS Software
FCMG – Take hash values on the system
FCMG – Establish any network connections and configurations necessary for the system.
FCMG – Set up administrator and user accounts, apply any security templates, system hardening or disabling of services that may be appropriate at this point in the installation.
FCMG – Take hash values on the system.

For each other hardware items to be used in this test:

FCMG – From the trusted build, install disk(s) provided by iBeta; install the operating system and/or firmware for each device. For firmware written directly to memory devices, off load and record hash values of the firmware after it is loaded.

Installation of the system applications:

For each server and workstation to be used in the test:

FCMG – From the trusted build, install disks provided by iBeta following the steps in the system documentation; install the appropriate Sequoia applications and any required COTS applications included on the installation disk.
FCMG – Take hash values on the system. Run a comparison of the hash results against the hash results at the end of the installation of the system environment.
FCMG & SVS – Compare the files that were loaded, deleted or changed against documentation including the listings in the iBeta reports of the files comprising the system.
FCMG – Establish application administrator and user accounts.
FCMG – Complete any final system hardening.
FCMG – Document the System Security Policies, Services, Data Sources and Registry.
FCMG – Take hash values on the system.

Configuring the system for the test jurisdiction:

For each server and workstation and other piece of equipment to be used in the test:

FCMG – Following system documentation and any applicable parts of the California Use Procedures, and San Francisco procedures, set up all jurisdiction specific configuration settings and jurisdictional administrative data. This includes graphics, configuration settings for California and the San Francisco functional requirements, precinct, polling place and vote center definitional data, political parties, districts, offices, standard report and ballot headers.
FCMG – Take hash values on the system.

In WinEDS –

FCMG – Following system documentation and California Use Procedures, load the election definition provided by SVS onto the system.
FCMG and SOS – Review the election definition. Print out all reports used to proof the definition.
FCMG – Take the steps necessary to verify the election definition and output and correct as needed.
FCMG – Produce the export files required for the other elements of the system and load those files on the devices.
FCMG – Backup all data files including a copy to hard media.
FCMG – Take hash values on the system.
Note: The test elections will include the following:

- California General Election with Rank Choice Voting Contests.
- The test election shall be structured to use the Insight for tabulating ballots in the precincts for Election Day voting. Early voting and

mail in absentee ballots will be treated as the same in one counter group tabulated on the 400-C.

Preparing and proofing test decks:

SOS – Review and Proof the test decks provided by Sequoia and adjust the content of the decks as necessary using spare ballots.

Tabulating ballots

FCMG and SOS - Tabulate a full set of ballots for each precinct on the Insight devices and a set for all precincts on the 400C in the vote by mail counter group. (The 400C should have two separate counter groups. One for vote-by-mail and early voting, the other for election day voting) Tabulate a small set of ballots on the 400C representing Edge duplicated ballots for early voting in the vote by mail counter group, and a small set representing Edge duplicated ballots for Election Day voting in the election day counter group.

Printing all reports:

FCMG and SOS – Print reports from each Insight device and from all three runs on the 400C. Upload all results to WinEDS and prepare all reports. Proof reports against expected results.

Preparing verification data for the system:

FCMG/SVS- from the hash values before tabulation and after the results are consolidated, compare and determine which files were added and modified under these operations. Check added files to determine if any are executables and add them to the master verification file set. Identify any master verification files that are altered during operation with changes in data and label as dynamic.

Preparing backups and preserve test documentation

FCMG - Create backups of all test data and necessary testing material including the election definition and tally reports from WinEDS.
SOS – Retain all printed tally reports, marked and blank ballots, and Edge voting sheets.

Attachment C

Test Cases for RCV Voting

1. Candidate A wins on first round although Candidate B has sufficient votes to win in second ranking. Pattern includes a ballot with an overvote in the first ranking and Candidate C in the second choice, and a ballot with an undervote in the first ranking with Candidate A in the second choice. This should show a simple win for Candidate A with a margin of two votes and an overvote. If the second choice on the undervoted ballot is not promoted then Candidate A will only win with a margin of 1
2. Candidate B wins in third round. One ballot in the deck will have an undervote in the second choice with Candidate B as the third choice. One ballot will have an overvote in the third choice. Two votes will come from the elimination of a tie between Candidates D&E in the third choice. One ballot will have a duplicate candidate between the second and third choice. (There have been two Write-ins added to this contest, but it is not in a round that will ever be reached.)
3. Candidate B wins on the second round even though Candidate A had more votes in the first round. Candidate B's votes in the second round will come from a tie between Candidate D and Candidate E who will have less votes to Candidate C. One ballot has an overvote in the Second choice. One ballot has a duplicate candidate between the first and third choice. Candidate B takes the lead in round 1 and wins in round 2.
4. Candidate A wins in the third round but requires elimination of Candidates C, D, and E, one in each pass picking up the necessary vote only in the last round. One ballot has an undervote in the third choice. One ballot has a duplicate candidate between first and second choice.
5. A tie occurs between Candidates C and D on the first round. C+D >B. One ballot has Candidate E as the first choice, a second choice for Candidate C and a third choice for Candidate D. (Candidate D must lose the tie. This causes a 3-way tie between Candidates A, B, and E. Candidate E must lose the tie. Candidate B wins.)
6. A tie occurs between Candidates C and D on the second round so that C+D = B.
7. Candidates A, B, C, D, and E all tie on the first round with second choice votes giving Candidate A the lead and third choice votes that will give Candidate A the win. (Candidate E must be eliminated first and Candidate D second.)
8. Candidates B, C, and D tie on the second round with more votes than Candidate A. The third choices for the tied ballots all create a third pass tie. (Candidate D must lose the first coin toss. Candidate C must lose the coin flip of the final tie.) This should end in a tie between two candidates (Anthony and Carnegie), but all ballots have been exhausted. In SF they would have to follow their law/rules to resolve a tie after all ballots have been exhausted. We

selected Carnegie to lose and Anthony to win. On our reports, it shows all 12 of Carnegie's ballots being exhausted because there were no vote positions were left.

9. A tie is created in the second round. There is a tie for 2nd with totals greater than the leader. Whoever loses the coin toss will result in Candidate B winning. (We selected Roosevelt to lose)
10. A tie is created between the first and second leader in the last round. We will have to select a loser and a winner (See Case 8). Curtis was selected to lose causing Aldrich to win. Exhausting Curtis gave Alrich 6 extra votes in Pass 4.
11. A tie for Candidate A and B (who are the first and second leaders) is created in the first round, Candidate A picks up a vote in the first round and Candidate B picks up sufficient votes to win in the second round.
12. A qualified Write-in makes it to the second round. In the second round, the qualified Write-in is thrown out creating a win for Candidate B. (Candidate C –Madison- has to lose.)