COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF STATE

REPORT CONCERNING THE EXAMINATION RESULTS OF UNISYN VOTING SOLUTIONS OPENELECT 2.0A2 WITH OPENELECT® VOTING OPTICAL (OVO), OPENELECT® VOTING CENTRAL SCAN (OVCS), OPENELECT® VOTING INTERFACE (OVI-VC), FREEDOMVOTE TABLET (FVT) AND OPENELECT® CENTRAL SUITE (OCS)

Issued By:

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December 14, 2018

EXAMINATION RESULTS OF UNISYN VOTING SOLUTIONS OPENELECT 2.0A2 WITH OPENELECT® VOTING OPTICAL (OVO), OPENELECT® VOTING CENTRAL SCAN (OVCS), OPENELECT® VOTING INTERFACE (OVI-VC), FREEDOMVOTE TABLET (FVT) AND OPENELECT® CENTRAL SUITE (OCS)

I. Introduction

Article XI-A of the Pennsylvania Election Code, 25 P.S. §§ 3031.1 *et seq.*, authorizes the use of electronic voting systems. Section 1105-A of the Pennsylvania Election Code, 25 P.S. § 3031.5, requires that the Secretary of the Commonwealth (Secretary) examine all electronic voting systems used in any election in Pennsylvania and that the Secretary make and file a report stating whether, in his opinion, the electronic voting system can be safely used by voters and meets all applicable requirements of the Election Code.

Upon the request of Unisyn Voting Solutions (Unisyn), the Department of State's Bureau of Commissions, Elections and Legislation (Department) scheduled an examination for August 27, 2018 of OpenElect 2.0A. The voting system presented for certification in Pennsylvania included the OpenElect® Central Suite (OCS) Software System election management software used in conjunction with the following components: 1) OpenElect® Voting Optical (OVO) optical scan system that scans, validates and tabulates hand-marked paper ballots and ballots produced on OVI-VC and FVT; 2) the OpenElect® Voting Interface (OVI-VC), an ADA compliant ballot marking device (BMD); 3) FreedomVote Tablet (FVT), an ADA compliant tablet-based BMD; and 4) OpenElect® Voting Central Scan (OVCS), a ballot scanning system that consists of a PC, bulk scanner and OVCS software.

The Secretary appointed SLI Global Solutions (SLI) and the Center for Civic Design (CCD) as professional consultants to conduct an examination of OpenElect 2.0A. The examination process included a public demonstration and functional examination (functional examination), accessibility examination and security testing. The functional and accessibility examinations were performed in Room G24A/B of the Commonwealth Capitol Complex - Finance Building, 613 North Street, Harrisburg, PA 17120. Mike Santos, Senior Test Manager and Kyle Johnson, Senior Test Engineer (Functional Examiner) of SLI Global

Solutions, conducted the functional examination of the OpenElect 2.0A pursuant to Section 1105-A(a) of the Election Code, 25 P.S. § 3031.5(a). Whitney Quesenbery, Denis Anson, Michael Weisman and Maggie Ollove (Accessibility Examiner), representing CCD, performed an accessibility examination of the OpenElect 2.0A system. The examinations commenced on August 27, 2018, and lasted approximately four days. Jonathan Marks Commissioner of the Bureau of Commissions, Elections and Legislation; Kathryn Boockvar, Senior Advisor to the Governor on Election Modernization; Jessica Myers, Deputy Director, Office of Policy; Kathleen Kotula, Executive Deputy Chief Counsel, Office of Chief Counsel; and Sindhu Ramachandran, Voting Systems Analyst, represented the Secretary of the Commonwealth. McDermott Coutts, Director of Software Development and Doug Beazer, Product Manager, represented Unisyn. Additional staff members from the Department also attended the examination. The functional examination was open to the public and was videotaped by Department staff. Security testing of the OpenElect 2.0A system was performed at SLI facilities located at 4720 Independence Street, Wheat Ridge, Colorado, prior to the functional examination. Mike Santos, Senior Test Manager, and Jesse Peterson, Security Specialist, at SLI Global Solutions, served as the Security Examiner for the OpenElect 2.0A security testing. The Functional Examiner concluded that the OpenElect 2.0A did not comply with Section 1107-A(13), 25 P.S. § 3031.7(13), of the Pennsylvania Election Code because the system did not accurately report the counts in summary reports and transposed one of the ballots in the auditor application.

Thereafter, Unisyn incorporated corrections for the issues identified during the OpenElect 2.0A examination, and re-submitted the new release, OpenElect 2.0A2, to both the U.S. Election Assistance Commission (EAC) for federal approval and the Department for state certification. The system components remained the same and the only change in the new release was the software enhancements to remediate the identified anomalies. The Functional Examiner performed a follow-up examination of OpenElect 2.0A2 on October 3-4, 2018, at SLI Global Solutions located at in Wheat Ridge, Colorado. Department staff observed the examination via web conference. The examination was videotaped by SLI and the video is on file at the Department. Since the software changes made to the OpenElect

2.0A2 system were specifically to remediate the identified anomalies in OpenElect 2.0A and did not impact security or accessibility of the systems, it was determined that the results of the accessibility examination and security testing conducted as part of the OpenElect 2.0A examination may be utilized for OpenElect 2.0A2 certification.

II. The OpenElect 2.0A2 Voting System

OpenElect 2.0A2 is a paper-based voting system that provides end-to-end election support; from defining an election to generating final reports. The system is comprised of both precinct and central count tabulators, and Ballot Marking Devices as the ADA component. The system components include: OpenElect® Central Suite (OCS) election management system (EMS), OpenElect® Voting Optical (OVO) polling place scanner, OpenElect® Voting Interface-Vote Center (OVI-VC), FreedomVote Tablet (FVT) ballot marking devices with ADA support, and OpenElect® Voting Central Scan (OVCS) central scanning software used with COTS scanners Canon DR-X10C and Canon DR-M160II.

The following is a description of the OpenElect 2.0A2 components summarized from Section 2.0 (System Overview) of the Test Report for Examination of OpenElect 2.0A2(Report id - PUV-307-FTR-01), prepared by the Functional Examiner and System Overview document submitted by Unisyn as part of the Technical Data Package (TDP).

OpenElect Central Suite (OCS)

The OCS application suite supports elections on the OVO, OVI-VC, FVT and OVCS systems. It includes Ballot Layout Manager, Election Manager, Election Server, Tabulator Client, Tabulator Server, Adjudicator, and Tabulator Reports. In addition, the OCS includes the Software Server (SS) system for updating and validating the OVO, the FVT and the OVI-VC (voting device) software.

OpenElect Voting Optical (OVO)

The OVO is a full-page dual-sided optical scan precinct scanner that scans and validates voter ballot pages and provides a summary of all ballot pages cast. The OVO

consists of the following components:

Personal Computer (PC) / Computer Component – The OVO has a computer component (with a touch panel display) that has pre-installed server software that manages data and communication and client software that provides a user interface for voting and maintenance. A new election loaded via the Election Server or manually via a Transport Media (TM) sets passwords, parameters, and ballot styles for that election. (Valid ballots for a poll location are reinitialized or set on Election Day startup by scanning a ballot header card).

Transport Media (TM) – 1 GB or larger USB thumb drive that provides the means of transporting audit, optional ballot page images and vote files from the precinct on Election Night to Election Headquarters where the central count system resides.

Ballot Reader - dual-sided scanner connected to the computer component to scan data from marked ballot pages. The Ballot Reader ejects accepted ballot pages into an attached ballot box or rejects unaccepted ballot pages back out to the voter.Printer - 58 mm thermal receipt printer connected to the computer component to print receipts and reports at the OVO.

UPS - uninterruptible power supply that must be located at each polling location in the event of a power failure.

OpenElect Voting Interface (OVI-VC)

The OVI-VC is a ballot marking device (BMD) that supports both ADA and Regional Early Voting requirements. The OVI-VC has a 15-inch display and consists of the following components:

Personal Computer (PC) – The computer component (with a touch panel display) has pre-installed server software that manages data and communication and client software that provides user interfaces for voting and maintenance. A new election loaded via the Election Server or manually via a Transport Media (TM) sets passwords, parameters, audio, and

ballot styles for that election.

Transport Media (TM) – A USB device with 1 GB or larger storage that provides the means of transporting audit files to the OCS system.

Printer – 82.5 mm thermal receipt printer that is connected to the PC to print OVI Ballots and reports at the OVI.

UPS - Uninterruptible power supply, provided as part of the system.

FreedomVote Tablet (FVT)

The FVT is a tablet ballot marking device that enables voters to make their vote selections and to print their voted ballot. The FVT presents each contest on the ballot style to the voter in visual and/or audio formats. It facilitates special needs voters through a variety of methods including wheelchair access, sip and puff, zoom-in ballot function and audio assistance for the visually impaired. The voter with limited vision can navigate through the ballot using an audio ballot and the ADA keypad or touchscreen to input their selections. Once the ballot is printed, it is taken to the OVO to be cast. Each FVT can support multiple languages for both visual and audio ballots, allowing the voter to choose their preferred language.

The FVT consists of the following components:

Tablet – The Android tablet has a 13.3 in. touchscreen and comes with pre-installed software that provides user interfaces for voting and maintenance. Election files generated by the EM are loaded manually via a USB. The election files will allow the jurisdiction to determine the FVT's mode such as early voting or training, sets passwords, parameters, audio, and ballot styles for that election.

Barcode Reader - 2D USB Barcode reader will read the 2D barcodes produced by the EM such as the initialize barcode and administrative/maintenance barcodes. It will also read the 'populate' barcode produced by other qualified systems.

USB Hub – A four port USB hub is installed in the FVT case to connect the printer, barcode scanner, and keypad to the tablet.

Printer – 82.5 mm thermal receipt printer is connected to the Tablet to print BMD ballots and reports.

Optional ADA Devices – 10-key keypad with Sip and Puff Interface, Headphones, Sip and Puff Device.

OpenElect Voting Central Scan (OVCS)

OpenElect Voting Central Scan (OVCS) is an application that interfaces with a high-speed scanner to quickly process and tally large numbers of ballots, capture images, and extract write-in images from ballots for reporting purposes. The OVCS units reside at election headquarters to read absentee, provisional and recount ballots in large jurisdictions or read the entire election's ballots at a central count location in smaller jurisdictions.The OVCS system consists of the following components:

OCS Desktop Computer

Bulk Scanner –

- Canon imageFORMULA DR-X10C - a large model dual-sided scanner that is connected to and controlled by the PC to scan data from marked ballots.
- Canon imageFORMULA DR-M160II- a small model dual-sided scanner that is connected to and controlled by the PC to scan data from marked ballots.

Manufacturer Software/Firmware

The **Unisyn OpenElect 2.0A2** voting system consists of the following software and firmware components:

	Firmware/Software	Version
Election Management System (EMS)	Ballot Layout Manager (BLM)	2.0.A
	Election Manager (EM)	2.0.A
	Tabulator Client (TC)	2.0.A
	Tabulator (Tab)	2.0.A.2
	Tabulator Reports (TR)	2.0.A
	Auditor	2.0.A.2
	Scripter	2.0.A
	Validator	2.0.A
	Common (Library)	2.0.A
	OCS Installer	2.0.A
	Regkey Builder	2.0.A
	Logger (Library)	2.0.A
	UnisynSecure (Library)	2.0.A
Unisyn Tabulators	OpenElect Voting Optical (OVO), Rev A&E firmware	2.0.A
	OpenElect Voting Central Scan (OVCS) Application	2.0.A.2
Voter Assist Terminal	OpenElect Voting Interface (OVI-VC), Rev. A&B firmware	2.0.A
	FreedomVote Terminal	2.0.A.1

COTS Software/Firmware

Additional COTS software and firmware included in the system has been defined as part of the EAC system certification scope added to this report as Attachment A.

Peripherals used during the examination included:

COTS Equipment	Make	Model
Headphones	Koss	KPH5
6 x Transport Media	STEC	Thumb Drive (UFD) 1GB Capacity
2 x Thumb Drives	PNY	USB 16 GB

ADA Voting Booth	American Made Election Equipment (AMEE)	Model 2000

Test support materials utilized during the examination included:

- 82.5mm thermal receipt paper for printing ballots on the FVT and OV-VCI, to be processed by the OVO and OVCS.
- Ballot stock, for printing of ballots to be processed by the OVO and OVCS
- USB thumb drives, used as Transport Media for transport of election data within the system

III. EXAMINATION APPROACH, PROCEDURES AND RESULTS

A. Examination Approach

To ascertain whether OpenElect 2.0A2 can be safely used by voters at elections in the Commonwealth and meets all the requirements of the Pennsylvania Election Code, the Examiners developed test protocols for the examination. The initial functional examination of OpenElect 2.0A determined that the system did not comply with Sections 1107-A(13), 25 P.S. § 3031.7 (13). The Examiners observed the following two issues

1. On the Tabulator application, when managing write-ins and needing to commit changes more than once, the summary reports had incorrect values; and

2. One of the ballot images was transposed because the barcode area, which is used to detect front and back barcodes on ballots, in one instance was insufficient for proper detection.

Unisyn remediated the software issues and the Examiners then performed a follow-up examination of OpenElect 2.0A2 to confirm that the anomalies identified in OpenElect 2.0A were corrected and the system complies with all the requirements of the Pennsylvania Election Code. The examination approach followed for OpenElect 2.0A and OpenElect 2.0A2 is discussed in the below sections.

OpenElect 2.0A Examination Approach

Functional Examination

The test protocols separated the requirements of Article XI-A of the Pennsylvania Election Code, Sections 1101-A to 1122-A, 25 P.S. §§ 3031.1 - 3031.22, into six main areas of test execution: (1) Source Code Review; (2) Documentation Review; (3) System Level Testing; (4) Security/Penetration Testing; (5) Privacy Analysis; and (6) Usability Analysis.

Source Code Review was performed prior to the functional examination to determine if there are any vulnerabilities found that would warrant additional security examination.

Documentation Review was performed to verify that the portions of the Pennsylvania Election Code, which reference documentation detail, are sufficiently met by the Unisyn OpenElect 2.0A documentation. The Functional Examiner validated compliance of the system to the following sections of the Election Code during the documentation review.

- 1105-A(a), 25 P.S. § 3031.5(a), requiring that an electronic voting system has been examined and approved by a federally recognized ITA;
- 1107-A(11), 25 P.S. § 3031.7(11), requiring an electronic voting system to be suitably designed in terms of usability and durability, and capable of absolute accuracy;
- 1107-A(13), 25 P.S. § 3031.7(13), requiring an electronic voting system to correctly tabulate every vote;
- 1107-A(14), 25 P.S. § 3031.7(14), requiring an electronic voting system to be safely transportable; and
- 1107-A(15), 25 P.S. § 3031.7(15), requiring an electronic voting system to be designed so voters may readily understand how it is operated.

System Level Analysis examined the Unisyn OpenElect 2.0A voting system in terms of conducting an election starting with creating an election definition using OCS and then creating the election media needed to populate the voting devices (the OVO, OVI-VC, FVT and OVCS). Ballots were marked, manually as well as via the ballot marking devices (OVI-VC and FVT), then tabulated through the OVO and OVCS. The results reports were

validated against the expected results of the voted ballots. All components of the OpenElect 2.0A system were exercised to verify that they meet all pertinent requirements of the Pennsylvania Election Code. The test cases were designed to ascertain compliance to the following sections of the Election Code

- 1101-A, 25 P.S. § 3031.1, requiring an electronic voting system to provide for a permanent physical record of all votes cast;
- 1107-A(2), 25 P.S. § 3031.7(2), requiring an electronic voting system to permit voting on both candidates and ballot questions, according to the official ballot;
- 1107-A(3), 25 P.S. § 3031.7(3), requiring an electronic voting system to permit straight party voting, including the "Pennsylvania method" of straight party voting;
- 1107-A(4), 25 P.S. § 3031.7(4), requiring an electronic voting system to permit a voter to vote for candidates of all different parties, and write-in candidates;
- 1107-A(5), 25 P.S. § 3031.7(5), requiring an electronic voting system to permit a voter to enter write-in votes;
- 1107-A(6), 25 P.S. § 3031.7(6), requiring an electronic voting system to permit a voter to cast votes for candidates and ballot questions he or she is entitled to vote for, and prevents a voter from casting votes the voter is not entitled to vote on;
- 1107-A(7), 25 P.S. § 3031.7(7), requiring an electronic voting system to prevent over-votes;
- 1107-A(8), 25 P.S. § 3031.7(8), requiring an electronic voting system to prevent a person from casting more than one vote for a candidate or question, except where this type of cumulative voting is permitted by law;
- 1107-A(9), 25 P.S. § 3031.7(9), requiring an electronic voting system to permit voters to vote in their own parties' primaries, and prevents them from voting in other parties' primaries, while also permitting voters to vote for any nonpartisan nomination or ballot question they are qualified to vote on; and
- 1107-A(10), 25 P.S. § 3031.7(10), requiring an electronic voting system that registers votes electronically to permit voters to change their votes up until taking the final step to register the vote, and for systems that use paper ballots or ballot cards, permits a voter to get a new ballot in the case of a spoiled ballot, and to mark and cancel the spoiled ballot;
- Parts of 1107-A(16), 25 P.S. § 3031.7(16), requiring an electronic voting system

which provides for district-level tabulation to include (i) a public counter to register how many ballots are submitted to be counted; (iv) will not tabulate an over-vote, with an option to notify a voter of an over-vote if used during voting hours; and (v) generates a printed record that counters are set to zero before voting commences; and

- Parts of 1107-A(17), 25 P.S. § 3031.7(17), requiring an electronic voting system which provides for central-count tabulation to (ii) preclude tabulation of an over-vote; and (iii) indicate that counters are set to zero before processing ballots, either by district or with the capability to generate cumulative reports.

The Functional Examiner also used the System Level Testing to further evaluate the design and accuracy aspects of the system as required by Sections 1107-A(11) and (13), 25 P.S. §§ 3031.7(11) & (13), through his use at public demonstration, even though the requirements were already validated in the documentation review phase by reviewing EAC certification reports.

The Security/Penetration Analysis examined the voting system's compliance with the requirements of the Pennsylvania Election Code by analyzing physical security procedures and impoundment of ballots. Precinct tabulation devices were installed for delivery to the precinct, and the Functional Examiner analyzed the pertinent security procedures performed on each device to ascertain compliance to Section 1107-A(12), 25 P.S. § 3031.7(12), requiring an electronic voting system to provide acceptable ballot security procedures and impoundment of ballots to prevent tampering with or substitution of any ballots or ballot cards. The Functional Examiner also used the security analysis phase of testing to validate compliance to parts of Sections 1107-A(16) and (17), 25 P.S. §§ 3031.7(16) & (17), that relates to system security.

The Privacy Analysis examined the voting system's compliance to Section 1107-A(l) of the Election Code, 25 P.S. § 3031.7(1), requiring that an electronic voting system provide for absolute secrecy of the vote, by analyzing how the polling place devices met the pertinent privacy requirements.

The Usability Analysis evaluated the compliance of the voting system to Sections 1107-A(14) and (15), 25 P.S. § 3031.7(14) & (15). The results from the tests were used by

the Functional Examiner to supplement his conclusions from the documentation review phase.

Accessibility Examination

The accessibility examination was designed to provide insights about each voting system's usability and accessibility especially for voters with disabilities, as well as how effectively the system could be deployed by poll workers and voters. The Accessibility Examination included a team of three examiners with accessibility, usability and election process experience collectively referred as Accessibility Examiner. The examination process was divided into three parts:

- **Expert review** by the Accessibility Examiner, using scenarios based on personas of people with disabilities from National Institute of Standards and Technology (NIST) and their professional experience.
- **Voters with disabilities used** the system voting a reasonable length PA ballot and completed a questionnaire about their experience. The Accessibility Examiner observed and made notes.
- **Election officials and poll workers tested the accessibility features** to evaluate how they would be activated during an election. They commented on the system based on their experience.

The testing team constructed a typical PA ballot, with a mix of contest types and variation in the number of candidates to be voted for each contest. The Accessibility Examiner conducted an expert review, observed 8 voters with disabilities, and worked with 7 poll workers in a guided review of the systems. Four voters used the FVT and three voters used the OVI-VC. All voters used the OVO to scan and cast their ballots.

Security Testing

The Security testing provided a means to assess the required security properties of the voting system under examination and ascertain compliance with PA

Election Code requirements including 25 P.S. §§ 3031.7(11), (12), (16) and (17). The security tests were based on the PA Voting System Security Standard, published as Attachment E to the Directive for Electronic Voting Systems. The Security Examiner conducted tests that covered the following areas of testing - documentation review, design, software security, network capabilities, audit logging, physical security and penetration testing.

OpenElect 2.0A2 Examination Approach

OpenElect 2.0A2 is a release to correct the anomalies noted in OpenElect 2.0A system. The examiners evaluated the changes submitted by Unisyn and developed test protocols to validate the modifications to OpenElect 2.0A to ensure that the fixes resolved the identified anomalies and that the modified system maintained compliance with all the PA Election Code requirements.

Functional Examination

The Functional Examiner and Department agreed that the test approach must include Documentation Review, Source Code Review and System Level Testing. Security/Penetration, Privacy and Usability analysis results were leveraged from OpenElect 2.0A examination since those aspects of the system remained unaffected by the isolated code changes made to the system.

Documentation review was performed to verify that the portions of the Pennsylvania Election Code, which reference documentation detail, are sufficiently met by the Unisyn OpenElect 2.0A2 documentation. Source code review was done to determine if there were any vulnerabilities that warranted additional testing and the review focused on source code modifications for the OpenElect 2.0A2 release. System Level Testing examined OpenElect 2.0A2 in terms of conducting a general election and closed primary election. The election runs were to (a) test and confirm that the anomalies identified during OpenElect 2.0A examination were remediated and (b) to perform regression testing of all components of the system. The election runs allowed the Functional Examiner to ascertain that the compliance

with the Election Code requirements determined during the System Level Testing of OpenElect 2.0A is maintained in the new release.

Accessibility Examination and Security Testing

The Department of State in consultation with the Accessibility Examiner and Security Examiner decided that the findings from OpenElect 2.0A Accessibility Examination and Security Testing can be used for OpenElect 2.0A2, since there were no hardware changes and the isolated code changes were for correcting the anomalies identified during OpenElect 2.0A Functional Examination.

B. Examination Process and Procedures

The examination process and procedures followed for the OpenElect 2.0A and OpenElect 2.0A2 examinations are listed in the sections below. The final determination in this report is based on the combined analysis of the results and conclusions from both examinations.

OpenElect 2.0A Examination

Functional Examination

The public demonstration and functional examination portion commenced on August 27, 2018, at Room G24A/B of the Commonwealth Capitol Complex - Finance Building, 613 North Street, Harrisburg, PA 17120. The test execution tasks took approximately four days. Members of the public were allowed as observers for the examination. The Functional Examiner performed System Level Testing, Security/Penetration Testing and Privacy and Usability Analysis during the examination. Source code and Documentation review were completed prior to the public examination at SLI lab facilities in Wheat Ridge, Colorado.

Unisyn supplied all the hardware equipment required for the examination. All software and firmware necessary to perform the examination was received directly from the Voting System Test Laboratories(VSTL) that tested the voting system for EAC certification. The trusted build of the software and firmware for each device being evaluated were

installed using the appropriate media for installation. The hash codes for all system components were captured using the process listed in the manufacturer's Technical Data Package (TDP) by the Functional Examiner with assistance from Unisyn representative. The Functional Examiner further compared and confirmed that all the captured hash codes matched the hash codes for the EAC certified system executables before executing the test scripts.

The Functional Examiner created the election definition using OCS and transport media was created to populate the devices under examination with the election. The polling place was set up using OVO, OVI-VC and FVT. A primary and general election were then run using polling place devices and central scanners. Ballots were tabulated at the polling place using OVO and central scanners using OVCS. Results were then tabulated using OCS and validated against expected results.

Accessibility Examination

The accessibility examination portion commenced on August 27, 2018, at Room G24A/B of the Commonwealth Capitol Complex - Finance Building. The examination lasted approximately three days followed by a debrief meeting on August 30, 2018, with DOS and CCD to discuss initial findings. The examination included expert review by the Accessibility Examiner, sessions with 3 poll worker groups from Dauphin County, PA, and sessions with 7 voters with disabilities using different accessible devices for voting. The voter sessions each took approximately an hour. The poll worker sessions took approximately an hour to 90 minutes each. Unisyn supplied the hardware and supplies for the Accessibility Examination. The equipment was prepared for the examination by loading the required election definition using transport media. The test examined the FreedomVote Tablet (FVT) and OpenElect Voting Interface (OVI) ballot marking devices and the OpenElect Voting Optical (OVO) ballot scanner. The typical voting experience involved the voter marking their ballot using either the FVT or the OVI, printing their ballot on one of those machines, and then scanning their printed ballot on the OVO to cast the ballot. The Accessibility Examiner identified the accessibility features of each component as below:

FVT accessibility features

- ADA compliant voting booth/stand
- Touch screen, 13" in portrait orientation (with gestures: swipe up, down, left, right)
- Audio ballot with MP3 sampled audio (we also reviewed the TTS audio)
- Tactile key pad with different-shaped, braille encoded buttons
- Binary input/Dual switch jack (on tactile key pad)
- Audio output jack; and
- Voter settings.
    - Screen reader toggle switch
    - Audio volume and tempo
    - Text Size (default, medium, large)
    - Screen brightness and contract (normal, low, inverted)
    - High contrast mode

OVI accessibility features

- ADA compliant voting booth/stand
- Touch screen, 15" landscape oriented (no gestures)
- Audio ballot
- Text to speech audio
- Tactile key pad with different shaped buttons
- Binary input/Dual switch jack (on tactile key pad)
- Audio output jack; and
- Voter settings.
    - Audio volume and tempo
    - Text Size (default, medium, large)
    - Screen brightness and contrast (normal, low, inverted)

OVO scanner features

Some features of the OVO scanner were also helpful for accessibility

- Small screen display (for visual instructions and confirmation)
- LED light status (green when ready, red when scanning)
- Engraved chevrons/arrows on the scanner bed that point toward the scanner opening

The machine features listed above are not exhaustive. For more information about the Unisyn OpenElect 2.0A2 system, refer to the vendor provided technical specifications.

The Accessibility Examiner prepared voting scenarios for each voting session to allow comparison of results between each session. The scenarios were constructed to provide a structured opportunity to explore how the system works in all interaction modes, using:

- visual touch screen with default settings;
- visual touch screen with text size and contrast changes;
- audio and the tactile keypad;
- audio and the visual touch screen; and
- audio or visual display with the dual switch.

Both the ballot contents and the instructions for marking the ballot were designed to exercise different types of interactions (navigation in ballot, navigation in contest, undervotes, overvotes, straight party, navigation within the review/summary screen, making changes to a contest from the review/summary screen). The ballot included both very short contests, and those long enough to potentially fill more than one screen, even at the default text size.

Expert Review by Accessibility Examiner

The Accessibility Examiner used the same ballot and instructions to be used for voter and poll worker review, for their expert review, so they would be familiar with the interaction voters would experience.

Sessions with voters

Each voter session took about an hour. They included:

- An opening interview about their previous voting experience and the types of assistive technologies they use in daily life and in voting.
- A very basic orientation to the system with opportunities for voters to ask questions about any assistive technologies available.
- Set-up of the machine using the provided assistive access features based on the needs of the individual voter. Where a blind voter would typically use the provided or personal headset to listen to the audio instructions, the tests used an external speaker so that the testers could inquire about the voters understanding of the instructions.
- Voting a ballot, following voting instructions given verbally by the facilitator, where necessary, and by reading them. Voters were encouraged to give feedback about their experiences, both positive and negative, as they went through the ballot. The Accessibility Examiner and the voters discussed any feedback and questions that occurred during the voting sessions and re-evaluated any findings as necessary.
- A closing interview including a questionnaire about their voting experience and reactions to the system.

Sessions with poll worker groups

Each poll worker session took approximately one hour, depending on the group size and provided the most activity variability. Each session included:

- A brief orientation to the voting systems and the accessibility features, similar to a poll worker training.
- An opportunity for the poll workers to review vendor-provided instructions before trying the system. They marked ballots and experimented with the accessibility features.
- An opportunity for the poll workers to interact with roll-played voters in two to six different access-needs scenarios, depending on the size of the

group and available time. Each scenario involved an examiner roll-playing as a voter with an unspecified disability. In some scenarios, the voter didn't immediately identify their disability. Since this was not intended to test the poll-worker's ability to determine appropriate accommodations, each simulated voter provided information about the accommodations they needed, in general language. This sometimes required the poll worker to ask the voter what additional assistance she or he might need. Then the poll worker activated the necessary accessibility features for the voter.

The Accessibility Examiner took notes about aspects of the system that worked well and problems they encountered during all three phases of the examination. The issues were then categorized based on their impact on a voter's ability to vote independently and privately.

- Positives – things that voters mentioned as meeting or exceeding their expectations
- Annoyances – things voters mentioned as problems, but which did not significantly slow their progress in marking their ballot
- Problem solving – instances where voters hesitated and had to figure out how to complete an action or task, but were able to do so on their own, by exploring the system or relying on past experience with technology
- Needs assistance - problems that could only be solved with help, such as instructions or assistance from a poll worker
- Show stoppers - problems that could prevent successful independent and private voting, even with good knowledge about how to use the system and accessibility features

The Accessibility Examiner then compiled the findings including categorizations from the examination into a report submitted to the Secretary.

Security Testing

The Security Testing was done at SLI lab facilities in Wheat Ridge, Colorado. The Security Examiner received the hardware devices from Unisyn and the software and firmware was obtained from the Voting System Test Lab (VSTL) which tested the system for EAC certification testing. The Examiner installed the Trusted Build prior to the evaluation using the appropriate media for installation. The Security Testing is comprised of a series of test suites which are utilized for verifying that a voting system will correspond to applicable security requirements within the Pennsylvania Election Code and PA Security Standards. The Security Examiner evaluated each component of the OpenElect 2.0A system and the system as a whole for interactions between components. These test suites covered areas of confidentiality, vote anonymity, integrity, availability, and auditability of the voting systems.

The requirements associated to each area of testing were applied to the OpenElect 2.0A system in the following manner. The Security Examiner did a review of the EAC testing reports of the system and also executed tests for a cross section of VVSG 2005 requirements to reconfirm compliance. The Security Examiner then designed tests that included in depth verification and validation of reports, audit logs and physical and logical access controls for each of the components of the voting system. The physical security examination included security seals, lock/key combinations, measures for collection of voting in the event of an extended power outage, ballot box and system access points. Tests were done to ensure that election results, media used, reports and audit logs were protected from attempts to decrypt, manipulate and corrupt election data.

The Security Examiner also created a vulnerability assessment and performed penetration testing of the OpenElect 2.0A system.

Unisyn OpenElect 2.0A2 examination

Functional Examination

The follow-up examination was conducted on October 3rd and 4th, 2018, at SLI

Global Solutions facility, 4720 Independence Street, Wheat Ridge, Colorado, and was observed by Department staff remotely in a conference room in BCEL, 210 North Office Building, 401 North Street, Harrisburg, Pennsylvania via web conference. Unisyn supplied all the hardware equipment required for the examination. All software and firmware necessary to perform the examination was received directly from the VSTL that tested the voting system for EAC certification. The Functional Examiner installed and/or verified the Trusted Build for each system component. A primary and general election was then run using OVO, OVI-VC, FVT, OVCS and OCS. Results were then tabulated and validated against expected results. The Functional Examiner performed the Source Code Review before the witnessed examination.

C. Examination Results

OpenElect 2.0A Functional Examination

On Sepember 6, 2018, the Functional Examiner issued his draft report for the testing of OpenElect 2.0A with a recommendation that the system was not in compliance with Section 1107-A(13), 25 P.S. § 3031.7(13), of the Pennsylvania Election Code. The report noted the following concerns:

1) One of the ballot images from the primary election was flipped when displayed for adjudication. Upon analysis, it was identified that the extracted barcode area, which is used to detect front and back barcodes on ballots, in one instance was insufficient for proper detection, which resulted in the images being transposed.

2) The summary reports for general election reported incorrect values when write-in adjudication sessions were committed more than once. An algorithm was applied incorrectly after the first commit operation, causing subtraction operations to be applied to counts in summary reports, which resulted in incorrect values being reported.

The Functional Examiner's report indicated successful completion of tests executed to ascertain compliance to all other requirements mandated by the Pennsylvania Election

Code. The Examiner report for OpenElect 2.0A (Test Report – PUV-003-FTR-01) included details of the test cases, execution and successful completion. The following section is a summary of the results of the examination as set forth in fuller detail in the Examiner's Report.

1. Source Code Review

Source Code Review for OpenElect 2.0A was performed, with a focus on determining whether any vulnerabilities could be found. The Functional Examiner reported that the code review was completed with no malicious software, cryptographic software, process control or password management vulnerabilities being found. The Examiner concluded that no deficiencies were found during source code review.

2. Documentation Review

The Documentation Review testing performed by the Functional Examiner demonstrates that the OpenElect 2.0A meets the relevant requirements of the Pennsylvania Election Code. The Examiner reviewed the "Test Report for EAC 2005 VVSG Certification Testing of Unisyn OpenElect 2.0A Voting System"

The review of the EAC test reports by the Functional Examiner and the EAC certifications submitted by Unisyn satisfy the requirements of Section 1105-A(a) of the Election Code, 25 P.S.§ 3031.5(a): requiring that an electronic voting system has been examined and approved by a federally recognized independent testing authority (ITA), or VSTL as such authorities are now called, as meeting the applicable performance and test standards established by the federal government.

Functional Examiner concluded that the design requirements of Sections 1107-A(11) and (14) of the Pennsylvania Election Code, 25 P.S. § 3031.7(11) & (14), are met by the combination of EAC hardware Non-Operating Environmental Tests, which included bench handling, vibration, low temperature, high temperature, humidity and product safety tests. The system accuracy testing during EAC certification testing provided confirmation of system accuracy as required by Section 1107-A(11) of the Pennsylvania Election Code, 25

P.S. § 3031.7(11).

The system summative usability test reports were accepted by the EAC as part of the Federal Certification. This along with the Functional Examiner's use of the system demonstrates that the system can be readily learned and hence satisfied the usability requirement of Section 1107-A(15) of the Pennsylvania Election Code, 25 P.S. § 3031.7(15).

Accuracy testing performed during EAC certification testing provided confirmation of system accuracy at a high level, even though additional testing was done during the Primary and General Election runs.

3. System Level Testing

As set forth in the examination approach, System Level Testing was divided into two separate tests, a closed primary election and a general election. The ballots defined had contests with voting variations supported in Pennsylvania.

A closed primary election consisting of two political parties (Republican, Democratic), three precincts (Precinct 1, Precinct 2 - split into Precinct 2a and 2b), Precinct 3, and 21 contests was run utilizing OCS, OVO, OVI-VC, FVT and OVCS (two scanners). For the Republican ballot, there were 21 contests: 19 partisan contests and 2 referendums, 10 "Vote for One", 1 "Vote for no more than Two", 3 "Vote for no more than Three", 4 "Vote for no more than Four" and 1 "Vote for no more than Fifteen" . For the Democratic ballot, there were 21 contests: 19 partisan contests and 2 referendums, 11 "Vote for One", 1 "Vote for no more than Two", 1 "Vote for no more than Three", 5 "Vote for no more than Four" and 1 "Vote for no more than Fifteen". Referendum contests were added to test the generation of non-partisan ballots. The Functional Examiner validated compliance of the system to Sections 1101-A and 1107-A(2), (5)-(11) and (13), 25 P.S. §§ 3031.1, 3031.7(2), (5)-(11) & (13). All test cases except the ones for validating 25 P.S. § 3031.7(13) passed without anomalies.

A general election consisting of four political parties (Republican, Democratic, Green and Libertarian), three precincts (one of which was a split precinct), and 21 contests

(18 partisan contests,1 non-partisan contest and 2 retentions , 11 "Vote for One", 1 "Vote for no more than Two", 5 "Vote for no more than Three", 1 "Vote for no more than Four" and 1 "Vote for no more than Fifteen") was run utilizing OCS, OVO, OVI-VC, FVT and OVCS. The Functional Examiner examined the compliance of the system to Sections 1101-A and 1107-A(2)-(8), (10)-(11) and (13), 25 P.S. §§ 3031.1, 3031.7(2)-(8), (10)-(11) & (13). All test cases except the ones for validating 25 P.S. § 3031.7(13) passed without anomalies.

Functional Examiner included test cases to validate Sections 1107-A(16) and (17), 25 P.S. § 3031.7(16) & (17), that mandate voting systems to generate zero proof reports and correctly handle over-votes during the election runs. The remainder of the requirements of 25 P.S. § 3031.7(16) and (17) were validated by the Functional Examiner during the Security/Penetration Analysis.

Election definitions for both primary and general elections were created within OCS, and transport media was created to populate OVO, FVT, OVI-VC and OVCS. Polls were opened and ballots were marked manually, as well as electronically via the ballot marking devices OVI-VC and FVT. Ballots were marked and tabulated utilizing the OVO and OVCS (Canon DR-X10C and Canon DR-M160II) scanners.

The Functional Examiner used English and Spanish ballots for the test. Reports were generated after closing polls and results were validated against expected results. Each specific hardware and software component was tested for compliance with the required sections of the Election Code.

The OpenElect 2.0A is a paper based system and paper ballots provide a permanent physical record of each vote cast adhering to Section 1101-A(1) of the Election Code, 25 P.S. § 3031.1. Hand-marked paper ballots and ballots marked using OVI-VC and FVT are tabulated when voters insert the ballots into the OVO polling place scanner.

The primary and general election definitions were created using OCS and loaded to polling place devices and central scanners, which provided assurance that the system can perform ballot creation activities. The Functional Examiner successfully added contests

including straight party, parties, choices, precincts, districts, ballot styles, referendum questions and retention contests with appropriate candidates and choices. Media was created to load the election to OVO, OVI-VC, FVT and OVCS. The OVO, OVI-VC and FVT components of the OpenElect 2.0A successfully permitted votes for "1 of 1," "N of M," and "Question" contests for a standard and ADA voting session. The test cases also included straight party voting to confirm that all appropriate candidates were selected. The Functional Examiner thus concluded that the system is in compliance with Section 1107-A(2), 25 P.S. § 3031.7(2).

Each of the applicable components of OpenElect 2.0A allowed the test voter to cast votes for candidates on the ballot and also a write-in vote, demonstrating compliance with Section 1107-A(5), 25 P.S. § 3031.7(5).

OpenElect 2.0A meets the requirements for Section 1107-A(6), 25 P.S. § 3031.7(6) because the test voters cast votes on different ballot styles for candidates and questions and the OVI-VC and FVT displayed only contests for which the voter was entitled to vote.

The system's compliance to Section 1107-A(7), 25 P.S. § 3031.7(7) was demonstrated since OVO has the capability to indicate overvotes for any office and the voter has the ability to either spoil the ballot or cast the ballot with overvotes if the voter decides to do so. Ballot marking devices OVI-VC and FVT did not allow overvotes. The Functional Examiner also noted that the system allowed undervotes, but warned the user about the undervote if configured to do so.

The successful validation of the election results shows that OVCS as well as precinct tabulator OVO include the capability to reject all choices recorded on the ballot for an office or question if the number of choices exceeds the number for which the voter is entitled to vote, adhering to Section 1107-A(8), 25 P.S. § 3031.7(8).

The OpenElect 2.0A complies with Section 1107-A(9), 25 P.S. § 3031.7(9), because test voters in the closed primary election were only able to vote for referendum questions and candidates seeking the nomination of their party.

Adherence to Section 1107-A(10), 25 P.S. § 3031.7(10), was demonstrated for both ADA and standard voting sessions. Ballot marking devices FVT and OVI-VC allowed the voters to review their ballots before printing for tabulation on OVO or OVCS. The Functional Examiner attempted to change votes on OVI-VC and FVT for candidates within the contest, as well as after leaving the contest and then returning to other contests and while reviewing the summary screen. The tests demonstrated that OVI-VC and FVT allowed changing the selections until the voter decides to print or cast the ballot. The OVO precinct scanner of OpenElect 2.0A provides the voter with a caution message when the ballot contains errors, such as overvotes or undervotes. The voter is also presented an error report on the screen when the tabulator detects potential errors. The voter can either decide to affirm their intent by casting the ballot, or spoil the ballot and fill out another ballot.

Accuracy requirements of 1107-A(11), 25 P.S. § 3031.7(11), previously ascertained by reviewing EAC test reports were further validated by the successful tabulation and validation of the primary and general elections run by the Functional Examiner.

The Functional Examiner validated via test cases during the primary and general election that the tabulating devices OVO and OVCS generated zero proof reports only before ballots were cast, the system rejected all votes for the contest in an overvote situation, and produced a results report when appropriately configured as required under Sections 1107-A(16) and (17), 25 P.S. § 3031.7(16) & (17). The Functional Examiner confirmed that the zero-proof report cannot be generated on demand after a ballot is cast.

Ballots were marked by hand including write-in votes during the general election to examine the system's ability to properly enact the PA method. The OVO, OVCS, OVI-VC and FVT demonstrated compliance to Sections 1107-A(3) and (4), 25 P.S. § 3031.7(3) & (4). The ballot marking devices allowed marking ballots following the PA method and the scanners/tabulators appropriately tabulated ballots with PA method test scenarios.

The voting variations used for the examination included write-in votes, to ensure that all components of the system will identify the appropriate write-ins and allow the election

official to tabulate all votes including write-in votes. The summary reports reported incorrect totals during the General Election test, when the write in management sessions were committed more than once. Also during the primary election one of the ballot images was transposed when being displayed for adjudication The Functional Examiner hence concluded that OpenElect 2.0A did not comply to Section 1107-A(13), 25 P.S. § 3031.7(13).

4. Security/Penetration Analysis

The Functional Examiner adopted a strategy to review each pertinent requirement for this test individually and then created test cases to address it in either a documentation review, a functional test, or both.

Precinct tabulation devices and ballot marking devices were configured for delivery to a polling place from warehouse including all seals and locks recommended by the manufacturer. The central scanners were configured for operation in a county office. The devices were inspected for the ability to be tampered with. The Functional Examiner examined the polling place equipment to confirm the following:

- Adequate seals and locks are present to prevent tampering, and the system provides noticeable evidence if any tamper attempt (successful or failed) occurs (OVO, OVI-VC);
- There is no access to the ballots/ballot cards, either via printer, the OVO or ballot card stock, to tamper or substitute any ballots (processed, unprocessed, challenged or provisional) (OVO, OVI-VC);
- Devices are not accessible to unauthorized personnel to programmatically tamper with the device that would affect ballot presentation, print, or any other feature/activity (OVO, OVI-VC); and
- The Ballot box is tamper proof and/or tamper evident.

The Functional Examiner also examined the components of the OpenElect 2.0A system for password management of administrative functions and ensured that the system counter could not be reset by unauthorized persons. In addition, the Functional Examiner also reviewed "Unisyn System Security Specification" document for ballot security

procedures at the polling place and central location to ensure that the manufacturer recommended the required steps for configuring the OpenElect 2.0A securely for Election. Based on the tests the Functional Examiner concluded that that the system complies to 1107-A(12), 25 P.S. § 3031.7(12).

The Functional Examiner included test cases during the Security/Penetration analysis phase of the testing to evaluate the security requirements mandated by Setion1107-A(16) and (17), 25 P.S. § 3031.7(16) & (17). The Functional Examiner validated that the polling place tabulation device, OVO had a visible public counter and the system prevented authorized and unauthorized users any access to vote data while polls are open. Tests were completed to determine that USB ports do not allow any data or information to be transferred to the OVO and no maintenance, poll worker or administrator accessible screens allow tampering with the tabulating element. The system did not allow polls to be opened without running a zero-proof report and the content of zero-proof report showed that all candidate positions, each question and the public counter were all set to zero. The functionality of the system to generate the close of polls report was verified and the report contents were analyzed to ensure that it contained the total number of ballots tabulated and total number of votes for each candidate and question on the ballot. Based on the above tests and the test cases executed while running the elections, the Functional Examiner concluded that OpenElect 2.0A complies with all requirements mandated by 25 P.S. § 3031.7(16) and (17).

5. Privacy Analysis

The Functional Examiner reviewed and inspected the privacy aspects of the OpenElect 2.0A system to determine compliance with Section 1107-A(1) of the Election Code, 25 P.S. § 3031.7(1). The Functional Examiner determined that the components of the system used at the polling place comply with 25 P.S. § 3031.7(1) by review of system documentation and physical inspection. Central scanners were physically examined by the Examiner for adequate visual secrecy. The Functional Examiner also verified that no voter data, including stored ballot images are tied back to any specific voter, in a manner that

would compromise voter secrecy.

6. Usability Analysis

The Functional Examiner determined that OpenElect 2.0A demonstrated compliance with the usability requirements of Section 1107-A(14) and (15) of the Election Code, 25 P.S. § 3031.7(14) & (15), by reviewing appropriate EAC certification reports and vendor documentation and from his experience of using all the functionalities of the system during the examination.

OpenElect 2.0A Accessibility Examination

The tests included examiner review, sessions with voters and poll workers. A summary of the test details and findings is discussed in this section.

Examiner Review

The Accessibility Examiner conducted a review of the voting system under examination prior to sessions with voters and poll workers. The Accessibility Examination team included both accessibility and usability expertise to ensure background and knowledge of the issues for accessible voting. The Accessibility Examiner had experience working with people with a wide variety of disabilities and their impact on daily life, knowledge of the range and use of assistive technologies that voters with disabilities might rely on for access, experience conducting usability evaluations with voters and strong knowledge of best practices and design principles for digital technology and voting systems. The expert review gave the examiners a chance to make sure they understand how the system and accessibility features works and to note anything they want to watch for during other testing.

Voter Sessions

The following voter population was represented in the test sessions.

- 1 blind from birth

- 1 cognitive disability
- 1 deaf/no usable hearing
- 1 dexterity/limited use of hands
- 1 dexterity no use of hands + using a power wheelchair
- 1 dexterity/no use of one hand + low vision (Caregiver)
- 1 mild cognitive disability + mobility/power wheelchair
- 1 mobility/artificial limb (Caregiver)

Age Ranges: 35 thru 70. All but one (a 70-year old) were in the 35-60-year-old age range.

Counties: Allegheny, Dauphin, Philadelphia, or York

The voters had a range of voting habits and included people who have voted with assistance and without. The mix of voters and the range of disabilities provided enough range to test most of the accessibility features.

Poll worker Sessions

Poll workers were invited to come in teams. Each team had an election judge and one team included a county election official. There were three poll worker sessions with a total of seven participants. These Poll workers:

- were from Dauphin county
- had between five and twenty-four years of experience and included one election judge
- had limited experience serving voters with disabilities

The Accessibility Examiner compiled the findings from the examiner review, voter sessions and poll worker sessions into positives, annoyances, problem solving, needs assistance and show stoppers.

The Accessibility Examiner noted in the summary section of the report that, the Unisyn systems are an advance in independence and privacy for Pennsylvania voters with

disabilities, and identified several positive aspects of the system including the following:

- Access features were easily learned by voters and poll workers and poll workers reported the features would help their voters.
- Sufficient default text size for almost all voters and the ability to make significant changes in font size available in the setup controls.
- Accessible voting booth was at a good height for voters sitting in a conventional chair or using mobility devices including powered and manual wheelchairs.
- Ballot summary/review screen and process are generally intuitive and helpful.
- Touchscreen gestures (scroll up and down, swipe left and right) on the FVT were not confusing and a welcomed surprise.
- OVO scanner has features that could make it accessible to voters.

The following are the top five accessibility issues identified. Attachment B of this document lists these issues in fuller detail and also describes all the observations from the Accessibility Examination.

- Silent/Hidden selection and deselection - The process for straight party voting and selecting and deselecting candidates caused enough confusion that a voter might end up casting a ballot marked in a way they did not intend. The system did not provide adequate explanation for what was happening when automatic changes were made, and some automatic changes were made off screen and not announced to the voter. As a point of interest, these changes were announced through the audio track, so that a blind user could be aware of them, but not in any way to sighted users.
- Confusing navigation and highlighting -Inconsistent navigation tools and insufficient highlighting caused some challenges and delays in voting. Voters

may inadvertently skip a contest because the button that scrolls through pages of candidates is also sometimes used to switch contests.

- Reviewing undervoted contests -. The FVT and OVI used dark red backgrounds, deficient text formatting, and insufficient communication to call attention to under-voted contests. This color was interpreted by voters as an indication of an error they must fix, was hard to read, and did not provide enough contrast with the black text. All of our test voters interpreted the color to indicate that full voting was compulsory.
- Compulsory behavior - The FVT and OVI systems require a voter to view all candidates, view all races, and view the entire ballot summary before they can move to the next step. This compulsory behavior is, at best, annoying and slow and, at worst, inappropriate.
- OVO scanner - The scanner had both positives and negatives for voters with disabilities, especially those with low or no vision, in the effort to independently insert their ballot.

The Accessibility Examiner noted that both test voters and poll workers stressed the need for a strong education program to introduce the new systems, including opportunities for hands on training or practice as a new system is rolled out. The examination team also stressed the need for well thought out deployment of any new voting machines (recommendations listed in Attachment B) and effective poll worker training.

OpenElect 2.0A Security Examination

As mentioned in the Examination Approach section of this document, the Security Examiner defined the Security Testing to be comprised of a series of test suites which are utilized for verifying that a voting system will correspond to applicable security requirements within the Pennsylvania Election Code. The examiner analyzed the test results and summarized any identified deficiencies into 4 major categories: documentation, source code, hardware, and functional. The Security Examiner then evaluated the physical and logical security, software hardening and control measures in place and identified items that

requires remediation before the system is certified for use in Pennsylvania. The examiner also provided recommendations on secure implementation and deployment.

OpenElect 2.0A2 Examination Results

OpenElect 2.0A2 Functional Examination

As identified in the test approach section of this document the follow-up examination of OpenElect 2.0A2 included Documentation Review, Source Code Review and System Level Testing.

1. Documentation Review

The Examiner reviewed the draft "Test Report for EAC 2005 VVSG Certification Testing Unisyn Voting Solutions OpenElect 2.0.A.2 voting system". The review confirmed that the Unisyn OpenElect 2.0.A.2 has been evaluated to federal standards by a VSTL.

2. Source Code Review

A Source Code Review for the code modifications for OpenElect 2.0A2 was performed, with a focus on determining whether any vulnerabilities could be found. It was concluded that the code review was completed with no malicious software, cryptographic software, process control or password management vulnerabilities being found. The Functional Examiner concluded that no deficiencies were found during source code review.

3. System Level Testing

The System Level Testing was divided into two tests, a primary election and general election. The Functional Examiner included test cases to specifically test the PA method anomalies identified during OpenElect 2.0A testing as part of the general election.

A closed primary election consisting of two parties (Republican, Democratic), three precincts, and 16 contests (14 partisan contests and 2 referendums - 8 "Vote for One", 1 "Vote for no more than Two", 3 "Vote for no more than Three", 1 "Vote for no more than Four" and 1 "Vote for no more than Fifteen") was run utilizing Electionware, ExpressVote

2.1, ExpressVote XL, DS200, DS450 and DS850. Referendum contests were added to test the generation of non-partisan ballots. The Functional Examiner validated compliance of the system to Sections 1101-A and 1107-A(2), (5)-(11) and (13), 25 P.S. §§ 3031.1, 3031.7(2), (5)-(11) & (13). No issues or anomalies were experienced during these tests, and the objective criteria established in the test protocols were met.

A general election consisting of four parties (Republican, Democratic, Green and Libertarian), three precincts (one of which was a split precinct), and 16 contests (13 partisan contests, 1 non-partisan and 2 retention referendum, 9 "Vote for One", 1 "Vote for no more than Two", 3 "Vote for no more than Three", and 1 "Vote for no more than Fifteen") was run utilizing Electionware, ExpressVote 2.1, ExpressVote XL, DS200, DS450 and DS850. The Functional Examiner examined the compliance of the system to Sections 1101-A and 1107-A(2)-(8), (10)-(11) and (13), 25 P.S. §§ 3031.1, 3031.7(2)-(8), (10)-(11) & (13).

The Functional Examiner created election definitions and executed appropriate test cases on all components of OpenElect 2.0A2 to ensure that the modified system satisfies all requirements of the Election Code. The Functional Examiner used English and Spanish ballots for the test. Reports were generated after closing polls and results were validated against expected results. Each specific hardware and software component was tested for compliance with the required sections of the Election Code. The Functional Examiner validated that the issues identified during the examination of Open Elect 2.0A are resolved.

The Functional Examiner confirmed with appropriate test cases and voting patterns that OpenElect 2.0A2 maintains compliance to Sections 1101-A and 1107-A(2), (4)-(11) and (16)-17), 25 P.S. §§ 3031.1, 3031.7(2), (4)-(11), (16) & (17), via tests cases in a similar manner as done during the OpenElect 2.0A2 examination.

The Functional Examiner also noted that the paper ballots will allow recounts as required by Sections 1117-A, 25 P.S. § 3031.17.

OpenElect 2.0A2 was certified by EAC on December 11, 2018, and hence complies with Section 1105-A(a) of the Election Code, 25 P.S.§ 3031.5(a), which requires that a

voting system must be examined and approved by a federally recognized independent testing authority (ITA), or VSTL as such authorities are now called. The final EAC certification scope is added to this report as Attachment A.

Additional Security/Penetration Analysis, Privacy and Usability results were not conducted during the OpenElect 2.0A2 examination since the test cases validated during these tests were not affected by the isolated modification done to the OVI-VC to adequately handle the PA method.

The Functional Examiner identified that the following within Article XI-A of the Pennsylvania Election Code, Sections 1101-A to 1122-A, 25 P.S. §§ 3031.1 – 3031.22, are not applicable to the current examination, as each deal with non-functional testing aspects of acquisition, use and maintenance aspects of a voting system:

- 25 P.S. § 3031.2;
- 25 P.S. § 3031.3;
- 25 P.S. § 3031.4;
- 25 P.S. § 3031.6;
- 25 P.S. § 3031.8;
- 25 P.S. § 3031.9;
- 25 P.S. § 3031.10;
- 25 P.S. § 3031.11;
- 25 P.S. § 3031.12;
- 25 P.S. § 3031.13;
- 25 P.S. § 3031.14;
- 25 P.S. § 3031.15;
- 25 P.S. § 3031.16;
- 25 P.S. § 3031.18;
- 25 P.S. § 3031.19;
- 25 P.S. § 3031.20;
- 25 P.S. § 3031.21; and
- 25 P.S. § 3031.22.

After all the testing activities, the examiners and Department concluded that the OpenElect 2.0A2 demonstrates compliance with all requirements as delineated in Article XI-A of the Pennsylvania Election Code, Sections 1101-A to 1122-A, 25 P.S. §§ 3031.1 –

3031.22. The conclusion was drawn based on the examination of OpenElect 2.0A2in conjunction with the OpenElect 2.0A examination.

D. Observations

During the examination, and in the review of documentation, the Examiner and/or Department staff noted the following observations:

1. The system presented for examination had undervote warnings turned on for straight party contest on OVI-VC and FVT. This may make the voter believe that there is a need to make a selection in that contest.

2. Observations/Findings from the Accessibility Examination listed on page 33 thru 36 of this document.

3. Unisyn OpenElect 2.0A2 does not support cumulative voting.

4. The vote summary/review screen of OpenElect 2.0A2 displays only the candidates name and not their party.

5. The instructions for navigation on the system presented for examination had the following issues:

A) Instructions for selecting language suggested to use up/down when really it was using the left/right

B) Instructions on OVI-VC and FVT informed the voter to "blacken the oval completely". This is not relevant since the ballot marking devices blacken the oval for the voter.

6. OVI-VC keyboard for write-ins is not QWERTY configured.

7. The configuration of the system complying with the Pennsylvania Election Code requirements including the PA method of straight party voting will require the use of appropriate selections of configurable parameters. If the system is configured for PA straight

party voting, the system deselects all other marks when the voter tries to overvote in a specific contest. For example, in a "Vote for 5" race, the sixth vote would deselect the first five marks and leave only the sixth vote marked. There were no alerts on the screen to warn the voter that they had made too many selections in that race, nor did the system warn the voter that their other candidates would be deselected. In long contests, the candidates being deselected might be on a different screen than the voter is currently seeing, so that these candidates would not be voted for as intended.

8. The system allows a configuration where the "Ignore Validation" checkbox on OVO will always display when a ballot is cast. This may cause the voter to bypass validating the ballots for overvotes before casting.

9. The ADA compliant ballot marking devices OVI-VC and FVT presented as part of the OpenElect 2.0A2 system, could be effectively used by all voters. This allows jurisdictions to expand the use of these devices for a larger universe of voters and not restrict their use to voters using assistive devices.

IV. Conditions for Certification

Given the results of the examination that occurred in August and October 2018 and the findings of the Examiners as set forth in his reports, the Secretary of the Commonwealth certifies the OpenElect 2.0A2 subject to the following conditions:

A. Pennsylvania counties using the OpenElect 2.0A2 must comply with the Directive Concerning the Use, Implementation and Operations of Electronic Voting Systems by the County Boards of Elections issued by the Secretary of the Commonwealth on June 9, 2011, and any future revisions or directives. In particular, Pennsylvania counties must adhere to item four (4) of the directive when setting up and positioning the OVI-VC and FVT in the polling place to assure compliance with the constitutional and statutory requirements that secrecy in voting be preserved *(see* Pa. Const Art. VII § 4; and Section 1107-A(l) of the Election Code, 25 P.S. § 3031.7(1)).

B. No components of the OpenElect 2.0A2 shall be connected to any modem or network interface, including the Internet, at any time, except when a standalone local area wired network configuration in which all connected devices are certified voting system components. Transmission of unofficial results can be accomplished by writing results to media, and moving the media to a different computer that may be connected to a network. Any wireless access points in the district components of OpenElect 2.0A2, including wireless LAN cards, network adapters, etc. must be uninstalled or disabled prior to delivery or upon delivery of the voting equipment to a county board of elections.

C. Because OpenElect 2.0A2 is a paper-based system, counties using the OpenElect 2.0A2 must comply at a minimum with Section 1117-A of the Election Code, 25 P.S. § 3031.17, that requires a "statistical recount of a random sample of ballots after each election using manual, mechanical or electronic devices of a type different than those used for the specific election." This audit must be conducted via a manual count of the voter marked paper ballots exclusively. Counties must include in the sample ballots marked by ADA compliant components. Counties are advised to consult the Directive Concerning the Use, Implementation and Operations of Electronic Voting Systems by the County Boards of Elections issued by the Secretary of the Commonwealth on June 9, 2011 and any future revisions or directives that may apply to audits of electronic voting systems.

D. All jurisdictions implementing the OpenElect 2.0A2 need to carry out a full Logic and Accuracy test on each device without fail and maintain evidence of Logic and Accuracy (L&A) testing in accordance with the statutory requirements for pre-election and post-election testing. The Department does not recommend automated L&A testing, and discourages the use of preprinted ballots provided by vendors. All components being used on election day, including any Electronic Poll Books being used must be part of the L&A testing. Counties must ensure that the L&A test cases include all applicable scenarios of the PA straight party method identified in Attachment C to the Directive for electronic voting systems published by BCEL on September 11,2017.

E. OpenElect 2.0A2 is a paper-based system and hence, implementation of the

system for precinct or central count scanning is scalable. Jurisdictions should calculate the number of voting booths necessary to accommodate the number of registered voters in a precinct to avoid long lines. Jurisdictions must include the OVI-VC or FVT as an ADA compliant device in configuring a precinct polling place. Jurisdictions must also take into consideration the printing, ballot box and Transport Media capacities on polling place components when deciding on the number of voting booths.

F. All jurisdictions implementing the OpenElect 2.0A2 must implement administrative safeguards and proper chain of custody to facilitate the safety and security of electronic systems pursuant to the Guidance on electronic Voting System Preparation and Security, September 2016.

G. Jurisdictions implementing the OpenElect 2.0A2 with the Central Count Tabulator as the primary system where votes are counted only at the central counting location using central scanners, must comply with Section 301(a) of Help America Vote Act of 2002. The mandate requires counties using central count paper based systems to develop voting system specific voter education programs that inform voters of the effect of over voting, and instruct voters on how to correct a ballot before it is cast, including instructions on obtaining a replacement ballot. Additionally, the mandate requires that the central count voting system must be designed to preserve voter confidentiality.

H. All jurisdictions implementing the OpenElect 2.0A2 must ensure that no default passwords are used on any devices and that all passwords are complex and secured. Counties must implement an audit process to review and ensure that no default passwords are used upon equipment install/reinstall and routinely change passwords to avoid any password compromise. The passwords and permissions management must at a minimum comply to the password requirements outlined in NIST 800-63. This publication can be accessed at https://pages.nist.gov/800-63-3/sp800-63-3.html

I. All jurisdictions implementing OpenElect 2.0A2 must configure the polling place components of the voting system to notify voter on overvotes. OVO precinct tabulation device must be configured to "Show Validation Checkbox When Alert Detected". This must be

done to ensure that the system does not show the "Ignore Validation" option that allows a voter or poll worker to ignore ballot validation on OVO before the voter inserts the ballot first time, thus allowing the voter to cast the ballot without validation. This is to ensure that the system implementation adheres to the requirement of notifying the voter of overvotes as mandated by 25 P.S. § 3031.7(16).

J. All jurisdictions implementing OpenElect 2.0A2 must work with Unisyn to ensure that only the certified system configuration is installed on purchase or anytime a system component is replaced or upgraded. Jurisdictions must as part of their user acceptance test verify the implementation to ensure that the components, software and firmware belong to the certified system. Jurisdictions must also perform a trusted build validation as part of the election preparation activities and post-election canvass activities utilizing the vendor supplied methods of validation and verification of voting system integrity. A sample format that can be used for the attestation is added Attachment C to this document.

K. Jurisdictions can make use of the adjudication functionality to adjudicate write-ins and evaluate questionable ballots, contests or selections to determine voter intent. Any decisions made during review of the ballot must be agreed upon by a team of at least two reviewers authorized by the election official. The election official can also consult the paper ballot to assist with determinations made during adjudication. In the event of a recount, the voter verified paper ballots must be used for the count.

L. Jurisdictions implementing OpenElect 2.0A2 must work with Unisyn to ensure that the implemented configuration is capable of operating for a period of at least two hours on backup power as required by the VVSG. If the system components don't include internal battery packs for reliable power, the Uninterruptible Power Supply (UPS) specified in the EAC certified configuration must be purchased and used at the polling places.

M. Jurisdictions using the services of Unisyn or a third-party vendor for election preparation activities must work with Unisyn or the vendor to ensure that systems used for ballot definition activities are considered part of the voting system and use certified voting system components. The systems used for ballot definition must be configured securely

following conditions outlined in this report and following any Directives and Guidance issued by the Secretary. Any data transfer between the vendor and county must be done using encrypted physical media or secure file transfer process. The file transfer and download must be tracked and audited to make sure that data has not been accessed by unauthorized personnel.

N. Jurisdictions must work with Unisyn to thoroughly test and review audio ballot instructions to ensure that the voters using an audio ballot can cast the ballot without requesting assistance. Jurisdictions must consider the following while reviewing the ballot:

- The audio ballot must fully inform the voter what has happened on the system and how to select/deselect their choices;
- The feedback messages must explain to voters what is happening, including the number and names of candidates being deselected; and
- The audio ballot must provide feedback on the reason for the changes in any selections and the interaction with straight-party choices.

O. Jurisdictions must make voters aware that voting straight party is optional via clear instructions on paper, on screen and audio ballots. This is to ensure that the voter doesn't assume that he/she must make a selection for the straight party contest. The ballot instructions must be approved by the Department and follow any directives and/or guidance issued by the Department. Jurisdictions must also ensure during the election definition process that the straight party contest is excluded from undervote warnings. This is to ensure that the voter doesn't assume that he/she has to make a selection for the straight party contest.

P. The electronic voting system must be physically secured while in transit, storage, or while in use at their respective locations. Unmonitored physical access to devices can lead to compromise, tampering, and/or planned attacks.

Q. Jurisdictions must implement processes and procedures involving

management, monitoring and verification of seals, locks/keys, before, during and after the election.

R. Jurisdictions must seal any unused ports on the voting system components using tamper evident seals even if the port is inside a locked compartment. Jurisdictions must work with Unisyn and use physical port blocking plugs to close unused ports whenever possible before placing the tamper evident seal. The Department also recommends using port blocking plugs for exposed ports for components of the voting system housed in county office that can be removed by authorized personnel when the port is needed.

S. Jurisdictions using standalone installation of the EMS server on portable devices must protect the laptops to prevent lost or stolen device.

T. Jurisdictions must implement processes to gather and safekeep system logs for each component of the voting system after each election. Consistent auditing of system logs and reports is vital to maintain system transparency and to ensure that any compromise or malfunction is observed and reported in a timely manner.

U. Jurisdictions implementing OpenElect 2.0A2 must ensure that the USB devices and any other removable or transportable media used for election activities is maintained with strict chain of custody. There must be a process to manage the removable/transportable media inventory to avoid misplaced and lost media. The devices must either be replaced or reformatted before use in each election. Appropriate steps must be taken to ensure that the format is a full reformat of the USB devices.

V. Jurisdictions implementing OpenElect 2.0A2 must work with Unisyn to ensure appropriate levels of training for election officials is planned on implementation. Counties must ensure that the trainings adhere to the "Minimum Training Requirements" specified in Attachment D of this document.

W. Jurisdictions implementing OpenElect 2.0A2 must include voter and poll worker training as part of the implementation plan. The training must include hands on practice for both voters and poll workers. Specific consideration must be given to voters

using assistive devices and also poll worker education to assist voters with disabilities. Refer to Attachment B, listing detailed recommendations for deployment noted by the Accessibility Examiner.

X. Jurisdictions implementing OpenElect 2.0A2 must consider the following during voting booth set up for serving voters requiring assistive devices

- Voters with disabilities may have assistive technology or personal notes that they need to place within reach. They may also need room to place the printed ballot on a flat surface to use personal technology such as magnifiers or text readers to verify it.

Refer to Attachment B, listing detailed recommendations for deployment noted by the Accessibility Examiner.

Y. Unisyn must submit the following system education materials to the Department of State and must consent to the publication and use of the video on any websites hosted by any Pennsylvania counties and the Pennsylvania Secretary of the Commonwealth or publicly available social media platform. The videos must be closed captioned for the visually impaired.

- A video (in an electronic format) for voters that demonstrates how to cast a vote and ballot using the Voting System.
- A video (in an electronic format) for precinct election officials that demonstrates how to setup, operate, and shutdown the Voting System components on an Election Day. The video must demonstrate how to set up and operate the voting system accessible devices for use by voters.
- A "quick reference guide" for precinct election officials to consult on Election Day. The guide must be specific to the purchasing county's setup and use of the Voting System including accessible options.
- A "quick reference guide" with images that demonstrates to voters how to cast

a vote. Must be provided in additional languages for any jurisdictions required to meet thresholds in the Voting Rights Act.

Z. Unisyn must adhere to the following reporting requirements and submit the following to the Secretary:

- Equipment Reporting. Reported field issues or anomalies that occur in Pennsylvania or elsewhere with any piece of equipment deployed in the Commonwealth of Pennsylvania within 3 days of the occurrence;

- Advisory Notices. System advisory notices issued for any piece of equipment deployed in the Commonwealth of Pennsylvania regardless of whether the incident behind the notice occurred in Pennsylvania;

- Ownership, Financing, Employees, Hosting Location. Any changes of information on the Supplier's employees and affiliates, locations, company size and ability to provide technical support simultaneously to several counties in the Commonwealth of Pennsylvania and other jurisdictions that use its Voting System. Additionally, Unisyn must provide information on foreign ownership/financing, data hosting, and production for any equipment or ancillary products, including any potential conflict of interest that may have developed for employees and affiliates;

- Security Measures and any updated security testing or risk/vulnerability assessments conducted by the Supplier or a third-party; and

- SOC 2 Reporting – Unisyn shall provide the Secretary with its annual American Institute of Certified Public Accountants (AICPA) Attestation Standard (AT) Sec. 101 Service Organization Control ("SOC") 2, Type 2 certification (AT Sec. 101 SOC 2, Type 2), or an equivalent certification approved by the Commonwealth. Equivalent certifications include, but are not limited to: International Organization of Standards (ISO) 2700x certification; certification under the Federal Information Security Management Act

(FISMA); and AT Sec. 101 SOC 3 (SysTrust/WebTrust) certification.

AA. Unisyn must adhere to the "Source Code and Escrow Items Obligations" specified in Attachment E of this document.

BB. Unisyn must work with jurisdictions to ensure that the system is configured to comply with all applicable requirements of PA Election Code delineated in Section Article XI-A of the Pennsylvania Election Code, sections 1101-A to 1122-A, 25 P.S. §§ 3031.1 – 3031.22.

CC. Jurisdictions implementing the OpenElect 2.0A2 and Unisyn must work together to implement system under this certification and must comply with the conditions found in this report, and any directives issued by the Secretary of the Commonwealth regarding the use of this System, in accordance with Section 1105-A(a)-(b) of the Election Code, 25 P.S. § 3031.5(a)-(b).Unisyn must ensure that future releases of the voting system with enhanced security and accessibility features are presented for approval to the Secretary.

DD. In addition, pursuant to the Directive on Electronic Voting Systems issued by the Secretary of the Commonwealth on August 8, 2006, the Directive Concerning the Use, Implementation and Operation of Electronic Voting Systems by the County Boards of Elections issued on June 9, 2011 and section 1105-A(d) of the Pennsylvania Election Code, 25 P.S. § 3031.5(d), this certification and approval is valid only for OpenElect 2.0A2. If the vendor or a County Board of Elections makes any changes to the OpenElect 2.0A2 Voting System subsequent to the date of its examination, it must immediately notify both the Pennsylvania Department of State and the relevant federal testing authority or laboratory, or their successors. Failure to do so may result in the decertification of the OpenElect 2.0A2 Voting System in the Commonwealth of Pennsylvania.

V. Recommendations

A. All jurisdictions implementing OpenElect 2.0A2 Voting System should ensure that the system is correctly set up pursuant to all the recommendations of the Directive Concerning the Use, Implementation and Operations of Electronic Voting Systems by the

County Boards of Elections issued by the Secretary of the Commonwealth on June 9, 2011 and Guidance on Electronic Voting System Preparation and Security, September 2016.

B. All jurisdictions implementing OpenElect 2.0A2 should take appropriate steps to ensure that voter education is part of the implementation plan.

C. All jurisdictions implementing the OpenElect 2.0A2 should ensure that precinct election officials and poll workers receive appropriate training and is comfortable using the system.

D. All jurisdictions considering purchase of the OpenElect 2.0A2 should review the System Limits as mentioned in the EAC certification scope added as Attachment A to this report.

E. The Secretary recommends that Unisyn and counties work with the Department on any changes to their voting equipment including, but not limited to, purchase and upgrades.

F. Secretary recommends in-house ballot definition activities at county location whenever possible. If an external vendor location is used the county should implement checks and balances to ensure that election data including ballot definition files and audit logs stored on devices outside of the county is protected from unauthorized access.

G. Secretary recommends configuring the election with only one contest being displayed on each screen presented to the voter for OVI-VC and FVT. This is to ensure that all screens presented to the voter is similar and voters don't need to adapt to the situation that there may be multiple contests displayed on a screen.

VI. Conclusion

As a result of the examination, and after consultation with the Department's staff and the Examiner, the Secretary of the Commonwealth concludes that the OpenElect 2.0A2 can be safely used by voters at elections as provided in the Pennsylvania Election Code and meet all of the requirements set forth in the Code, **provided the voting system is implemented with the conditions listed in Section IV of this report**. Accordingly, the Secretary certifies OpenElect 2.0A2 for use in this Commonwealth.

The FVT and OVI can accommodate 4 to 5 voters using assistive devices or 8-12 voters an hour when used as the primary voting system depending on the size of the ballot. OVO precinct scanner can serve 120 voters per hour depending on the length of the ballot. The FVT and OVI-VC prints 75-100 ballot cards with one roll of paper. After that new paper roll will need to be inserted to continue the printing process OVO, precinct tabulator allows a maximum of 5,000 ballots cast per session after which the units will need to have another TM inserted to continue the tabulation process. The Unisyn recommended batch size for OVCS is 100 ballots.

Attachment A – EAC Certification Scope

Unisyn 2.0.A.2
Certificate and Scope

United States Election Assistance Commission

Certificate of Conformance

OpenElect 2.0.A.2

The voting system identified on this certificate has been evaluated at an accredited voting system testing laboratory for conformance to the 2005 *Voluntary Voting System Guidelines (2005 VVSG)*. Components evaluated for this certification are detailed in the attached Scope of Certification document. This certificate applies only to the specific version and release of the product in its evaluated configuration. The evaluation has been verified by the EAC in accordance with the provisions of the EAC *Voting System Testing and Certification Program Manual* and the conclusions of the testing laboratory in the test report are consistent with the evidence adduced. This certificate is not an endorsement of the product by any agency of the U.S. Government and no warranty of the product is either expressed or implied.

Product Name: OpenElect

Model or Version: 2.0.A.2

Name of VSTL: SLI Compliance

EAC Certification Number: UNS10121966-2.0.A.2

Date Issued: December 11, 2018

Executive Director
U.S. Election Assistance Commission

Scope of Certification Attached

Scope of Certification

This document describes the scope of the validation and certification of the system defined above. Any use, configuration changes, revision changes, additions or subtractions from the described system are not included in this evaluation.

Significance of EAC Certification

An EAC certification is an official recognition that a voting system (in a specific configuration or configurations) has been tested to and has met an identified set of Federal voting system standards. An EAC certification is **not**:

- An endorsement of a Manufacturer, voting system, or any of the system's components.
- A Federal warranty of the voting system or any of its components.
- A determination that a voting system, when fielded, will be operated in a manner that meets all HAVA requirements.
- A substitute for State or local certification and testing.
- A determination that the system is ready for use in an election.
- A determination that any particular component of a certified system is itself certified for use outside the certified configuration.

Representation of EAC Certification

Manufacturers may not represent or imply that a voting system is certified unless it has received a Certificate of Conformance for that system. Statements regarding EAC certification in brochures, on Web sites, on displays, and in advertising/sales literature must be made solely in reference to specific systems. Any action by a Manufacturer to suggest EAC endorsement of its product or organization is strictly prohibited and may result in a Manufacturer's suspension or other action pursuant to Federal civil and criminal law.

System Overview:

The Unisyn OpenElect Voting System 2.0.A.2, herein referred to as OVS 2.0.A.2, is a modified system based on the earlier certified OVS releases. The OVS 2.0.A.2 Voting System is a paper-ballot based optical scan voting system consisting of five major components:

1. OpenElect Central Suite (OCS)
2. OpenElect Voting Optical (OVO)
3. OpenElect Voting Interface (OVI-VC)
4. OpenElect Voting Central Scan (OVCS)
5. Freedom Vote Tablet (FVT)

The Unisyn OVS 2.0.A.2 voting system Technical Data Package (TDP) was the source for much of the information in this document.

Pre-Voting - Election Center/Central Count

OCS

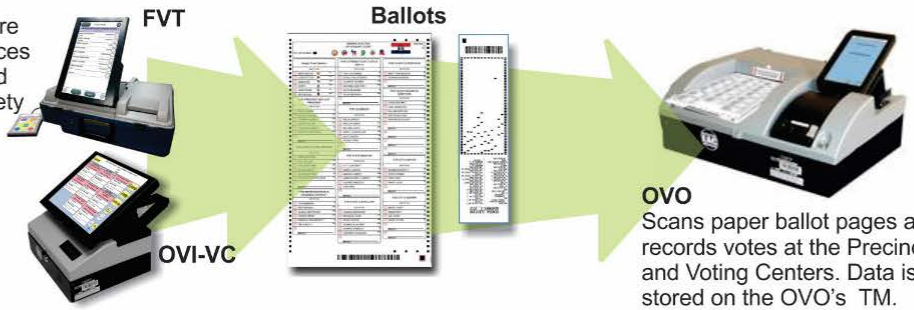
Ballot Layout Manager (BLM)
- Defines Election
- Produces Ballots

Election Manager (EM)
- Sets Election Options
- Creates Election Files

Election USB TM
Loads the Election directly on Voting Devices

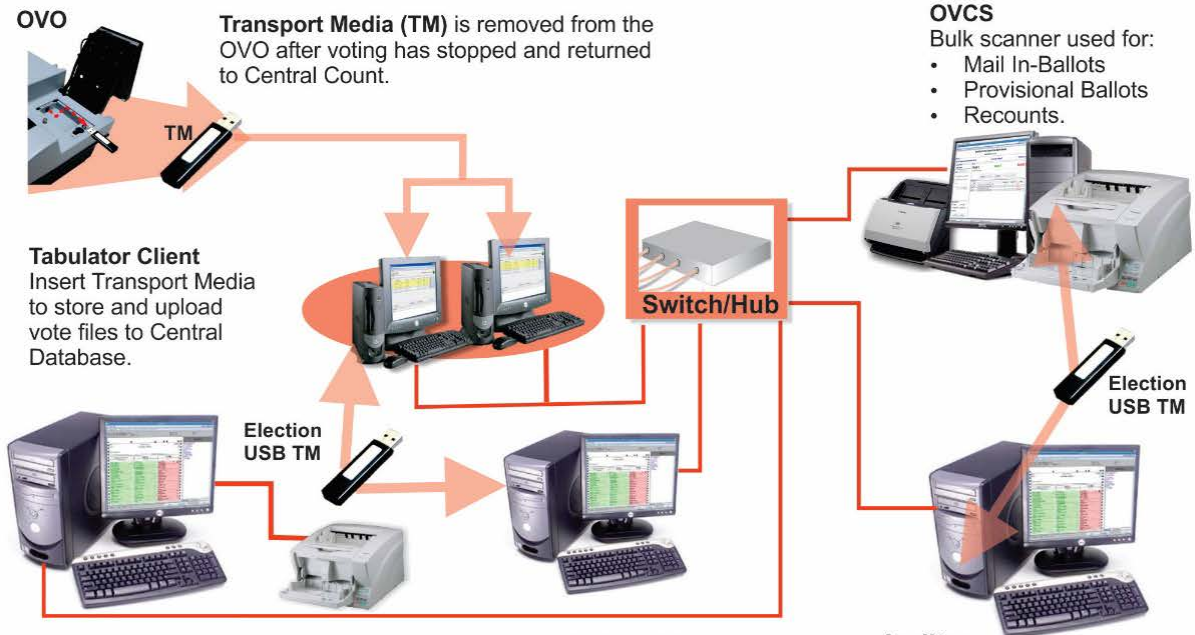
Voting - Poll Locations

OVI-VC and FVT are ballot marking devices that produce printed ballots using a variety of Input Devices:
- Touchscreen
- Keypad
- Sip and Puff



OVO
Scans paper ballot pages and records votes at the Precincts and Voting Centers. Data is stored on the OVO's TM.

Post-Voting - Election Center/Central Count



Transport Media (TM) is removed from the OVO after voting has stopped and returned to Central Count.

OVCS
Bulk scanner used for:
- Mail In-Ballots
- Provisional Ballots
- Recounts.

Tabulator Client
Insert Transport Media to store and upload vote files to Central Database.

Tabulator Reports
Report consolidated results.

Tabulator & Database
Track uploads and consolidated results.

Auditor
Evaluate and update questionable or erroneous marks on Ballots.

OpenElect Central Suite (OCS)
The OCS consists of the eight components running as either a front-end/client application or as a back-end/server application: Ballot Layout Manager (BLM), Election Manager (EM), Tabulator Client (TC), Tabulator, Auditor and Tabulator Reports (TR)).

OpenElect Voting Optical (OVO)
The OVO device is a precinct-level optical scan ballot counter (tabulator) designed to perform the following major functions: ballot scanning, tabulation, and second chance voting.

The OVO is a full-page, dual-sided optical scan ballot system which scans and validates voter ballots and provides a summary of all ballots cast. The election is loaded from the OVS Election Server over a secure local network or via a USB thumb drive. On Election Day, an OVO at each polling location scans and validates voters' ballots, and provides precinct tabulation and reporting. The OVO unit is also paired with the OVI for early voting to scan and tabulate early voting ballots. OVO units can also be used at election headquarters to read absentee, provisional, or recount ballots in smaller jurisdictions.

OpenElect Voting Interface (OVI)
The OVI supports both ADA and Early Voting requirements. The OVI enables voters during early voting to cast regional ballots and voters with special needs to prepare their ballots independently and privately on Election Day. The OVI unit features a 15-inch full-color touch-screen display. The OVI will present each contest on the correct ballot to the voter in visual and (optionally) audio formats. The voter with limited vision navigates through the ballot using the audio ballot and the ADA keypad or touchscreen input to make their selections. The voter validates his or her selections by listening to the audio summary, printing the ballot, and inserting it into the OVO.

The OVI facilitates special needs voters through a variety of methods including wheelchair access, sip & puff, zoom-in ballot function, and audio assistance for the visually impaired. The OVI provides for write-in candidates when authorized by the jurisdiction. Voters input candidates' names via the ADA keypad, touchscreen or sip & puff device. Each OVI can support multiple languages for both visual and audio ballots, allowing the voter to choose their preferred language.

OpenElect Voting Central Scanner (OVCS)
The OVCS resides at election headquarters designated to read absentee, provisional, or recount ballots in large jurisdictions, or read the entire election's ballots at a central count location in smaller jurisdictions. The OVCS also captures write-in data images and produces a write-in image report for manual processing upon request. The OVCS system consists of the following components: OVCS Workstation and Canon DR-X10C Scanner or a Canon M-160II Scanner.

Freedom Vote Tablet (FVT)

The FVT is a tablet ballot marking device that enables voters make their vote selections and to print their voted ballot. It can be used on Election Day or during an early voting period. Like the OVI-VC, the FVT is ADA compliant. It assists voters, with varying levels of ability, through the voting process, ballot review, and printing functions. The FVT presents each contest on the ballot style to the voter in visual and/or audio formats. It facilitates special needs voters through a variety of methods including wheelchair access, sip and puff, zoom-in ballot function and audio assistance for the visually impaired. The voter with limited vision can navigate through the ballot using an audio ballot and the ADA keypad or touchscreen to input their selections. Once the ballot is printed, it is taken to the OVO to be cast. Each FVT can support multiple languages for both visual and audio ballots, allowing the voter to choose their preferred language.

Certified System before Modification (if applicable):

OpenElect 2.0.A.1

Anomalies and/or Additions addressed in OpenElect 2.0.A.2:

Tabulator

- Updated algorithm for assigning write ins to write in candidates

Auditor

- Update improved recognition of ballot orientation on display

Mark Definition:

The Unisyn Open Elect system will consistently recognize a 1mm wide line across the full length of the target area. Marks must be made with a marking device with sufficiently low reflectance in the visible red band and is of sufficient density/color such that the scanner registers it as black. Most blue, black and green ballpoint pens and markers also meet necessary reflectance requirements and may be used.

Tested Marking Devices:

- BIC Grip Roller
- EF Felt Tip Pen

Language Capability:

System supports Chinese, Hindi, English, Japanese, Korean, Spanish, Thai, Vietnamese, and Navajo.

Components Included:

This section provides information describing the components and revision level of the primary components included in this Certification.

System Component	Software or Firmware Version	Hardware Version	Operating System or COTS	Comments
OVO	2.0.A	Rev A, E	Linux CentOS 6.3	
OVI-VC	2.0.A	Rev A, B	Linux CentOS 6.3	
OVCS	2.0.A	ImageFORMULA DR-X10C & M160	Linux CentOS 6.5, 6.8	
FVT	2.0.A.1	Rev A	Android 4.4.4	
Auditor	2.0.A.2			
Ballot Layout Manager	2.0.A			
Common (Library)	2.0.A			
Election Manager	2.0.A			
OCS Installer	2.0.A			
Regkey Builder	2.0.A			
Tabulator	2.0.A.2			
Tabulator Client	2.0.A			
Tabulator Reports	2.0.A			
OVCS Application	2.0.A.2			Compiled but unchanged from 2.0.A
OVI Firmware	2.0.A			
OVO Firmware	2.0.A			
Scripter	2.0.A			
Validator	2.0.A			
Logger (Library)	2.0.A			
UnisynSecure (Library)	2.0.A			
COTS Components				
CentOS Linux	6.3, 6.5, 6.8			
Java JRE + Unlimited Cryptographic Extension	1.6.0_02			
Apache Tomcat Application Server	6.0.13			
MySQL Database	5.0.45-7, 5.1.71-1			

System Component	Software or Firmware Version	Hardware Version	Operating System or COTS	Comments
JasperReports	2.0.5	JasperReports		
Android	4.4.4	Android		
OpenSSL	1.01f-fips			
OpenVPN	2.4.4			
Desktop for non-redundant solutions	Dell OptiPlex	Desktop for non-redundant solutions		
Desktop for redundant solutions	Dell Precision	Desktop for redundant solutions		
Canon Scanner	Canon DR-X10C or DR-M160II	Canon Scanner		
Transport Media		STEC- Industrial Grade		
Laptop		Dell Latitude	COTS	

System Limitations

This table depicts the limits the system has been tested and certified to meet.

Characteristic	Limiting Component	Limit	Comment
Maximum Elections	BLM	8	
Maximum Precincts	BLM	2000	
Maximum Splits per Precinct	BLM	9	
Maximum Districts	BLM	400	
Maximum Contests per District	BLM	20	
Maximum Parties	BLM	24	
Maximum Parties in primary	BLM	12	
Maximum Parties w/ Straight Ticket	BLM	12	
Maximum District types	BLM	25	
Maximum Languages	BLM	15	
Maximum Ballot styles per Election	BLM	400	
Maximum Contests per Election	BLM	150	
Maximum Measures per Election	BLM	30	
Maximum Instruction Blocks per Election	BLM	5	
Maximum Headers per Election	BLM	50	
Maximum Candidates per Contest	BLM	120	
Maximum Ballot Pages	BLM	3	
Maximum Votes for N of M	BLM	25	
Maximum Ranks in RCV	BLM	3	
Maximum Ballot sheets per OVO	BLM	5000	
Maximum Units simultaneously loading	BLM	20	

Characteristic	Limiting Component	Limit	Comment
Maximum Precincts initialized per OVO on Election Day	BLM	30	
Maximum Precincts initialized per OVI-VC/FVT on Election Day	BLM	2000	
Maximum Precincts initialized per OVO/ /OVI-VC/FVT in early voting	BLM	2000	
Maximum 11″ Ballot positions	BLM	38 x 6	Limit (Double Sided)
Maximum 14″ Ballot positions	BLM	50 x 6	Limit (Double Sided)
Maximum 17″ Ballot positions	BLM	62 x 6	Limit (Double Sided)
Maximum 19″ Ballot positions	BLM	70 x 6	Limit (Double Sided)

Functionality

2005 VVSG Supported Functionality Declaration

Feature/Characteristic	Yes/No	Comment
Voter Verified Paper Audit Trails		
VVPAT	No	Not applicable
Accessibility		
Forward Approach	No	
Parallel (Side) Approach	No	
Closed Primary		
Primary: Closed	Yes	
Open Primary		
Primary: Open Standard (provide definition of how supported)	Yes	A registered voter may vote in any *party primary* regardless of his own party affiliation
Primary: Open Blanket (provide definition of how supported)	No	
Partisan & Non-Partisan:		
Partisan & Non-Partisan: Vote for 1 of N race	Yes	
Partisan & Non-Partisan: Multi-member (“vote for N of M”) board races	Yes	
Partisan & Non-Partisan: “vote for 1” race with a single candidate and write-in voting	Yes	
Partisan & Non-Partisan “vote for 1” race with no declared candidates and write-in voting	Yes	
Write-In Voting:		
Write-in Voting: System default is a voting position identified for write-ins.	Yes	
Write-in Voting: Without selecting a write in position.	No	

Feature/Characteristic	Yes/No	Comment
Write-in: With No Declared Candidates	Yes	
Write-in: Identification of write-ins for resolution at central count	Yes	
Primary Presidential Delegation Nominations & Slates:		
Primary Presidential Delegation Nominations: Displayed delegate slates for each presidential party	Yes	
Slate & Group Voting: one selection votes the slate.	No	
Ballot Rotation:		
Rotation of Names within an Office; define all supported rotation methods for location on the ballot and vote tabulation/reporting	Yes	Top to Bottom by Precinct grouping
Straight Party Voting:		
Straight Party: A single selection for partisan races in a general election	Yes	
Straight Party: Vote for each candidate individually	Yes	
Straight Party: Modify straight party selections with crossover votes	Yes	
Straight Party: A race without a candidate for one party	Yes	
Straight Party: "N of M race (where "N">1)	Yes	
Straight Party: Excludes a partisan contest from the straight party selection	Yes	
Cross-Party Endorsement:		
Cross party endorsements, multiple parties endorse one candidate.	No	
Split Precincts:		
Split Precincts: Multiple ballot styles	Yes	
Split Precincts: P & M system support splits with correct contests and ballot identification of each split	Yes	
Split Precincts: DRE matches voter to all applicable races.	No	
Split Precincts: Reporting of voter counts (# of voters) to the precinct split level; Reporting of vote totals is to the precinct level	Yes	
Vote N of M:		
Vote for N of M: Counts each selected candidate, if the maximum is not exceeded.	Yes	
Vote for N of M: Invalidates all candidates in an overvote (paper)	Yes	
Recall Issues, with options:		
Recall Issues with Options: Simple Yes/No with separate race/election. (Vote Yes or No Question)	Yes	
Recall Issues with Options: Retain is the first option, Replacement candidate for the second or more options (Vote 1 of M)	Yes	
Recall Issues with Options: Two contests with access to a second contest conditional upon a specific vote in contest one. (Must vote Yes to vote in 2nd contest.)	No	

Feature/Characteristic	Yes/No	Comment
Recall Issues with Options: Two contests with access to a second contest conditional upon any vote in contest one. (Must vote Yes to vote in 2nd contest.)	No	
Cumulative Voting		
Cumulative Voting: Voters are permitted to cast, as many votes as there are seats to be filled for one or more candidates. Voters are not limited to giving only one vote to a candidate. Instead, they can put multiple votes on one or more candidate.	No	
Ranked Order Voting		
Ranked Order Voting: Voters can write in a ranked vote.	Yes	
Ranked Order Voting: A ballot stops being counting when all ranked choices have been eliminated	Yes	
Ranked Order Voting: A ballot with a skipped rank counts the vote for the next rank.	Yes	
Ranked Order Voting: Voters rank candidates in a contest in order of choice. A candidate receiving a majority of the first choice votes wins. If no candidate receives a majority of first choice votes, the last place candidate is deleted, each ballot cast for the deleted candidate counts for the second choice candidate listed on the ballot. The process of eliminating the last place candidate and recounting the ballots continues until one candidate receives a majority of the vote	Yes	
Ranked Order Voting: A ballot with two choices ranked the same, stops being counted at the point of two similarly ranked choices.	Yes	
Ranked Order Voting: The total number of votes for two or more candidates with the least votes is less than the votes of the candidate with the next highest number of votes, the candidates with the least votes are eliminated simultaneously and their votes transferred to the next-ranked continuing candidate.	Yes	
Provisional or Challenged Ballots		
Provisional/Challenged Ballots: A voted provisional ballots is identified but not included in the tabulation, but can be added in the central count.	Yes	
Provisional/Challenged Ballots: A voted provisional ballots is included in the tabulation, but is identified and can be subtracted in the central count	No	
Provisional/Challenged Ballots: Provisional ballots maintain the secrecy of the ballot.	Yes	
Overvotes (must support for specific type of voting system)		

Feature/Characteristic	Yes/No	Comment
Overvotes: P & M: Overvote invalidates the vote. Define how overvotes are counted.	Yes	Supported. Overvotes are tabulated for each office as an Over / Under Vote report in Vote Tabulation
Overvotes: DRE: Prevented from or requires correction of overvoting.	No	
Overvotes: If a system does not prevent overvotes, it must count them. Define how overvotes are counted.	No	
Overvotes: DRE systems that provide a method to data enter absentee votes must account for overvotes.	No	
Undervotes		
Undervotes: System counts undervotes cast for accounting purposes	Yes	Supported. Undervotes are tabulated for each office as an Over / Under Vote report in Vote Tabulation
Blank Ballots		
Totally Blank Ballots: Any blank ballot alert is tested.	Yes	
Totally Blank Ballots: If blank ballots are not immediately processed, there must be a provision to recognize and accept them	Yes	
Totally Blank Ballots: If operators can access a blank ballot, there must be a provision for resolution.	Yes	
Display/Printing Multi-Lingual Ballots		
Spanish	Yes	
Armenian	Yes	
Alaska Native (Other Group specified)	No	
Aleut	No	
Athabascan	No	
Eskimo	No	
Native (Other Group Specified)	No	
Cambodian	Yes	
Chinese (Cantonese and Mandarin)	Yes	
Filipino (Tagalog)	Yes	
Japanese	Yes	
Korean	Yes	
Russian	Yes	
Vietnamese	Yes	
Apache	No	
Cent/So American	No	
Cheyenne	No	

Feature/Characteristic	Yes/No	Comment
Chickasaw	No	
Choctaw	No	
Navajo	No	
Other Tribe-Specified	No	
Paiute	No	
Pueblo	No	
Seminole	No	
Shoshone	No	
Sioux	No	
Tohono O'Odham	No	
Tribe not specified	No	
Ute	No	
Yaqui	No	
Yuman	No	
Demonstrates the voting system capability to handle the designated language groups		
Default language (English)	Yes	
Secondary language using a Western European font	Yes	
Ideographic language (such as Chinese or Korean),	Yes	
Non-written languages requiring audio support	Yes	

Attachment B – Accessibility Examination Findings and Recommendations

A) Top problems and Recommendations as listed in the accessibility examiner's report

Top problems

B) All observations from Accessibility Examination

All observat

C) Recommendations for Deployment from Accessibility Examiner report

Recommendat

D) Top positives

Positives Ur

Top problems

The following discusses the problems that surfaced during the expert examinations and voter/poll worker observations with the Unisyn FVT, OVI, and OVO machines.

Testing identified four accessibility problems that could reduce the ability of people with disabilities to vote independently and privately on the FVT or OVI voting machines.

Each of these problems are limitations of the machines regardless of the voter. The issues could act as a "canary in the coal mine," they are likely to affect all voters, even if to lesser degree. Likewise, they will all detract from the ability of the voter to concentrate on the process of deliberate voting.

All of these problems increased the difficulty of using the system for voters with disabilities, especially when using some of the accessibility features. They all include:

- **Complex navigation.** Large text means that more contests require multiple pages—even for races with fewer candidates. This adds complexity to navigation through the ballot and makes it harder for voters to easily check their selections on a contest. This problem is made worse by the required behavior for over-riding straight party voting selections under the PA Method.
- **Inconsistent behavior.** Some buttons change their function without a clear explanation. The button in the lower right-hand corner of the screen changes from "More candidates" to "Next Contest." This caused confusion for almost all of the voters using the visual display.

1. Silent/Hidden selection and deselection

What happened?

There were three elements of silent and/or hidden selection and de-selection on both the FVT and OVI that voters found confusing. In most cases, voters were able to mark their ballot as instructed through trial and error, but in others, they did not notice changes made by the system and might vote in a way that does not match their intent.

- **Destructive candidate deselection when changing a straight party contest**
  After making a straight party choice, if voters wanted to vote for additional candidates from another party or "scratch" and change party for that contest, the system automatically deselects all of the other pre-marked candidates. In a contest with a short list of candidates, this behavior, dictated by the PA Method, caused confusion, but with persistence voters were able to select the candidates specified in the instructions. When the voters were asked to vote for just one of the three automatically selected candidates, they universally attempted to deselect an unwanted candidate by pressing on that candidate's name. Because of the interpretation of the PA Method, this resulted in deselecting the other preselected candidates and selecting the candidate whom the voter had just attempted to deselect. The voters were, in this case where the changes were evident, able to correct the error and vote as instructed.
- **When the contest was long, candidates were often de-selected on a different screen, with no notification from the system**. Voters using the audio format had an advantage in this situation, because the audio announced the deselected candidates. For sighted voters, this automatic change resulted in candidates who had been selected not being voted for as intended by the voter.
- **Confusing behavior when trying to deselect a candidate in a straight party slate**
  Voters also expected to be able to deselect a candidate in the same method they would deselect other choices (toggle on and off). However, when trying to deselect a candidate in a straight party slate, the result is that *only* that candidate was left selected. Voters reported that they expected the mark for that candidate to be removed, instead of what happened.
- **Destructive and confusing behavior for overvotes**
  When voters attempted to make more selections in a race than allowed (or overvoting), the system deselected all other marks, leaving the most recent candidate selected. For example, in a "Vote for 5" race, the sixth vote would deselect the first five marks and leave only the sixth vote marked. There were no alerts on the screen to warn the voter that they had made too many selections in that race, nor did the system warn the voter that their other candidates would be deselected. In longer ballot measures, the candidates

being deselected might be on a different screen than the voter is currently seeing, so that these candidates would not be voted for as intended.

There were two positive system behaviors to note:

- Once a voter made a change to a straight party contest it followed the regular selection rules, including allowing no selection to be made at all in the contest.
- The audio ballot announces all selections and deselections, both on entry to the contest (if the voter waits long enough to hear it) and as any change is made, including deselections made when changing a straight party selection. However, in the case where a blind voter wants to vote for only the first of three straight party candidates, the audio first announces that each of the three candidates has been deselected, then announces that the first candidate has been selected. Since the first thing the voter hears is the opposite of his/her intent, this causes concern.

Why is this a problem?

The system relies on voters perceiving the change in selections and understanding why those changes have happened. This is a problem because:

- All voters should have control of all selections.
- Off-screen actions force all voters into problem solving. This is worse for voters using the audio format or a dual switch because navigation is more difficult.
- Voters with cognitive disabilities may be unable to understand what has happened when the interface is unpredictable and/or inconsistent.
- If a voter has to ask for assistance in the middle of the ballot, their privacy and independence are compromised.
- Ultimately, voters may vote in a way they had not intended.

Recommendations

While the machines must comply with the "Pennsylvania Method" of straight party voting, there are ways to fully inform the voter of selection and deselection changes. For example:

- Create meaningful feedback messages and confirmation screens to tell voters what is happening—including the number and names of the candidates being deselected. No selection or deselection should ever take place without

explicit action or confirmation from the voter. Language should be included like: “If you do X, these voters will be deselected” or “Are you sure you want to….”

- Be consistent and toggle all selections on and off when touched or selected with the tactile keypad, including selections made when the straight party option is active. This is consistent with how selection and deselection works in general and is not destructive.

2. Confusing navigation and highlighting

What happened?

Voters found two navigation problems while moving through the FVT's different screens.

- **Confusing buttons.** The FVT's main navigation buttons change functions without warning and this confused voters. The buttons are located at the bottom of the touchscreen. They include a circle-shaped navigation button in the lower left and right corners and a larger oval button labeled done in the middle. Also, the navigation using the dual switch did not meet some expected behavior.
    - **Circle-shaped navigation buttons.** When the system loads a contest with more candidates than it can display on one screen, the circles function as scroll buttons to move up and down the candidate list. The buttons turn red when there is more to view. Once all candidates have been viewed, the circles change to contest navigation buttons, allowing voters to move backward or forward to another race. These changes are not well described to the voter.
    - **Oval-shaped action buttons.** For initial contest and candidate selection, the oval button sits at the bottom of the screen with a light grey color and the word "Done." Its function is not enabled until the voter reached the last contest. Then, it changes to a dark grey button, with the word "Print" on it. When a voter returns to a contest screen to make a change it changes back to a "Done" button, but this time it is dark grey and active. When pressed, it returns to the ballot summary screen. Several voters tried to advance to the next contest with the "Done" button, since it seemed to indicate that the voter was done with a specific contest. The button should be hidden completely.
    - **Inconsistent dual switch navigation.** In most navigation of the system, when moving between contests, the switch scanning starts at the top of the screen. By the time the voter reaches the review screen, this is a strong expectation. However, when returning to a ballot measure for review, the scanning begins on the scroll button. The automatic behavior of pressing the switch to move in to the contest selections instead moves the voter to the control icons at the top of the screen

- **Highlighting.** When using the tactile keypad or the dual switch input devices, voters reported difficulty seeing which button or section of the screen was highlighted. This problem was worse on the write-in onscreen keyboard:
  - The highlighted letter button was only slightly different than the surrounding buttons.
  - On the FVT, the on-screen keyboard used a QWERTY layout, but using the tactile keypad or dual switch input devices, the system cycled through the letters in alphabetical order. Voters using both the screen and keypad found this confusing since they could see the keyboard was in QWERTY order. For such voters, it is common to look at how many letters lie between the current highlight and the next target, then rapidly advance to near the target, slowing only for final selection. It is not possible to visually make this estimation when the user sees a different order than the highlight advances.

The OVI had two additional problems not seen on the FVT.

- **Confusing "Continue" prompt.** On the OVI, voters tried to touch the prompt that there are more candidates than fit on a screen, not realizing it is not an active button. This screen also included an arrow icon that seemed to indicate that it would advance, though it was not an active control.
- **More than one contest on the screen.** For most of the ballot, the OVI presented one contest on the screen at a time. In the middle of the test ballot, however, the last candidate from one contest and two additional short contests were displayed on a single screen. At least one participant did not understand that there were multiple contests displayed at once and could not tell which office the candidates were running for.

Why is this a problem?

These navigation issues are problems for voters with disabilities, specifically those who are blind, have low vision, or low literacy for four reasons.

- When navigation is inconsistent, it becomes a problem for everyone, but the problem is amplified for people with limited resources to solve them.

Example: Inactive buttons

When the "Done" button is visible at the bottom of the screen, but is not functional, it confuses users. Voters thought when they finished making

selections in each race the should touch or select the "Done" button. However, pressing this button did not do anything, confusing voters

Example: Buttons that change function
The button in the bottom right corner of the screen is used to both display more candidates in a contest *and* to move from one contest to another. In long contests, voters sometimes pressed the button too many times, and skipped a contest. Using large text makes this problem worse, as contests are more likely to span multiple screens.

- People who use assistive technologies on a regular basis have expectations about basic navigation. Whenever possible, those expectations should be supported.

Example: Write-in keyboard
Using the tactile keypad or dual switch input device to enter text is a slow process requiring voters to scan through the alphabet one letter at a time to spell a name. The highlighting on letter buttons was difficult to see, but more importantly, it was hard to predict how the other buttons on the screen – including space, backspace, and completing the entry, were placed in the selection sequence.

Recommendations

Many of these problems were relatively easy to find during the expert review and confirmed through observing voters. Two changes would make the interactions clearer:

- **Hide buttons that are not available rather than simply disabling them**. Voters could not tell that the buttons were disabled and were forced to problem solve to figure out what to do.
- **Increase the visual difference for highlighted buttons.** Better contrast between selected and unselected items, or between items have focus and those that do not would make it easier for voters to understand the current status.

3. Reviewing undervoted contests

What happened?

Once a voter has completed their ballot, they move on to a ballot summary screen to review all the choices they have made. Expert review and voter observation identified three problems with the ballot summary/review screen on the VFT and OVI.

- **Red background with black text for undervoted contests.** In any race where voters have not voted for the maximum number of candidates, the system displays the entire contest block in black text with a dark red background.
- **Undervotes are not communicated clearly or consistently.** If no candidate or option has been selected, the system reports "No selection made (for vote-for-1). If fewer than the maximum selections in a vote-for-N contest, the system reports a single "Undervote" under the list of candidates selected, no matter how many voting options remain. Test voters did not see this message clearly, in part because it is displayed in the same font and size as the candidate names.
- **Red means compulsory.** Voters immediately noticed the red shaded areas. Some voters said that it made them think they were required to correct the "error". The audio message says that "You have not voted for all of the *required* number of candidates, reinforcing this perception

Why is this a problem?

- Voters could not figure out why races were highlighted red and had trouble understanding why the system had drawn their attention to it.

Example: Undervotes in a vote-for-N contest

Two voters and one poll worker all voted the County Commissioner "Vote for 5" race in such a way that they chose four candidates. When they finished the rest of the ballot and made it to the ballot summary, they noticed this race was highlighted with the red background. Two individuals took a significant amount of time, along with assists from the moderator, to figure out why the race was highlighted. One voter was unable to solve this question.

Their confusion stemmed from the formatting. The system displayed the four candidate names chosen by the voter, but also included the word "undervote" directly beneath the final name, The word "undervote" looked like another name in the fifth spot. Voters who saw this message in other races were able to make sense of it more quickly because the number of items did not match the maximum "Vote for" number.

- Red backgrounds are hard to read, in general, but a serious problem for voters with red-green color blindness, who perceive the background as dark greyish brown which means the black text and the dark background are indistinguishable from one another.
- Using this shade of red with black text does not meet the Voluntary Voter System Guidelines (VVSG) 1.1 contrast requirements.
- "Undervote" is election jargon and may not make sense to all voters.
- The bright red color suggested to some voters that this is an error and that they were required to make a change or vote for additional candidates.
- Ultimately, voters may vote in a way they had not intended because they cannot read and understand the review function.

Recommendations

Using a color that does not meet the VVSG 1.1 requirements of a 10:1 contrast ratio for candidate information is a serious problem that must be fixed.

It is also possible to make the undervote messages on the review screen clearer and more consistent, for example:

- Using easily understand language that is meaningful to all voters. "No selection made" is clearer than "Undervote"
- Make the message informative by explaining the actions voters can take, both on the review and contest screens. For example, saying "Selected 2 of 5 candidates" or "You may select 3 more candidates" makes both the problem and action to fix it clear.
- Design the message to clear and visually noticeable without making the selection of additional candidates appear compulsory.

4. Compulsory behavior

What happened?

Voters reported and the expert team discovered that the FVT requires voters to:

- Scroll through all candidates before leaving a contest.
- Page through all contests before moving to the review screen.
- View all pages of the review screen before printing the ballot.

Why is this a problem?

This compulsory behavior is a problem for two reasons.

- Voters who voted straight party and/or do not wish to make any more selections in a race or on the ballot must page through all of it in order to print their ballot.
- As the expert team, we ask if this level of review is necessary or appropriate? There are a number of legitimate reasons why a voter may not need to or want to page through the entire ballot before printing. In years with many contests and many candidates, this requirement can slow down voters.

Recommendations

As long as legal requirements have been met and there are sufficient safe guards in place to alert voters of undervotes/no selections at the review screen, there is no need for system-imposed obstacles to completing the ballot.

5. Paper ballot handling

One of the goals of the voting machine upgrade is to allow all voters to vote independently and privately, including verifying their ballot. All paper ballots introduce barriers for voters with low-vision, no-vision, and with limited dexterity.

Most voters appreciated the printed ballot, which allowed a second chance to review the vote before casting. However, paper ballots intrinsically add accessibility issues. The implementation of the printing and paper-handling of these paper ballots had several limitations that limited the ability of voters to use them effectively.

The layout of the printed ballot

- The font used on the printed ballot is too small. It may be smaller than the VVSG requirement of 3.0mm. The tight spacing of the letters and lines of text, so that the print was compressed into a very tight block further reduce the legibility. In the heading of the ballot, there were no spaces between the words of the ballot title.
- The number preceding each candidate name confused some of the voters, especially when listening to the ballot being read by an OCR reader. Among the guesses for the meaning of the numbers was "it might be the number of votes that this candidate has gotten so far…" The actual purpose of the number was to indicate the field at the bottom of the ballot where the bar-coding was printed.

Reading the paper ballot

In both the OVI and FVT ballot marking systems, the ballot is printed on a roll of paper stored inside the machine. This means that voters do not have to handle a blank ballot before making choices.

It also means that there is no feature to allow a voter to "read back" the ballot by reinserting the printed, completed ballot into the voting system. The single blind voter participant raised this issue as a common feature that makes it possible for voters with visual disabilities to verify the paper ballot.

She tried using a personal OCR application on her phone to read the ballot. Because she was holding the ballot in her lap with limited stability and because of

some of the design elements of the printed ballot (run-together words and the numbers in front of the candidate names) she was only partially successful,

Interacting with the OVO ballot scanner

The scanner had both positives and negatives. In general, the ballot scanner does not produce any major accessible voting barriers.

Four features stood out and could be considered positives for voters with disabilities.

- Voters may insert the ballot in any orientation. This provides another layer of privacy and limits the potential failures. However, this was not clear to any of the voters or poll workers
- The scanner bed includes engraved chevrons/arrowheads that point toward the ballot insertion area. A blind or low vision voter feel the indentations allowing them to independently cast their printed ballot. While our volunteer voters were able to use the scanner independently, some had difficult aligning the ballot for insertion.
- Unisyn provided an optional ballot privacy sleeve that also serves to position the ballot correctly to be scanned. Using the sleeve, a poll worker may assist a voter without seeing their ballot. Our voters with limited dexterity had some difficulty aligning the ballot against the fold/guide, though they managed this task independently.
- There are subtle visual cues from a small screen and LED that notify voters that the scanner is ready, reading a ballot, and finished scanning. These were not available for voters with low or no vision.

The most serious problems are

- There are no audible instructions. The scanner did not include robust features to alert voters that their ballot has been cast successfully.
- Despite the guides voters struggled to align the narrow ballot to insert it straight enough that the system would grab it into the scanning path.
- It is also important to mention that voters with no/low use of their hands would rely on assistance for this part of voting. Some of the test participants commented on this issue.

While the voter does not spend as much time interacting with the ballot scanner as the touchscreen machine, there are barriers for voters with disabilities that can limit voter privacy and independence.

- **Blind or low vision voters** would have difficulty scanning their ballot without instruction or assistance. Voters must insert the smaller ballots in the center of the scanner bed, aligned perfectly with the path of travel. Blind or low vision voters can feel the engraved arrows to orient the ballot but would need to know that this feature exists.
- **Voters have limited cues that ballots are cast successfully**. There is a small screen and an LED that changes colors for different steps of the ballot scanning process, but these cues are do not work for voters who cannot see them.
- **Voter privacy and independence**. If a voter must ask a poll worker for ballot scanning assistance, this increases the likelihood that the poll worker will see how the individual voted. Privacy sleeves are available to jurisdictions as a purchase option, which also allow someone to assist a voter without seeing the ballot.

Recommendations

For the printed ballot layout

- The text on the printed ballot could be larger, with additional line spacing to make it easier to read.
- The numbers can be moved after the names or placed on the right margin so that they are separated from the candidate name.

For reading back the ballot

- At the polling place, having a small table with a mobile phone stand (a common and inexpensive tool) would provide blind voters with appropriate personal technology to read and verify their ballot with a personal OCR application.
- Alternatively a station with full magnification and OCR tools could be deployed in every polling place to complete the voting system and allow blind and low vision voters to verify their ballot.

For the scanner

- Use physical guides on the ballot scanner that minimize the chance for error. Because voters have to insert the ballot in the middle of a scanner that also accepts full size sheets of paper, it makes it more difficult to position the ballot correctly

- Make the cues that the ballot is cast more obvious. Large print words or simple images to indicate the scanning steps, and a stronger visual cue can show that the ballot scanned successfully. Adding an audio cue that the ballot scanned properly would help blind or low vision voters confirm their ballot was cast.
- Train poll worker to assist voters in ways that do not compromise the voter's privacy. This might include having standard instructions that can guide a voter in casting their own ballot, or narrating the poll worker's actions so that the voter understands what the poll worker is doing.

Other issues for deployment

A few other issues produced consistent enough observations to call them out in some detail.

Reading the activation code

The FVT voting machine has a useful feature that uses a printed, one-time-use QR code which to select the ballot style and accessibility features (font-size, contrast, audio rate, volume, and other settings) of the machine. (We did not test using personal preference in the QR code because this feature depends on the capabilities of a separate electronic poll book not included with the system being tested)

Several voters had difficulty scanning the QR code.

- There is no guide or audio instructions for blind or low-vision voters.
- It is easy to cover the code with a finger while trying to position the paper under the scanner.
- Deaf voters cannot hear the (quiet) beep indicating the scan was successful and the visual cue was not sufficient to draw attention.

Recommendation for deployment. A simple guide for where to place the activation code would increase the accessibility of this feature. If not included with the voting system, election officials might create one, for example by taping a tactile ridge in position as a guide.

Audio quality for instructions

For a voter who cannot see the screen, voice quality is just as important as print quality is to a sighted voter and can affect their understanding of the ballot contents, navigation options, or both.

Voice quality is critical to understanding candidate names, especially because there is no option to spell out a name when it is not clear.

The voice used for testing was created using MP3 files, pieced together to create the messages. The resulting voice was very difficult to understand, and the flow of the instructions was very poor. One blind voter immediately said, “Oh, that’s nasty!”

- The letters in the write-in alphabet are not pronounced clearly.

- The words “Done” and “Down” were indistinguishable making it hard to understand the action of these navigation buttons.
- The narration had pauses and changes in tone that made the semantics of the sentences hard to understand.

The system has a second style of audio that uses text-to-speech (TTS) technology. This voice (based on Google’s speech synthesis) was clear and smooth, and vastly superior in understandability.

Recommendation for deployment: Election officials should use the TTS option over the voice constructed from recorded snippets. We understand that this is an option available as part of the standard system.

Screen freezing

We had one other problem that may have simply been a technical issuer or a misunderstanding about how the system works: plugging in the speaker we were using so a group could hear the audio froze the system. This may have been because the poll workers first plugged the speaker into the switch jack. We managed to freeze the system twice with the powered speaker.

We later were told about a “screen reader mode” in which the system only activates buttons through the tactile keypad and the screen responds only to limited gestures. It is possible that the system was in this mode when we believed the screen had frozen.

All observations

Voter comments and reviewer observations about each machine are described below. For each are, the observations are organized by the machine function then by the severity.

Positives

Function	Observation	System	Severity
General	Voter liked that the voting machine height works for power wheelchair users. “It’s on my voter's level.”	OVI	Positive
	Voters liked having a review screen: "You get to go back twice to check your vote."	OVI	Positive
	"This is a lot easier" than the currently used voting machine.	OVI	Positive
Display and Navigation	When the system returns to the review screen, it lands on the item that was just reviewed rather than the top of the ballot.	FVT	Positive
	Despite some initial confusing, voters said it was easy to move around the ballot once you figure it out.	FVT	Positive
	The ability to scroll the screen with a swipe was useful, but not obvious.	FVT	Positive
	Some voters liked that the system forced viewing all candidates."	FVT	Positive
Setup for voters	Poll workers felt that setting the accessibility features for voters was easy.	FVT	Positive
	"Very self-explanatory"	FVT	Positive
	Changing your vote is simple.	FVT	Positive
	Changing settings seems straight forward	FVT	Positive

Function	Observation	System	Severity
	Accessibility settings can be included in the QR setup code, but polling place would have to use an electronic voter register to print them as needed.	FVT	Positive
Write-Ins	Voters were able to write in a candidate without difficulty.	Both	Positive
	Voter started the session by saying that they had a problem with write-ins because they're too short to reach the place where you do the write in on the Danaher (it's at the top of the machine).	OVI	Positive
	Voter liked the write-in process. "That was better for me"	OVI	Positive
	Voter thought the write-in was easy. Voter OK with the ABC keyboard	OVI	Positive
	Voter uses the keyboard OK, but asks why not QWERTY	OVI	Positive

Problems

Function	Observation	System	Severity
Setup for voters	"People will play with the settings, slowing down voting."	FVT	Annoyance
	Machine had difficulty picking up QR Code	FVT	Annoyance
	The machine needs to be in speaker mode before vote is initiated with QR code, or resets to beginning.	FVT	Annoyance
	Voters had difficulty getting QR code aligned for camera. A tray or tactile guide would help this.	FVT	Annoyance
	Cable management might be an issue on this device. When the voter was trying to take the ballot, she had to reach around the headphone and tactile keypad cables.	FVT	Annoyance
Privacy	The privacy barriers on the voting tables do not fully mask the screen. The displays are crisp enough to be easily read from the side.	FVT	Annoyance
	The ballot is longer than the privacy sleeve. This is intentional to allow feeding the ballot into the scanner, but to a blind voter has the appearance of a security issue.	FVT	Problem solving
Audio/Voice Quality	In reference to the voice quality: "Ooh, that's nasty!"	FVT	Annoyance
	Some of the letters in the write-in keyboard were pronounced in ways that was hard to understand.	FVT	Annoyance
	The voice quality was not good. Pronunciation was not always clear.	FVT	Problem Solving
	"You have deselected ... " caused confusion. The pronunciation of "deselected" was unclear at both ends of the word.	FVT	Problem Solving

Function	Observation	System	Severity
	In the spoken instructions, "DONE" sounds very much like "DOWN." The voter tried to use the Down arrow to move on, but this was not successful. She did this three times before trying to use the "Select"	FVT	Problem Solving
	The pause between saying the name of the candidate and "Selected" caused the voter to lose the connection between the name and cue. This was especially true on straight party selections where the voter had not directly selected the candidate.	FVT	Problem Solving
Audio Instructions	There should be an indication on the screen that the audio voice is active. Poll workers consistently tried to provide assistance to a blind (simulated) voter who was listening to the narration, making concentration more difficult.	FVT	Annoyance
	When a multi-vote item is presented, the cues say that "you have not selected the [three] 'required' for this election." This makes it seem that voting for the full allowed slate is mandatory.	FVT	Problem Solving
	On screen to select straight party, the audio instructions indicate to use the arrow keys to select a candidate. A voter pointed this out as inaccurate and possibly confusing. The same thing occurs on ballot questions.	FVT	Problem Solving
	There is no command to have words or candidate names spelled. Because of the voice quality this may make it impossible to differentiate names that are near homophones.	FVT	Needs assistance
	The feedback on multi-vote contests is that you have not voted for the "required" 5 candidates. This implies that you must vote for all five, not fewer. This was interpreted as "Must" by this voter, and could be an issue for voters with cognitive issues.	Both	Show Stopper

Function	Observation	System	Severity
Touch Screen	The screen does not respond well to attempts to operate it with a knuckle rather than a fingertip. This is a strategy commonly used by those with limited hand function. We were able to improve this by making the font larger, which increases the target size for the knuckle	FVT	Show Stopper
Keypad	Arrangement of the arrow keys was unexpected and difficult to remember. Voters expected the select button to be in the middle of the direction arrows, rather than to the right of the right arrow.	FVT	Annoyance
	The Braille notation PS on the tactile keypad is intended to mean "Pause." The Braille on the "Tempo" key is "RT" (presumably for Rate). Neither of these labels was clear to the blind voter, who also noted that only 10% of people who are blind can read Braille, so visual labels are important	FVT	Problem Solving
Screen gestures	Tried to scroll screen with finger, inadvertently selected two candidates.	OVI	Annoyance
Printed Ballot	One voter interpreted the numbers next to each candidate as showing how many votes that candidate had received.	Both	Needs assistance
	The font on the printed ballot is small and hard to read. It is, however, 3.0mm, meeting VVSG requirements	Both	Needs assistance
	Leading and kerning is also minimal, making reading even harder.	Both	Needs assistance
	The title “STRAIGHTPARTYSELECTION” is printed as a single word	Both	Needs assistance
Verification and handling the ballot	There is no way for a blind or low vision voter to verify the paper ballot using only the voting system. A voter asked "If I can OCR on my own phone, why can't there be a device as part of the system to do it?"	FVT	Show stopper

Function	Observation	System	Severity
	Using a personal OCR system, it is possible to read the ballot, though with some difficulty. Without a way to lay the paper flat, phone-based OCR readers do not work well. Because of the length of the ballot, it must be read as "short text" not as a document. This includes being able to move the phone across the ballot in a smooth and level motion.		Show stopper
Printing the ballot	When done with the voting process, it was not clear to the voter what to do next to cast the ballot. Eventually selected the "Print" button which was the correct thing to do.	FVT	Problem Solving
	For a blind voter, finding the printed ballot was not easy. She knew the general direction of the printer by its sound, but was confused by the wires to the tactile keypad and the headset which passed in front of the ballot.	FVT	Problem Solving
	Voters reported that the print on the ballot is too small.	Both	Needs Assistance
Navigation	Requirement to view all candidates before moving on prompted voter to say "That's stupid. I know who I wanted to vote for. This is especially annoying when the candidates to be viewed are all "write in" entries that are not candidates.	Both	Annoyance
	Voters felt it would be helpful if the machine provided how many more candidates were available, and how many selected on multi-vote competitions. (“You have selected 2 of the available 5 candidates”)	FVT	Problem Solving
	The pagination of the ballot included going to a screen which had just one write-in box, confusing voters.	OVI	Problem Solving
	Voters were always aware of when the contest is continued - the header doesn't change appearance as a cue.	OVI	Problem Solving

Function	Observation	System	Severity
	Voter had trouble finding names near the end of a contest because the paging model confused them.	OVI	Problem Solving
	Voters were confused when one screen included the end of one contest and two additional contests	OVI	Problem Solving
	In review process, the voter was confused initially about how to get back to the review screen after making a change. It was not clear that the right arrow key, which is used to advance to the next ballot measure now returns to the review screen.	FVT	Problem Solving
	On overvote, suggested "I think it guesses, blanking to a clean slate."	FVT	Problem Solving
	If the voter attempts to over-vote, the system silently deselects the previously selected candidates, and selects the over-vote. There is no verbal cue that it is doing this. The voter indicated that there should be a message that says "You have already voted for the full number of candidates. You must deselect one before making this selection."	Both	Show Stopper
Buttons – Display and naming	The highlight of the buttons is not strong enough of a cue to allow the user to identify the change. This makes switch navigation difficult.	FVT	Annoyance
	The “Next” button is modal, either advancing to a new contest or scrolling the screen, confusing voters.	Both	Annoyance
	Red button to see more candidates was confusing as it looked like an error alert. Voters reported it made them think something is wrong.	Both	Problem Solving
	The “Continue” message confused voters who thought it was an active button	OVI	Problem Solving

Function	Observation	System	Severity
	"Screens have both 'Done' and 'Next', confusing voters about which to use. Voters often tried both - "Do I hit '"Done" ' (grayed) or the arrow?"	FVT	Problem Solving
	The "?" Symbol isn't as clear as "HELP" would be on the button for the help screen.	FVT	Problem Solving
	In one case, the system displayed a button to scroll the screen even when most of the final write-in block was already displayed	OVI	Problem Solving
	Grayed candidates were confusing when a voter encountered a contest with a full slate selected through straight party, but with no selections visible on the first page.	FVT	Problem Solving
	On multi-candidate elections, "If I didn't notice the '3', I would assume that I could only vote for one."	OVI	Problem Solving
	On the last contest - says "Uh oh. No next button" Tries to use the right arrow then finds the DONE button at the top	OVI	Problem Solving
	Tries to use DONE to complete the selection on a contest.	OVI	Problem Solving
	In the review screen, tries settings and then help to make a change, finally finds Change	OVI	Problem Solving
	After going to a contest to correct a vote, uses the arrows to move forward, and doesn't realize that he's seeing the same contests he saw before.	OVI	Problem Solving
	The selection targets on the right side of the contest area were so close the buttons on right side that a voter accidentally pressed the button by mistake. Had to be told that he could press any space on the name or blank.	OVI	Needs assistance
Straight Party	The poll workers did not comment on the machine erasing straight party candidates when out-of-party was selected.	FVT	Annoyance
	"Straight party screen makes it feel like you have to select one."	OVI	Problem solving

Function	Observation	System	Severity
	There is no confirmation of what happens as a result of selecting a party – for example, a simple message that candidates (and perhaps how many) have been pre-selected	OVI	Problem solving
	Voter tried to deselect "straight party" selection as part of making a new selection. This has the effect of "selecting the same candidate. Need to select out of party candidate first, then deselect.	Both	Problem Solving
	Voter (who is an advocate) indicated that the PA Method behavior would be "very confusing for someone with an intellectual disability. They would leave."	FVT	Needs Assistance
	Instructions and warnings for undervote seemed to make full voting compulsory.	FVT	Show Stopper
Write-ins	Voters asked why write-ins were on their own screen on so many contests	Both	Problem Solving
	Write-in candidate that would cause an overvote cancels selections even if it is canceled rather than entered on the ballot.	FVT	Show Stopper
Entering Write-Ins	The write-in process with tactile keypad requires scanning through the alphabet, which is very inefficient. Voter commented that, when scanning through the alphabet, when moving from "S" to "I", for example, there is a mental process of deciding whether to move forward or backward will be shorter. The insertion of a half dozen non-letter buttons complicates this process.	FVT	Annoyance
	A two-switch user doing a write-in can only move forward through the alphabet. In many situations, such a user will look at the visual distance from the current location to the target, and quickly press the switch a few less than that to approach the target, then finish in a more measured way. When scanning a QWERTY keyboard alphabetically, this is not possible.	FVT	Annoyance

Function	Observation	System	Severity
	Was looking for normal keyboard layout rather than alphabetical.	OVI	Annoyance
	On-screen keyboard is alphabetical, slower than QWERTY (for experienced typists), and unexpected	OVI	Annoyance
	Navigating the write-in screen: It was not clear to the voter how to enter the write-in name	FVT	Problem Solving
	Voter looked for a stylus to write in the name, decides to use her finger. When she touches the area, the keyboard pops up and no problem from there.	OVI	Problem Solving
Review Screen: Overvotes	If the undervote were a color other than red, or if it had white text rather than black, it would be more readily seen, and less like an error.	FVT	Problem Solving
	Commented that the red highlight for undervote suggests that this is an error, and full voting is required.	Both	Problem Solving
	The red color could make the text of a contest with undervote unreadable. At least one advocate commented on this asking “what if I can’t see red?”	FVT	Show Stopper
	Makes the voter think that you have to fully vote each competition. Undervotes are cued as errors.	Both	Show Stopper

Recommendations for deployment

The participants – and examiners – saw the systems being tested for the first time during the examination. Many voters will also try using a new system for the first time in the voting booth, so our test was realistic for Pennsylvania voters.

The problems we encountered also suggest ideas for how election officials can support voters and poll workers as they introduce the new system and design their processes and procedures.

The recommendations here are based on observations of how both poll workers and voters used the system and direct suggestions they made.

Advanced training and hands-on practice

The need for an introduction and a chance to try out the system before Election Day was the strongest recommendation from every poll worker participant.

Poll workers felt strongly that any new system – particularly those with digital interfaces – would be intimidating to voters and fellow poll workers who were not used to computers. They recommended:

- Longer training sessions for poll workers to give them more time to familiarize themselves with a new system.
- Opportunities for hands-on experience, including scenarios for different situations they might have to handle.
- An aggressive voter education program to give voters a chance to try out the new system.
- Outreach to voters with disabilities, including those who regularly vote with assistance to let them know about the capabilities of a new system that might help them.
- Have voting machine demonstrations at disability events so that voters can get to know the machines, practice voting, and be prepared for what they may need on Election Day.
- Instructions or a practice system in the polling place, especially in districts with many older people.

Training for poll workers to support voters with disabilities

Poll workers may not be familiar with how to help people with disabilities. Most of the poll worker participants said that they had no blind or disabled voters in their polling places, although one pointed out that the features on these systems might enable their "assisted voters" to try voting independently.

In addition to a good training module on ways to help voters with disabilities, the training should focus on how to give instructions before and during a voting session to avoid compromising their privacy. For example:

- A "what if" troubleshooting guide could include specific questions to ask and prompts that poll workers can use to help a voter with problem solving without looking at the screen.
- Give poll workers guidance on where to stand while supporting voters. For example, standing behind the FVT and facing the voter would make it clear that they are not looking at the screen.
- Using the procedures for initiating a voting session, including the screens to select a language or acknowledge that assistive technology has been activated, to make sure that the voter has found the basic navigation keys on the keypad. On the VFT, there is a help button and a setting "cog" that the poll worker can review with the voter (reading the instructions to be sure they are consistent and accurate).

Poll worker procedures

Poll worker procedures can also help bridge any information gaps for voters, with instructions embedded in the voting process.

- Tell voters how to insert their ballot: identify that the ballot must be placed in the center of the scan bed, and tell them the ballot is inserted directly into the machine, not just slid forward.
- Remind voters to check both the review screen and their paper ballot before casting.
- Tell voters that if they make a mistake, they can get a new ballot.
- Instruct voters that their ballot can be inserted into the scanner in any orientation. Using the privacy sleeve is the most secure. However, inserting the ballot upside down, with the print toward the floor, is sufficient.

Support for voters using the tactile keypad or dual switch and audio ballot might include:

- A keypad they can try out before entering the voting booth.
- Instructions for how to use the keypad in Braille, audio, and large print. The FVT help screen could be the basis for these instructions, though the language should be simpler (3rd or 4th grade reading level).
- Test all assistive aids with local voters.

As a voter approaches the voting station, poll workers can help voters adjust the voting system or attach personal assistive technology:

- Help voters get positioned at the voting system so they can reach all controls. The FVT screen can be adjusted to change its angle for a closer approach, adapting to standing or sitting postures, and avoiding glare.
- Provide assistance plugging in personal headsets or switches with verbal instructions or by doing it for the voter.
- A voter with a disability is likely to know how to plug in their personal headset or switch, but they will not know the location of the jacks on the machine. On the FVT, the tactile keypad that is used by a blind voter includes a 3.5mm jack that seems appropriate to insert a headset. However, this is where the dual switch connects rather than the headphone, which plugs directly into the screen component.
- Make sure voters are oriented and know where all parts of the voting system are, including the privacy shields. The FVT includes options to blank the screen during the audio ballot.
- Remind voters how to cast their ballot and how to know when they are finished.

Polling place setup

Ensure all polling locations have at least one accessible voting booth with a chair that is easily removed if a voter uses a mobility device.

Voters with disabilities may have assistive technology or personal notes that they need to place within reach. They may also need room to place the printed ballot on a flat surface when using simple personal technology, such as magnifiers or text readers to verify it.

For all voting machines, the path to the touch screen and the scanner should be as easy as possible, ideally a straight line with no obstructions. The path should include ample room to turn a wheelchair if the machine is positioned with the screen facing the wall. The ADA standards suggest a minimum of 60x60 inches for this.

Use assistive technology to support blind and low-vision voters in verifying their ballot, for example, a magnification unit or a simple OCR scanner.

Voting booth setup for this system

Two issues were identified specifically for this system during the examination and usability testing related to how the system and attached devices are placed. The system fits very tightly in the accessible voting booth supplied by the vendor for the exam.

- **Cable management for assistive devices.** The tactile keypad is normally stored behind the screen, connected on a permanent cord. The headphone is plugged in on the right side of the screen. The printer and location where the paper ballot appears is also on the right.
  Recommendation: The cords need to be placed so that they don't interfere with the printed ballot or the voter's ability to find and take it.
- **Privacy.** The screen for both systems sits close to the front of the booth. It is easy to read the crisp, clear screen display over the shoulder of someone sitting down, or from the side, especially when large text is used.
  Recommendation: Position the booth so the voter's back is to a wall, so no one can walk behind them, and with sufficient space to the left and right that people cannot "peek" from the side. However, be sure that there is a good path for a pushed or motorized wheel chair to get to the voting booth easily (see above).

Top positives

The expert examination, voter experiences, and poll worker sessions recognized several positives of these voting systems.

Independent voting

Generally, voters were able to complete their ballot on the FVT and OVI independently, once the facilitator/poll worker provided them with the appropriate accessibility features. No one found the system so difficult or frustrating that they were unable to vote, although several identified features that they felt would frustrate less competent voters.

Access features easily learned and helpful

As voters explored the access features, they seemed to learn them easily. Some voters use similar assistive devices daily or when they vote. Others use an assistant or do not have the options on their current voting machines. One voter who had never used the sip and puff dual switch before picked it up quickly and was able to successfully complete a ballot. She wished it was an option in Philadelphia County.

After a very brief overview of each machine, the facilitator asked poll workers to demonstrate that they understood the function of each access feature by offering the appropriate option to the roll-play voter. Poll workers set up the machines successfully without a great deal of help.

Two of the three groups of poll workers reported that the access features would help voters that already visit their location on Election Day. They also agreed that these features would likely assist other voters with disabilities that do not currently come to the polls on Election Day.

Default text size

The default text size was large enough for most of the participants. Once the voters discovered the settings button and options, they could easily change the font size. Only one voter required a larger font size to read the screen more easily.

Accessible voting booth

The FVT and OVI sat on top of a vendor provided, collapsible voting booth that placed the machines at an accessible level and had wide legs to accommodate wheelchairs. The voting booth height was not adjustable, but worked for all participants. One power wheelchair voter even exclaimed the voting machine is “at my level.”

One negative about these booths relates to the position of the screen in the booth. The booths were clearly designed for voting systems that place the screen toward the back of the booth, so that the side shields provide some privacy. With the two machines in this test, the touch-screen is positioned at the front of the booth, and is very close to the leading edge of the side walls, so it provides only minimal privacy protection. Voters used to voting inside curtains were particularly sensitive to this issue.

Summary-screen/review process

The ballot summary and review process seemed to be intuitive to both voters and poll workers. Voters were able to make changes to the ballot and then return to the summary screen without more than minimal confusion about the navigation.

This worked best on the FVT. On the OVI, the button to return to the review screen was in the upper-right. Participants often used the button in the lower right to move to the next contest rather than returning directly to the review screen. In a least one case, the voter did not realize he was seeing the same contests he had already marked.

Voters using the FVT were pleased that they were returned to the same contest on the review screen, rather than having so start over from the top. This was particularly important to people using the audio format or dual-switch access.

Gestures

Those voters who discovered the screen gestures of the FVT (scroll up and down, swipe left to right) had no confusion about the function and adjusted quickly. They reported liking that it was an option.

Other issues for deployment

A few other issues produced consistent enough observations to call them out in some detail.

Reading the activation code

The FVT voting machine has a useful feature that uses a printed, one-time-use QR code which to select the ballot style and accessibility features (font-size, contrast, audio rate, volume, and other settings) of the machine. (We did not test using personal preference in the QR code because this feature depends on the capabilities of a separate electronic poll book not included with the system being tested)

Several voters had difficulty scanning the QR code.

- There is no guide or audio instructions for blind or low-vision voters.
- It is easy to cover the code with a finger while trying to position the paper under the scanner.
- Deaf voters cannot hear the (quiet) beep indicating the scan was successful and the visual cue was not sufficient to draw attention.

Recommendation for deployment. A simple guide for where to place the activation code would increase the accessibility of this feature. If not included with the voting system, election officials might create one, for example by taping a tactile ridge in position as a guide.

Audio quality for instructions

For a voter who cannot see the screen, voice quality is just as important as print quality is to a sighted voter and can affect their understanding of the ballot contents, navigation options, or both.

Voice quality is critical to understanding candidate names, especially because there is no option to spell out a name when it is not clear.

The voice used for testing was created using MP3 files, pieced together to create the messages. The resulting voice was very difficult to understand, and the flow of the instructions was very poor. One blind voter immediately said, “Oh, that’s nasty!”

- The letters in the write-in alphabet are not pronounced clearly.

- The words “Done” and “Down” were indistinguishable making it hard to understand the action of these navigation buttons.
- The narration had pauses and changes in tone that made the semantics of the sentences hard to understand.

The system has a second style of audio that uses text-to-speech (TTS) technology. This voice (based on Google’s speech synthesis) was clear and smooth, and vastly superior in understandability.

Recommendation for deployment: Election officials should use the TTS option over the voice constructed from recorded snippets. We understand that this is an option available as part of the standard system.

Screen freezing

We had one other problem that may have simply been a technical issuer or a misunderstanding about how the system works: plugging in the speaker we were using so a group could hear the audio froze the system. This may have been because the poll workers first plugged the speaker into the switch jack. We managed to freeze the system twice with the powered speaker.

We later were told about a “screen reader mode” in which the system only activates buttons through the tactile keypad and the screen responds only to limited gestures. It is possible that the system was in this mode when we believed the screen had frozen.

Attachment C – Implementation Attestation

Implementation attestation Unisyn.pdf

Voting System Implementation Attestation

System Name: _____

County: _____

Date Installed/Upgraded: _____

The below hardware/software was installed and verified on the system implemented:

System Component	Software or Firmware Version	Hardware Version	Model	Comments
Ballot Layout Manager (BLM)				(Please specify the implementation details, single device /(desktop/laptop), Client/server/ as applicable
Election Manager (EM)				
Tabulator Client (TC)				
Tabulator (Tab)				
Tabulator Reports (TR)				
Auditor				
Scriptor				
Validator				
Common (Library)				

OCS Installer				
Regkey Builder				
Logger (Library)				
UnisynSecure (Library)				
OpenElect Voting Optical (OVO), Rev A&E firmware				
OpenElect Voting Central Scan (OVCS) Application				
OpenElect Voting Interface (OVI-VC), Rev. A&B firmware				
FreedomVote Terminal				

Further to the key hardware/software components listed above, any of the COTS software and

ancillary components like switches, ballot boxes, charging carts sold on this contract are EAC certified components of the OpenElect 2.0.A2 electronic voting system. (Attach a list of items sold on this contract.)

Unisyn also has validated that the systems have been installed and hardened following the EAC certified system hardening instructions and no software other than the voting system software has been installed on any of the components.

Vendor Representative Signature: _____

Vendor Representative Name: _____ **Title:** _____

Telephone: _____ **Email:** _____

County Representative Signature: _____

County Representative Name: _____ **Title:** _____

Attachment D – Minimum Training Requirements

Unisyn must provide training and training materials as set forth below prior to the first use of the voting system in a primary or general election.

a) A demonstration of and training on the setup and operation of the Voting System to the purchasing county's board of elections' members and staff and the county's precinct election officials.

b) A training session on the Voting System's election management system and/or EPBs for the purchasing county's board of elections' members and no less than two and no more than six staff members chosen by the board of elections. The training sessions must afford the board members and its staff the opportunity to learn how to setup and program an election, and if applicable design and layout ballots independently of the Supplier's assistance and support.

c) A training session on the following subjects for the purchasing county's board of elections' members and no less than two and no more than six staff members chosen by the board of elections:

i. programming of all voting units and ancillary devices;

ii. tabulating results during the unofficial and official canvass;

iii. ensuring accuracy and integrity of results;

iv. preparing polling places and setting up the system for election day operation;

v. Training on accessibility options of the voting system

vi. Election day operating procedures;

vii. auditing procedures;

viii. conducting a recount;

ix. preserving records;

x. printing, designing, and formatting election reports;

xi. troubleshooting common issues;

xii. safeguarding and preventing tampering and unauthorized access to all parts of the Voting System; and

xiii. Post-election care, maintenance and storage.

d) Any and all system manuals necessary to allow a purchasing county to operate the Voting System independently of the Supplier's assistance and support.

e) Training materials for a purchasing county board of elections to use when training its precinct election officials on how to setup, operate, and close down the Voting System on Election Day.

Attachment E – Source Code Escrow Obligations for Unisyn

The Supplier must maintain an escrow agreement covering all source codes of the Voting System and/or EPB for a period of ten years from the date of delivery to and acceptance by a purchasing county board of elections. The Pennsylvania Secretary of the Commonwealth shall have the right to access the source codes in escrow subject to the conditions specified below in Section D(8)(d). The Supplier must pay all costs associated with 1) placing the codes in escrow and 2) verifying that the Supplier has placed the codes in escrow (note: the escrow agent conducts this verification and charges a separate fee for this service).

a. Source code. Simultaneously with delivery of the Voting System and/or EPB software to purchasing Members, the Supplier shall deliver a true, accurate and complete copy of all source codes relating to the software to an escrow agent.

b. Escrow. To the extent that Voting System and/or EPB software and/or any perpetually-licensed software include application software or other materials generally licensed by the Supplier, Supplier agrees to place in escrow with an escrow agent copies of the most current version of the source code for the applicable software that is included as a part of the Services, including all updates, improvements, and enhancements thereof from time to time developed by Supplier.

c. Escrow agreement. An escrow agreement must be executed by the parties, with terms acceptable to the Commonwealth prior to deposit of any source code into escrow.

d. Obtaining source code. Supplier agrees that upon the occurrence of any event or circumstance which demonstrates with reasonable certainty the inability or unwillingness of Supplier to fulfill its obligations to Commonwealth under this Contract, Commonwealth shall be able to obtain the source code of the then-current source codes related to Voting Systems software, EPB software, and/or any Supplier Property placed in escrow from the escrow agent.