Voting System Examination of Election Systems & Software EVS 6.0.4.0

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1 Background

An examination of the Election Systems & Software (ES&S) EVS 6.0.4.0 voting system was conducted at the Texas Secretary of State Elections Division offices on June 26-27, 2019. EVS 6.0.4.0 is a comprehensive voting system which can consist of a subset of the following components [1][2][3]:

- Electionware - an suite of end-to-end election management software applications
- ExpressVote Previewer – a ballot preview utility
- PaperBallot – a ballot layout editor
- Event Log Service – a service which monitors and logs users' interactions with the Election Management System (EMS)
- Removable Media Service - a utility that runs in the background of the Windows operating system used for media validation purposes.
- ExpressTouch - a direct recording electronic (DRE) voting device which supports electronic vote capture (for use in Texas only as a curbside voting device)
- ExpressVote XL (HW 1.0) - a ballot marking device (BMD) that provides a large-format touch screen interface and integrated thermal printer
- ExpressVote (HW 1.0 & 2.1) - a BMD that provides a touch screen interface and printer
- DS200 - a digital scanner and tabulator for use in the polling place
- DS450 - a central scanner and tabulator
- DS850 - a central scanner and tabulator with increased speed compared to the DS450
- ExpressLink - a standalone application that interfaces with voter registration (e.g. electronic pollbook) systems and the ExpressVote Activation Card Printer
- ExpressVote Activation Card Printer - a small thermal printer used to print the ballot activation code on the vote summary card
- Toolbox – a software suite run on non-EMS workstations

Configuration options are presented in detail in [3]. The Election Assistance Commission (EAC) certification includes tables that describe in detail the voting system software components, voting system platforms, hardware components, and system limits [2].

The Secretary of State obtained the software and firmware images used in the EAC certification directly from the EAC. ES&S personnel used those same files to perform installation under the supervision of the technical examiners. In [4]-[13], ES&S provides instructions for the identification and verification of the components included in EVS 6.0.4.0.

The examination also consisted of an accessibility test, vendor presentations and demos, a mock election, and a free-form session where examiners could ask follow-up questions and use the voting equipment in an unscripted manner.

I was not present for the accessibility portion of the exam. ADA compliance will be presented in the legal examiners' reports. A detailed description of the Texas Secretary of State examination including my observations, concerns, and recommendations is presented in the sections that follow.

2 Election Management System

The election management system (EMS) is a set of servers, workstations, and software which provides an end-to-end solution for jurisdictions to define, manage, configure, export, and tabulate elections. The following subsections will describe the hardware workstations and servers, media, software, and observations from the exam.

2.1 Hardware

EMS workstations can be standalone or act as a client connected to a server. Client and standalone workstations are all Dell products. The following models have been certified by the EAC for use with EVS 6.0.4.0:

- Latitude 5580 and E6430
- OptiPlex 5040, 5050, and 7020

The client/standalone workstations run either 64-bit Windows 7 Professional SP1 or 64-bit Windows 7 Enterprise SP1 as their operating system (OS). Windows Enterprise includes Microsoft's proprietary disk encryption utility, BitLocker. Windows Enterprise also enables the ability to configure workstation access with two-factor authentication. The option to use Windows Enterprise is a new feature of EVS 6.0.4.0 [17].

Use of BitLocker requires that the motherboard be configured with a Trusted Platform Module (TPM) chip. ES&S only supports BitLocker in a client-server configuration when all client workstations and the server have BitLocker enabled.

The server certified by the EAC for use with EVS 6.0.4.0 can be a Dell PowerEdge T420 or T630. The server hardware runs 64-bit Windows Server 2008 R2 SP1 as its OS. ES&S does not support a blended

OS configuration; i.e. all client workstations must be running the same OS (either Professional or Enterprise).

When election hardware is networked together is must be done in a closed network environment. In [14], ES&S defines a closed network environment as consisting of “a stand-alone server used for a specific purpose, such as an Election Management System (EMS) like Electionware, with restricted access to specific workstations and no connection to any other network. Only EMS components are allowed on this network, and any voting system component at a precinct voting site is forbidden from being connected.”

Best practices for physically securing EMS workstation and server hardware are found in [15].

2.2 Media

Full use of the EMS requires some special purpose media. Two-factor authentication is accomplished via an ES&S Security Key USB stick. The Security Key contains encryption keys coped from the TPM chip.

Election qualification codes and election definitions are stored on Delkin USB sticks that are custom-made for ES&S. While workstations and servers will accept any style of USB storage media, voting devices and scanners will only accept the ES&S Delkin USB stick as storage media.

2.3 Software

Electionware is the suite of ES&S software modules used for administering elections. ES&S divides Electionware into five groups: Define, Design, Deliver, Results, and Manage.

Modules under the Define group are used to create, edit, and manage elections. This is where jurisdictions enter or import election-specific information into the database. Graphics and translations are also managed under this software group.

The Design software group includes the modules used to design paper, touchscreen, and accessible ballots. The PaperBallot and ExpressVote Previewer listed on Form 100 fall into this category.

Modules under the Deliver group are used to configure voting/scanning devices, create election media (such as ES&S Delkin USB sticks), and ballot-on-demand printing.

The Results group manages election results data and produces reports.

The Manage software group allows for the administration and management of user roles and permissions.

Every Electionware software module can generate reports from event logs. This is accomplished via the Event Log Service which runs in the background.

The Removable Media Service is another background application which provides media validation and allows for the safe removal and addition of USB media within the EMS.

Electionware utilizes a PostgreSQL database which can be secured with its own password.

Updates to the Electionware in EVS 6.0.4.0 include [17]:

- Removal of support for adjudication of ExpressVote/ExpressVote XL vote summary cards
- Enhancement of the Reporting Admin Settings for the Precinct Summary Report to suppress results on a contest-by-contest basis rather than by ballots cast in the precinct
- Ability to recognize and load media burned from an election restored on any instance of Electionware when loading results
- Update of Users.xml to ensure the most up-to-date version (users_5.0.xml) is utilized
- Improvement of latest version of Removable Media Service to ensure media packaging remains consistent

2.4 Observations

Examiners observed the installation of Electionware on a standalone workstation. A client-server configuration was not demonstrated during the exam. Installation was straight-forward and typical of what most users who have installed Windows applications have encountered.

Examiners did not witness extensive use of the Define and Design SW groups since election data was imported and ballots were designed for the mock election prior to the exam. These SW groups were covered during the vendor briefing and Q&A. The creation of election media, tabulation, and reporting of results was observed. No issues were observed during the mock election as a result of the EMS. Electionware event logs produced after the mock election were detailed and human readable.

3 Voting Devices

ES&S is requesting certification of four different voting devices (one DRE and three BMDs). All devices employ touchscreens and can be configured with accessibility peripherals.

3.1 ExpressTouch

The ExpressTouch is a DRE intended for use in Texas solely as a curbside voting option. The touchscreen tablet can be removed from its base for this purpose. Voters use the touchscreen (or accessibility controls) to select their choices, and can cast their vote electronically after viewing the summary screen(s). The voting session is activated by a smart card.

Internal CFast cards are utilized in a RAID-1 configuration for data redundancy.

When configuring for an election, an election qualification code (EQC) flash drive is initially inserted to clear prior election information and to load security codes, encryption keys, and an election identifier for the current election.

The election definition is copied to internal CFast memory using an election flash drive. In the process of opening polls, the election flash drive is converted to collection media.

The EQC and election flash drives must be ES&S Delkin USB sticks. The ExpressTouch will not recognize any other USB storage media. Blank ES&S Delkin USB sticks can also be used to export logs and back up voting results from a closed ExpressTouch terminal.

Best practices for physically securing the ExpressTouch are found in [15].

In EVS 6.0.4.0 The ExpressTouch firmware version was incremented to remain synchronized with common code stack changes [17].

3.2 ExpressVote XL

The ExpressVote XL is a BMD with a large screen and integrated thermal printer which produces a human-readable vote summary card. The large format allows for multiple contests to be displayed on the screen at once. A marker mode with front eject (i.e. BMD-only) configuration is being introduced with EVS 6.0.4.0 [17] and that mode is what is under consideration for certification in Texas.

The ExpressVote XL session is activated in one of two ways; both begin by inserting a voter summary card in the correct orientation. The poll worker can activate the session by selecting the correct precinct for the voter, or if the polling place is using the ExpressVote Activation Card Printer (see Section 5), the poll worker provides the voter with a pre-printed vote summary card which the ExpressVote XL scans to determine which ballot the voter sees. Voters use the touchscreen (or accessibility controls) to select their choices. The voter then takes their printed vote summary card to the precinct scanner (DS200) for tabulation.

An internal CFast card is used to store the installed election definition and audit log information. When configuring The ExpressVote XL for an election, an EQC flash drive is initially inserted to clear prior election information and to load security codes, encryption keys, and an election identifier for the current election. The election definition is copied to internal CFast memory using an election flash drive.

The EQC and election flash drives must be ES&S Delkin USB sticks. The ExpressVote XL will not recognize any other USB storage media. Blank ES&S Delkin USB sticks can also be used to export logs and back up voting results from a a closed ExpressVote XL terminal.

The ExpressVote XL comes with its own stand which includes an integrated privacy curtain (necessary due to the large screen size). The privacy curtain makes it harder for poll workers to monitor the status of the polling booth so ES&S has included indicator lights that show whether there is an active voting session or if poll worker assistance is needed. As an anti-tamper measure, if any of the secured doors are opened, an audible alarm is played.

Best practices for physically securing the ExpressVote XL are found in [15].

Other updates to the ExpressVote XL in EVS 6.0.4.0 include [17]:

- Added ability for voters to use assisted mode to review selections using audio capabilities
- Addition of audible alert and onscreen warning message when media door is open while in voter mode
- Added Electionware configuration related to voter selection checkbox borders

3.3 ExpressVote HW 1.0

The ExpressVote is tablet sized BMD with integrated thermal printer for producing vote summary cards. The ExpressVote session is activated in the same manner as the ExpressVote XL (see Section 3.2). The voter uses the touchscreen (or accessibility controls) to make their selections. After reviewing their choices, the voter prints a vote summary card which they then take to the precinct scanner for scanning and tabulation.

An internal SSD is used to store the installed election definition and audit log information. When configuring The ExpressVote for an election, an EQC flash drive is initially inserted to clear prior election information and to load security codes, encryption keys, and an election identifier for the current election. The election definition is copied to internal memory using an election flash drive.

The EQC and election flash drives must be ES&S Delkin USB sticks. The ExpressVote will not recognize any other USB storage media. Blank ES&S Delkin USB sticks can also be used to export logs and back up voting results from a a closed ExpressVote terminal.

Best practices for physically securing the ExpressVote are found in [15].

Updates to the ExpressVote HW 1.0 in EVS 6.0.4.0 include [17]:

- Enhancement of audio playback of the write-in keyboard to support multi-language
- Removal of DS200 Status from ExpressVote HW1.0 System Readiness Report since “tethered mode” will not be supported
- Updated instructions for voter-facing review screens

3.4 ExpressVote HW 2.1

The ExpressVote HW 2.1 is an updated version of HW 1.0. There were hardware components on version 1.0 which went end-of-life necessitating the update to 2.1. From the voter’s perspective, ExpressVote HW 1.0 and 2.1 are functionally equivalent. There are some auxiliary ports of the backside of the voting device which are different. Otherwise, the ExpressVote HW 2.1 interfaces are the same as described in Section 3.3

Updates to the ExpressVote HW 2.1 in EVS 6.0.4.0 include [17]:

- Enhancement of audio playback of the write-in keyboard to support multi-language
- Updated instructions for voter-facing review screens

3.5 Observations

Examiners observed the installation of firmware, EQCs, and election definitions on all of the voting devices as well as the export of data and logs. There were no issues with this process.

The UI for the ExpressTouch and the ExpressVote HW 1.0 and 2.1 was the same. During the mock election, the voting instructions and touchscreen ballots were easy to understand and navigate.

The large format of the ExpressVote XL touchscreen allows for many contests to be displayed to the voter at once. The Electionware ballot designer provides a lot of flexibility in designing the ballot layout for this device. This layout potentially reduces the time the voter spends in the booth and creates a ballot that is easy to see all-at-once. The downside is that there is greater surface area for creating a confusing ballot. Jurisdictions should take great care to consider the user experience when designing their ballots for the XL. In general, there were no issues observed when using this device during the mock election.

The ExpressVote XL, HW 1.0, and HW 2.1 all used the same thermal printer/scanner hardware for the vote summary cards. The printer was fast and the feed mechanism was not prone to jamming. For the design used in the mock election, the vote summary card was easy to read. Though none of the voting devices support a multi-page vote summary card, when using small font and a 19” card, EVS 6.0.4.0 can support up to 104 selections.

Examiners were only provided with audit logs from the ExpressTouch. The log was in csv format and easy for a person with knowledge of the device to read.

For some of the devices there is a default, unchangeable administrator password that is used to support certain functions such as changing the date/time, loading firmware, and configuring scanners. While this is far from ideal from an operational security perspective, a bad actor with knowledge of the password would have to breach physical security measures in order to gain access. Because of this vulnerability, jurisdictions should carefully implement best practices for physical security recommended by ES&S.

The ExpressVote HW 1.0 has an unsecured Ethernet port on the rear side next to the power terminal. The best practices provided by [15] do not recommend securing this open port with seals or port locks. ES&S states that the port is completely inactive and that a user would not be able to use it interface with the single board computer (SBC). The port was put in place for future use, but functionality has not been activated and there is no plan to make the port active. Nevertheless, jurisdictions may want to secure the open port with a seal or port lock simply to remove the temptation for tampering.

4 Scanners

ES&S presented three scanners for certification. The DS200 which is designed as a precinct scanner, and the DS450 and DS850 which are both central scanners. All scanners are capable of scanning both paper ballots and vote summary cards.

4.1 DS200

This DS200 is a precinct scanner that voters would use to scan their paper ballots or vote summary cards depending on how the polling place is operated. It may also be used as a central scanner for small jurisdictions. The DS200 scans both sides of the ballot and the ballots can be entered at any orientation. The election definition can configure the scanner to reject ballots under certain conditions (undervote, overvote, incomplete marks, etc).

The DS200 has an internal thermal printer for producing reports, a flip-up touchscreen for voter and poll worker interaction, and guides to help feed ballots. The scanner locks securely to the top of a ballot box.

ES&S offers two ballot box options; a rigid plastic ballot box and a collapsible ballot box. Both configurations have an emergency slot with an auxiliary compartment for the storage of uncounted ballots in the event of a power outage or equipment malfunction.

When configuring the DS200 for an election, an election qualification code (EQC) flash drive is initially inserted to clear prior election information and to load security codes, encryption keys, and an election identifier for the current election. The election definition is stored on a removable ES&S Delkin USB storage device. The same device is also used to store scanned voting records and audit logs. An additional Delkin USB stick of equal or greater capacity than the primary storage can be used for data backups. The EQC, election flash drives, and backup flash drives must be ES&S Delkin USB sticks.

Best practices for physically securing the DS200 and ballots boxes are found in [15].

Updates to the DS200 in EVS 6.0.4.0 include [17]:

- Hardware modifications to replace end-of-life parts (motherboard, display, touch screen controller, drivers, and scanner board motor driver)
- Firmware update to accommodate above modifications
- Collapsible ballot box which “introduces better ballot box sidewalls and auxiliary slot for product improvement.”
- Added an Electionware configuration setting to show or hide the Write-Ins icon (used to access the onscreen write-in review feature) on the DS200 Polls Closed screen

4.2 DS450

The DS450 is a central scanner and tabulator designed for high-throughput. It can scan 85 11-inch ballots per minute. The DS450 can be configured to sort scanned ballots into discrete outstack bins based on user-defined preferences. The input tray and main output bin can hold up to 480 standard sized ballots each. The two outstack bins can hold up to 150 standard sized ballots each. Both sides of the ballot are scanned and ballots can be stacked at any orientation.

The DS450 system includes a metal rolling cart with integrated cable storage, a COTS laser printer for results printing, a COTS dot-matrix printer for printing audit logs, and an uninterruptible power supply (UPS).

The primary storage media is a single 1TB hard drive. There is no data redundancy, and ES&S recommends regular backups to prevent data loss. Firmware is loaded using a CF card. When configuring the DS450 for an election, an EQC flash drive is initially inserted to clear prior election information and to load security codes, encryption keys, and an election identifier for the current election. The election definition is copied to memory using an election flash drive.

The DS450 can be networked with an Electionware workstation or server to directly transfer tabulated results. Optionally, results can be transferred via ES&S Delkin USB media (see Section 2.1 regarding closed network environments).

Best practices for physically securing the DS450 are found in [15].

Updates to the DS450 in EVS 6.0.4.0 include [17]:

- Addition of new UPS and report printer to replace end-of-life parts
- Modification of firmware to account for end-of-life replacements

4.3 DS850

The DS850 is a central scanner and tabulator designed for high-speed processing. It can scan 365 11-inch ballots per minute. The DS850 can be configured to sort scanned ballots into discrete outstack bins based on user-defined preferences. The input tray and main output bin can hold up to 480 standard sized ballots each. The two outstack bins can hold up to 150 standard sized ballots each. Both sides of the ballot are scanned and ballots can be stacked at any orientation.

The DS850 system includes a metal rolling cart with integrated cable storage, a COTS laser printer for results printing, a COTS dot-matrix printer for printing audit logs, and a UPS.

The primary storage media is a single 1TB hard drive. There is no data redundancy, and ES&S recommends regular backups to prevent data loss. Firmware is loaded using a CF card. When configuring the DS850 for an election, an EQC flash drive is initially inserted to clear prior election information and to load security codes, encryption keys, and an election identifier for the current election. The election definition is copied to memory using an election flash drive.

The DS850 can be networked with an Electionware workstation or server to directly transfer tabulated results. Optionally, results can be transferred via ES&S Delkin USB media (see Section 2.1 regarding closed network environments).

Best practices for physically securing the DS850 are found in [15].

4.4 Observations

The DS200, DS450, and DS850 were all used to scan and tabulate ballots during the mock election. No issues were observed with scan quality, accuracy, or reliability. They did not appear prone to jams or other slow downs.

Examiners witnessed the use of the DS200 with the rigid plastic ballot box option. The collapsible configuration was not demonstrated. No issues were observed with the ballot box itself. The DS200 takes a few seconds to process an inserted ballot prior to releasing it into the ballot box or rejecting it. It is possible for a voter to mistakenly leave the area without realizing their ballot had been rejected. In fact, this happened at least once during the mock election with examiners who are used to encountering these issues. Ultimately poll worker training and voter education are both needed to prevent rejected ballots from being abandoned.

ES&S should consider adding data redundancy to future models of their central scanners. A high-speed scanner loses some of its advantages if users have to regularly pause ballot processing to export or backup results to prevent data loss.

5 ExpressLink and ExpressVote Activation Card Printer

The State of Texas does not certify these components for use in elections and they are not part of the EAC certification. Nevertheless, they were demonstrated during the examination and provide functionality that jurisdictions may want to use.

The ExpressLink is a standalone software application that interfaces with electronic pollbooks and the ExpressVote Activation Card Printer. The ExpressVote Activation Card Printer prints a bar code at the top of a voter summary card that encodes the ballot style that the voter should receive. The voter can then use the pre-printed vote summary card to activate their own session and receive the correct touchscreen ballot on ExpressVote and ExpressVote XL BMDs.

The ExpressVote Activation Card Printer also provides a mechanism for marking a ballot as provisional and preventing it from being prematurely scanned and accepted as a regular ballot by the precinct scanner.

5.1 Observations

The ExpressLink and ExpressVote ActivationCard printer were not used as part of the mock election, but examiners were given the opportunity to use them during the free-form session of the exam. No issues were observed. Pre-encoded vote summary cards activated the correct ballot on the ExpressVote BMDs. Ballots marked as provisional by way of the judge’s initial box were properly rejected by the precinct scanner.

I would recommend the use of these products in large polling places since they will likely reduce the cognitive load on already busy poll workers and reduce voter waiting times.

6 Toolbox

The State of Texas does not certify this type of application suite for use in elections nor was the Toolbox part of the EAC certification. However, it was demonstrated during the exam and can be used to implement ES&S best practices for handling removable media. Toolbox is installed on a Windows 7 system separate from the EMS closed network environment.

The Toolbox has four main components [16]:

- Test Deck – used to create test decks for use in logic and accuracy (L&A) testing
- Text to Speech – used to create audio playback files for use with ADA-compliant devices
- Media Restore – used to securely clear data from ES&S Delkin USB media and reformat to the FAT32 format
- Data Conversion - used to convert exported election data to formats compatible with Electionware

6.1 Observations

Test Deck and Text to Speech were demonstrated during the exam, and Media Restore was used to clear all USB media prior to use in the mock election. No issues with the use of Toolbox were observed.

The security best practices documentation does not address how the host running toolbox should be secured. Since ES&S USB media will necessarily be introduced into this outside system, I recommend precincts physically secure the host computer running Toolbox according to the same best practices outlined by ES&S for Electionware workstations. Furthermore, the hosts running Toolbox should be quarantined within their own closed network environment separate from the closed network environment used to run Electionware.

7 Upgrade Procedures

ES&S provided the following response when asked to define the process for customers wanting to upgrade from EVS 6.0.2.0 to EVS 6.0.4.0:

- ES&S Field Services will upgrade Hardware
- The EMS will be sent back to Omaha for upgrading and hardening
- One day of onsite assistance will be provided for training, connecting the EMS, and verification of report printer and other peripherals
- ES&S also will perform an L&A test to ensure results can be tabulated with new EMS version
- Note: There are no significant process changes between the versions as far as Hardware Processes or EMS reporting

8 Conclusions

While some concerns arose during the exam, none were disqualifying. In future updates, ES&S should do away with default, unchangeable passwords on devices. Adding data storage redundancy to the central scanners would be another welcome improvement.

The remaining issues observed during the exam can be mitigated with proper training of central election staff and poll workers. Jurisdictions should budget for appropriate levels of training and support when considering use of EVS 6.0.4.0. Similarly, jurisdictions should budget for the added consumables (e.g. ink, paper, USB thumb drives) that are required to operate EVS 6.0.4.0 in an EAC certified configuration.

Overall, EVS 6.0.4.0 is a comprehensive voting system that is secure, well-designed, and user-friendly. ES&S's responses to Voting System Certification Form 101 are truthful and adequate. The system tallied and reported results accurately during the mock election portion of the exam. ES&S personnel provided clear and knowledgeable answers to the examiners' questions.

I recommend certification of EVS 6.0.4.0.

9 References

[1] Application for Texas Certification of Voting System – Form 100, Election Systems & Software, ES&S EVS 6.0.4.0

[2] United States Election Assistance Commission Certificate of Conformance, ES&S EVS 6.0.4.0, EAC Certification Number: ESSEVS6040, May-3 2019
URL: https://www.eac.gov/voting-equipment/evs-6040/

[3] System Overview, ES&S Voting System 6.0.4.0, Document Revision 2.8

[4] Verification Procedure: Verification PC Setup, ES&S Voting System Security, Document Revision 1.2

[5] Verification Procedure: DS200 Precinct Scanner and Tabulator, ES&S Voting System Security, Document Revision 1.10

[6] Verification Procedure: DS450 High-Throughput Scanner and Tabulator, ES&S Voting System Security, Document Revision 1.6

[7] Verification Procedure: DS850 High-Speed Scanner and Tabulator, ES&S Voting System Security, Document Revision 1.3

[8] Verification Procedure: Election Management System, Operating System: Windows 7 Enterprise, ES&S Voting System Security, Document Revision 1.1

[9] Verification Procedure: Election Management System, Operating System: Windows 7 Professional, ES&S Voting System Security, Document Revision 1.0

[10] Verification Procedure: ExpressTouch, ES&S Voting System Security, Document Revision 1.3

[11] Verification Procedure: ExpressVote Hardware 1.0, ES&S Voting System Security, Document Revision 1.3

[12] Verification Procedure: ExpressVote Hardware 2.1, ES&S Voting System Security, Document Revision 1.3

[13] Verification Procedure: ExpressVote XL, ES&S Voting System Security, Document Revision 1.2

[14] Electionware Vol. I: Administrator Guide, Software Version 5.0, Manual Version 1.3, Mar-6 2019

[15] Best Practices for Physically Securing ES&S Equipment, ES&S Voting System 6.0.4.0, Document Revision 2.0

[16] Electionware Toolbox User Guide, Software Version 3.5, Manual Version 1.4, Mar-19 2019

[17] System Change Notes, ES&S Voting System 6.0.4.0, Document Revision 2.2