Voting System Examination of Hart InterCivic Verity Voting 2.3

Brian Mechler, Technical Examiner
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1 Background

An examination of the Hart InterCivic Verity Voting 2.3 was conducted at the Texas Secretary of State Elections Division offices on June 22-23, 2019. Verity Voting 2.3 is a comprehensive voting system which can consist of a subset of the following components [1]:

- Verity Data - Data management software application
- Verity Build - Election definition software application
- Verity Central - Central scanning software application
- Verity Count - Tabulation and reporting software application
- Verity User Management - User management software application
- Verity Election Management - Election management software application
- Verity Scan - Digital scanning voting device
- Verity Touch Writer with Access - Ballot marking device (BMD), with audio tactile interface (ATI) and external commercial off-the-shelf (COTS) ballot printer
- Verity Touch Writer Duo - BMD, with internal ballot summary printer and optional ATI
- Verity Touch - Direct Recording Electronic (DRE) device
- Verity Touch with Access – Accessible DRE device with ATI
- Verity Controller – Polling place management device for Verity Touch or Touch Writer Duo

Configuration options are presented in detail in [2].

The Secretary of State obtained the software and drive images used in the Election Assistance Commission (EAC) certification directly from the EAC. Hart personnel used those same files to perform installation under the supervision of the technical examiners. In [3], Hart provides instructions for the identification and verification of the certified products included in Verity Voting 2.3.

The EAC certification includes tables that describe in detail the voting system software components, voting system platforms, hardware components, and system limits [4].

The set of general feature changes between Verity Voting 2.0 and 2.3 are as follows [5]:

- Support for additional languages. The following languages are supported: English, Spanish, Chinese, Japanese, Korean, Khmer, Thai, Vietnamese, Tagalog, Ilocano, Hindi (11 total)
- Higher system limits
- Digitally signed reports and exports
- Generate English-only paper ballots before entering any translations or audio for election data
- WMA audio format in Data/Build.
- Support for dependent contests
- Support for 8.5” x 20” ballots
- Increased physical security with a serialized security seal that fully secures the Smart Panel CFast door compartment on devices and on all workstation chassis.

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 Verity Workstations

Verity workstations run the Data, Build, Central, Count, User Management, Election Management, and Desktop applications. The workstations are COTS PCs (either HP Z240 Workstation or HP Z230 Workstation) that run the 64-bit Windows Embedded Standard 7 OS with Service Pack 1 in kiosk mode.

Each workstation has two hard-drives in a RAID-1 configuration for fail-safe redundancy. The drives are delivered pre-imaged with the OS, necessary drivers, and Verity software components appropriate for the particular configuration. Hard drives are physically secured with key locks. The Verity System Administrator’s Guide [3] provides best practices for placement of other physical security measures, such as tamper evident seals, on Verity workstations.

Workstations can be stand-alone or setup in a client-server configuration. Workstations are only intended to operate within their own local network (i.e. air-gapped from public and other private networks). The network traffic is encrypted and digitally signed. All wireless capabilities are disabled.

Workstations will only boot up into the Verity desktop environment. Users are not able to access the Windows desktop without intervention from Hart’s technical support team. As an additional security measure, only whitelisted applications are permitted to run on Verity workstations.

Changes between Verity Voting 2.0 and 2.3 for all workstation software components include [5]:

- Audit log reports are digitally-signed
- All PC workstation chassis now feature a metal serialized security seal that fully secures the chassis from physical access to interior components

2.1 Observations

The configuration demonstrated at the exam had Data and Build on one workstation and Central and Count each on their own workstation. A client-server style configuration was not demonstrated. Installation was accomplished by extracting and duplicating the drive images sent by the EAC. Hashes of the drive images were checked against those provided by SLI Compliance, the voting system test laboratory used for the EAC certification.

There were no major concerns regarding the Verity workstation hardware or configuration. Installation was simple and the COTS components performed adequately during the observed tasks (discussed in more detail later in this report). The audit logs were very detailed and tied events to both the user and device; they can be exported in multiple formats including human readable csv-files. Restricting access to the Windows OS and enforcing a strict applications whitelist are good security measures. It is recommended that users follow the best practices provided by Hart to ensure physical and cyber security of the workstations.

3 Verity Data

According to [4], “Verity Data provides users capabilities to input jurisdiction- and election-specific data for paper and accessible electronic ballots, as well as audio for accessible electronic ballots. Verity Data also includes capabilities to allow proofing of data, layout, and audio that has been created. Verity Data also performs validation on the entered information to ensure that it is ready for use in Verity Build.”

New Features added to version 2.3 of Verity Data include [5]:

- Ability to define custom wording for “This page left blank” (40 char limit)
- Ability to define custom wording for “Read both sides” on paper ballots (40 char limit)
- Ability to define custom instructions for ballot marking device paper handling
- Validation to ensure that every precinct is assigned to at least one polling place
- Validation to ensure that every polling place has at least one precinct assigned to it
- Support for multiple paper sizes in a single election: allow up to two different ballot size templates: one 8.5" wide template for Central or in–person scanning on Verity Scan, and option to add 11"x17" for Central only
- Support for condensed format summary vote records

3.1 Observations

Use of Verity Data was not directly observed as the data, layout, and audio for the mock election were created prior to the start of the exam. However, no problems were observed during the export to Verity Build or during the mock election.

4 Verity Build

Verity Build is the application where election definitions, election media (known as vDrives), and two-factor authentication dongles (known as Verity Keys) are created. Users are also able to use Build to proof data, view reports, print ballots, and configure settings for digital scanners and Verity Touch Writer BMD devices.

vDrives are special purpose USB thumbdrives which deliver election definitions to voting devices and are considered the official storage media for cast vote records (CVRs). For faster production, jurisdictions can purchase vDrive duplicators from Hart. A unique identifier is written to the vDrive by the voting machine upon the first use of the vDrive in that machine for a particular election. vDrives must be purchased from Hart; use of other COTS USB drives for the above purposes has not received EAC certification.

Verity keys are USB dongles which provide two-factor authentication for special functions which require extra security. They are used in voting machines to predefine polling place information, and in Verity Central and Verity Count to import a signed election export from Verity Build. Keys can be configured with different passwords for administrative access, device access, and applications access.

New Features added to version 2.3 of Verity Build include [5]:

- Elimination of pre-determined vDrive IDs in Verity Build, to allow batch writing of vDrives with vDrive duplicator
- Device settings:
    - Allow/reject “Blank page” on Scan (as distinct from “Blank ballot”)
    - Allow/reject “Marginal mark” on Scan
    - Voter idle timeout feature – enable/disable
    - Default voting session volume setting for accessible devices
    - Enable/disable human-readable unique ID for Touch Writer Duo
- Print queue import includes field to define the starting ballot number for each row in the import (can be used to support integration with third-party systems, including remote accessible vote-by-mail)
- The device password for Verity Key is now required to be 8-10 alphanumeric characters (0-9, Uppercase A-Z).

4.1 Observations

Technical examiners observed the import of a signed election export from Verity Build as well as the creation of vDrives and Verity Keys. The Build UI was fairly intuitive; a “chevron” at the top of each screen guides users step-by-step through various processes where the workflow is always top-to-bottom, then left-to-right. This same UI design was consistent across all Verity workstation applications examined. No issues were observed with the use of the Build application, vDrives, or Verity Keys.

5 Verity Central

Verity Central is a digital ballot scanning system intended for high volume processing of ballots. Typically, jurisdictions would use Central to process vote-by-mail ballots. Verity Central utilizes COTS scanning hardware in addition to Hart’s ballot processing software.

New Features added to version 2.3 of Verity Central include [5]:

- Allow administrators to set conditions that will be automatically accepted in all batches during the scanning process (e.g. accept all undervotes during scanning, in lieu of manual review and adjudication)
- Allow administrators to control/limit the conditions included in “Accept” feature, for all users (i.e. ability to place limitations on adjudicators’ ability to accept undervotes, overvotes, etc.)
- Support adjudicators’ ability to accept (i.e. auto–resolve) specific types of conditions by batch, on a selective basis (e.g., for selected batches, accept all undervotes)
- Allow users to adjudicate damaged contests, where an option box is unrecognizable, through the Ballot Review window (instead of requiring users to locate the rejected ballot during scanning)
- Filter for specific marked contest choices
- Import/export certified write–in names (in same format as Verity Count import/export)
- Precinct Summary Report
- Batch Summary Report
- Batch Summary by Precinct Report
- Scanned Batch report includes Batch Notes
- Features to support risk-limiting audits (RLAs):
    - In Central, when a CVR is written to vDrive, the globally unique identifier (GUID) used in the CVR filename is associated with the ballot in Central
    - In Central’s Scanned Ballot Information Export, there is now a column for the GUID
    - In Central’s Ballot Review window, for any image, the GUID for the ballot sheet is displayed on the left-hand side of the screen, along with Batch and Sequence information.

- In Central, exported ballot images default to a naming convention that includes page number and GUID
- In Central, provide the capability to search for a specific ballot (i.e. its images) by GUID.
- Verity Count tracks CVRs by GUID

5.1 Observations

Examiners observed the use of Verity Central to scan a batch of ballots during the mock election. No issues were found with respect to accuracy, speed, paper jams, or interpretation of ballot marks. The quality of the scanned images was good and suitable for the adjudication of ballots.

6 Verity Count

According to [4], “Verity Count is an application that tabulates election results and generates reports. Verity Count can also be used to collect and store all election logs from every Verity component/device used in the election, allowing for complete election audit log reviews.”

New Features added to version 2.3 of Verity Count include [5]:

- Support "freeform write–in resolution," so that users can enter additional write–in candidate names without leaving the write–in assignment interface.
- Option to sign data exports and reports (and include the public key information as part of each export). Note: if this option is disabled, Count will still sign audit log reports.
- Option to include turnout boxes for each contest on Cumulative Report
- District Results report
- Support import of additional district definitions
- In CVR reports, the GUID for each CVR is now in the header of the report.

6.1 Observations

During the mock election, examiners observed the tabulation of votes from vDrives and the generation of reports. No major issues were observed. The Count application properly refused to double count batches that had already been tabulated.

7 Verity User Management

Verity User Management is a tool administrators can use to manage user accounts and assign specific roles to users along with the associated permissions. User Management provides a default set of user roles, but administrators are able to create customized roles for users.

New Features added to version 2.3 of Verity User Management include [5]:

- Role–Based Access Control (RBAC) allows user to create & delete custom roles & assign or remove permissions
- Configurable password options

7.1 Observations

While User Management was not used extensively for the mock election, examiners were given the opportunity to interact with the UI. The set of roles and permissions that could be granted (or restricted) were comprehensive and highly configurable. It is strongly recommended that users only be granted the narrow set of roles and permissions necessary to perform their given tasks.

8 Verity Election Management

Per [4], “Verity Election Management allows users to manage and import elections. Elections are available through the “Elections” chevron in Verity Build. Users can also delete, archive, restore, and rename the elections.”

8.1 Observations

Though the Election Management application is used throughout the election process, it’s full set of features was not demonstrated during the examination and mock election. Nevertheless, no issues with this application were observed.

9 Verity Devices

Verity Devices include a custom touch screen tablet docked in a base. The tablet, base, and associated cables can be folded into a rugged carrying case. Depending on the configuration, Verity Devices are paired with a COTS printer or daisy-chained together to a Verity Controller. Bases and tablets are not interchangeable; e.g. a base configured for Verity Touch must always use a tablet configured for Verity Touch. Unique configuration details will be discussed in the sections that follow.

The device software is loaded with a CFast card. Logs and, if applicable, cast vote records (CVRs) are stored redundantly on the CFast cards and vDrives. All files are digitally signed. A software daemon ensures that the records are kept in sync. Should the two storage devices get out of sync, the vDrive is considered the official record. CFast cards are never cleared; Hart estimates that CFast memory will fill up after 22 months of elections given typical election schedules.

Devices store hashes of the software internally when installed, and those hashes are checked each time a device is booted. Similar to Verity Workstations, Verity Devices enforce a strict applications whitelist; devices also enforce a strict hardware whitelist on USB ports. USB ports for vDrives and other peripherals are secured underneath locked covers. The CFast slot is also sealed underneath a locked cover which includes a hasp for additional tamper prevention during long term storage. USB cables used to connect the daisy-chain are keyed and custom wired to prevent malicious access to those ports

which are not physically secured. Data that flows across the daily-chain network is encrypted and digitally signed as an additional security measure.

For all devices, new features in Verity Voting 2.3 include [5]:

- Support users' ability to set time zone on devices
- Screens indicate if devices do not have AC power ("Batteries last a limited time only")
- "Battery low" warning is displayed when AC power is disconnected, and battery is critically low
- Metal serialized security seal that fully secures the Smart Panel CFast door compartment.

For devices with electronic ballot interfaces, new features in 2.3 include [5]:

- Warning is displayed if a voter attempts to deselect a write–in name previously entered
- Warning is displayed if voter makes substitution in <n of m> contest
    - If all selections are made, and if the voter selects an additional choice, the screen indicates which selection is being removed, and which selection is being added
- Voting session idle timeout

For devices with an Audio Tactile Interface (ATI), version 2.3 introduces an optional orientation wizard, with guidance for audio and screen settings, and additional voter instructions [5].

9.1 Verity Touch and Touch with Access

Verity Touch and Touch with Access are interoperable Direct Recording Electronic (DRE) devices. They are networked to other Verity Touch devices and the Verity Controller via a daisy-chain network. It is recommended that the Touch with Access is the last device in the daisy-chain. The Touch with Access includes an ATI which provides accessibility features. Voters are issued an access code from the Controller and use the touch screen to mark and review their ballot which is then cast electronically.

9.2 Verity Touch Writer with Access

Verity Touch Writer with Access is a standalone Ballot Marking Device (BMD) that is paired with a COTS printer. Unlike the Verity Touch and Touch Writer Duo, the Touch Writer with Access is not daisy-chained with other devices or a Verity Controller. Instead, a poll worker must be in-the-loop to initiate each voting session for voters. The Touch Writer with Access is designed to act an accessibility device in a jurisdiction where voters would normally fill out paper ballots by hand at the polling place.

Voters use the touchscreen to mark and review their choices and subsequently print a marked ballot. The marked ballot is then taken to the Verity Scan device where it is scanned and deposited into a ballot box (see Section 9.5 for more detail on Verity Scan). The Touch Writer with Access includes a Verity ATI which provides accessibility features.

The Verity Touch Writer is not able print numbered ballots in a manner that meets the ballot numbering requirements of the State of Texas. Verity recommends the following actions for jurisdictions to maintain compliance:

- Jurisdictions should pre-print ballot numbering on ballot stock (numbered consecutively beginning with the number 1
  - Alternatively, jurisdictions could use a hand numbering machine to consecutively number ballots
- Polling Places should be assigned a specific printed range of ballots
- Election workers should shuffle ballots prior to loading paper ballots into the printer paper tray

New Touch Writer with Access features introduced in version 2.3 include [5]:

- Removal of Access Codes
- Support for AutoBallot (previously available on Verity Print and Verity Controller)
- Software alternative for Poll Worker button on rear of device (touch “Ready to Use,” on the idle screen)
- Support for customized instructions at the end of voting session, to include references to casting the ballot at Verity Scan, or anything else specific to the polling place that the jurisdiction may wish to mention; customized instruction is entered in user–defined preferences in Data (Preferred Wording)

9.3 Verity Touch Writer Duo

The Verity Touch Writer Duo is a device which has not been previously certified for use in the State of Texas. Touch Writer Duo is a BMD with an integrated thermal printer that creates a printed vote record (PVR) that is both human- and machine-readable. It is configured for use in a daisy-chained network with Verity Controller similar to the Verity Touch. Voters are issued an access code from the Controller and use the touch screen to mark and review their choices. They are then instructed to insert as many pages of thermal paper as needed into the on-board printer. The printed output contains a summary of their choices. Voters then take the PVR to the Verity Scan where it is scanned and deposited into a ballot box. The Touch Writer Duo includes an ATI which provides accessibility features.

The Verity Touch Writer Duo is not able print numbered ballots in a manner that meets the ballot numbering requirements of the State of Texas. Verity recommends the following actions for jurisdictions to maintain compliance:

- Jurisdictions should pre-print ballot numbering on the *back side* of the ballot stock (numbered consecutively beginning with the number 1
  - Alternatively, jurisdictions could use a hand numbering machine to consecutively number ballots
- Polling Places should be assigned a specific printed range of ballot stock
- Election workers should shuffle ballots before handing blank paper ballot pages to voters prior to the start of their voting session with the Touch Writer Duo

9.4 Verity Controller

Verity Controller is used by the poll worker to create access codes for Verity Touch, Touch with Access, and Touch Writer Duo systems. Access codes are used by the voter to initiate their voting session and either cast a vote or mark a ballot. The Verity Controller can manage up to 12 devices connected via a daisy-chain network. The Verity Controller touchscreen gives the poll worker the current status of each device in the daisy-chain. The Verity Controller base also has an integrated on-board thermal printer for

printing reports. A daisy-chain network can only be used to control one type of Verity device, i.e. only Verity Touch or Verity Touch Writer Duo.

New Verity Controller features introduced in version 2.3 include [5]:

- Dashboard icons indicate power and battery status of all connected units
- Dashboard icons indicate when a ballot has been cast on a connected Touch DRE unit

9.5 Verity Scan

Per [4], "Verity Scan is a scanning device (tabulator) that is used in conjunction with an external ballot box. The unit is designed to scan marked paper ballots, interpret and record voter marks on the paper ballot and deposit the ballots into the secure ballot box. Verity Scan is capable of tabulating votes, or producing a ballot count report which includes quantities of ballots scanned." Verity Scan can only be configured to accept marked ballots (by hand or from the Touch Writer) or PVRs from the Touch Writer Duo, but not both.

New Verity Scan features introduced in version 2.3 include [5]:

- Second-chance voting check for marginal marks
- Second-chance voting check for blank page (in addition to existing check for blank sheet)
- Support for scanning summary vote records
- If a user elects to save ballot images (based on Build settings), when saving the image on the vDrive, in PNG format, the image filename includes the GUID that links to the GUID in the CVR (this is to provide support for RLAs)

9.6 Observations

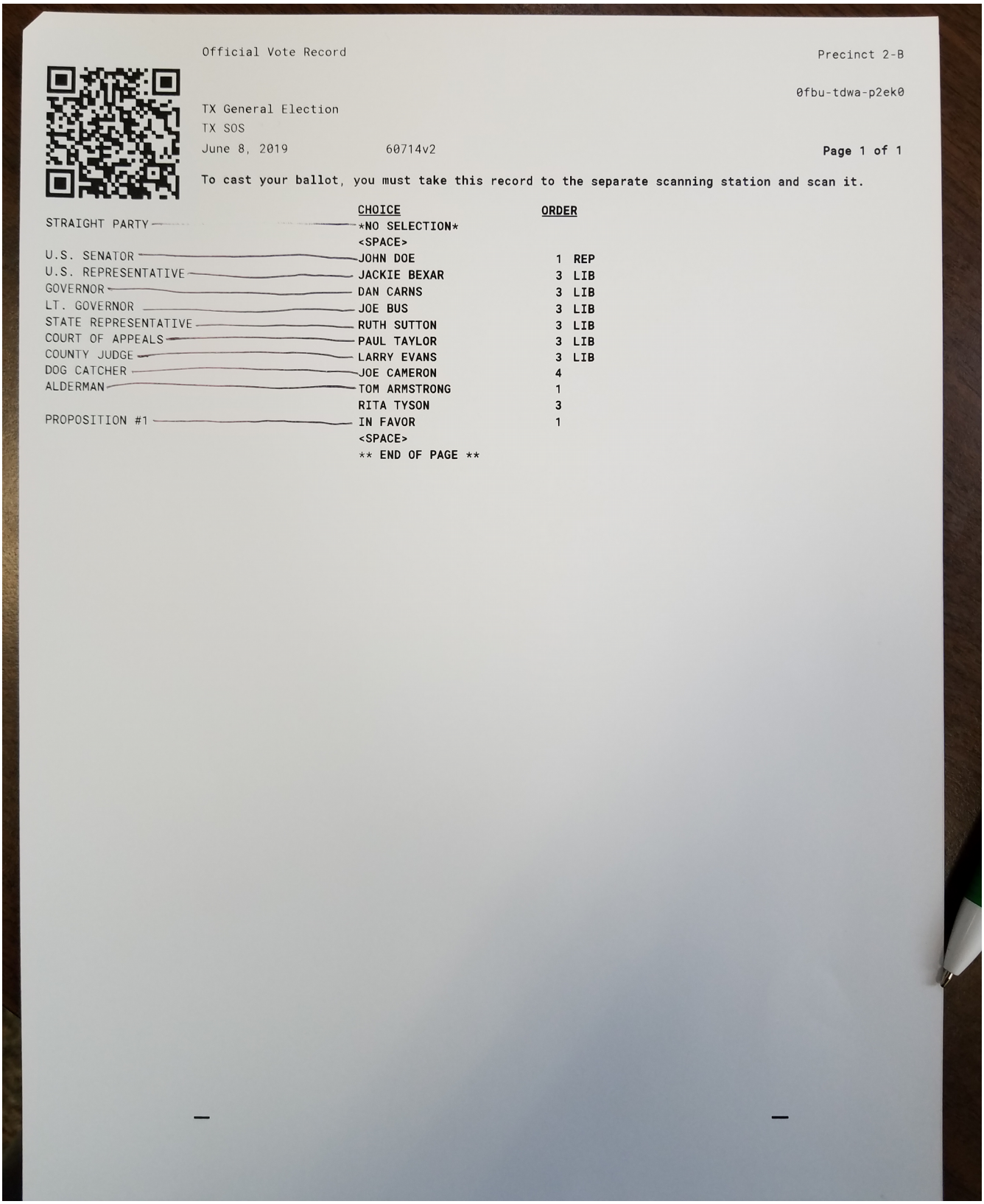
Examiners were given the opportunity to interact with all of the above devices during the mock election and during a free-form session. The UI was consistent across all devices and easy to use. The ballot box provided with Verity Scan provided sufficient security measures. No major problems were found; however, there are a few issues which should be noted.

The Touch Writer with Access is slow to print and activating sessions for voters requires too much poll worker intervention for it to be used as the only voting option in a polling place. If the Touch Writer's COTS printer is disconnected prior to a voting session, the user will be stuck on the "activating voter" screen. The only way to resolve the stuck screen is by pressing the pollworker button on the back of the base.

The Touch Writer Duo's printed vote record has readability issues; the font is small and the whitespace between the contests and the selected candidates' names is too wide. Some voters may have a hard time reviewing their PVR. One might be tempted to draw lines on the PVR to connect the contest to the candidate. This action will likely spoil the ballot. See Figure 1 for an image of a PVR that was rejected by the Verity Scan device.

If an election requires a two-page PVR, voters may experience more problems with the Touch Writer Duo than usual since they have to insert each page one-at-a-time. In the event of such an election, poll workers would require extra training regarding procedures for spoiling a single page of a multi-page PVR.

For curbside voting, the entire Touch Writer Duo assembly would have to be brought out on a cart. This is different from the Touch DRE where only the tablet needs to be brought to the voter.



Official Vote Record

Precinct 2-B

0fbu-tdwa-p2ek0

TX General Election
TX SOS
June 8, 2019 60714v2

Page 1 of 1

To cast your ballot, you must take this record to the separate scanning station and scan it.

	CHOICE	ORDER
STRAIGHT PARTY	*NO SELECTION*	
	<SPACE>	
U.S. SENATOR	JOHN DOE	1 REP
U.S. REPRESENTATIVE	JACKIE BEXAR	3 LIB
GOVERNOR	DAN CARNS	3 LIB
LT. GOVERNOR	JOE BUS	3 LIB
STATE REPRESENTATIVE	RUTH SUTTON	3 LIB
COURT OF APPEALS	PAUL TAYLOR	3 LIB
COUNTY JUDGE	LARRY EVANS	3 LIB
DOG CATCHER	JOE CAMERON	4
ALDERMAN	TOM ARMSTRONG	1
	RITA TYSON	3
PROPOSITION #1	IN FAVOR	1
	<SPACE>	
	** END OF PAGE **	

Figure 1: Touch Writer Duo PVR Rejected By Verity Scan

10 Upgrade Procedures

For jurisdictions wanting to upgrade from Verity Voting version 2.0 to 2.3, Hart provides the following options.

For both options, the following components are upgraded:

- CFast cards on all devices (Verity Scan, Touch Writer, Controller, Touch Writer Duo, Touch, Touch with Access, and Print)
- Software on all workstations (Verity Data, Build, Count, and Central)

Option 1: Hart On Site

- Workstations: On site, Hart employees image all workstations using the supplied product images for all workstations possessed by the jurisdiction. Imaged workstations are configured by Hart using a signed EMS Configurator, requiring an exit to the desktop, in accordance with the steps outlined in the Texas Verity Use Procedures.
- Device CFast: A CFast duplicator is used to make CFast images from the master CFast cards. CFast cards are then installed into the devices, and CFast security doors, tamper evident seals, and rear covers are applied.
- The jurisdiction’s hardware acceptance testing procedure is then able to be executed.

Option 2: Customer ships equipment to Hart

- Workstations: Customer ships hard drives from Verity workstations. Hart employees image all workstations using the supplied product images for all workstations possessed by the jurisdiction. Imaged workstations are configured by Hart using a signed EMS Configurator, requiring an exit to the desktop, in accordance with the steps outlined in the Texas Verity Use Procedures.
- Device CFast: Customer will remove CFast from each device type with training from Hart Professional Services and then ship all device CFasts to the Hart office. Hart will use a CFast duplicator to make CFast images from the master CFast cards. CFast cards are then mailed back to customer. Customer installs CFasts into their devices, and CFast security doors, tamper evident seals, and rear covers are applied.
- The jurisdiction’s hardware acceptance testing procedure is then able to be executed.

11 Conclusions

While some concerns arose during the examination, none were disqualifying. For the next revision of Verity Voting, Hart should consider improving the readability of the Touch Writer Duo's PVR and fixing the Touch Writer's buggy behavior when the COTS printer is disconnected.

Overall, Verity Voting 2.3 is a comprehensive voting system that is secure, well-designed, and user-friendly. Hart's responses to Voting System Certification Form 101 are truthful and adequate. The system tallied votes accurately during the mock election portion of the exam. Hart personnel provided clear and knowledgeable answers to the examiners' questions.

I recommend certification of Verity Voting 2.3.

12 References

[1] Montoya, Julian, III, Application for Certification of Verity Voting 2.3 Cover Letter, Mar-18 2019

[2] Hart Intercivic. LLC Verity Voting 2.3 Configurations, Required materials submitted with Voting System Certification Form 100

[3] Verity System Administrator's Guide, Version 2.3, Document Number 6641-024 B

[4] United States Election Assistance Commission Certificate of Conformance Hart Verity Voting 2.3, EAC Certification Number HRT-VERITY-2.3, Mar-15 2019,
URL: https://www.eac.gov/voting-equipment/verity-voting-23/

[5] Verity Voting 2.3 Change Notes